Staffordshire University
Business School

Fiscal Decentralisation and Economic Growth in Transition Economies

Aida GJIKA

A thesis submitted in partial fulfilment of the requirements of Staffordshire University for the degree of Doctor of Philosophy

May 2018

Abstract

Since the collapse of the communist system, transition economies (TEs) have witnessed significant growth in fiscal decentralisation (FD). In order to meet the needs of the new decentralised system and adapt to new political changes such as the EU accession, these countries started to reform their governance system by devolving greater power to subnational governments. The ongoing intergovernmental fiscal relations and territorial reforms during these twenty-eight years of transition have demonstrated that decentralisation in general, and FD in particular, is an ongoing process, continually evolving and contributing to democracy, economic efficiency and ultimately economic development (Bird, 1993; Bird *et al.,* 1995). Given the variation in FD during transition and the attention it has received especially amongst developed TEs, this dissertation aims to assess the relationship between FD and economic growth in the context of the transition process. First, it contributes to the current theoretical literature by critically reviewing the existing theories on this relationship and exploring new potential (direct and indirect) channels of transmission from FD to economic performance. Also, this thesis contributes to the current empirical literature on FD by providing an empirical investigation of the impact of FD on economic growth for selected transition economies, taking into account the relevance of important factors such as the level of analysis (national *vs* subnational levels), the stage of economic transition, the geographical location and the size of countries - factors that have not been sufficiently investigated in previous studies. The previous empirical studies were unable to provide conclusive evidence concerning the impact of FD on economic performance. By shedding light on the factors that contribute to the FD-economic growth relationship and using statistical methods that are appropriate to the analysis of this relationship, this thesis provides some explanation for the inconclusive nature of previous studies. Using data for TEs in Europe and the former Soviet Union, the empirical results suggest that the economic effects of FD are sensitive to the FD measures used and, more importantly, to the economic and institutional reforms implemented in these countries. The thesis shows that while FD may have an insignificant effect on countries in early stages of transition, it can be employed with beneficial effects by countries at relatively advanced stages of transition. In this sense, this thesis confirms the theoretical claim, ignored up to now, that FD is a "normal good". Exploring the FD-economic growth relationship on a more homogenous dataset and at subnational level, this thesis concludes that the economic effect of FD is more visible at regional level, while being moderated by the country size and other characteristics of countries involved. The empirical evidence has potentially useful policy implications for the ongoing decentralisation reforms in transition economies

Table of Contents

CHAPTER 4 FISCAL DECENTRALISATION AND ECONOMIC PERFORMANCE IN TRANSITION ECONOMIES - AN EMPIRICAL INVESTIGATION

CHAPTER 5 AN EMPIRICAL INVESTIGATION OF THE EFFECT OF FISCAL DECENTRALIZATION ON ECONOMIC GROWTH AT REGIONAL LEVEL FOR SELECTED ETEs

CHAPTER 6 CONCLUSIONS AND RECOMMANDATIONS

APPENDIX OF CHAPTER 3

APPENDIX OF CHAPTER 4

APPENDIX OF CHAPTER 5

List of Tables

List of Figures

CHAPTER 2

CHAPTER 2

CHAPTER 3

CHAPTER 4

CHAPTER 5

List of Abbreviations

CD – Cross-Sectional Dependence

CEE – Central and Eastern Europe

CEEC – Central and Eastern European Countries

COFOG – Classification of Functions of Government

EBRD – European Bank for Reconstruction and Development

ETEs – European Transition Economies

EU – European Union

FAT – Funnel Asymmetry Test

FD – Fiscal Decentralisation

FE – Fixed Effects

FEVD – Fixed Effects Vector Decomposition

GDP – Gross Domestic Product

GFS – Government Finance Statistics

GFSM2001 – Government Finance Statistics Manual of 2001

GLS – Generalised Least Squares

GMM – Generalised Method of Moments

GNI – Gross National Income

IMF – International Monetary Fund

IV – Instrumental Variable

LSDV – Least Squares Dummy Variable

LSDVC – Corrected Dynamic Least Squares Dummy Variable

MRA – Meta Regression Analysis

NALAS - Network of Associations of Local Authorities of South East Europe

NUTS2 - Nomenclature des unités territoriales statistiques (regions belonging at second level)

NUTS3 - Nomenclature des unités territoriales statistiques (regions belonging at third level)

OECD – Organisation for Economic Co-operation and Development

OLS – Ordinary Least Squares

PCC – Partial Correlation Coefficient

PCSE – Panel Corrected Standard Error

PEESE –Precision Effect Estimate Standard Error

PET – Precision Effect Test

PISA – Programme for International Student Assessment

RE – Random Effects

RESET – Regression Equation Specification Error Test

SE – Standard Error

SEE – South Eastern Europe

TEs – Transition Economies

UNESCO – United Nations Educational, Scientific and Cultural Organization

UNICEF – United Nations Children's Fund

VIF – Variance Inflation Factor

WB – World Bank

WGI – Worldwide Governance Indicators

WLS – Weighted Least Squares

Acknowledgments

First of all, I express my profound gratitude to my principal supervisor Dr. Mehtap Hisarciklilar. Words fail me to express my appreciation to her. I would have never been able to finish my dissertation without her persistent confidence, motivation, ideas, suggestions and friendship. Her dedication and many motivating discussions have been invaluable at both an academic and a personal level. I will be eternally grateful to her. Also, my deepest gratitude goes to my second supervisor Prof Iraj Hashi for his continuous support and advice throughout these years. I want to express my gratitude not only for his critical assessment that made me grow as a researcher, but also his dedication and encouragement during my PhD. Also, my gratitude goes to Jenny Herbert and Marion Morris for their continuous support and friendship during all these years.

I owe my greatest debt of gratitude to my mother and brother for their endless understanding, patience and encouragement during these years. Although they did not know, and still do not know, anything about my topic, they knew exactly how I felt about every chapter. I am thankful to you, more than words can ever say.

I would like to thank Open Society Foundation and Staffordshire University for their generous financial support during my PhD studies. I will always be grateful for their support. Also, special thank you goes towards my friends in Tirana and Stoke-on-Trent.

Most importantly, I thank God for his blessings throughout this research and giving me the strength to finally complete this task.

Chapter 1

INTRODUCTION AND CONTEXT OF THE INVESTIGATION

Shortly after the breakup of the socialist system, many countries began the process of transition from a centrally planned to a market economy which was also accompanied by extensive decentralisation. The process of decentralisation emerged in these countries in all its dimensions (political, administrative, fiscal and/or market), partly as a reaction to the failure of the centralised system and partly due to the belief that decentralisation is accompanied by increased efficiency (Smoke, 2001; Rodriguez-Pose and Kroijer, 2009). Whilst each of the dimensions of decentralization are important topics of analysis and research, here we are only concerned with fiscal decentralization (FD) and its impact on economic growth.

FD was promoted as a tool to consolidate democracy, build and strengthen the local capacity, provide better public services at local level, promote economic development and contribute to the resolution of ethnic conflicts (Bird, 1993; Bartlett *et al.,* 2013). The process of FD in particular has received a growing interest among different actors (governments, development agencies, etc.) to further decentralise TEs as a tool to promote economic development (Bruno and Pleskovic, 1996; Rodriguez-Pose and Kroijer, 2009). In spite of continuous emphasis on the importance of FD for a country's democracy and development process, FD has differed widely throughout transition economies (TEs) in terms of not only its progress but also its outcomes. TEs have witnessed considerable variation in the pace and commitment to FD, despite starting from the same initial conditions where subnational governments operated as administrative units with no or little fiscal responsibility. These countries have successfully overcome the initial fundamental problems of legacies of the centralised system. Though, challenges of accountability, clarity of roles and lack of capacity to provide adequate local goods and services still remain present, especially in Southern Europe and Southern Caucasus.

Whilst facing many challenges in successfully implementing the existing FD reforms or undertaking new reforms of intergovernmental fiscal systems, (Prud'homme, 1995), the process of transition in these countries raises particular issues in terms of FD and its implications for economic development. Despite the dominat view in TEs that FD is a tool to increase economic development rather than the more traditional objective of efficient delivery of public goods and services (Rodriguez-Pose and Gill, 2005), there is however little empirical evidence in these countries to support the economic benefits of FD.

Given the variation in FD during transition and the attention it has received especially amongst developed TEs, this thesis explores the concept of FD and its impact on economic growth TEs. It, tackles the relationship between FD and economic growth by drawing extensively on the existing theoretical and particularly empirical studies in order to investigate this relationship in a transition context.

1.1 Definition of (fiscal) decentralisation

While FD represents a broad multifaced concept, its definition and measurement still remain rather unclear. Defined broadly, decentralisation refers to the process of transferring authority and responsibility from national/central government to regional or subnational governments (intermediate and local level), quasi-independent government organisations and/or the private sector (World Bank, 1999; 2011). In this regard, decentralisation does not involve only a public-sector reform. Rather, it encompasses the relationships between multiple agents whether private sector, civil society or governmental entities. The transfer of authority from national to subnational levels involves the four broad dimensions of political, administrative, market and fiscal decentralisation.

Political decentralisation consists of constitutional or statutory reforms, the creation and development of pluralistic political parties and support for democratisation at local level by giving citizens or their representative more power in the public decision-making process (Rondinelli, 1999, p.12; World Bank, 1999). Administrative decentralisation is the process of redistribution of responsibility for planning, financing and managing public functions from the central government and its agencies to subordinate levels of government or units and semi-autonomous governmental authorities (Rondinelli *et al.,* 1983; Rondinelli, 1999, p.12; World Bank, 1999; Schneider, 2003). Third, market decentralisation refers to the transfer of responsibility for public functions from public to the private sector represents (Rondinelli, 1990; 1999; World Bank, 1999).

Fiscal decentralisation addresses the financial relationship between national and subnational governments. More specifically, fiscal decentralisation represents the devolution of authority for public finances and the responsibility for public services to lower levels of government (Tanzi, 1995). This dimension of decentralisation encompasses four main interrelationships between levels of government, also known as the pillars of FD, focusing on: (i) expenditure decisions, (ii) revenue and tax-raising powers, (iii) intergovernmental transfers and (iv) subnational borrowing (Vo, 2010, p.657).

The first pillar refers to the assignment of expenditure responsibilities (public functions) among different levels of governments. The second refers to the shift of financial resources (local taxes, fees, user-charges, share of national indirect taxes) among different levels of government. The third represents the transfer of finances (conditional and unconditional grants) from central to subnational governments. The last pillar refers to the capacity of subnational governments to borrow money when the central governments are unable to meet their expenditure responsibilities with their own revenue (Feruglio and Anderson, 2008).

1.2 Fiscal decentralisation in transition economies

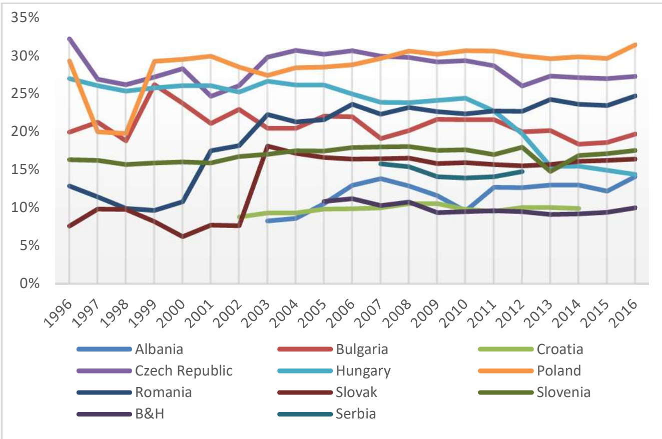
In order to identify and analyse the key features of FD during the transition process, a cross-country comparison of measures of FD that take into account the multidimensional nature of FD is required. Following extensive debate on the appropriate measures of FD[1], there is general agreement on the following three measures: (i) the expenditure decentralisation measured by the share of the subnational government expenditure as a share of total expenditure, (ii) revenue decentralisation measured by the share of the subnational government revenue as a share of total government revenue and (iii) the vertical imbalance measured by the share of the intergovernmental transfers to subnational revenues.[2]

Figure 1.1 shows the expenditure decentralisation in TEs, more precisely the Central and Eastern European countries (CEEC), the Baltic countries (Baltics) and the

[1] A more detailed discussion will be provided in Section 4.2.2 and 5.2.2.

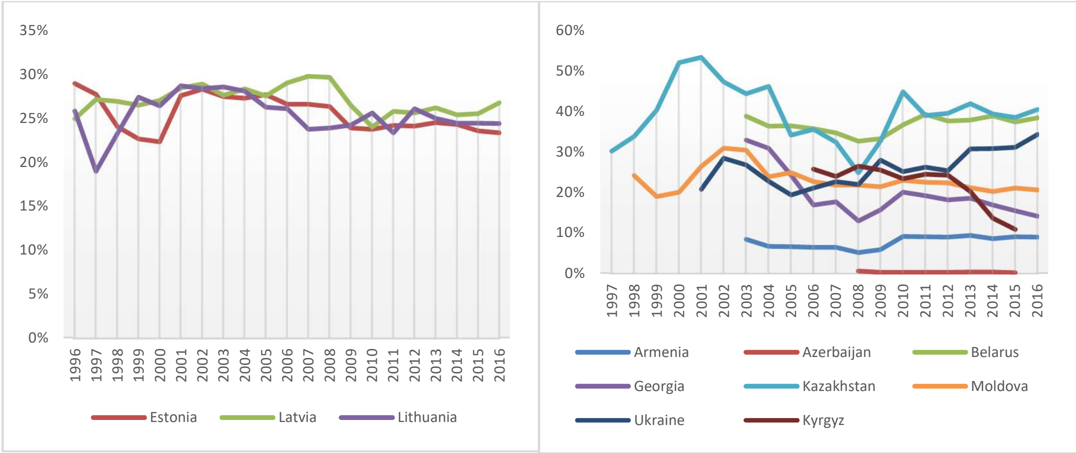
[2] An alternative measure of vertical imbalance is the share of intergovernmental transfers to subnational expenditure (World Bank, 1999).

Commonwealth of Independent States (CIS).[3] Whilst significant change can be observed during the initial stage of transition, at least in countries for which data is available, in general, the development of FD appears to be stable with no extreme fluctuations (IMF, 2017).[4] A breakdown of the expenditure decentralisation by group of countries (CEEC, Baltics and CIS), as presented in Figure 1.1, shows that countries within the same group experience different trends of FD. The Baltics seem to be among the countries that have decentralised expenditure the most on average terms compared to the CEE and CIS, with an average of 26%, 20% and 25%, respectively. In general, the degree of expenditure decentralisation in TEs reflects the country characteristics (size, population, diversity etc.), though some countries, especially within the same group of countries, do not always match the expectations.[5]



(a) CEEC

[3] Albania, Bosnia and Herzegovina, Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, the Former Yugoslav Republic (FYR) of Macedonia, Montenegro, Poland, Romania, Serbia, Slovak Republic, Kosovo, Slovenia, Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyz Republic, Moldova, Tajikistan, Turkmenistan, Ukraine, Uzbekistan.
It should be noted that Russia was excluded from our datasets, although the data availability and the accuracy of the data did not seem to be a problem. This is because these two countries stand out as extreme outliers regarding all indicators of decentralisation, large part owing to its federation status and large geographical size. Given that these two countries were excluded in our empirical research, they were also excluded from this section.
[4] The data limitation during the initial stage of transition (1990-1995) means that for a majority of countries, the trend of expenditure decentralisation, revenue decentralisation and intergovernmental transfers cannot be shown in this period.
[5] Although Belarus is a relatively homogenous and small country, it has a high level of expenditure and revenue decentralisation.



(b) Baltics (c) CIS

Figure 1.1 Expenditure decentralisation (subnational government expenditure as a percentage of total government expenditure) by group of countries, 1996-2016

Source: IMF (2017)

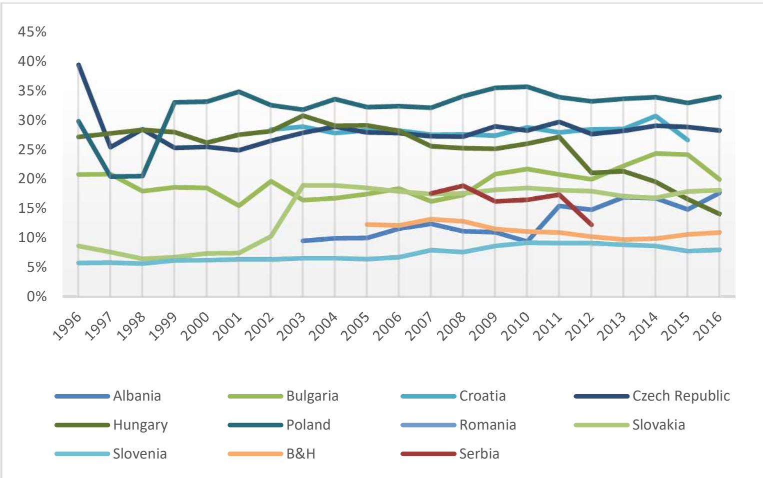
In the Baltic group, the level of expenditure decentralisation between the three countries seems to have converged close to each other. But in the other two groups the differences in FD appear to be substantial. In the CEE group, the Czech Republic, Hungary Poland and lately Romania are renowned for being fast reformers among ETEs with expenditure decentralisation varying from 20% to 30%, with Poland leading the group.[6] On the contrary, Albania, Bosnia and Herzegovina and Croatia lag behind in terms of carrying out FD, though Croatia seems to have been more active recently in delegating responsibilities to local government.[7] However, the process of FD in the latter countries has often been criticised for the lack of clear division of authorities between national and subnational levels and efficient provision of local public goods (Alibegović and Slijepčević, 2012; NASLA, 2016). From the CIS group, only Belarus, Kazakhstan and Ukraine seem to stand out in terms of their success in increasing local decision-making authority over expenditure and embarking on ambitious processes of reform. Despite being unitary governments, the above countries, especially Kazakhstan, demonstrate a strong commitment to increasing the responsibilities of subnational governments. The large-scale reforms of the expenditure dimension of decentralisation have put the above countries among the

[6] See Levitas (2017) for a detailed explanation on the success of FD in Poland.
[7] FYR Macedonia, Kosovo and Montenegro, although not included in Figure 1.1 because of the lack of data, have also slowly decentralised their expenditure.

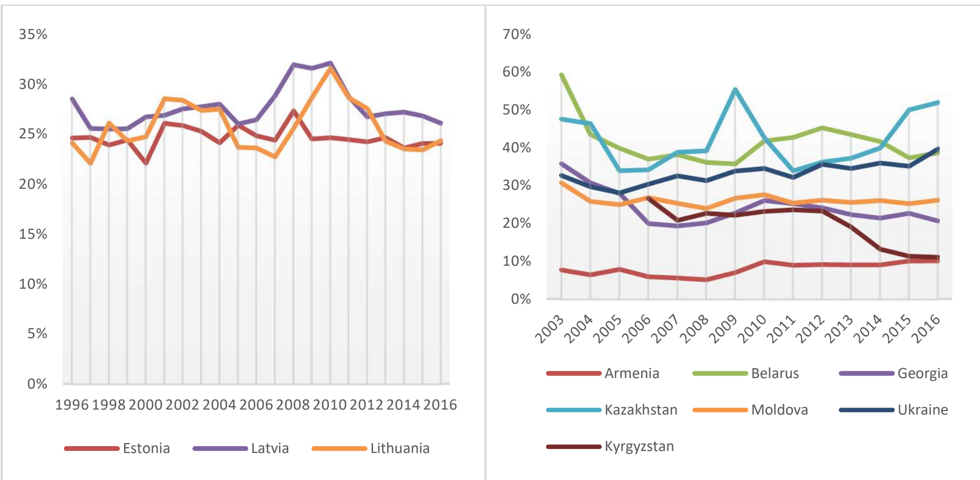
advanced reformers, despite the fragility shown in the financial crisis of 2008, which caused a sharp decrease in the same year, as shown in Figure 1.1, (panel c). However, a note of caution is in order when referring to expenditure decentralisation in Kazakhstan. Having no formally shared responsibilities for subnational governments, and with assignments changing each year based on the willingness of the central government (Luong, 2004), the situation often resembles administrative rather than fiscal decentralisation.

Moving on to the second measure of FD, the revenue decentralisation, it seems that on average TEs appear to be less revenue than expenditure decentralised (Figure 1.2). Lower levels of revenue decentralisation, both in terms of degree and speed over the years, can be observed across all TEs, irrespective of the geographical location (the Baltics, CEE or CIS). In general, in the early years of transition, the process of revenue assignment was non-transparent and unstable. However, in the later period, TEs made strides to enhance fiscal autonomy with some countries resembling the level of revenue and tax decentralisation of the EU28 and OECD countries. Referring to the IMF data (2017), the extremes of revenue decentralisation were recorded in CIS, with the highest in Belarus (41.1%) and the lowest in Armenia (7.9%). In contrast, the CEEC and the Baltics show less extreme values (27.2% in the Czech Republic and 9.8% in Bosnia and Herzegovina). However, there is still a huge gap between countries that have advanced their FD reforms fast and the ones that are slow in reforming their revenue decentralisation. While the first group of countries have almost finalised the transformation process and have joined the EU, many countries from the slow reformers are still lagging behind in terms of their FD reforms as well as the transformation process, reflected in their low values of revenue decentralisation.

Despite this progress, the mismatch between expenditure assignments and adequate revenues to meet the related responsibilities is a major challenge of decentralisation across all TEs. The absence of sufficient revenue basis (taxes, other revenues and intergovernmental transfers) in some of the countries, mostly in CIS, led to undesirable consequences regarding the quality and quantity of local public goods (Urinboyev, 2015). The lack of a sound financial revenue base, accompanied by effective tax autonomy, has hampered the implementation of revenue assignments. Whilst for the Baltics and the CEEC the development of the genuine local fiscal autonomy has not been a priority, in the CIS, local budget planning remained highly centralised, with local governments being unable to set the tax rate and base independently, while highlighting their dependence from intergovernmental transfers. In general, all local governments in CIS, except Moldova and Uzbekistan at a certain extent, are deprived from the right to develop their own budget planning (Bektemirov and Rahimov, 2001; Urinboyev, 2015).



(a) CEEC



(b) Baltics (c) CIS

Figure 1.2 Revenue decentralisation (subnational government revenue as a percentage of total government revenue) by group of countries, 1996-2016

Source: IMF (2017)

A breakdown of the revenue decentralisation by country and sources of revenue, as presented in Figure 1.2, shows noticeable differences within countries of the same groups. Similar to the expenditure decentralisation, the Czech Republic, Hungary, Latvia and Poland are amongst the advanced reformers of the tax autonomy in the CEEC and the Baltics, while Belarus, Kazakhstan and Ukraine have decentralised more revenue to local governments than their counterparts in Southern Caucasus. Despite the increased decentralisation over years, the TEs still struggle in creating self-sufficient and accountable subnational governments with limited local taxes, while minimising the dependency on intergovernmental transfers. Augmenting the revenue autonomy in general and the tax autonomy in particular remains one of the main challenges facing TEs.

A disaggregation of local government revenues into revenue sources (tax revenues, grants revenue, social contributions and other revenues), based on the IMF classification and data, shows that local governments in TEs have limited subnational autonomy and depend to a large extent on intergovernmental sources of revenue (conditional and unconditional grants). Using tax decentralisation (measured as the share of local government tax revenues in general government revenues) instead of revenue decentralisation still highlights the diverse trends of FD across TEs. While Belarus, Kazakhstan, Czech Republic, Latvia and Poland (on average having a tax decentralisation index of 28%, 24%, 14.5%, 11.5%, 10%, respectively (IMF, 2017) appear to be the top five countries with self-sufficient local governments, Azerbaijan, Slovakia, Armenia, Romania and Albania (with 0.1%, 2.5%, 3.5%, 4%, 4.1%, respectively (IMF, 2017)) seem to be positioned at the lower end of the ranking. However, it is worth noting that countries in the CEE and Baltics show an increasing trend of fiscal autonomy, unlike CIS countries which have shown a concerning tendency to centralise tax revenue. Despite the relatively higher tax decentralisation in the CIS and the increasing trends in the CEE and Baltics, local governments across TEs lack real capacity to address the local needs through their own revenues (tax revenues and other revenues), while being highly dependent on intergovernmental transfers to meet local expenditure responsibilities.

An important concern in TEs is the shared taxes (personal income tax, corporate tax, VAT, etc.) which, being totally decided on by the central government, creates fluctuations in the local revenues (Dabla-Norris, 2006; Krivorotko, 2007). Whilst for some countries, especially those that have joined EU, the clarification of roles and shares received by subnational governments from shared taxes is already established, for others these issues continue to remain unclear.

As for the third measure of decentralisation, i.e., vertical imbalance (the intergovernmental transfers as a percentage of subnational governmentrevenue) is concerned, here too there have been large discrepancies. Whilst in the early stages of transition TEs experimented with the degree of vertical imbalance and the formula to distribute grants from central to local governments, in the last decade the share of intergovernmental transfers to subnational revenues has been stable with no drastic changes across years. However, evident differences in vertical imbalance exist between countries. According to the IMF data, displayed in Figure 1.3, the highest average vertical imbalance in 2016, as the most recent year for which the data is available, was recorded in the Baltic region (Lithuania with 86.3%), whereas the lowest in the CEE (Bosnia and Herzegovina with 4%). Important improvements regarding the dependency of local governments to the central government have been observed especially among the CEEC (i.e. Albania, while the Baltics and the CIS countries in general show a negative trend (i.e. Estonia, Lithuania, Ukraine, Moldova etc.).

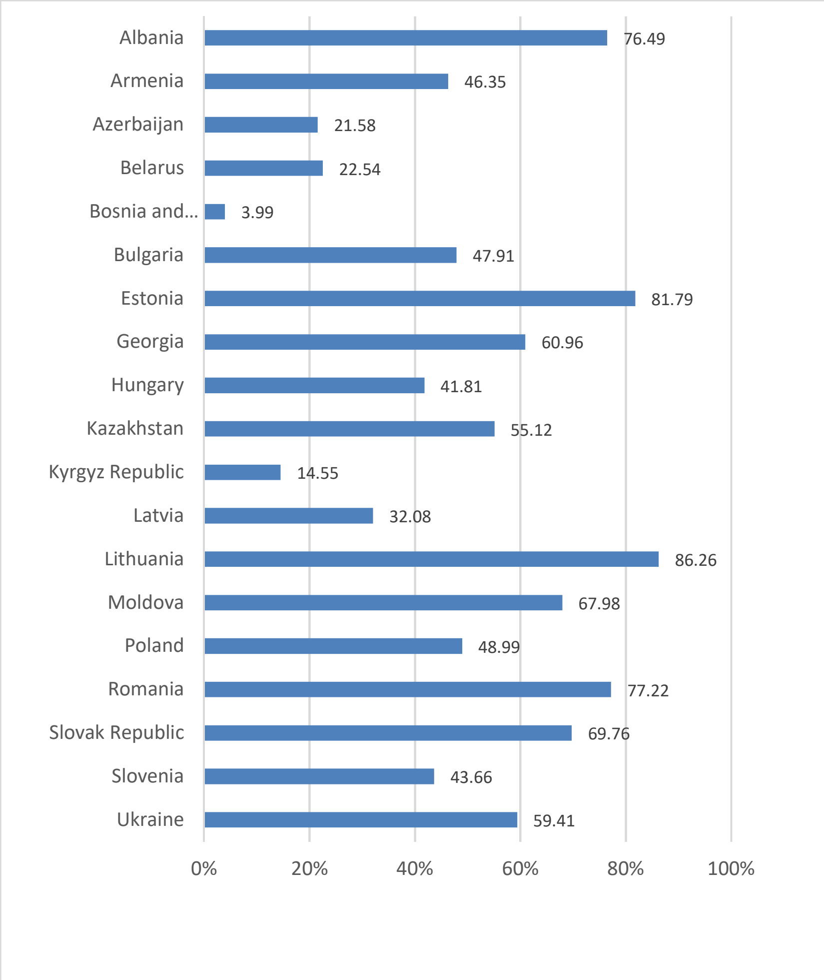


Figure 1.3 Vertical imbalance (intergovernmental grants as a share of subnational revenues) by country, 2016

Source: IMF (2017)

Overall, the analysis of the three main measures of FD (expenditure decentralisation, revenue decentralisation and vertical imbalance) across TEs highlights the uneven process of FD in these economies. Important discrepancies in the degree and speed of FD are observed more between countries than groups, which point to a different categorisation of countries based on their FD progress rather than geographical location. Consistent with the previous categorisation in the literature (Wetzel and Dunn, 2001; Dabla-Norris, 2006), TEs can be classified into three main groups: (i) the advanced decentralisers (ii) the intermediate decentralisers and (iii) the laggard decentralisers. The first group consists of advanced reformers which have either decentralised expenditure and revenue at a faster and larger degree since the beginning of transition or moved progressively towards higher FD levels, approaching the standards of advanced economies. This group includes the Czech Republic, Croatia, Estonia, Hungary, Latvia, Lithuania, Poland, Slovak Republic, Slovenia, Belarus, Kazakhstan, Ukraine. The intermediate group consists of countries that have decentralised at a lower pace compared to the advanced decentralisers and face limited fiscal autonomy, efficient delivery of public goods and relatively high dependency on intergovernmental transfers. This group includes Albania, Bulgaria, Romania, Moldova, Serbia, Kyrgyz Republic, Moldova. The third group of countries includes the slow reformers of FD – Armenia, Azerbaijan, Belarus, Georgia, Tajikistan, Turkmenistan, Uzbekistan – that have been the least successful in devolving expenditures and taxes, strengthening accountability and clarifying the transfer system (Valdivieso, 1998; Dabla-Norris, 2006).

In conclusion, it is important to note that in spite of the progress in FD reforms in TEs, these countries have witnessed large variations in terms of different dimensions of FD (expenditure, revenue/tax and intergovernmental transfers), which complicates the analysis of FD-economic growth relationship from an empirical perspective. Hence, it is important to consider the varying features of FD across TEs and incorporate them in the main research questions of this thesis.

1.3 Aims and objectives of the thesis

Promoted as a tool to increase the efficiency of the public sector and to promote economic development (Bird, 1993), TEs considered decentralisation in general and FD in particular as essential to the economic and institutional reforms. Whilst the investigation of the economic effect of FD is primarily motivated by the theoretical justification where, according to Oates Theorem (Oates, 1993), economic growth as a measure of economic development is the ultimate output of FD, there are also other reasons for choosing to assess the relationship between FD and economic growth. The investigation of the economic effects of FD has special importance in the context of transition economies not only for the way FD was promoted, but also because of the very low levels of GDP per capita of these countries at the beginning of the process of FD (Svejnar, 2002) and their need to use this tool to boost economic growth.

Despite the reviving debate on the well-functioning nature of intergovernmental fiscal relations, various forms of decentralisation, and the prevalence of FD in TEs, the investigation of the economic effect of FD in these countries has been somewhat scarce. Motivated by this scarcity and the specificities of the economic effect of FD in a transition context, this thesis aims to investigate the relationship between FD and economic growth. In order to explore the economic effect of FD, the following specific objectives have been developed:

1. To provide a comprehensive and critical review of the FD-economic growth theories with particular emphasis on the channels of transmission;
2. To critically review the empirical literature related to the relationship between FD and economic performance, highlighting the differences in economic development, measures of FD and other methodological differences as possible explanation of the contradictory and mixed empirical results;
3. To quantitively analyse the results of previous empirical literature whether an authentic effect of FD on economic growth is present in previous research;
4. To explore whether different characteristics of the original studies can explain the contradictory results of the empirical research;
5. To adapt the FD-growth model to the transition context by taking into account the stages of transition;
6. To empirically evaluate the economic effect of FD in TEs, and its nature based on the income elasticity and geography;
7. To empirically evaluate the economic effect of FD in selected ETEs from a sub-national perspective and examine the moderating role of country size;
8. To provide policy recommendations to better utilise the benefits of FD as a development tool.

1.4 The structure of the thesis

The remainder of this thesis is structured as follows.

Chapter 2 reviews the main theoretical and empirical literature on the FD-economic growth relationship. In order to address the first objective, this chapter starts by outlining the major theoretical contributions underlying the FD-economic growth relationship from the perspectives of neoclassical and endogenous growth theories. In critically reviewing these theories on this relationship, particular attention is paid to the channels of transmission from FD to economic performance, including new channels, both direct and indirect. The second part of this chapter addresses the second objective by reviewing the empirical research, elaborating the complexity of defining FD and focusing on the differences in economic development amongst transition countries and the levels of investigation (national vs subnational levels). Whilst the empirical findings appear mixed and contradictory, the categorisation into national and subnational level sheds some light on this relationship by showing the insignificance of the effect of FD on economic growth at national level, but relatively significant effect if the investigation is disaggregated to lower levels. The theoretical review together with the discussion of the shortcomings of the current empirical literature serves as the conceptual framework for the later empirical chapters of the thesis.

Chapter 3 addresses the third and fourth objective of this thesis by examining the robustness of empirical findings by employing a Meta-regression analysis in order to go beyond the ambiguity of empirical research. This analysis provides a quantitative assessment of the accumulated empirical evidence on the effect of FD on economic performance, while also modelling the heterogeneity of the econometrics literature. The first research questions addressed in this chapter is: "*Does the FD-economic growth relationship have an authentic effect and/or publication bias?".* To assess the severity of contamination from publication bias and identify the presence of a genuine effect, the MRA synthesises the previous empirical literature and provides an average of the estimated results. Subsequently, the next research question addressed by MRA is: "*What are the causes of the extensive empirical heterogeneity in the FD-economic growth literature?*" By synthesising the extant empirical literature, the MRA provides a discussion on the characteristics of the original studies that could explain the differences in the empirical results, by stressing the importance of choosing appropriate measures of FD.

Based on the discussion of the theoretical framework in Chapter 2 and the elaboration of the empirical studies through the MRA in Chapter 3, **Chapter 4** (related to the fifth and sixth objective) conducts an empirical investigation to address the question: "*Does FD affect economic growth in TEs?*" This chapter starts by discussing in detail the importance of using appropriate measures of FD in the context of TEs, followed by a discussion of potential problems when estimating a growth model. Specific attention is paid to the previously neglected issues in the empirical investigations such as the cross-sectional correlation, slowly-changing variables and the endogenous nature of the FD. In the presence of evident differences between countries in different geographical locations (European vs Southern Caucasus TEs), the other research question addressed in this chapter is whether FD could be described as a "normal good", *i.e.,* one which is increasingly employed as countries incomes rises). To answer this question, the level of development and the geographical location are included in the baseline model, thus introducing a new dimension to empirical research on the relationship between FD and economic growth.

Building on the empirical investigation at national level, **Chapter 5** (related to Objective 7) disaggregates the investigation to subnational level to further explore and better understand the economic effect of FD. More precisely, this chapter examines the economic effect of FD from a regional perspective in selected ETEs by addressing the question of: "*Does the economic effect of FD become more visible at regional level?*" In addition to the static models, a dynamic system GMM model is also used in order to capture the dynamic nature of FD and address some potential problems of misspecification associated with estimating a growth model (omitted variables bias, endogeneity, slowly-moving or time-constant variables and cross-sectional correlation). In order to shed more light on the relationship between FD and regional growth, this chapter considers the 'country size' as a moderator and lead us to the next research question: "*Does country size matter?*"

The concluding chapter, **Chapter 6** (related to the eighth objective), summarises the main findings of this thesis, while highlighting its contributions to knowledge, from both theoretical and empirical perspectives. The chapter concludes with presenting some policy implications on FD and some suggestions on the limitations of this research and how this research programme can be further extended.

Chapter 2

THE EFFECT OF FISCAL DECENTRALISATION ON ECONOMIC GROWTH: A REVIEW OF LITERATURE

2.1 Introduction

The renewed focus on decentralisation and the growth experience of different economies has generated a growing strand of theoretical and empirical literature on the FD-growth relationship. Many countries have devoted themselves to decentralisation, driven by the Oates' Decentralisation Theorem where devolution is expected to deliver greater efficiency in the provision of public goods and greater economic growth (Oates, 1993; 1995). However, the theory lacks clear economic arguments to explain the mechanism by which FD contributes to growth and specify whether this is a direct or indirect relationship. Arguably, it is still debatable whether the theoretical claim that FD contributes to economic growth is due to a better matching of public policies to local needs or other factors that are not fully explored in the theoretical literature.

Whilst the FD-growth relationship is not one of the conventionally addressed issues in the growth or public finance literature, considerable empirical research has spurred on the relationship between FD and growth. Some studies provide evidence supporting the contribution of FD to economic growth (Lin and Liu, 2000, Behnisch *et al.,* 2003), while others find a negative (Xie *et al.,* 1999, Rodriguez-Pose and Kroijer, 2009) or no relationship at all (Thornton, 2007, Cantarero and Gonzales, 2009; Baskaran and Feld, 2009). These heterogenous empirical results lay emphasis on the lack of consensus in the literature concernin`g the FD-growth relationship, which in turn, highlights many open questions regarding the economic effect of FD such as: does the change of fiscal structure affect economic growth; are countries with a higher degree of FD economically more successful than centrally governed ones; is the economic effect of FD subject to the context of investigation, etc.

To comprehensively review the literature, this chapter locates the present studies within the theoretical and empirical canvas of the relationship between FD and economic growth. Attention is drawn to the theoretical examination of potential transmission channels from FD to economic growth, by investigating and redesigning the existing channels and introducing new direct and indirect ones. Alternatively, to provide structured answers related to the empirical literature review, the emphasis shifts to the distinct levels of investigation, namely, at national and subnational levels. It is argued that such distinction might help in better understanding the ambiguity of empirical results. Failing to distinguish between these two levels might hinder potential accumulation of the economic effect of FD from subnational up to the most aggregate (national) level. It is important to note that this division is not the same as reviewing single- and cross-country studies separately, as could be the case that the former investigates the FD-growth relationship at both levels or that cross-country studies focus on subnational growth. It is precisely this distinction that this dissertation wishes to analyse critically different from the other empirical literature review and uncover the sources of heterogeneity. The estimation approach, measures of FD, covered time horizon, type of study (single- or cross-country study), development stages and other study characteristics will be additionally considered to better uncover the differences in the empirical literature.

To sum up, this chapter is organised as follows. Section 2 reviews the most important determinants of economic growth identified in the neoclassical and endogenous growth literature, while focusing on the FD-economic growth models. A critique of these models is also provided in this section. Next, Section 3 identifies and discusses the mechanism by which FD contributes to growth by elaborating the potential channels of transmission. Section 4 provides a critical review of the empirical literature by identifying the shortcomings and limitations related to the investigation of the FD-economic growth relationship, with particular focus on transition economies. The findings of the chapter are summarised in Section 5.

2.2 Economic growth models incorporating the effect of FD

Both theoretical and empirical research have devoted substantial attention to the determinants of economic growth. Though, there is little agreement on a universal economic growth model and the sources of growth. As Levine and Renelt (1992) argue, no model fully specifies the control variables when statistically testing the relationship between economic growth and an economic variable of interest. Whilst the neoclassical and endogenous growth theories have mainly focused on a narrow perspective regarding the determinants of growth (i.e. capital, labour and technology), the new theoretical and empirical basis have emphasized the relevance of socio-economic and institutional characteristics, by considering economic performance as a multidimensional process (Pike *et al.,* 2006; Ascani *et al.,* 2012). Amongst other factors, the devolution of power from central to local governments has been highlighted by the empirical research as a significant determinant of economic performance, though rarely articulated in the public finance theoretical literature. In the context of this thesis, it seems appropriate to understand the genesis and the evolution of the economic growth models, while rationalising the role of FD as a determinant of growth from the neoclassical and endogenous view, as it will be presented in Section 2.2.1 and 2.2.2, respectively. Therefore, this section will be divided according to these two distinct views, while first providing an overview of the neoclassical and endogenous growth models and then focusing on FD as a determinant of growth.

2.2.1 Neoclassical growth models

a. Neoclassical growth model

The starting point of the economic growth theories is the neoclassical model of Solow, which postulates stable equilibrium with a constant long-run income growth rate determined by an increase in factor endowments and technological progress (Mankiw *et al.,* 1992).[8] Initially, this model focused on a closed economy where output (Y) is produced by two factors of production, labour (L) and capital (K). In successive advanced models, human capital, government spending and measures of trade openness (Barro and Sala-i-Martin, 1995; 2004) are incorporated in the model as additional determinants of growth.

The basic assumptions of Solow model are the constant returns to scale, diminishing marginal productivity of capital, a certain degree of substitution between capital and labour and an exogenously determined technological progress (Mankiw *et al.,* 1992). The latter enters into Cobb-Douglas production function as labour-augmenting (also known as the effectiveness of labour (A)), as presented below[9]:

$$Y_t = F(K_t, A_tL_t) = K_t^{\alpha} (A_tL_t)^{1-\alpha} \qquad 0<\alpha<1 \qquad (2.1)$$

[8] Some refer to this model as Solow-Swan model as both Solow (1956) and Swan (1956) analysed the consequences of capital accumulation and technological progress on growth.

[9] This is also known as *Harrod-neutral*. If knowledge enters as capital-augmenting, technological progress is known as *Solow-neutral*. If knowledge enters as a multiplier of the production function by an increasing scale factor, technological progress is known as *Hicks-neutral* (Barro and Sala-i-Martin, 2004).

where t denotes time, and α and $1-\alpha$ denote the output elasticities of capital and labour, respectively. By dividing this production function, by the technology-augmented labour $1/A_tL_t$, Equation (2.1) is transformed as follows[10]:

$$y_t = \left(\frac{K_t}{A_tL_t}\right)^{\alpha} = k_t^{a} \tag{2.2}$$

where output per unit of effective labour y_t is a function of capital per unit of effective labour k_t. Considering the saving rate (s), the depreciation rate (δ), which determines the evolution of K, the rate of technological progress (g) and the growth rate of population (n), the balanced growth path of an economy (known as the steady state) can be found by condensing Equation (2.2) into a single differential equation in the per capita capital stock as presented below:

$$\dot{k}_t = sf(kt) - (n + g + \delta)\, k_t \tag{2.3}$$

where $\dot{k}_t$ denotes the change of the capital per unit of effective labour. The steady state, which is found at $\dot{k}_t$=0, shows that the current level of capital-effective labour ratio, the saving rate and the rate of population growth determine the change in capital-labour ratio (Barro and Sala-i-Martin, 2004; Romer, 2011).[11] The economy would converge to a steady state where output and the capital stock grow at the exogenous rate of population growth (after solving for k). Once the steady state is reached, the growth of per capita output (income) can occur only from technological progress which is exogenous and unexplainable by the model. Alternatively, an increase in the saving rate (or any other policy change to stimulate income) or population growth do not have a permanent effect on growth (Romer, 2011). Overall, the model underlines savings or investment ratio as important determinants of the short-run economic growth. Alternatively, the engine of long-run growth is deemed to be technological change, which is measured as the total factor productivity, and determined outside the model.

The model is also utilised to assert the convergence process across economies to their steady states, while distinguishing between the absolute and conditional

[10] This production function satisfies the Inada conditions where marginal product of each factor is very large when its amount is sufficiently small, and becomes very small when the amount becomes large. Further, the limit of the derivative towards zero is positive infinity and the limit of the derivative towards positive infinity is zero.
[11] For simplicity, hereinafter capital-labour ratio will denote the capital-effective labour ratio.

convergence.[12] Namely, it is argued that poor economies will grow faster than rich ones in per capita terms if economies have the same steady state, but differ in the initial quantity of capital per person. However, if economies have different steady states, each economy's speed of convergence will depend on the determinants of its own steady state. Thus, economies will grow faster the further they are from their steady state. Higher complexity of the Mankiw *et al.*'s model is reached by Islam (1995) by reformulating the equations, used to estimate convergence, into a dynamic panel data model with country effects, which reconfirms the compatibility of neoclassical growth in development economics.

An important contribution to the neoclassical growth models is made by Mankiw *et al.* (1992) by augmenting the existing Solow model with human capital. As argued by the authors (p.417), the economy will still converge to a steady state, though the income per capita will now depend on population growth and physical and human capital accumulation. Further, Mankiw *et al.* (1995) argue that human capital accumulation will also increase the impact of physical capital accumulation on output.

Another concern in the neoclassical growth model, and partly related to the focus of this thesis, is the question whether fiscal policy affects long-run growth. Given that economic growth is an effect of an external cause, such as technological progress, the impact of government policy in the neoclassical framework is limited only to the transitory effect of an economy towards its steady state (temporary effect), but not to the long-run growth (Hejidra and Van der Ploeg, 2002). Starting from this, the neoclassical theories further augment Mankiw *et al.*'s (1992) model by introducing public consumption or taxing systems (Sheehey, 1993) or more recently by introducing public physical capital and transfer payments (Bajo-Rubio, 2000). Overall, these theories claim that government contributes to economic growth and the economy moves towards the steady state by providing basic public goods. However, as government expands its scope, a greater government intervention would distort the incentives systems (Bajo-Rubio, 2000), while the likelihood that its activities lower economic efficiency grows (Sheehey, 1993).

[12] From the empirical approach, the convergence between economies is investigated by regressing growth of per capita income on the initial level of per capita income. If the estimated coefficient has a negative sign, this indicates that regions/countries with low initial level of income per capita grow faster than regions/countries with high initial level of income per capita.

b. Neoclassical FD-growth models

It has become widely accepted in the growth literature that the augmentation of the Solow model by fiscal policy in addition to (effective) labour and capital is a substantial contribution in a cross-country growth regression (Barro, 1990; Bajo-Rubio, 2000). However, this traditional approach did not pay attention to the assignment of fiscal responsibilities to different levels of government. Eventually, both neoclassical and endogenous growth models on the FD-economic growth relationship have emerged. Although the neoclassical approach has been the starting point of all economic growth models, it has not been such regarding the FD-growth models; the endogenous theoretical framework in this literature has started earlier and advanced far more than the neoclassical model. In most of the cases, the latter have extended the Solow or the Mankiw *et al.*'s (1992) approach to account for efficiency, distinguish between the temporary and permanent effect of FD on economic growth, and investigate the (potential) transmission channels. The neoclassical growth models are considered as *ad hoc*, due to the absence of explicit theoretical references for including a presumed growth determinant. Different from the endogenous FD-growth model, which focuses on the direct economic effect of FD, the neoclassical models have emerged as consideration of the indirect/intermediate impact of FD.

The first group of studies (Eller, 2004; Bodman and Ford, 2006; and Bodman *et al.,* 2009a), which employ neoclassical growth models, are based on Mankiw *et al.* (1992) and cross-country growth accounting. In the context of FD-growth relationship, the Cobb-Douglas production function accounts for different channels of the contribution of FD to economic growth, given their explicit motivation, as above mentioned, on the intermediate effect of FD on economic performance. The initial specification has the following form:

$$y_t = A\, k_t^{\alpha}\, h_t^{\beta} \qquad (0<\alpha<1;\ 0<\beta<1 \text{ where } \beta=1-\alpha) \tag{2.4}$$

where y denotes the output labour ratio, k is the physical capital-labour ratio, h denotes the human capital-labour ratio, and A is the overall efficiency or the total factor productivity (TFP). By logging and taking the first-order differentiation with respect to time, Equation (2.5) is obtained:

$$\dot{y}_t = \dot{A}_t + \alpha\dot{k}_t + \beta\dot{h}_t \tag{2.5}$$

This equation suggests that the growth rate of output labour ratio (output per capita) depends on the growth rate of capital-labour ratio and the rate of technological progress. Following Lin and Liu (2000), the term $\dot{A}(t)$ denotes not just the technology, but also the differences in resource endowments and institutions across countries and time. It is precisely this term that contains the FD variable along with other variables such as household responsibility system, fiscal capacity, the percent of rural population, etc. Further, the rate of change of TFP ($\dot{A}(t)$) is assumed to be determined by either the change or level of *FD*, as shown in Equations (2.6) and (2.7), respectively.

$$\dot{A}_t = \gamma_0 + \gamma_1 \Delta FD_t \tag{2.6}$$

$$\dot{A}_t = \gamma_0 + \gamma_1 FD_t \tag{2.7}$$

Following Eller (2004), the growth effects of FD might be observable either in the short-run as *a temporary efficiency-led growth effect* caused by a change in FD (ΔFD_t) or in the long-run as *a permanent efficiency-led growth effect* caused by a shift to a new level of FD (FD_t).[13] By substituting these two equations into (2.5), the *temporary* and the *permanent decentralisation-induced efficiency-led growth* hypothesis will be yielded as:

$$\dot{y}_t = \gamma A_0 + \gamma A_1 \Delta FD_t + \alpha \dot{k}_t + \beta \dot{h}_t \tag{2.8}$$

$$\dot{y}_t = \gamma A_0 + \gamma A_1 FD_t + \alpha \dot{k}_t + \beta \dot{h}_t \tag{2.9}$$

The first basic analytical framework proposed by Thiessen (2003) is a growth accounting regression for country/region *i* and time *t,* which resembles that of the typical neoclassical growth model. Namely, their growth regression consists of regressing economic growth ($\dot{y}_t$) on a list of country characteristics including the measures of *FD*, the initial level of GDP (GDP_0) and a set of control variables

[13] Since changes in FD affects also its level, the shifts from one level to the other of FD trigger an effect to economic growth (Eller, 2004; 36).

incorporated in X such as human capital, investment, trade openness, different measures controlling for institutional quality etc.

$$\dot{y}_{t\,it} = \beta_0 + \beta_1 FD_{it} + \beta_2 X_{it} + \beta_3 GDP_{i0} + u_{it,} \quad (2.10)$$

Regressing the rate of economic growth on the level of FD, amongst other determinants of growth, sheds light on two potential channels through which FD might affect economic growth: (i) capital formation and (ii) total factor productivity. The first one regresses capital formation on FD and different macroeconomic disturbances.[14] Whereas, the second equation regresses total factor productivity on FD measures (Thiessen, 2003). The former is known as Solow residual and denotes the part of growth that cannot be explained by Equation (2.10). However, a note of caution is required when commenting on these two channels. Unfortunately, there is no theoretical model provided in this approach to incorporate these two potential channels. To investigate these channels, the author suggests estimating separately Mankiw *et al.*'s (1992) growth model augmented by the FD measures, the equation of capital formation and the equation of productivity residual (total factor productivity growth also known as Solow residual).

In a separate line of research, the third group of studies augment Mankiw *et al.*'s model by macroeconomic stability and FD variables to explicitly investigate how decentralisation may affect economic growth indirectly through its impact on macroeconomic stability. More specifically, Martinez-Vazquez and McNab (2003; 2006) assume a model in which technological progress is disaggregated into exogenous technical progress, the direct impact of FD on growth and the indirect impact of FD on economic growth. The augmented growth model, assumed to be a Cobb-Douglass production function, is as follows:

$$Y_{it} = V_{it}\, K_{it}^{\alpha}\, G_{it}^{\beta}\, H_{it}^{\varphi}\, L_{it}^{\theta} \qquad \alpha, \beta, \varphi \text{ and } \theta > 0;\ \alpha + \beta + \varphi + \theta \geq 1 \quad (2.11)$$

where V is the level of technology and other institutional factors, L is the stock of labour, and K, G, and H, similarly as in Mankiw *et al.*'s model, are the stocks of private, public and human capital, respectively. Additionally, the model assumes that

[14] Macroeconomic disturbance is measured by fiscal balance as a share of GDP, inflation, uncertainty of economic agents with regard to macroeconomic stability and dummy variables to capture the catch-up effects of countries of countries with relatively low initial income.

V is a product of technical progress (A), decentralisation (D) and macroeconomic stability (MS):

$$V_{it} = A_{it} D_{it} MS_{it} \quad (2.12)$$

The authors (p.28) argue that this disaggregation of exogenous technological progress into decentralisation and macroeconomic stability, however, should not be interpreted as these variables affect economic growth indirectly through technological progress. Rather, they affect the physical inputs separately, which in turn denies the complex nature of technological progress as a function of decentralisation. However, it is the macroeconomic stability which is a composite function of decentralisation and other exogenous variables included in X_{it}:

$$MS_{it} = g(D_{it}; X_{it}) \quad (2.13)$$

This model uses the change in the Consumer Price Index (inflation rate). However, different measures of macroeconomic stability have been proposed in the literature such as the M2 growth, fiscal balance and a combination between inflation and unemployment (Fukasaku and De Mello, 1998; Iqbal and Nawaz, 2010).

Following the neoclassical assumption, the model shows that the steady-state per capita output is determined by the accumulation of capital, stock of technology, direct and indirect impact of decentralisation on output.

$$ln y^*_{it} = ln\, A_{it} + ln\, D_{it} + ln\, MS_{it} + \frac{\alpha}{1-\alpha-\beta-\varphi} ln\, i^k_{it} + \frac{\beta}{1-\alpha-\beta-\varphi} ln\, i^g_{it} + \frac{\varphi}{1-\alpha-\beta-\varphi} ln\, i^h_{it} + \frac{\alpha+\beta+\varphi}{1-\alpha-\beta-\varphi} \ln(n + g + \varphi) \quad (2.14)$$

where i^k, i^g and i^h denote the fraction of output in private, public and human capital, respectively. Once the steady state is achieved, the long-run growth can be increased only by enhancing capital productivity and increasing the level of decentralisation. Also, it is argued that decentralisation will affect growth directly through its effect on growth and indirectly through the macroeconomic stability channel.

Similar approach as in Martinez-Vazquez and McNab (2003) was also followed by Bodman *et al.* (2009a) in which they assume FD to be a composite function of federalism dummy, subnational government units, number of subnational tiers of government and subnational central government employee ratio. Whilst Martinez-Vazquez and McNab (2003) does not provide any justification of the economic effect of FD through macroeconomic stability, Bodman *et al.* (2009a, p.7) argue that if the macroeconomic shocks are not equally distributed across the country, subnational governments might be better situated than central government to provide counter-cycle policies. However, the authors (p.8) also argue that subnational governments' competition for revenue might destabilise national fiscal policy objectives by contributing further to the macroeconomic instability (more details on the effect of FD on economic growth through macroeconomic stability will be provided in Section 2.3.2).

2.2.2 Endogenous growth models

a. Overview of endogenous growth models

The endogenous growth models developed different from the neoclassical growth models, provide an endogenous mechanism for long-run growth either by relaxing the assumption of diminishing returns to capital or by explaining technological change due to specific actions. By escaping from the diminishing marginal productivity of capital assumption, the endogenous growth theory allows capital accumulation, which eventually is escalated into an unlimited growth (Barro and Sala-i-Martin 2004).

There are two waves of endogenous growths model in the literature: (i) the AK model (where A represents the total factor of productivity and K represents the capital) and (ii) the innovation based theory. Although the latter model is an important wave in the endogenous growth model as it links innovation and economic growth through either new (not necessarily improved) varieties of products or innovations that render old products obsolete through creative destruction (Schumpeter, 1942; Romer, 1990), in the context of this thesis, however, importance will be drawn only to the AK model and the introduction of fiscal policy in this model. The AK model, proposed by Romer (1986), Barro (1990) and Rebelo (1991), in its most rudimentary form, assumes a production function with only one production factor: capital. Based on the overview of Barro and Sala-i-Martin (2004), the AK model in the absence of diminishing marginal returns to capital is:

$$Y_t = AK_t \tag{2.15}$$

where A is a positive constant that denotes the level of technology (productivity level), and K is the capital in which the physical capital, human capital and the stock of knowledge are embedded. By following the neoclassical approach to use the per capita terms and deriving the growth path, this theory claims that economic growth, in the long run, will be equal to the growth rate of capital:

$$\dot{y}_t = \dot{k}_t = sA - (n + \delta) \tag{2.16}$$

The AK model in per capita terms predicts positive long-run per capita growth without any technological progress (Barro and Sala-i-Martin 2004, p.64). This is because sA is greater than $(n + \delta)$ due to non-restrictions of diminishing marginal productivity of capital, implying a constant increase in k at a steady state rate. Hence, development will be enhanced by any policy that increases investment, for instance, an increase in saving rate. Such positive long-run per capita growth will occur without any technological progress, as argued in the neoclassical approach. Though, the model does not imply convergence as by definition if economies start out with different initial stocks of capital, then the gap becomes larger across time. Likewise, the model does not predict any transitional dynamics because of the constant increase of capital stock.

An essential contribution to the endogenous growth theories is the Barro's (1990) model, which focuses on the implications of government intervention on economic growth. As previously stated in the AK model, anything that changes the baseline technology A will also impact the long-run per capita growth rate. In the same vein, it is argued that the government's choice about public goods and services will affect the growth rate of an economy. By assuming constant returns in the aggregate production function, this model introduces a significant mechanism through which the government can affect the output level and its rate of growth. More specifically, it is argued that the per capita income depends on the public expenditure of a public good g, which is financed by a proportional tax on income and capital τ. The production function is presented as follows:

$$y_t = \mathrm{A}k_t^{1-\alpha} g_t^{\alpha} \tag{2.17}$$

In this simple endogenous model, the effect of increased government spending on economic growth is considered as non-monotonic depending on the size of the government. In a small size government, the productivity effect dominates the distortionary effects of taxes, which in turn generates a positive relationship between growth and the size of the government. However, as the government becomes larger, the distortionary effect of the taxes, raised to finance the expenditures, dominates while generating a negative relationship between growth and the size of the government.

To compound this problem further, additional attention in the Barro's model is given to the effects of different types of government spending on growth. Distinction is made between productive and non-productive public expenditures (Lee, 1992 and Devarajan *et al.,* 1996). Productive spending includes expenditures on infrastructure, legal system, education, and training, whereas, non-productive spending comprises expenditures on national defence, national parks, and social programs, to mention a few. Based on this distinction, Barro's model shows that the long-run economic growth depends, amongst others, on the composition of public spending (Barro, 1992; Devajaran *et al.,* 1996). Higher complexity is reached when different types of taxes (distortionary and non-distortionary) are included in the model while emphasising the vital role of taxes in financing growth enhancement expenditure.[15]

b. Overview of endogenous FD-growth models

Inspired by the explicit recognition that the endogenous growth model gave to the effect of economic policies on growth, the first endogenous FD-growth model was introduced relatively late in 1998 by Davoodi and Zou (1998). Accordingly, a Cobb-Douglas production function based on the endogenous growth model of Barro (1990) is used by incorporating both private capital and public spending. Whilst the influential study of Barro (1990) describes a nonlinear relationship between government spending and growth (where the former is an input to the production function), the model of Davoodi and Zou (1998) departs from Barro (1990) by assuming that public spending is carried out by three distinct levels of government, more precisely at federal, state and local level. The same logic would apply in case of

[15] See Kneller *et al.* (1999) for a detailed review.

a unitary government, where different from the federal government, the public spending would be carried out only by the central and local government. However, since Davoodi and Zou's model incorporates three layers of government, we would follow their approach and shift to the unitary case when needed. The Cobb-Douglas production function is:

$$y = F(k, f, s, l) = k^{\alpha} f^{\beta} s^{\gamma} l^{\omega} \quad 1>\alpha>0;\ 1>\beta>0;\ 1>\gamma>0;\ 1>\omega>0 \tag{2.18}$$

where *y* represents the per capita output, *k* denotes the level of private per capita capital stock which can be considered as a measure of both human and physical capital (or separated in an empirical work as argued by Xie *et al.* (1999, p.230)), *f, s* and *l* represent the government spending at the central/federal level, intermediate/state level and local level, respectively. The model assumes that the allocation of consolidated or total government spending depends on the share of each level of government such as $\theta_f g = f$; $\theta_s g = s$ and $\theta_l g = l$, while β, γ and ω denote their respective output elasticities. Whilst the output elasticity of capital remains the same as in Equation (2.1), the constant returns to scale assumption implies that the sum of the output elasticities of all inputs shall equal 1 ($\alpha + \beta + \gamma + \omega = 1$). Irrespective of the level at which the spending is carried out, the total government spending is assumed to be financed by a constant tax rate τ, such that:

$$\tau y = f + s + l \tag{2.19}$$

By assuming a representative agent with CES utility functions and a dynamic budget constraint as shown in Equation (2.16) and (2.17), respectively, the choice of consumption is determined by maximizing (2.16) subject to (2.17) and the government's budget allocation (Davoodi and Zou, 1998, p. 246).

$$U = \int_0^{\infty} \frac{c^{1-\sigma} - 1}{1-\sigma} dt \tag{2.20}$$

$$\frac{dk}{dt} = (1-\tau)\, y - c = (1-\tau)\, k^{\alpha} f^{\beta} s^{\gamma} l^{\omega} - c \tag{2.21}$$

Where *c* denotes the per capita private consumption, ρ denotes the time discount rate and σ is the coefficient of relative risk aversion. Consequently, maximization of the utility function subject to the budget constraint yields the following long-run growth path of the economy:

$$g(i) = \frac{dy/dt}{y} = \frac{1}{\sigma}\left[(1-\tau)\tau^{\frac{1-\alpha}{\alpha}}\alpha\, \theta_f^{\frac{\beta}{\alpha}}\, \theta_s^{\frac{\gamma}{\alpha}}\, \theta_l^{\frac{\omega}{\alpha}} - \rho\right] \quad (2.22)$$

Equation (2.18), which forms the theoretical foundation for including FD measures into a growth production function, shows that the long-run growth rate of per capita output depends on the tax rate and the shares of expenditure by different levels of government. In this context, growth-aiming shares of each level of government can be found by maximising the growth path of the economy with respect to each level of government as shown below:

$$\theta_f^* = \frac{\beta}{\beta+\gamma+\omega} \quad (2.23)$$

$$\theta_s^* = \frac{\gamma}{\beta+\gamma+\omega} \quad (2.24)$$

$$\theta_l^* = \frac{\omega}{\beta+\gamma+\omega} \quad (2.25)$$

By analysing the above solutions, it is argued that for a given share of total government expenditure in GDP, a reallocation of public spending through different levels of government can lead to higher economic growth if the existing allocation is different from growth-maximising expenditure shares .

Higher complexity is reached in Zhang and Zou's (1998), Xie et al.'s (1999) and Zhang and Zou's (2001) models, though following the same approach as in Davoodi and Zou (1998). Whilst these models are quite similar to each other, this thesis will focus only on the Xie *et al.*'s approach because it may be considered as one of the most comprehensive and sophisticated models in the FD-economic growth theoretical literature. More precisely, this model departs from the Davoodi and Zou's model by assuming a CES production function, which is not necessarily a Cobb-Douglas function, and a different definition for the shares of federal, state and local governments as presented in Equations (2.26) and 2.27), respectively.[16]

$$y = \left[\alpha k^{\phi} + \beta f^{\phi} + \gamma s^{\phi} + \omega l^{\phi}\right]^{1/\phi} \quad (2.26)$$

[16] Please note that we used another symbol for shares because Xie *et al.* (1999) used a different definition for governments' shares.

$$\varphi_f = \frac{f}{g}\,;\, \varphi_s = \frac{s}{g}\,;\, \varphi_l = \frac{l}{g} \tag{2.27}$$

The Cobb-Douglas function in Davoodi and Zou (1998) represents a special case of Equation (2.26) where $\phi = 0$. Also, as argued before, the sum of all these shares shall be equal to 1. By solving the growth-maximization problem with respect to the three shares of government expenditure, Xie *et al.* (1999, p.230-232) shows that these shares are as below:

$$\varphi_f^* = \frac{\beta^{1/(1-\phi)}}{\pi} \tag{2.28}$$

$$\varphi_s^* = \frac{\gamma^{1/(1-\phi)}}{\pi} \tag{2.29}$$

$$\varphi_s^* = \frac{\omega^{1/(1-\phi)}}{\pi} \tag{2.30}$$

Where $\Pi = \beta^{1/(1-\phi)} + \gamma^{1/(1-\phi)} + \omega^{1/(1-\phi)}$, also interpreted by Xie *et al.* (1999, p.232) as the overall productivity of government spending at all levels. Overall, the model suggests that the growth-maximising shares of each level of government can be found as a share of individual productivity over the overall productivity of government public spending. It is important to note that if the production function is assumed to be a Cobb-Douglas technology as in Davoodi and Zou's model, namely substituting ϕ =0, the growth-maximising shares would be identical to those in Equations (2.23) to (2.25). Overall, it is clearly suggested by the model that if the actual spending shares do not correspond to the growth-maximising ones, reallocation of resources among the three levels (or two levels in case of unitary government) would be growth enhancing (Xie *et al.,* 1999, p.232).

Another important contribution in the FD-growth models is an extension of Zhang and Zou (2001) which investigates the growth impact of the allocation of public expenditures among multiple sectors (such as health, education, transportation etc.) with multiple levels of government. The theoretical analysis (p.60-64) shows that the growth rate in a decentralised country is determined by the allocation of public spending among different levels of government and sectors, the tax rate used to finance the public spending, and all the other exogenous variables commonly used in an endogenous growth model. Whilst the conclusions seem to be similar to those of Xie *et al*. (1999), where the growth-maximising allocation shares for public expenditure are determined by the individual and total productivity of government spending, the implication with regard to FD-growth relationship appears slightly different. More specifically, Zhang and Zou (2001) contradict the existing claims of a positive relationship between FD and growth. Instead, they point towards an optimal degree of FD, above which there is no growth-enhancement effect of further reallocation of the budget at subnational level. However, any level of FD below the optimal share would be growth-increasing and, at the same time, welfare-increasing.

Further, Akai *et al.* (2007), based on Nishimura (2001), extended the above model by introducing differences in the quality of public goods and the structure of complementarity in global and local levels. Different from the other literature, complementarity denotes the inter- and intra-jurisdictional spillovers of the public goods on the national economy (p.343). Despite their additions, the theoretical implication of their model appears to be similar to those above, by emphasising the role of the fiscal decentralisation on economic growth, while focusing on intra-regional (local) and inter-regional (global) complementarity. The authors also provide explanations on the hump-shaped of the FD-growth relationship showing that this relationship depends on the complementarity structures in the economy.

2.2.3 Critical appraisal of the FD-growth models

Despite the theoretical contribution of the aforementioned FD-growth models, there is hitherto no clear, automatic and unique theoretical framework which would justify the inclusion of FD in a growth model and thus, guide empirical research. Incorporation of FD into a growth model (neoclassical or endogenous approach) often appears to be arbitrary and lacks explicit theoretical rationale based on an underlying relationship between FD and economic growth. This is because of a critical overlap between the orthodox fiscal federalism theory focusing on efficiency and distributive consequences of FD and the empirical framework of FD-growth models being unable to measure efficiency in a growth model. The problem is mostly attributed to the difficulty in quantifying efficiency in the allocation of fiscal resources (Rodriguez-

Pose *et al.,* 2007; Arze del Granado *et al.,* 2012), which is barely testable in the empirical framework (Feld *et al.,* 2004).

Whilst the efficiency-FD relationship has gone untested, the focus of the empirical research has switched to the investigation of the FD-growth relationship. Economic growth is seen as an objective of decentralisation and public-sector efficiency (Breuss and Eller, 2004), where higher efficiency is likely to lead to higher economic growth. The literature argues that economic growth is used as an indirect measure of efficiency (Rodriguez-Pose *et al.,* 2007; Eller, 2004; Feld *et al.,* 2004; Feld *et al.,* 2009a; 2009b). Hence, the exclusion of efficiency is justified through the inclusion of FD measures capturing the efficiency arising from decentralisation. Nevertheless, there is still vagueness on the mechanism between FD, efficiency and economic growth.

Despite the attempt of Eller (2004) and Bodman and Ford (2006) to implicitly introduce efficiency into a growth model via *the decentralisation-induced efficiency-led economic growth effect* of FD, there is still no clear conclusion on whether FD enhances consumption, production or both consumption and production efficiency. Unfortunately, both neoclassical and endogenous FD-growth models have so far been unable to distinguish between these two types of efficiency. Recalling the last section where the models assume that all levels of government produce the same amount and/or quality of public goods for a representative consumer, it is impossible to account for the growth effect influenced by higher/lower consumption efficiency[17] and higher/lower production efficiency[18] (Thiessen, 2003). In most cases, FD is measured as the share of subnational spending and/or revenue in total national spending/revenue, which does not measure efficiency in the public sector.

Another critique addressed to both growth models is the lack of the Tiebout mechanism (a demand revealing the mechanism for local public goods), where greater efficiency in public service provision is likely to be achieved through the increased mobility and sorting of the population in locations under decentralized governments (Tiebout 1956). Further, none of the models takes into account individuals with different preferences and different levels of government producing different quality

[17] By assuming several agents with different preferences for public goods
[18] By assuming different levels of government producing different amount and/or quality of public goods subject to a given amount of public expenditure

and amount of public goods and services (Thiessen 2003; Bodman and Ford 2006). This process of matching local public goods provision to preferences is empirically neglected because the assumptions of Tiebout mechanism do not necessarily hold and thus local expenditure and revenue patterns due to "vote with their feet" process cannot be observable and incorporated in the growth model. Nevertheless, in both cases (whether these assumptions hold or not) this process affects the efficiency of local public goods, which is not explicitly incorporated into the FD-growth models. Another weakness of both models is the failure to account for economies of scale and externalities (Stegarescu, 2004), which might weaken the validity of FD-growth effect.

An important concern in both models might be the assumption of tax revenues via flat tax rate, which surprisingly has gone indisputable.[19] Revenue decentralisation might be as relevant as the expenditure side, which requires attention from the theoretical perspective. Arguably, this might be linked to the well-known weakness of both FD-growth models from the empirical perspective: the inability to agree on the appropriate FD measures, leading to diverse designs for decentralisation-economic growth relationship. These critics are merely addressed to the earlier empirical investigations (i.e. Davoodi and Zou, 1998), which included limited FD measures. Alternately, the neoclassical FD-growth models are criticised to a lesser extent as they were moderately able to address this drawback. The use of only one measure of FD, expenditure decentralisation[20], is criticised by arguing on the inability of this measure to capture the "true" level of decentralisation considering the multidimensionality of this process, especially when investigating cross-country studies. Thus, it is required to consider additional measures such as revenue decentralisation, tax autonomy and transfer decentralisation (Triesman, 2002; Feld *et al.,* 2004) as important dimensions of FD. The expenditure decentralisation is not likely to reflect accurately the subnational government's autonomy in expenditure decision making. The decisions at local level may be constrained by the central government especially in developing and transition economies where local governments are mostly acting as administrative

[19] See Equation 2.19.
[20] Although Iimi (2005), Enkilopov and Zhuraskaya (2007) incorporate a measure of political freedom, still this measure does not represent a measure of fiscal decentralisation but a measure of political decentralisation. When referring to fiscal decentralisation, one should take into account possible measures of revenue decentralisation, revenue autonomy, transfer decentralisation, vertical imbalance etc.

agents of national government. Moreover, the use of solely expenditure decentralisation ignores the potential effects of revenue decentralisation and the importance of intergovernmental income transfer by central government to subnational governments. Expenditure decentralisation without corresponding revenue decentralisation and an indication of the "common pool" resources such as grants and revenue-sharing will tend to bias the true level of decentralisation (Rodden, 2003). Intergovernmental transfers should be additionally considered as a relevant measure of FD as it incorporates the difference between revenue-raising power and spending responsibilities. Overall, expenditure, revenue, and transfer are various dimensions of decentralisation, as such, no single indicator can capture and precisely estimate the real level of FD (Stegarescu, 2005; Sacchi and Salotti, 2011).

A note of caution is required when comparing growth models considering one or all dimensions of FD. Whilst in the former there might be some argument on the nonlinear economic effect of FD as in the endogenous FD-growth models, there is vagueness in the literature when referring to multiple measures of FD. In fact, the optimal size would be challenging and perhaps impossible for expenditure, revenue and intergovernmental transfers simultaneously. As Martinez-Vazquez and McNab (2003, p.1601) argue instead of single optimum, the relationship between FD and economic growth might offer multiple optimal sizes, which in turn dims the nonlinearity arguments. Either way, the FD-growth models provide little discussion on the appropriate measure and specification.

Although the latest studies (Gemmell *et al.,* 2013) have addressed a major part of the abovementioned drawbacks of FD-growth models, what requires attention is the general specification proposed by FD-growth models. First, there are no substantial differences between the endogenous and exogenous FD-growth model, while pointing towards *ad hoc* growth regressions with no strong theoretical foundations. This is because both approaches face almost the same abovementioned problems. Second, there is still work lagging behind regarding the channels of transmission from FD to economic growth, which weakens the proposed framework and the validity of empirical results. There are some attempts from the exogenous approach to indirectly investigate the channels of transmission (i.e. macroeconomic channel, a total factor of productivity), although these are considered insufficient in detangling the economic effect of FD. First, the lack of theoretical justification regarding the impact of FD on economic growth via macroeconomic stability might inflate the real effect of FD. Second, the inclusion of decentralisation (*D*) and public-sector expenditure (*G*) in the same model (see Equations 2.12 and 2.13) appear to be optimistic regarding the duplication of functions of local governments in these two variables.

Summing up, undertaking research in identifying the potential channels of transmission of FD-growth effect is challenging, while there are theoretical and as well empirical gaps waiting to be filled. Though, it is necessary to detangle the relationship between FD and economic growth from different perspectives by shedding light on different channels of transmission.

2.3 Channels of transmission

The review of FD-growth models showed the lack of a universal theoretical framework in linking the well-known Oates' Decentralisation Theorem on increased efficiency (in consumption and production), greater competition between local governments and mobility of consumer with enhanced economic growth. Both exogenous and endogenous models vaguely justified the inclusion of FD measure(s) into a growth production function, while basing their rationale mostly on empirical purposes (Thiessen, 2003; 2005). Hitherto, no clear and comprehensible economic arguments are provided on the mechanism and transmission channels of FD to economic growth, and the expected economic effect under different settings (i.e. different structure of governance, level of investigation, possible externalities etc.). Despite strenuous efforts by the existing literature on these issues, there is still uncertainty on the generally-accepted channels, which demands further investigations on (new) avenues through which decentralisation in general and FD in particular impact economic performance. Reformulation of existing channels and introduction of new ones, followed by a novel classification, are presented in this section by considering the FD-growth relationship as a complex and manifold relationship. Accordingly, the channels of transmission are divided into two main categories: (i) direct effect of FD on economic growth and (ii) indirect effect of FD on economic growth.

Direct effects in the context of FD-growth relationship are considered changes in which the economic performance is altered due changes induced by local governments on public policies or behaviour of economic agents (i.e. efficiency of provision of public goods, the pro-business agenda and the composition of public expenditures). *Indirect effects* are considered changes induced by socio-economic factors (i.e. macroeconomic stability, the degree of institutional development, size of the public sector, political innovation, and corruption) that are likely to be affected by FD, which in turn, might influence economic performance.

2.3.1 Direct effects of FD

As argued in the previous section, the central argument used to justify the contribution of FD to economic growth is the increased overall efficiency induced by decentralisation. Oates (1993) argues that, intuitively, the static preposition that FD increases consumption and production efficiency should have a parallel in a dynamic setting of economic growth. Based on this theorem, where the relationship between FD and economic growth is twofold, our proposed channels of transmission are classified subject to the consumption and producer perspective. Within the second category, channels of transmission are further classified into (i) existing channels of transmissions and (ii) new proposed channels of transmission. As to the first category, this thesis relies on the existing channels of transmission with no new channels of transmission introduced.

a) Consumer perspective

Starting from the consumer perspective, it is argued that the potential economic efficiency benefits from higher devolution of power towards subnational level stem from the informational advantage of subnational governments, as argued in the Oates' Decentralisation Theorem (Jin *et al.,* 2005; Oates, 1999). Because of this advantage, local governments are likely to be more pro-consumer welfare than central government, by offering goods and services that best suit their preferences, contrary to the homogenous goods and services provided nationally. Such tailoring of outputs to local needs is assumed to increase the consumption efficiency and net welfare, which might be additionally boosted in the presence of greater individuals' mobility

(Tiebout, 1956; Klugman, 1994). The expenditure and revenue side of FD would be altered accordingly and, eventually, induce greater welfare at individual level and greater welfare/growth at aggregate level. This increase in the welfare and economic growth, by adapting local government policies to fulfill the citizens' demand, is termed by the existing literature (Martinez-Vazquez and McNab, 2003; Feld *et al.,* 2009b) as the ***consumer heterogeneity channel***.

Whilst the above arguments are considered insufficient to explain the ultimate effect of FD on economic growth, several new arguments, trying to detangle this relationship from different perspectives, are at play. Martinez-Vazquez and McNab (2003, p.1604) argue that better tailoring of preferences might produce secondary effects on work effort and savings, eventually expected to impact growth. More specifically, if for instance spending at local government is efficiently spent on goods and services affecting the education and health of the individuals (or any other goods and services which could be embodied by the consumer), the effect is likely to be visible through the labour force and eventually impact growth. Intuitively, the better educated and healthier labour force (who are also consumers of public goods), in the presence of additional goods and services that facilitates its commute, will experience an increase in productivity. Eventually, this would result in greater economic growth in the future. Also, the authors (p.1604) mention other secondary effect induced by increased efficiency from devolution such as increased savings and investment. Summing up, the existing literature stresses that allowing for consideration of heterogeneous demand for public goods, FD is likely to affect economic growth through the ***consumer heterogeneity channel,*** very likely embodied by consumers.

However, it would be utopian to *a priori* accept this channel as an explicit transmission mechanism. First, it seems difficult to quantify the efficiency either through the better matching of consumers' preferences or embedded goods and services. We argue that is exactly this reason, the inability to quantify efficiency, which interrupts the dynamics of the Oates' Decentralisation Theorem from consumption efficiency to economic growth. From a microeconomic perspective, it is relatively easier to test these embodiments from local goods and services through a utility function estimation. Though, it seems difficult to justify this channel from a macroeconomic perspective, by incorporating it into a growth model. Further, in the presence of the hypothetical secondary effect, it seems that the economic effect of FD should not be investigated only directly through the consumer heterogeneity channel, but also indirectly through the quantity and quality of inputs (i.e. education). Second, the efficiency criteria do not inevitably arise in a decentralised system. Prud'homme (1995) and Frenkel (1986) contradict the efficiency criteria claiming that it might be inappropriate and insufficient to explain the effect of FD on growth as this criteria works only in the presence of externalities and spillovers effects due to the provision of public goods (Bardhan, 2002). Lack of clearly defined responsibility and weak accountability may challenge efficiency and make local policies less effective. Taking into account this trade-off, decentralisation will work only if devolution of power and responsibility is associated with higher efficiency.

b) Producer perspective

Alternatively, from the production perspective, the channels of transmission appear to be less intuitive. However, the existing channels are still insufficient and, in many ways, incapable to fully explain the mechanism by which FD affects growth. In the light of this discussion, this thesis explains the existing channels of transmission and introduces new arguments, which gives rise to new potential channels of transmission. Before presenting all these channels, a graphical presentation of the existing and new direct channels of transmission is presented in Figure 2.1.

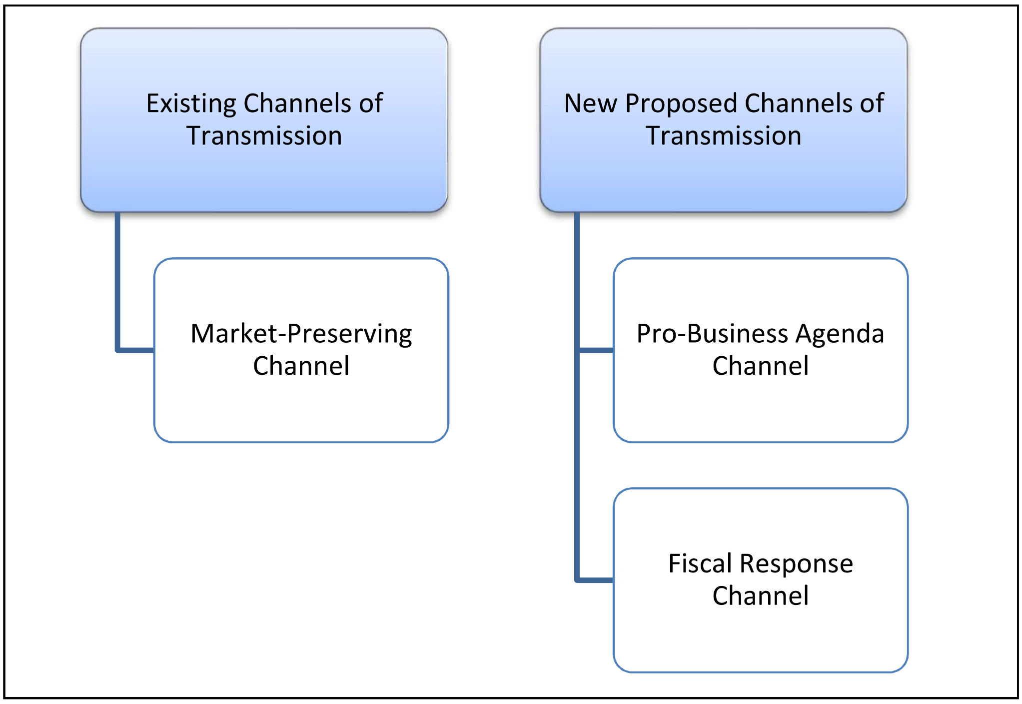


Figure 2.1 Graphical presentation of the existing and new channels of transmission from the producer perspective.

(i) Existing Channels of Transmission

The FD-growth theories rely on the 'productivity enhancement hypothesis', which stresses that FD, through raising production efficiency, is growth enhancing. Production efficiency, defined in terms of cost, quantity, and quality of local governments, is hypothesised to be affected by competition, labeled under the ***market-preserving channel*** (Jin *et al.,* 2000; Martinez-Vazquez and McNab, 2003; Thiessen, 2003).

In the presence of limited tax base and funds available, local governments are likely to compete to better tailor the preferences to public goods provision (Brennan and Buchanan, 1980; Thiessen, 2003), which becomes indispensable with the increasing sensitivity and vulnerability of local governments to factor and residential mobility (Sato, 2001). When taxpayers (citizens and business) "vote with their feet", local governments are faced with additional urges to provide more and better efficient policies (Tiebout, 1956; Martinez-Vazquez and McNab, 2003; Rodriguez-Pose and Ezcurra, 2009). Local participation is further promoted by decentralisation, which also helps in building the social capital and "bring the state closer to the people" (Larson, 2002). Also, it might be argued that a better-informed subnational government regarding local needs is also likely to face lower planning and decision-making costs than central government (Lutz and Linder, 2004), which in turn would contribute to the overall performance of the provision of local goods and services. This manifestation of subnational governments to competition, is viewed as a way of reducing the monopolistic power of central government and its market-obstructing impulse (Rodden and Rose-Ackerman, 1997; Rodden and Wibbels, 2002). In turn, this type of vertical competition might favour the economic efficiency at lower level of governance. Overall, better reallocation of resources, lower decision-making costs, better information on local needs would contribute to an efficient provision of public goods and services, in terms of greater quantity, quality or lower cost of output with a given budget constraint (Feld *et al.,* 2004), which are likely to determine the development path of regions and entire economy.

Another argument regarding competition between local governments concerns the capacity for innovation. A subnational government, triggered by competition, can serve as a "laboratory" (Oates, 1999) in which new policy solutions (i.e. reallocation of specific funds, provision of certain public goods, change of tax rate) promoting innovations and cost-effectiveness are tested without the threat to harm the whole country. In this context, these incumbent local governments are better equipped in designing regional economic policies to the necessities of regional jurisdictional (Martinez-Vazquez and McNab, 2003; 2006) and contributes to a more appropriate business environment, while providing opportunities for enhanced economic efficiency. The existing literature on the channels of transmission accentuates precisely the competition between subnational governments (horizontal competition) as the underpinning force behind the relationship between FD and economic growth, while labelling it under the market-preserving federalism concept (Qian and Weingast, 1997; Weingast, 2006).

Similar to the consumer heterogeneity channel, the existing literature appears to be indefinite and unclear in uncovering the full transmission process from devolution to economic growth, with many steps being optimistically presumed. Further, the tribute only to the positive side of tax competition, without acknowledging the potential drawbacks or insufficiencies, might be considered prejudiced and inappropriate regarding the economic effect of FD through market-preservation channel. To provide a more comprehensive view than the existing literature, this thesis questions the existing arguments on the market-preserving channel, while complementing it with new arguments. For this reason, it is important to distance our discussions from the traditional market-preservation federalism. This becomes of special relevance in the presence of local governments that are moving fast from its traditional role of providing goods and services to new functions of enabling and facilitating the business community to produce and lead the local economic development. (Preteceille, 1990; Goldsmith, 1992; Zhu, 1999).

With regards to the market-preserving channel, there are several incomplete and biased arguments pro-efficiency that need to be questioned. As argued above, local governments have strong incentives to compete, which rises naturally from the need to attract the scarce mobile factors (Yao and Zhang, 2008). However, it might be argued that forcing local governments to compete is not necessarily associated with the desired outcomes. This competition can lead to a "race to the bottom", while forcing local governments to reduce tax rates to avoid further erosion of tax base (Wilson, 1999). Further, tax competition can as well lead to a "race to the top" when certain local governments are unable to enter the competition because of tight budget constraint. In the light of this discussion, local governments might be exposed to predatory tax practices (Yao and Zhang, 2008), which questions the reliability of the market-preserving channel.

On the negative side of the innovative local government, it is argued that this approach does not always result in successful outcomes. Arguing that the policy-related knowledge generated by decentralization experiments is available at no cost to any free rider, an expected tendency for local governments is to wait and watch, rather than actively experiment. Whilst this tendency might be justified by the extinction of the first mover advantage, there are still some arguments on the reluctance of local governments to engage in risky political experiments (Schnellenbach, 2007).

Overall, it may be argued that the market-preserving channel approach is not wrong, but, in many ways, it has been invaluable in fully detangling the FD-economic growth relationship from different perspectives. In the light of this discussion, this thesis introduces new arguments, which later gives rise to new potential channels, which will be elaborated in the next section.

(ii) New Channels of Transmission

The first contribution of this thesis regarding the channels of transmission relates to the pro-business environment argument, while considering local government as a "helping hand" to the economy. Before jumping to the argument, it might be helpful to provide a discussion regarding the superiority of local government in tailoring business development policies in comparison to the central government.

The complex and dynamic process of globalisation, characterised by increasing competitive pressure of international markets, exposes economic development to local challenges which are considered to be, mostly, location-specific. This characteristic of regional development might also explain the difference of regions in triggering economic development, which becomes of special relevance in developing and transition countries, where only certain locations are leading growth, while other stagnate in perpetuity (Ascani *et al.,* 2012; Parkinson *et al.,* 2014). Whilst the traditional regional growth literature highlights geographical proximity between actors as favouring development at local level, the new stream of literature explain development as the occurrence of intangible and complex "untraded interdependencies" between economic agents (Rodriguez-Pose and Crescenzi, 2008; Ascani *et al.,* 2012), such as social, political and institutional settings.

Namely, the region-specific characteristics are the ones that determine the suitability of a certain economic policy to the region. In this framework, local government represents the capacity of heterogeneous regions to embrace a flexible-to-demand-changes system (Amin, 1999; Ascani *et al.,* 2012), which becomes pronounced with the increasing globalisation process. By being aware of endowment of natural resources, economic, social, political and institutional characteristics, (both formal and informal), local governments may encourage context-specific advantages of local agents by facilitating economic activities. Given that these characteristics are location-specific, it becomes difficult to replicate the advantages and the local economic development in a different setting (Ascani *et al.,* 2012, p.8).

In this context, the bottom-up policies of central government (uniform for all regions) appear to be less suitable than the context-specific arrangements of problem-solving designed at local level. This becomes of special relevance for rich-resource regions which is very difficult to be covered by the bottom-up policy (Larson, 2002).

Alternatively, acknowledging the regional perspective of economic development, local features (socio-economic characteristics) appear important in shaping development trajectories, which highlights the importance of bottom-up policies instead of top-down (Crescenzi and Rodriguez-Pose, 2011). Given the density and peculiarity of interactions between economic agents at local level, it becomes apparent that "one size fits all" policies do not accurately address the local problems. Contrary, highlighting the local strength and alleviating the weakness is the only way to root economic activity in territories in a sustainable manner (Pike *et al.,* 2006).

A simple model by Zhuravskaya (2000) relates the strength of government fiscal incentives with the support for business growth and the efficiency of public goods and services provision. More specifically, the authors (p.351) argue that pro-business local policies and strategies can stimulate the entrepreneurial activity. In the presence of sufficient level of FD such as to alter the tax rate and tax base, fiscal incentives would be highly correlated with the speed of private business formation, which also would impact the efficiency of public spending. Similar arguments are also elaborated by Jin *et al.* (2005) for China, while emphasizing the focal contribution of local governments' fiscal incentives in the development of non-state enterprises. It is exactly this scenario that might shed light on a new argument and potential channel of transmission, where local governments might be considered a facilitator of business objectives.

At first sight, this might be considered a win-win situation. First, local governments through attracting new business in their area are directly increasing their tax base and consequently offering more goods and services that best suit the local preferences, while also, increasing their chances to be re-elected. On the other hand, local government policies, especially the business agenda, are considered vital regarding the businesses' competitiveness and siting decision (locate or dislocate) or profitability (Fox and Murray, 1990). Infrastructure, education policy, property taxes, local business subsidies/taxes are some of the potential factors influencing the decisions of firms. Any variation in local policies and strategies will alter the perception of the firms' profitability at a given location (Fox and Murray, 1990, p.426). Consequently, if this variation in local policies improves businesses' competitiveness and increases local jobs, then eventually it might be argued on increased national economic efficiency and total output. Under greater FD, local governments might create a friendly investment local environment, develop tax incentive policies, provide education and training programs that can attract and/ or help prepare a competitive workforce (which will affect firm performance) and/ or offer loans or credits to entrepreneurs (Jin *et al.,* 2004; Feiock *et al.,* 2008; Kwon *et al.,* 2009). In light of this discussion, a new potential channel of transmission regarding the economic effect of FD might be introduced, the ***pro-business agenda channel***. Interestingly, there is substantial research on jobs creation, productivity, and local government policies (see Bartik, 1991; 1994; Rauch and Schleicher, 2015), though no efforts have been made hitherto to formalise the pro-business agenda as a channel of FD to economic growth.

However, a note of caution is required when simultaneously analysing the pro-business agenda and the competition channels. Arguably, the competition between local governments may lead to an efficient local government but not necessarily consistent with a pro-business environment. Alternatively, it could be the case when local governments create a pro-business environment through different tax incentives as a result of a "race to the bottom", but local governments are not efficient.[21] Studies on tax competition highlight that FD might harm the economy by distorting the taxation system (Tanzi, 2000; Brueckner, 2004). Local governments enter the competition with the expectation that there will be a boost in investments and local employment through job creation. Nevertheless, this competition may result in misallocation of resources, which in turn, might affect both public and private sectors, while signalling potential market failures.

Taking the above caveats into account, a new potential channel can be introduced in the literature, which unfortunately has not been formally channelised into the FD-growth relationship, though its effect has been recognized in different areas. So far, competition between local governments concerns only tax policy (change of tax rate and tax base), without considering the competition on the spending side and mostly the composition of the spending. In this context, we would like to aggregate both tax and spending side of FD into a possible channel named ***fiscal response***. It is important to note that although this channel might coincide with and (maybe) duplicate the pro-business agenda channel, conceptually they are not the same. Whilst the pro-business

[21]For instance, local governments through tax incentives might create a large asymmetry between local revenue and local expenditure, which creates higher budget deficits.

agenda channel targets only businesses, the fiscal response targets both business and consumers, while altering the local expenditure and taxes to maximise growth.

Local governments may alter the combination of goods and services offered to each jurisdiction, contrary to a uniform package like the central government is forced to do. For instance, education might not be considered a priority of central government, or it is ensured at a minimum provision in all jurisdictions, local government might reallocate more funds on education. Additionally, higher revenue decentralisation would increase the percentage of revenues retained by local governments, which in turn will increase the marginal benefit of productive spending and thus, the efficiency in public spending will increase (Kappeler *et al.,* 2012). Attention in the literature has been drawn to the infrastructure investment, while arguing that fiscal competition (induced by decentralisation) alters the composition of public investment towards more productive and notably infrastructure project (Estache and Sinha, 1995; Kappeler and Välilä, 2008).

However, the reallocation of funds from local governments might lead to a wasteful duplication of expenditure functions among different levels of government in the presence of poor governance, which is likely to affect the overall efficiency, thereby the quality of public services. Thus, by altering the composition of spending, local governments (either by shifting from non-productive spending to productive ones or vice versa, or changing the reallocation of funds) affects the overall efficiency of local public spending.

Further, the literature argues that decentralisation is likely to have a positive effect on growth if there is a shift of resources from current to capital expenditure (Rodriguez-Pose *et al.,* 2009). Orthodox wisdom suggests that capital expenditures will have a positive effect on growth, whereas, current expenditure will have no effect at all or a negative one (Barro, 1990; Kneller *et al.,* 1999). However, the shift to different types of expenditures through FD does not necessarily lead to economic growth.

Following the same logic, but on the revenue side, the FD-growth relationship *per se* does not provide guidance on whether the higher revenue decentralisation is growth enhancing, as presumed for the expenditure side. However, other disciplines, such as local taxation, provide meaningful insights into potential effects of local taxation, which could be linked to regional/national growth (Helms, 1985; Mofidi and Stone, 1990; Buss, 2001). In this regard, Helms (1985) and Mofidi and Stone (1990) argue that local taxes might reduce growth if revenues were to be devoted to transfer-payment programs. Contrary, if taxes are used to finance public services, valued by local agents, the negative impact of taxation might be outweighed by the value of services provided, while resulting in a positive overall contribution to growth (Helms, 1985, p.581). An advanced theoretical model by Hatfield (2015) shows that subnational governments tend to choose tax policies that maximise the private rate of return and growth, different from a centralized government which tends to maximise its own objective that does not coincide with growth maximisation level (p.123).

Overall, when referring to all these channels simultaneously, there are two concerns that need to be clarified. These relate to the potential extinction of growth and economic efficiency at the aggregate level. With regards to the first one, Bartik (1991, p.13) argues that local economic development policies are not necessarily transferred among local government units or regions. In this regard, it is important to note that, especially in decentralisation, "one size does not fit all", which means that a specific local government policy in one area does not necessarily have to be embraced by others. Consequently, the growth of a particular region might not have the same development trajectory as another region.

Whilst the transferability of growth from one region to the other does not seem to be perplexing from the decentralisation perspective, what appears unclear is the presumed local and national economic efficiency. In this context, it is surprising (to some extent) that the efficiency criteria is positively prejudiced in the FD-growth literature. Despite the arguments provided in the beginning of this section, it is important to acknowledge that devolution might be also associated with lower efficiency because of the disadvantages from the economies of scale and scope of local governments when compared to the central government. Indeed, a central government is larger than subnational units. However, Ezcurra and Pascual (2008) argue that even under diseconomies of scale for local government (economies of scale for central government), additional benefits could be generated. Local delivery shortens supply chains and reduces some costs and risk associated with the loss of redistributive power by central government.

Confronting these two views on the advantages regarding the economies of scale and scope, Prud'homme (1995) suggests that increased efficiency from devolution occurs only in cases where local governments have a sufficient level of demography, geographical size and economic level. Otherwise, the benefits of devolution might not necessarily result in a positive outcome regarding economic efficiency and growth. In the light of this discussion, we favour the views of Ascani *et al.* (2012, p.15) who argue that the relationship between devolution and regional economic development depends on the initial level of efficiency in a country, structural characteristics of regions and countries, and modalities of FD process.

2.3.2 Indirect effects of FD

In general, our knowledge of understanding the economic effect of FD is limited only to the direct channels of transmission, with little acknowledgment of the indirect ones. Whilst the FD-growth literature has mainly emphasised the direct channels of transmission, potential indirect channels of transmission, such as macroeconomic stability, size of government and corruption, have been somehow neglected. Understanding and exploring the indirect effect of FD from multiple perspectives and dimensions might better shed light on the hypothesised economic gains of FD.

(i) Existing Channels of Transmission

Despite the lack of a clear triangular relationship between FD, macroeconomic stability, and economic performance, there is wide consensus that inadequately designed decentralisation policies might endanger macroeconomic stability (Prud'homme, 1995; Ter-Minassian, 1997), and in turn, retard growth. However, several contradicting arguments are at play before escalating to the economic growth effect.

In the presence of soft-budget constraint and unclear vertical structure, local governments tend to overspend and overborrow without eventually facing the full cost of their increased expenditure (Rodden *et al.,* 2003). The overspending effect and the increased tendency of financing expenditure with transfers from central government rather than local revenue (flypaper effect) may create a fiscal illusion problem. More specifically, increased local expenditure by oversupplying local goods or services, it creates the perception that local expenditures are funded by non-residents. This creates misjudgment regarding the true benefits and costs of the local provision. Whilst this tendency is often driven by the politicians' maximization chances of election, the fiscal illusion might negatively affect the efficiency of public spending (Vo, 2010). If not controlled, it might also cause unstable borrowing and undermine the credibility of central government not to bail out the high dependent regions (Rodden and Wibbels, 2002, p.506). Following the same logic, the intergovernmental transfers might reward fiscal deficit (Shah, 1994), in cases where local governments are allowed to overborrow from local banks with little national oversight (Wibbels, 2000), as evidenced in many countries.[22]

Alternatively, by allowing local governments to mobilise their revenue, local governments are likely to put less pressure on central government budgeting and lower the chances for larger national deficits, increased money supply and inflation (Martinez-Vazquez and McNab, 2006, p.43). In the same vein, Marlow (1988) states that in the absence of decentralisation, the central government might heavily rely on inflationary finance due to the exclusivity of printing money.

A note of caution is required when considering FD and macroeconomic stability in times of crises or economic downturn. In times of crises, local governments' fiscal policy might be different, even contradictory, with the one at central government (Prud'homee, 1995; Thiessen, 2003). This becomes problematic when local governments might be asked to reduce the expenditures and alter the tax base to mute economic shocks in synchrony with the central government. Local governments' officials might be unwilling to respond accordingly to negative shocks (Rodden and Wibbels, 2002) and thus undermine policies at national level. In contrast, Sewell (1996) contradicts on the argument on the anticyclical nature of local government policies by claiming that local governments, mainly large ones, can play an essential role in the stabilisation policy as a response to business cycles. Due to diverse business cycles, the respond of local governments is likely to be more efficient than central government as for the latter it may be costly to differentiate the budget subject to diverse business cycles.

[22] See Rodden and Wibbels (2002) and Rodden *et al.,* (2003) for a detailed overview.

Returning to the triangular relationship, it seems that the debate on the relationship between FD, macroeconomic stability, and economic growth requires more attention both from the theoretical and empirical perspective, while considering a variety of fiscal and political factors such as the level of FD or political structure. Despite the formal incorporation of the macroeconomic stability into a growth production function (Martinez-Vazquez and McNab, 2003; 2006), the precise relationship between FD, macroeconomic stability, and economic growth has not yet been clarified (Rodden and Wibbels, 2002; Martinez-Vazques and McNab, 2003; 2006; Treisman, 2006; 2007). The existing literature (Martinez-Vazquez and McNab, 2003; 2006) is sceptic on the definite economic effect of FD through macroeconomic stability.

De Mello (2000) argues that as far as FD promotes efficiency and accountability among local governments, FD can contribute to macroeconomic stability. Soft-budget constrained and debt-overhang problems (p.1) smooth the fiscal imbalances of local governments, which in turn help to better channelise the public resources into more growth-enhancing practices. Contrary, Eller (2004) disagrees with the ability of FD to affect growth through macroeconomic stability. As local governments cannot engage in expansionary policies due to soft-budget constraint, this channel of transmission is weakened as far as central government intervenes by controlling spending patterns at all levels (to match it with its cyclical efforts) and the size of subnational governments is considerably small to react to expansionary policies.

Overall, the maintenance of fiscal discipline is considered as a severe challenge of FD, which drags this relationship in the opposite direction, especially in developing and transition economies (Martinez-Vazquez and McNab, 2003, p.1605). Further, Rodden and Wibbels (2002) argue that fiscal and monetary mismanagements are mostly observable among the federations (which are developing countries), rather than the unitary ones. The rationale behind the importance of federal political structures on macroeconomic management relates to the high level of devolution in these countries. Any attempts to ensure price stability, money growth and fiscal budget balance must be coordinated with all governing levels (p.500). However, there are weak incentives for local officials, which are self-interest driven, to coordinate their actions and create positive externalities for the whole country.

(ii) New Channels of Transmission

Another potential indirect channel of transmission, though not explicitly recognised in the FD-growth literature, is the ***government size***, which is linked to the well-known Leviathan theory. By focusing on the behaviour of political agents and the performance of the decentralised system based on the fiscal and political incentives faced by subnational officials (Weingast, 2006), the Leviathan theory treats politicians as rent-seekers who tend to maximize rents extracted (strong incentives to stay in power, augment salaries, control more money and people) from the economy. This theory considers FD as a solution to the problems associated with rent-extraction via introducing competition among jurisdictions, which breaks the monopoly just as in the private sector (Porcelli, 2009). In this context, it is argued that local government officials tend to be more focused on their citizens' objectives than central government politicians, due to their greater proximity to residents and the need to gain their approval for re-election.

In the light of this theory, FD is considered as a tool to restrict (i) the provision of public goods under revenue constraint, which would prevent the oversupply by raising the x-inefficiency (Thiessen, 2003), and (ii) growth of government spending (Rodden 2003), caused by competitive pressures at local level. Consequently, this would lead to a smaller government size at national level (Brennan and Buchanan, 1980). Alternatively, FD might increase the government size by better matching public goods and services to local preferences and enhancing citizens' trust (Ligthart and Van Oudheusden, 2011). Whilst the local demand for goods and services would be increased by this bottom-up pressure, the overall public sector size would be ultimately greater.[23]

Despite the contribution of Leviathan theory in linking the government size and FD, there is still vagueness on the causal mechanism of the economic effect of FD through this presumed indirect channel. However, we may hypothesise on potential associations between the change in the government size, FD (i.e. higher or lower subnational spending/revenue) and economic growth by using Barro's (1990) model on the relationship between the government size and economic growth in a context of multi-tier government. Assuming a bottom-up approach, a change in subnational

[23] Also, this might confirm the fiscal illusion hypothesis.

government size, as a reaction to horizontal or vertical competition, would also affect the overall public sector size. A smaller government at national and subnational level is likely to stimulate the intervention of the private sector (by creating market conditions that allow firms to exploit their competitive advantage (Porter, 1996)), which could promote local markets and in turn enhance regional and national economic performance (Smith, 1992; 1997). Next, FD is assumed to affect economic growth through institutional failings, such as ***corruption***, as the third potential indirect channel of transmission. It is well known that corruption, through bribes and kickbacks, distorts the allocation of resources and the composition of government expenditure (Martinez-Vazquez and McNab, 1997). According to Mauro (1996), this is a typical phenomenon in large capital investment project. In this concern, it is argued that central government, having power and budget, is more prone to be engaged in corruption schemes different from the local governments with limited fiscal power. Further, creating advantages by the pronounced distance from the public eye, central government, particularly in developing countries, have a tendency to be less accountable (Fisman and Gatti, 2002). Following the same logic but at local level, local governments are likely to be more directly accountable and observable by the public (p.328), which forces them to properly match the provision of public goods to local preferences.[24] Opposing arguments are provided by Thiessen (2005), who alerts that proximity to local agents might, in contrast, favour the misuse of power from certain jurisdictions due to nepotism and clientelism.

On the other side of the discussion, from the political perspective, Fisman and Gatti (2002) urge caution, especially for developing countries, on competence and bureaucratic “quality”. Local governments are less likely to attract high skilled bureaucrats given the low (economic and political) reward of politicians at local level in comparison to the central government. In this context, two opposing arguments are in place. Politicians at local levels tend to be less accountable due to the presence of lower monitoring, which might result in increased corruption. Alternatively, the low reward at local level, relative to central government, might demotivate politicians to engage in small benefit corruption practices.

[24] The rationale is that local governments might be more directly accountable than central government because the former are responsible for certain task of the region different from central government which focuses on the overall country’s performance.

Irrespective of the direction of the effect of FD on corruption, the above discussion might point towards the relationship between local corruption and economic growth. Whilst this relationship is beyond the scope of this thesis, it is important to emphasise and introduce in the literature the concept of local corruption as a phenomenon induced by FD, which could hinder/boost regional and eventually national growth. However, the direction and the magnitude of this effect needs further theoretical and empirical investigation, while focusing on political decentralisation.

2.4. Review of the Empirical Literature

Reviewing the FD-economic growth literature is challenging, mostly due to the multidimensional nature of FD, disagreement on the appropriate FD measures and the lack of a solid theoretical justification on the inclusion of the latter into a growth model. Despite the limited theoretical guidance on the FD-economic growth relationship, as reviewed intensely in the previous sections, the empirical literature has widely spurred during the last two decades. The empirical research provides meaningful insights into various aspects of this relationship, though failing to agree on its nature and strength. Given the heterogeneity and diversity of the studies, this section will provide a review, organised as Section 2.2, based on the level of investigation/aggregation: national and subnational level. Subsequently, it will be easier to shed light on the differences between these two groups and heterogeneities within the same group such as the development stage, model specification, time horizon covered and the theoretical framework followed. Hence, the review presented below aims to analyse the empirical research at different levels of aggregation, while focusing also on the main heterogeneities which, for simplicity, can be grouped into: (i) development level of a country and FD measures used (ii) theoretical framework, and (iii) methodology employed. The first subsection will provide a review of studies at national level, proceeding with Section 2.4.2 at regional level.

2.4.1 Empirical Literature at National Level

Following the aforementioned structure, the results of the main studies conducted at national level have been first summarized in a tabular format. Table 2.1 summarises the key features of the empirical studies by providing details about their authors, sample under analysis, period of investigation, measures of FD, methodology and main conclusions of the analysis.

Table 2.1 Summary of the review of main empirical literature on FD-economic growth relationship at national level

Study	Sample	Period	FD measure(s)	Method(s)	Main Conclusions
Davoodi and Zou (1998)	46 developing and developed countries	1970-1989	Expenditure decentralisation	OLS	Negative, although weak effect in developing countries and none in developed countries.
Xie *et al.* (1999)	USA	1948-1994	Expenditure decentralisation	OLS	The existing local spending shares are consistent with growth maximization. Further decentralisation may be harmful to growth.
Im and Lee (2001)	63 developing, semi-developed and developed countries	1972-2007	Expenditure decentralisation and Political decentralisation	Random Effect Model	A significant negative relationship between FD and economic growth for the mixed sample, developing countries and semi-developed countries and an insignificant relationship for developed countries.
Thiessen (2003)	21 OECD countries	1973-1998	Expenditure decentralisation, Revenue decentralisation, Quadratic term of decentralisation, dummy variables for low, medium and high degree of decentralisation	Generalised Least Squares	Significant non-linear effect of FD on growth; there seems to be a point where no longer further decentralisation promotes growth, which suggests that medium degree of FD is growth enhancing. Extreme decentralisation (both low and high) may retard growth.
Iimi (2005)	51 developed and developing countries	1997-2001	Expenditure decentralisation, Political decentralisation	OLS, IV	Positive significant effect of FD on growth; FD is instrumental in promoting growth
Bodman and Ford (2006)	21 OECD countries	1981-1998	Expenditure decentralisation, Revenue decentralisation, Taxation decentralisation, Vertical imbalance	OLS	No significant relationship between FD and growth in the cross-section analysis, whereas taxation decentralisation is suggested to affect negatively growth in the panel data analysis.
Thornton (2007)	19 OECD countries	1980-2000	Revenue decentralisation, Revenue autonomy over, the quadratic term of revenue autonomy	OLS	Insignificant effect when FD is limited to the revenue autonomy (revenues over which subnational governments has full autonomy).

Rodriguez-Pose and Kroijer (2009)	16 Central and East European Countries	1990-2004	Expenditure decentralisation, Revenue decentralisation, Vertical Imbalance	Dynamic model (Fixed effects with different annual lags)	Expenditure decentralisation and transfer from central government affect negatively growth. Revenue decentralisation initially correlates negatively with growth, after 6-year lag relates positively and significant.
Behnisch *et al.* (2003)	Germany	1950-1990	Expenditure decentralisation	Time Series Analysis[25]	Negative and significant association between expenditure decentralisation and growth
Feltenstein and Iwata (2005)	China	1952-1996	Economic decentralisation, fiscal decentralisation (tax, expenditure, revenue and transfers from central government)[26]	Vector Autoregression (VAR)	Positive and significant effect of economic decentralisation on economic growth. Other forms of decentralisation insignificant.
Malik *et al.* (2006)	Pakistan	1971-2005	Expenditure decentralisation, Revenue decentralisation, Subnational expenditure as a share of revenue (gap)	Vector Autoregression (VAR)	Mixed results; expenditure and revenue decentralisation have a significant contribution to growth, whereas the gap between expenditure and revenue has a negative effect on growth.
Faridi (2011)	Pakistan	1972-2009	Expenditure decentralisation, Revenue decentralisation	OLS	Positive and significant effect of both expenditure and revenue decentralisation on economic growth.
Gemmell *et al.* (2013)	23 OECD countries	1972-2005	Expenditure decentralisation; Self-expenditure decentralisation; Own-revenue decentralisation; Tax decentralisation; Revenue decentralisation.	Pooled Mean Group	Negative effect of expenditure decentralisation on economic growth, but positive impact of revenue decentralisation on economic growth.

[25] No detailed information on the methodology is provided in the paper.
[26] Economic decentralisation is defined as the shift of economic activities from the state to non-state sector.

(i) Development level of a country and FD measures used

Research has produced diverse and inconclusive results on the impact of FD on economic growth for mixed samples[27], developed, developing and transition economies, primarily due to the wide range of FD measures adopted and country characteristics.

Mixed Sample

As to the mixed sample group of studies, some research provide evidence of a positive effect of FD on economic performance (Ebel and Yilmaz, 2002; Iimi, 2005; Enkilopov and Zhuravskaya, 2007), while others claim the detrimental (Davoodi and Zou, 1998; Im and Lee, 2001) or even insignificant impact (Martinez-Vazquez and McNab, 2006). The first empirical study in the FD-economic growth relationship (also part of the mixed study group) Davoodi and Zou (1998), provides evidence of a negative economic effect of FD, measured by expenditure decentralisation, for a dataset of 46 developed and developing countries. Whilst pooling countries of different stages of development appear to be less informative, a more detailed analysis of the two subsamples showed the importance of development stages in determining the economic effect of FD. A negative relationship between expenditure decentralisation and growth is found in developing countries, whereas no impact is exerted in developed economies. The authors attribute this negative relationship in developing economies to several factors such as: (i) the measurement of FD and its inability to capture the welfare effects of capital and current spending, (ii) the excessive current expenditures, which are unlikely to contribute positively to a higher economic growth, and (iii) the lack of financial resources and administrative capability, and the inability of local government to respond effectively to local needs especially in developing countries where the level of decentralisation is practically low.

A similar study, conducted by Im and Lee (2001) for a sample of 62 countries, confirms the moderating role of development stage in the FD-economic growth relationship. More precisely, this investigation suggests a negative relationship between expenditure decentralisation and economic growth for the world sample,

[27] A mixed sample consists of different countries with different level of income: developed, developing and transition economies.

semi-developed countries and developing countries and an insignificant effect for the developed ones.

Alternatively, Iimi (2005), while addressing potential endogeneity in the FD-growth relationship through the use of an IV approach, report that FD (particularly expenditure decentralisation) is influential to economic growth, though no moderating role of stages of development is observed. In the same vein, Yilmaz (1999) and Ebel and Yilmaz (2002) claim that the economic effect of FD does not necessarily depend on the development stage of a country; it is the country's governance structure that is more likely to influence this relationship. The estimated effects are more likely to be distorted by differences in the governance system due to the different meaning and impact of decentralisation in unitary and federal countries, which if not considered might produce problems of misspecification. To overcome this shortcoming, Yilmaz (1999) estimates the FD-economic growth relationship by distinguishing between unitary and federal states in a panel of 46 developed and developing countries. This study found that the decentralisation of expenditure has a positive effect on growth in unitary states, but none in federations. Instead, studies that used dummy variables to distinguish between these two distinct governance systems failed to find significant differences in the FD-growth effect (Thornton, 2007; Baskaran and Feld, 2009). When dividing the existing empirical literature subject to the governance system, little variation in the economic effect of expenditure decentralisation is observed, while suggesting that this characteristic does not prevail in a qualitative literature review. As the majority of studies focusing on national level are cross-country studies, variations appear to be larger across samples with different income level rather than across governance system (see Behnisch *et al.,* 2003; Feltenstein and Iwata, 2005; Bodman *et al.,* 2009a).

Despite its widespread use and popularity, Davoodi and Zou's (1998) research and the above succeeding studies have been criticized for neglecting the multidimensional nature of FD, namely using only expenditure decentralisation as a measure of FD.[28] No single indicator can capture and precisely estimate the real level of a country's

[28] Although Iimi (2005), Enkilopov and Zhuraskaya (2007) incorporate a measure of political freedom, still this measure does not represent a measure of fiscal decentralisation but a measure of political decentralisation. When referring to fiscal decentralisation, one should take into account possible measures of revenue decentralisation, revenue autonomy, transfer decentralisation, vertical imbalance etc.

decentralisation in general and FD in particular (Stegarescu, 2005; Sachi and Salotti, 2011). A replication of Davoodi and Zou's research by Ebel and Yilmaz (2002) reveal the sensitivity of empirical findings to the choice of FD measure. Once the FD measure changes from expenditure to revenue decentralisation, the estimation results change drastically from negative to positive, with contradictory consequences for policymaking. The authors explain that measuring expenditure decentralisation by subnational expenditure as a share of total expenditure does not accurately reflect the subnational government's autonomy in expenditure decision making. The decisions at local level may be constrained by the central government, especially in developing and transition economies where local governments mostly act as administrative agents of national government (Rodden, 2003). Also, the use of solely expenditure decentralisation ignores the potential effects of revenue decentralisation and the importance of intergovernmental income transfer by central government to subnational governments. Expenditure decentralisation without corresponding revenue decentralisation (tax powers) and indication of the "common pool" resources such as grants and revenue-sharing will tend to bias the true level of decentralisation.

Similarly, using only revenue shares to measure FD tends to produce biased (mostly) positive impact on economic growth (Zhang and Zou, 2001; Ebel and Yilmaz, 2002). Despite the incomplete argument on the predetermined economic impact of revenue/tax decentralisation, it is worth noting that no inference has been made by these studies on the channels of transmission from FD to economic performance, neither on the superiority of FD measures, which could shed light on the relative relationship between expenditure and revenue decentralisation and their distinct effect on growth. It should be noted that studies that consider either expenditure or revenue decentralisation to measure FD are incomplete and might reveal only half of the relationship between FD and growth. It is their simultaneous effect on economic growth that should better uncover the FD-economic growth relationship (Jin and Zou, 2005).

However, the results should still be interpreted with caution not only with respect to the coefficients of each measure, but also to the imbalance between expenditure and revenue decentralisation. An important dimension of FD, ignored in all the above studies, is the local financing in meeting the expenditure responsibilities (Rodriguez-Pose and Kroijer, 2009). Ignoring the dependency of local governments to central government might still blur the genuine relationship between FD and economic growth. To uncover all the dimensions of FD and their economic effect it is important to consider intergovernmental transfers as an additional measure of FD due to its superiority in measuring the difference between revenue-raising power and spending responsibilities (dependency of local government), impossible to be captured otherwise.

Apart from the interesting insights and the popularity of the above research, the use of mixed samples might be considered as not much informative as it pools together countries with substantial differences in economic development, importance of decentralisation and many other socio-economic differences (e.g. institutions, culture, history). However, a study conducted on a more homogenous group of developed economies may not show conclusive evidence, with results that are highly sensitive to the FD measures used.

Developed economies

Some studies from developed countries suggest that expenditure decentralisation, independently of the additional measures used, affect negatively economic growth, contrary to the positive impact of revenue decentralisation (Behnisch *et al.,* 2003; Bodman *et al.,* 2009a; Rodriguez-Pose and Ezcurra, 2011; Gemmell *et al.,* 2013). Alternatively, Bodman *et al.* (2009b) and Asatryan (2011) suggest that FD, measured by revenue decentralisation, affects negatively the growth of GDP per capita. These studies attribute the negative effect of FD (either measured by expenditure or revenue decentralisation) on growth to the lack of subnational governments' ability to better tailor local preferences to public goods and services, lack of power to overcome issues regarding lower quality of governance and inconsistent and arbitrary use of FD measures. However, it should be noted that the majority of the studies from developed countries fail to find a significant relationship between FD and economic growth (Xie *et al.,* 1999; Feld *et al.,* 2004; Bodman and Ford, 2006; Thornton, 2007; Bodman *et al.,* 2009a; Baskaran and Feld, 2009; Feld *et al.,* 2009a; Asatryan and Feld, 2013). Likewise, empirical results concerning the impact of FD on economic growth for both cross-country and single-country studies grant clear evidence on neither the existence of this relationship nor its magnitude.

Baskaran and Feld (2009) attribute this insignificance to the fact that decentralisation in general and revenue decentralisation in particular are not related to economic growth as the former is quite sticky and rarely changing because is thought as a part of a country's long-run institutional structure, which does not fluctuate very often. On the other hand, Xie *et al.* (1999) interpret the insignificant coefficient of FD as a growth-maximising level of FD, based on the FD-growth model presented in Equations (2.26-2.30). Others (Thiessen, 2005; Feld and Kirchgassner, 2004) argue that this insignificance might come from an erroneous assumption of a linear relationship between FD and economic growth. Pooling countries with distinct FD-growth relationships in a cross-country study become impossible to find any significant relationship between FD and growth if the nonlinearity of this relationship is not taken into consideration. Some weak evidence is found regarding the nonlinear relationship between FD and growth at national level and the hypothesis that the medium degree of FD promotes growth (Xie *et al.,* 1999; Thiessen, 2003, 2005; Eller, 2004), however some fail to confirm the hump-shaped relationship between FD and growth (Bodman and Ford, 2006; Thornton, 2007; Rodriguez-Pose and Ezcurra, 2011). These studies claim that decentralisation is not subject to the level of country's income, as suggested by mixed samples; nevertheless, an optimal level of FD has to exist to be able to maximize economic growth.

By using a cross-section and panel dataset of OECD countries from 1973 to 1998 and in a parallel panel dataset between 1981 and 1995, Thiessen (2003) suggests a non-linear relationship between FD and economic growth, though no theoretical reasons are provided for the humped shape. Conventional and new FD measures were used such as the expenditure decentralisation, variables to account for a hump-shaped relationship, a measure of self-reliance and three dummy variables for low, medium and high degree of FD.[29] The quadratic of the expenditure indicator and the dummy variables, also known as "spline" variables, were employed to test for the non-linear relationship between FD and growth, following the Calmfors and Driffill (1998) method.[30] This study suggests that the successive increase of expenditure

[29] Self-reliance is measured as the share of own revenues as a percentage of subnational total revenues.
[30] First, the countries are ranked for each period subject to their level of decentralisation: low, medium and high. Numbers are assigned to countries according to their ranking, where countries that have the lowest and highest level of decentralisation get the value of one. The next lowest and highest values of decentralisation get a higher value. This procedure goes on up to the medium degree of decentralisation that has the highest value.

decentralisation for countries with low degree of decentralisation may stimulate investment and improve technological progress, which is estimated as potential channels of transmission of FD on growth; consequently, enhance economic growth. However, beyond a certain point, FD has no longer positive effect on growth. Extreme decentralisation and centralization (high and low decentralisation, respectively) seem to create more disadvantages than advantages for a country's growth. Long-term economic growth would be promoted only by an optimal degree of decentralisation, which would avoid the adverse effect on growth from either "too much" decentralisation (i.e. regional inequalities) and "too little" decentralisation (i.e. low fiscal autonomy) (Thiessen, 2005). The empirical findings reveal an inverted hump-shaped relationship between FD and growth, where countries need to find the optimum (medium degree of decentralisation) to enhance growth. In the same vein, Eller (2004) in a similar panel data analysis of OECD countries suggests that extreme decentralisation does not necessarily hinder growth; high degree of FD does not impede growth, but so does the low degree of decentralisation. The author argues that low degree of FD is likely to affect negatively growth because of unconsidered preferences' heterogeneity, which in turn causes inefficiencies in public goods and services provision.

Thornton (2007), on the other hand, fails to provide any evidence of a hump-shaped relationship between FD and economic growth. In fact, the issue of the optimal size of FD becomes challenging when considering all dimensions of FD simultaneously. Reinforcing the argument made by Martinez-Vazquez and McNab (2006), as argued also in Section 2.2.3, instead of single optimum, the FD-economic growth relationship might be faced with multiple optimum which challenges the nonlinearity of this relationship. It is unclear whether all the dimensions of FD (expenditure, revenue and vertical imbalance) have an optimal level or only one/few of them. Moreover, the nonlinearity argument becomes less relevant in a cross-country context with supposedly many optimal degrees of FD, in general, of individual countries across many unknown optimal degree of individual measures of FD in particular.

Developing countries

A growing body of literature on developing countries investigating national growth has also emerged in recent years. However, empirical evidence at national level is scarce. Within this limited number of empirical studies, evidence is mixed. Regarding the cross-country studies, Woller and Philips (1998), using a sample of 23 developing countries between 1974 and 1991, failed to find a significant contribution of FD (measured by expenditure and revenue decentralisation) to economic growth, though a weak inverse relationship is found only in long-run between revenue decentralisation and economic growth. Similar results were suggested by Martinez-Vazquez and McNab (2006), while some fragile evidence of an indirect relationship through the inflation channel is reported.

Alternatively, the other studies conducted in developing countries at the national level are all single-country studies. Malik *et al.* (2006) provide mixed results when estimating the relationship between FD and growth for Pakistan during the period 1971-2005. Some of the variables of decentralisation (expenditure decentralisation and the ratio of subnational government revenues fewer grants-in-aid to total government revenues) are found to be positively correlated to economic growth, whereas other measures correlate either negatively or insignificantly to growth (revenue decentralisation). Overall, the study suggests that FD accelerates economic growth. With a similar dataset (period 1972-2009), Faridi (2011) estimates the economic effect of FD on national growth. Through a time-series analysis, the author confirms Malik *et al.*'s (2006) results, although the FD measures are limited only to expenditure and revenue decentralisation. Both measures employed are positively correlated with economic growth. On the other hand, Philip and Isah (2012) failed to find a significant relationship between FD and growth for Nigeria, whereas Khattak *et al.* (2010) contradicts the positive relationship between revenue decentralisation and economic growth. Despite the novelty in investigating this relationship in developing countries, the above findings can be challenged by noticeable misspecification errors not only to the appropriate measure of FD but also to the main determinants of growth, neither complete explanation was given to support the findings.

Possible reasons for a negative relationship between FD and economic growth in these countries might be related to high deficits, poor quality of governmental decisions, higher inequality and corruption (Rodden, 2003). Lack of sufficient capacity of local governments compared to the central (Rodden and Rose-Ackerman, 1997) one might challenge the FD advantages to boost economic growth.

Transition economies

Characterised by similar problems, the transition economies produce mixed and contradictory results. Despite the emergence of FD in transition countries in general and ETEs countries in particular, evidence appears sporadic and sensitive to the FD measurement. The empirical research at national level appears relatively scarce, while the majority of studies are either conducted for China at subnational level or focusing on country-specific problems and policy solutions, especially for former Communist countries in Europe.

Meloche *et al.* (2004) investigate the impact of FD measured by expenditure decentralisation and fiscal autonomy (amongst alternative measures of the latter), point out the necessity of considering subnational governments' fiscal autonomy when referring to FD effect on economic growth. Their research on 10 selected ETE (from 1997-2002) concludes that the expenditure decentralisation itself does not seem to be related to economic growth, it is the degree of subnational government's autonomy that does affect growth positively. By addressing one the major weakness of measuring revenue decentralisation, this study highlighted the importance of considering the real fiscal autonomy of subnational governments when measuring decentralisation. Whilst this investigation might be criticised for its small size sample (30 observations), potential problems of heteroscedasticity and endogeneity which restricts the validity of the results provided, it makes an important contribution to the discussion over the appropriate measures of FD in transition economies.

Since neglecting the vertical imbalance is likely to cause a serious omitted variable bias, Rodriguez-Pose and Kroijer (2009), in their panel research analysis of 16 Central and Eastern European countries over 1990-2004, introduced intergovernmental transfers as a share of either subnational expenditure or revenue. The findings, somehow in accordance with Meloche *et al.* (2004), reveal that expenditure decentralisation and vertical imbalance retard the economic performance, while the degree of local tax-raising powers appears to have a negative impact in short run, but a positive economic effect in long run. Using different time lags, the analysis highlighted some of the acute problems of FD in ETEs related to lack of local accountability, tax-raising capacity and experience in being self-sufficient and meeting the local needs. However, it revealed that subnational government with their own revenue source are better able to tailor output to local preferences and eventually impacts growth positively in long run. Again, unfortunately, there is still no debate on the endogenous nature of this relationship and the appropriateness of using different time lags of FD as a dynamic approach, which risk the validity of the results. However, the existing studies for ETEs could not be used as a replica or comparison to this research given their inappropriate use of FD measures (e.g. subnational governments as a share of GDP) and misspecification errors (e.g. Stoilova and Patonov, 2012).

To date, China is the country where the relationship between FD and economic growth in a context of TEs has been most studied, partly because FD has been a central component of China's economic policy at a time when it has experienced remarkable economic growth and because its fiscal system is much decentralized despite being a communist country. However, there is only one study which focuses at national level. Using a VAR model with latent variables, Feltenstein and Iwata (2005) find a positive effect of both economic and fiscal decentralisation (revenue, tax decentralisation subnational transfers) on economic growth in a time-series analysis between 1975 and 2005. They argue that the institutional change toward a competitive market through decentralisation reform has impacted growth positively in China.

Overall, these mixed results among transition economies could be attributed partly to the large variety of devolved systems of decentralisation (varying degrees of fiscal, political and administrative powers) among transition countries and partly to specification differences of the studies investigating the FD-growth relationship. To investigate this relationship more thoroughly, it might be appropriate to limit the investigation into a homogenous set of countries or at least control for cultural, historical and institutional differences between countries (Akai and Sakata, 2002; Iimi, 2005; Enkilopov and Zhuraskaya, 2007; Rodriguez-Pose and Ezcurra, 2010).

The empirical evidence from transition countries and mostly from mixed samples draws attention to the role of institutions and political decentralisation. As local governments are closer to citizens, FD empowers individuals and helps to generate greater trust, collaboration and networking between citizens and government, which in turn can moderate the intensity of the FD effect on growth. In this context, Iimi (2005) and Filippeti and Sachi (2013) suggest that the economic effect of decentralisation, although does not change radically, is affected by various complementary factors such as institutions. FD may lead to pro-growth effects only when intergovernmental relationships are well-established within the institutional system. Thus, political decentralisation may play an essential role in shaping policies and the provision of public goods and services, which eventually is likely to influence the returns of subnational expenditure and revenue efforts (Rodriguez-Pose and Ezcurra, 2011, p.620). Complementing this argument, Iimi (2005), and Enkilopov and Zhuravskaya (2007) stress the importance of political freedom as a complementary to expenditure decentralisation as it reflects the benefits a country can have from the Tiebout mechanism. Overall, these arguments might point towards a critical level of income or institutions above which a country can utilise the potential gains from further decentralisation.

(ii) Theoretical framework followed

The lack of robust evidence, irrespective of the sample, has been attributed to some extent to the lack of a clear theoretical link (Martinez-Vazques and McNab, 2003), measurement of FD per se, misspecification errors and trade-off construction, which according to Breuss and Eller (2004) reflects the various pros and cons of decentralisation. As to the theoretical framework in which empirical investigations at national level sustain, the literature can be divided into two groups: (i) the Davoodi and Zou approach and (ii) the neoclassical approach. Although the majority of studies followed the first approach, the findings of these studies differ widely. Some provide evidence supporting the contribution of FD on growth (Xie *et al.,* 1999; Iimi, 2005), while others find mixed results (Meloche *et al.,* 2004; Malik *et al.,* 2006; Khattak *et al.,* 2010), negative (Zhang and Zou, 1998; 2001; Im and Lee, 2001) or no relationship at all (Woller and Philips, 1998; Gemmell *et al.,* 2013; Philip and Isah 2012). Though, it should be noted that the majority of the studies that adopt this framework are mainly cross-country studies. Similarly, the second group of studies fails to reach a consensus on the nature and strength of FD-economic growth relationship. Empirical evidence varies from positive (Martinez-Vazquez and McNab, 2003; 2006, Faridi 2011) to negative (Bodman *et al.,* 2009b), insignificant (Bodman and Ford, 2006; Thornton, 2007) and to studies showing a change over time of the FD-growth effect (Thiessen, 2003; 2005).

Mixed results are provided from both groups of studies. For instance, Malik *et al.* (2006) and Faridi (2011) both estimate the FD-growth relationship in Pakistan using a time-series analysis. Although they follow different theoretical framework (Faridi, 2011) follows an exogenous growth model, whereas Malik *et al.* (2006) follow an endogenous growth model) they both suggest a contribution of expenditure decentralisation and revenue decentralisation on economic growth. In this regard, the theoretical framework followed does not seem to be an important feature when reviewing the empirical research.[31] Rather, there are other factors that seem to influence the results on the effect of FD on economic growth.

(iii) Methodology

There is considerable heterogeneity in terms of methodological approaches and diverse designs for decentralisation among studies that investigate the FD-growth relationship. In most of the cases, empirical literature suffers from various methodological weakness. First, differences are due to the estimation technique: time-series analyses tend to provide more positive and significant results than cross-section and panel analyses. All the time series analysis investigating the FD-growth relationship at national level suggest either a positive effect or FD (independently of how FD is measured) or a positive effect for at least one of the measures employed (Behnisch *et al.,* 2003; Feltenstein and Iwata, 2005; Malik *et al.,* 2006; Khattak *et al.,* 2010; Faridi, 2011; Philip and Isah, 2012). Though, it could be argued that since all time-series analyses are single-country study, they offer a clearer picture than cross-country studies which are faced with strong institutional differences and measurement problems. As to the other two estimation techniques, the studies estimating a cross-section or/and panel analysis provide ambiguous results on the effect of FD on economic growth.

Another concern when investigating the FD-growth relationship is the distinction between short-run and long-run economic effect of FD. To capture the long-run effect, the first group of studies have used the multi-year (triennial or five-year) averages

[31] Though, it should be noted that Malik *et al.* (2011) use an additional measure of FD compared to Faridi (2011): the gap between expenditure and revenue decentralisation,

(Davoodi and Zou, 1998; Woller and Philips, 1998; Thiessen, 2003; Iimi, 2005; Meloche *et al.,* 2004; Thiessen, 2005; Thornton, 2007; Rodriguez-Pose and Ezcurra, 2010). Alternatively, Gemmell *et al.* (2013) uses a Pooled Mean Group model (PMG) to allow for short-term effect and as well to depict any possible long-term effect, and Rodriguez-Pose and Kroijer (2009) use different time lags to grasp the long-term effects depending on the type of decentralisation (using different lags of revenue decentralisation, expenditure decentralisation and vertical imbalance). However, no conclusive results are provided from both types of studies.

It is now recognized that studies that attempt to infer a causal relationship between FD and growth are often fraught with reverse causality, although some of them are unambitious in the way they treat causality. Reverse causality occurs because efficiency gains from FD appear as economies grow and more decentralisation is demanded at relatively higher levels of development (Martinez-Vazquez and McNab, 2003). To mitigate endogeneity, studies have used either instrumental variable (such as political decentralisation, transfers from central government), or lagged value of FD. However, there is a considerable lack of debate and estimation methods tackling endogeneity (mainly from samples with developing and transition economies), though some studies, at least, acknowledge it (Meloche *et al.,* 2004; Martinez-Vazques and McNab, 2006; Khattak *et al.,* 2010; Faridi, 2011). Whilst the studies that mention endogeneity and try to mitigate it are superior to those that neglect this problem, still, no conclusive evidence could be provided (Behnisch *et al.,* 2003, Iimi, 2005, Thiessen, 2003; 2005, Gemmell *et al.,* 2013, Rodriguez-Pose and Kroijer, 2009). As to the estimation technique used to mitigate endogeneity, some use Two or Three Stage Least Squares, others use IV, and a few recent studies have used dynamic panel model (Filippetti and Sachi, 2013). The last concern is the problem of omitted variables which is likely to produce biased estimates. Considering reverse causality in the FD-growth relationship and the problem of omitted variables (which may simultaneously affect FD and growth), estimates of the effect of FD on growth tend to suffer from simultaneity bias.

2.4.2 Empirical Literature at Subnational Level

As previously highlighted, the wide range of FD measures used and the lack of theoretical framework have contributed to a quite broad and diverse empirical literature on the FD-economic growth literature. It is pertinent to note, however, that the empirical evidence at subnational level offers more conclusive results than studies focusing on national level. A slight preponderance is noted among studies conducted at subnational level, by agreeing on the significant, mostly positive, role of FD on regional growth. Table 2.2 summarizes the authors, sample under analysis, period of investigation, FD measures used, methodology and the findings of main studies investigating the effect of FD on economic growth at subnational level. Consequently, the empirical literature review is organised similarly as the previous section by (i) the development level and FD measurement, (ii) theoretical framework and (iii) methodology used.

Table 2.2 Summary of the review of main empirical literature on FD-economic growth relationship at subnational level

Study	Sample	Period	FD measure(s)	Method(s)	Main Conclusions
Zhang and Zou (1998)	28 provinces in China	1980-1992	Expenditure decentralisation (consolidated, extra-budgetary and spending relative to income)	LSDV	Decentralisation of expenditure is harmful to provincial economic growth. Central and local tax rate has negative but non-significant effect on economic growth
Lin and Liu (2000)	28 provinces of China	1970-1993	Marginal retention rate of locally collected budgetary revenue and average retention rate of locally collected budgetary revenue	Fixed Effect Model	A significant positive relationship between FD and economic growth at provincial level.
Akai and Sakata (2002)	50 USA states	1992-1996	Expenditure decentralisation, Revenue decentralisation, Production decentralisation, Autonomy decentralisation, Production-Revenue decentralisation	Fixed Effect Model	Decentralisation of spending and Production-Revenue decentralisation (average of spending and revenues) affect growth positively and significantly at 1% level of significance. Revenue and Autonomy indicator do not significantly affect growth.
Feld *et al*. (2004)	26 Swiss Cantons	1980-1998	Expenditure decentralisation, Tax decentralisation, Lump-sum grants, Matching grants	OLS and TSLS	Decentralisation of spending, revenue and lump-sum grants have a non-significant effect on economic growth. Contrary, matching grants affect negatively growth.
Gil-Serrate and Lopez-Laborda (2006)	17 Spanish Autonomous Communities	1980-1997	Full revenue control decentralisation, Medium revenue control decentralisation, low revenue control decentralisation	Fixed Effect Model	Only low revenue control decentralisation does significantly contribute to regional economic growth.

Huang and Cheng (2005)	31 provinces of China	1996-2004	Provincial revenue as a share of budgetary revenue, Provincial revenue as a share of extra-budgetary revenue, Square term of both abovementioned measures	OLS	The relationship between FD and economic growth at provincial level has a U-shaped trajectory. Initially, FD contributes negatively and after reaching the critical point then contributes to growth.
Rodriguez-Pose *et al.* (2007)	Separate analysis at regional level in Germany, India, Mexico, Spain, and the USA	1985-2002	Decentralisation of capital expenditure, decentralisation of current expenditure and their respective growth rates	OLS	An increase in current expenditures at the expense of capital expenditures has impacted regional growth negatively in countries where devolution has been driven from above and positively where devolution has been driven from below.
Carrion-i-Silvestre, Espasa and Mora (2008)	17 Spanish Autonomous Communities	1980-1998	Expenditure decentralisation	OLS	The decentralisation of spending has a negative effect on overall growth (national level), however a positive effect when focusing at subnational level. Evidence of a development level threshold.
Feld *et al.* (2009a)	16 German Lander	1975-2005	Expenditure decentralisation, Revenue decentralisation, Vertical and horizontal transfer	Fixed Effect Model	Intergovernmental transfers have no impact on economic development. Providing subnational governments with more responsibilities would enable them to enter competition and affect economic growth.
Samimi, Haddad and Alizadeh (2010)	30 provinces of Iran	2001-2007	Expenditure decentralisation	Fixed Effect Model	A significant positive relationship between FD and provincial economic growth exists at provincial level.
Yushkov (2015)	78 Russian regions	2005-2012	Expenditure decentralisation, revenue decentralisation, 2 vertical imbalance measures and the municipality autonomy indicator	Fixed Effect Model	Excessive expenditure decentralisation, without corresponding revenue decentralisation, is harmful to regional growth. Intergovernmental transfers contribute positively to growth.

(i) Development level of a country and FD measures used

The studies focusing on the subnational level are single-country studies, different from the empirical literature at national level where the majority of studies were cross-country studies.

Developed countries

Regarding the studies conducted for the U.S, empirical evidence suggests either a positive relationship between FD and growth (Wallis, 1999; Akai and Sakata, 2002; Hammond and Tosun, 2009) or a non-linear relationship (Akai *et al.,* 2007). Wallis and Oates (1988) and Wallis (1999), using the expenditure and the revenue shares as FD measures, provide the first contributions in the FD-growth relationship by arguing that fiscal federalism is crucial in fostering economic growth in the U.S. Another important contribution in this field is the study of Akai and Sakata (2002), which heavily criticizes Xie *et al.*'s (1999) results at national level. Akai and Sakata (2002) argue that the multidimensionality and complexity of federalism become difficult to be measured and estimated at national level, especially when substantial historical, cultural and/or stage of development differences across countries are not taken into consideration. To overcome this weakness, the authors disaggregate the U.S. into its 50 States and consider additional explanatory variables to capture the differences between states.[32] The results of this investigation revealed the sensitivity of the economic effect of FD to the measurement of the latter. Whilst revenue decentralisation is conducive to growth, expenditure decentralisation impacts negatively on economic growth at state level.

Akai *et al.* (2007), on the other hand, argue that such weak (both positive and negative) relationship might be attributed to the erroneous linear relationship assumed. By using the square term of expenditure decentralisation and revenue decentralisation in a panel dataset with 50 U.S. states over 1992-1997, the authors suggest that the existing degree of FD is below the optimal level, and further decentralisation is recommended to enhance growth. Despite the novelty in introducing nonlinearity in the FD-economic growth relationship, it might be argued that the short time series makes it difficult to

[32] Population growth rate, education level and labour quality, liberal vs. conservative tendencies, Gini coefficient, quality of regional human capital, trade openness, regional-specific effect, revenue indicator decentralisation, production indicator decentralisation, autonomy indicator and production-revenue indicator.

depict a decent trajectory of the effect of FD on long-run economic growth, necessary for a non-linear relationship to be visible. Also, the small sample size, especially when forcing it into a cross-section, might risk the validity of the results. An important shortcoming in all the above studies is the lack of a clear debate on the appropriateness of the FD measures, which addresses the real authority of regions to impose taxes, alter tax rates and bases, and the reliance on its own funds. Also, it is pertinent to note that these studies lack critical discussion regarding potential sources of endogeneity and ways to account for it.

With regard to other countries, the evidence is also offered from the most fiscally decentralized developed countries such as Germany, Switzerland and Canada, and for other countries with a medium degree of decentralisation such as Australia and Spain (Rodriguez-Pose and Ezcurra, 2011). Evidence is mixed, however still less ambiguous than the respective studies at national level. In general, research trying to grasp the link between fiscal federalism and economic growth in Germany and Switzerland raise attention to the negative effect intergovernmental transfers has on economic development. Feld *et al.* (2004a) claim that apart from the use of conventional measures of FD (expenditure and revenue decentralisation), intergovernmental transfers should be additionally incorporated in FD measures because the latter can be considered as an important instrument of cooperative federalism (cooperation between national and subnational governments). In a similar vein, Berthold *et al.* (2001) and Feld *et al.* (2009a) reveal that grants (mainly matching grants) are harmful to regional economic development of Germany and Switzerland. This contradicts the study of Behnisch *et al.* (2003) which suggests a positive effect of FD at national economic growth of Germany. However, while this study's reliance solely on expenditure decentralisation may be considered a weakness, its results challenge the FD conventional measures used in the literature. Regarding the conventional measures, evidence provides ambiguous results. Feld *et al.* (2009a) fail to find any significance of both expenditure and revenue decentralisation on economic performance. The authors argue that the theoretical importance of competition for tax bases for beneficial effects of FD on economic growth does not hold in case of Germany because this country is not characterized by competitive federalism, where tax competition can be used by local governments to enhance growth. The latter, as also previously stressed, emphasizes the need to include transfers and grants as a measure of FD where it is a feature of cooperative federalism in Germany.

As for Spanish economy, where the degree of FD is similar to the main federal countries and greater than unitary ones, a considerable amount of studies aiming to quantify the FD-growth relationship has emerged. The evidence offered by this series of studies, to some extent, agree on the contributing role of FD on regional growth, despite being subject to the FD measurement. Different from the other countries, studies for Spain offer a very wide range of FD measures from expenditure to decentralisation to dummy variable if regional government has the responsibility of providing education, which challenges the comparison of empirical findings at regional level.

Studies using expenditure decentralisation and dummy variables as a measure of FD[33] provide positive evidence of the impact of FD on regional economic development (Solé-Ollé and Esteller-Moré, 2001; Carrion-i-Silvestre *et al.,* 2008), whereas, other studies, which use revenue decentralisation as an additional measure of FD, suggest an insignificant effect or a negative one (Agundez-Garcia, 2000; Perez and Cantarero, 2006; Cantarero and Gonzales, 2009). Gil-Serrate and Lopez-Laborda (2006) went further by distinguishing between different types of fiscal revenue control which Spanish regional governments have (full revenue, medium revenue and low revenue control decentralisation) according to the economic classification of public accounts and analysing the indirect effects of FD on growth. An FE estimation over the period 1984-1995 showed that the low revenue decentralisation indicators usually exert a weak positive effect on growth, while the full and medium revenue indicators have a strong significant effect on growth only indirectly through the private investment channel. However, the rationale of these indicators, while neglecting the other dimensions of FD (i.e. expenditure, transfers), and the reverse causality of the FD-economic growth relationship especially when investigating its indirect effect, are considered as potential explanations of the insignificant results when investigating the direct effect. More explanation regarding the appropriateness of the methodology used and control variables are required to validate the empirical findings.

[33] Dummy variable if regional government has the responsibility of providing regional roads and dummy variable if regional government has the responsibility of providing education.

Another study conducted in Spain is the one of Carrion-i-Silvestre *et al.* (2008), which found that FD has a negative effect on economic growth at the aggregated level of Spain but a positive economic effect in those regions where FD is high, while stressing the Prud'homme argument (recall Section 2.3.1) over the existence of a critical level of FD to be conducive to growth. Further, an attempt to verify whether a nonlinear relationship holds for the case of Spain, Gil-Serrate and Lopez-Laborda (2006) and Cantarero and Gonzales (2009) fail to suggest such relationship between FD and regional growth.

Developing countries

The evidence from developing economies mostly suggests that FD enhances regional economic growth. The recent major contributions are from Indonesia, Iran, Pakistan, amongst others South Africa. Unlike the studies in developed countries, studies using expenditure and revenue decentralisation as an indicator of FD suggest that spending decentralisation contributes to economic growth, whereas revenue decentralisation is found to be harmful to regional growth (Ismail and Hamzah, 2004; Shahdani *et al.,* 2012). Similarly, the studies that use only expenditure decentralisation as a measure of FD, although some of them incorporate measures of political decentralisation, argue that FD boosts economic growth (Samimi *et al.,* 2010; Pal and Roy, 2010). One of the key studies in this field is that of Ismail and Hamzah (2004), which assess the effect of the implementation process of FD on the Indonesian regional growth. By using a dataset of 26 provinces for the periods of 1992-2002, the estimated model suggests that only revenue decentralisation is negatively correlated with economic growth both in short term and in the long term. Other evidence on developing countries, unfortunately, do not deeply investigate the effect of FD on growth such as investigating whether FD through enhanced resource allocation, accountability or/and competition affects growth. A common weakness of all the studies from developing countries is the little attention paid to the real decision-making power of local governments and the intergovernmental transfers from central government, as such, it is assumed that the level of share in revenue indicates the level of autonomy in local governments, which is likely to distort the estimated effect of FD on growth.

Transition economies

Mostly due to its need to decentralise, empirical research in Russia has emerged lately, though still limited at regional level. The findings turn out to be mixed, from positive effect of fiscal autonomy (Desai *et al.,* 2005) to negative impact of expenditure decentralisation to regional growth (Yushkov, 2015). Contrary to the conventional expectations and findings, greater transfers from the federal government are conducive to growth, highlighting the advantage of regional government in better allocating the funds according to the region's needs. Another explanation could be related to the flypaper effect (also known as *money sticks where it hits*), which reduces the excessive expenditure decentralisation at regional level and funds are spent efficiently.[34]

China, on the other hand, remains a country where the FD-growth relationship has been widely investigated at subnational level. Studies provide a mixture of FD measures, economic growth measures and estimation techniques. Despite this variety, empirical findings based on panel data analysis, come up with more significant results than findings from national level. These studies suggest that the devolution process was conducive to China's economic growth, where in most cases it has been found to make a positive and robust contribution (Qi, 1992; Qian and Weingast, 1997; Ma, 1997; Lin and Liu, 2000; Jin *et al.,* 2005; Ding, 2007). Studies attribute this contribution to several factors. Jin and Zou (2005) attribute the positive effect of revenue decentralisation to the increased mobilisation of revenues from local sources, which improves the overall fiscal performance and induces economic growth. Further, Qi (1992), Qian (1999) and Jin *et al.* (2005) argue that the fiscal system in China has provided adequate incentives for local governments to stimulate local economies, while also avoiding revenue predation from the central government and holding to its own financial resources for investment that promotes economic growth.

Lin and Liu (2000), on the other hand, argue that mainly the increased efficiency of resource allocation and to a lesser extent the increased capital investment by local governments are the two channels of transmission through which FD impacts regional growth. Using marginal retention rate as a measure of FD, the study stresses the unequivocal contributing role of FD to growth in China over 1970-1993 period, by

[34] The flypaper effect refers to the phenomena where local expenditure stimulus is greater from intergovernmental transfers than an equivalent increase in income (Lalvani, 2002).

comparing the process of devolution to technological changes with a long-lasting effect. Apart from FD, the study emphasises also other institutional arrangements (i.e. household responsibility system at rural level), which favoured the increased efficiency of local governments by allocating a bigger portion of their revenues to high-productivity areas. Despite these enthusiastic findings and introduction of a measure for local fiscal incentives, the empirical results could be challenged as the analysis neglects important dimensions of FD (spending and transfers), neither controls for important determinates of growth (e.g. human capital), nor pays attention to estimations problems (e.g. endogeneity, cross-sectional dependence between regions).

Alternatively, other studies provide evidence of a negative economic effect of FD (Zhang and Zou, 1998; 2001; Young, 2000; 2002). Zhang and Zou (1998) claim that central government is in a better position to undertake public investment with nation-wide externalities in the early stage of economic development, which in the presence of aggressive decentralisation may crowd out the public investment. The central government, especially in developing and transition economies, are constrained in their limited resources for public investment in national priorities (railways, highways, telecommunications etc.), expenditure which has a far more significant impact across jurisdictions than in each province. Further, this study suggests that the impact of FD on economic growth should be measured relative to the stage of a country's development and the existing expenditure and revenue assignments. Further, Young (2000) claims that FD stimulated local protectionism in China by also duplicating some investment of central government, which in turn impacted growth negatively. In the context of China, it seems pertinent to note that the lack of local democratic elections and controlled migration across regions, might danger one of the fundamentals of decentralisation, the Tiebout mechanism, where people vote by their feet.

Interestingly, there are also other two studies which challenge the conventional wisdom over the relationship between FD and economic growth in China. First, the findings of Jin and Zou (2005) suggest that the divergence rather than convergence in revenue and expenditure of local government contributes to economic growth. Namely, FD can contribute to growth if the local government are responsible only for collecting money, whereas central government in spending it. Second, Huang and Cheng (2005) suggest that the FD-growth relationship in China is nonlinear conjecturing a U-shaped curve, different from the inverse U-shaped suggested at many studies at national level. Hence, this study indicates that initially FD effects negatively on local economic growth and after the critical value it contributes to higher regional growth.

However, it is important to note that results from China as a transition economy do not hold for all the other countries in general and ETEs in particular. At regional level, unfortunately, empirical evidence from ETEs is limited only to studies with descriptive statistics or with substantial methodological problems. Naumets (2003) provides evidence of FD-growth relationship from a panel of 24 Ukrainian regions from 1996 to 2000. Despite the short time span and the absence of a fully specified model, the study suggests negative, though not robust impact of the share of own revenue from consolidated regional revenue on subnational growth.

(ii) Theoretical framework followed

Most of the empirical literature on FD and growth at subnational level is not based on an explicit theoretical framework. Endogenous and exogenous growth models are among the mostly used growth models. However, additionally, Tosun and Yilmaz (2008) and Hammond and Tosun (2009) employ a spatial error model for testing the FD-growth relationship. Both studies confirm the positive association between the number of municipalities (fragmentation) and income growth. Given the innovative measures of FD used in these two studies, comparisons with other studies investigating the FD-growth relationship are difficult to be made. Regarding studies using conventional measures, it becomes difficult to depict any trend whether studies following an endogenous growth model find more/less positive effect than those employing an exogenous growth model. Instead, the country’s level of income does provide some weak evidence that less developed countries (developing and transition) offer more positive results than the ones with high-income levels.

(iii) Methodology

In spite of the extensive number of studies having assessed empirically the relationship between FD and regional growth, empirical literature seems to have suffered from estimation bias due to omission of important determinants of economic growth and all dimensions of FD measures used. To the complexity of accurately measuring FD is also added the potential prevalence of endogeneity, which often is neglected in the empirical research. Studies that have tackled endogeneity at regional level have used either the lagged levels of FD (only transfers from central government) (Lin and Liu, 2000; Feld *et al.,* 2004; Rodriguez-Pose *et al.,* 2009; Yushkov, 2015) or the bargaining power through the number of population represented by the vote in legislative chambers (Feld *et al.,* 2009a, p.16). In terms of estimation methods, it seems that the above studies do not introduce dynamic estimation methods or more contemporary ones to estimate the FD-economic growth relationship. The majority of the studies employ an OLS or a FE, though the structure of the data might be suitable for other estimation techniques and the estimation biasness might still prevail. Partly justified by the lack of data at regional level, investigating the FD-economic growth relationship at regional level remains a challenge, though studies agree, to a large extent, that such relationship is better uncovered at regional level given the origin of FD at lower levels of aggregation.

2.5 Conclusions

Throughout this chapter, the relationship between FD and economic growth has been elaborated in the light of different schools of thought. As being an underdeveloped issue in the public finance literature, decentralisation was mainly assessed in the context of the mainstream theory. This chapter, however, made the first attempt distinguish between the neoclassical and endogenous FD-growth models and shed light to the theoretical foundation of the relationship between FD and economic growth. These two, often claimed as *ad hoc*, theoretical framework claim the contributing role of FD, mainly measured by expenditure decentralisation, to economic growth, while also pointing toward an optimal level of decentralisation. The lack of a solid theoretical foundation which could explain the mechanism from which FD might contribute to economic growth was blamed as a substantial drawback in this literature. By redesigning and adding channels of transmission necessary to understand this relationship, this chapter contributes by distinguishing and incorporating them into (i) direct channels of transmission (efficiency criteria, pro-business environment, and fiscal response) and (ii) indirect channels of transmissions (macroeconomic stability, size of government etc.).

Despite the limited theoretical guidance, an extensive number of studies have assessed the FD-economic growth relationship. Unfortunately, the empirical evidence has left us without clear assessments regarding the potential effects of FD on economic growth, channels of transmission, empirical specification and whether the potential effect of FD on growth differ subject to the level of investigation. Overall, this comprehensive empirical literature at all levels of investigation (national and subnational) has generated mixed and contradictory results regarding the sign and magnitude of the FD-growth relationship. However, the level of investigation, whether a study is conducted at national or subnational level, shed some light on the ambiguity of the empirical results, by agreeing on the insignificance of the FD-economic growth relationship at national level and on greater economic effect observed at subnational level. Disaggregating this relationship at lower levels of government might better uncover the economic effect of FD by exploring the complexity of the latter and avoiding the risk of individual subnational unit effects to cancel out with each other and result in a (potential) distorted overall economic effect of FD.

To a large extent, the complexity and multidimensionality of FD are attributed as one of the main reasons, which exacerbates the ambiguity of empirical findings. The ability to incorporate all dimensions of FD (expenditure, revenue/tax and intergovernmental transfers) is relevant in better understanding the economic effect of FD, both directly and indirectly, which is often neglected by empirical research. Also, different country and sample characteristics evolving differently across time and countries are possible explanations for this lack of conclusive empirical results. To take a step beyond all the FD-growth relationship research and the ambiguity associated with it, a Meta-Regression Analysis focusing on the empirical studies will be undertaken in the next chapter.

Chapter 3

FISCAL DECENTRALISATION AND ECONOMIC GROWTH – A META REGRESSION ANALYSIS

3.1 Introduction

Despite the limited theoretical guidance, the empirical research on the FD-economic growth relationship has widely spurred in the last twenty years, though being unable to provide conclusive evidence on the economic effect of FD, neither for the magnitude nor the significance of this effect. Some studies provide evidence of a positive effect of FD on economic growth (Lin and Liu, 2000; Behnisch *et al.,* 2003), while others claim the detrimental (Xie *et al.,* 1999; Rodriguez-Pose and Kroijer, 2009) or even insignificant (Woller and Philips, 1998; Thornton, 2007) impact. The empirical literature review provided in the previous chapter suggested that findings from the empirical research are widely heterogeneous, which is mostly attributed to the differences in country characteristics, FD measures, time spans and estimation methods used. Such heterogeneity and the limited consensus on the economic effect of FD are the core factors which have motivated this chapter.

In order to take a step beyond all these studies and the ambiguity of their results, this chapter undertakes a Meta-Regression Analysis (MRA) to synthesise and evaluate the consistency of the existing research using statistical methods (Stanley *et al.,* 1989). An MRA can shed light on the determinants that drive the (in)significance of the FD-economic growth relationship, while also identifying the statistical framework that characterises a genuine empirical effect. Generally speaking, the aim of MRA is to combine comparable estimates, of a specific effect, from different studies and relate them to one or more characteristics of the studies.

The use of MRA in economics is not so common as compared to medicine or psychology, where it has a long-standing tradition. However, not very recently, Stanley (1989) and Stanley and Doucouliagos (2012) introduced and further developed techniques to investigate empirical reviews in economics. Applications can already be found in a range of fields, which includes labour economics (Jarell and Stanley, 1990; Stanley and Doucouliagos, 2007), international trade (Disdier and Head, 2008; Cipollina and Salvatici, 2007; Coric and Pugh, 2008), and development economics (Abreu *et al.,* 2005; Doucouliagos and Ulubasoglu, 2008; Efendic *et al.,* 2011). Evidence of MRA can also be found in the public finance field in general (Nijkamp and Poot, 2004, Costa-Font *et al.,* 2011, Ligthart and Martin Suarez, 2011) and FD in particular (Feld *et al.,* 2009b; Baskaran *et al.,* 2016; Zhenfa and Wei, 2016).

In the context of this chapter, the MRA provides a comprehensive statistical approach to estimating the FD-economic growth empirical effects. More specifically, our MRA is conducted to determine:

(i) the causes of the heterogeneity among the FD-economic growth empirical studies
(ii) the presence of publication bias in the FD-economic growth empirical studies,
(iii) the existence of the genuine effect, after controlling for the sources of the heterogeneity and accounting for publication selection bias, in the FD-economic growth empirical literature.

Previously, the existing MRAs in the FD-economic growth relationship (Feld *et al.,* 2009b; Baskaran *et al.,* 2016; Zhenfa and Wei, 2016) investigated only the first issue, while ignoring the degree of infection of this literature by the publication bias and the presence, if any, of a genuine effect. It is important to note that a comprehensive MRA accounts for all the above issues, while paying attention to a rigorous protocol, as suggested by Stanley and Doucouliagos (2012). Therefore, our research presents an extension of the existing MRA, by providing a comprehensive meta-analysis which relies on an unbiased assessment of the FD-economic growth empirical literature.

The structure of the chapter emerges along the following lines. After the introduction, Section 3.2 provides an overview of MRA, which additionally emphasises the difference of our approach compared to the existing MRA studies of Feld *et al.* (2009b) and Baskaran *et al.* (2016). To the best of the author's knowledge these are the only studies conducted on the relationship between FD and economic growth (although the latter is only a revised version of the former). In Section 3.3 we proceed by discussing the methodology followed in coding the empirical studies and constructing the meta-sample. Descriptive statistics are offered to better understand the heterogeneity of the sample. Section 3.4 provides a general framework to model economic research and tackle different problems such as publication bias, genuine empirical effect and heterogeneity between studies. The variables that could potentially explain the excess variation in the empirical results and the methods used for an MRA are additionally discussed in this section. The fifth section will present and discuss the MRA results. Finally, Section 3.6 concludes.

3.2 Rationale for an MRA and Search Strategy

3.2.1 Rationale for an MRA

The empirical review in Chapter 3 revealed a significant systematic variation in the reported estimates of the economic effect of FD, which was linked to differences in country development, research design and temporal dynamics. Namely, the model specification, type of data, number of observations, and publication status of the research were considered as potential factors influencing the effects' variation. Similar conclusions were also reached by existing studies in the field (Thiessen, 2003, Martinez-Vazquez and McNab, 2006, Rodriguez *et al.,* 2007, Thornton, 2007, Feld *et al.,* 2009b). Drawing on this qualitative literature review, which sometimes may rely on subjective judgment, it appears difficult to unequivocally outline the role of FD on economic growth. Hence, starting from an agnostic view of what the impact of decentralisation could be, this thesis employs an MRA to go beyond such qualitative and subjective judgements.

An MRA provides a comprehensive quantitative review of the estimated results from different studies collected, enabling in principle the identification of various sources of heterogeneity between empirical studies, and the quantification of the presence of a genuine effect and publication bias (Rose and Stanley, 2005). Whilst the first two issues were indirectly tackled in the previous MRA literature, publication bias seems to be ignored, which is surprising given the severe doubts casted in economics.

This problem exists when editors, reviewers and/or researchers are more likely to publish research with statistically significant results (Stanley, 2008) that are consistent with the theory (Stanley, 2008; Costa-Font *et al.,* 2011). Researchers can be easily overwhelmed by publication bias given the abundant available econometric models. If the results are insignificant, models are frequently re-specified and re-estimated until significant estimates are found. Alternatively, published papers might suffer from the biased tendency of journals towards significant results. It may be argued that studies selected for publication are likely to have more optimistic (overestimated) results than studies producing insignificant or unconventional results, which in turn, are less likely to be published. The failure to report non-significant empirical results also known as *the file-drawer effect* (Rosenthal, 1979), since these studies, which show no effect, are just filed away. Thus, it is argued that publication bias occurs whenever the published literature is systematically unrepresentative of the population of completed studies (Rothstein *et al*., 2005, p.1). In order to avoid potential selection bias from selecting only published studies, which might amplify the existing publication bias, our MRA will include studies both published in (i) peer-review journals or/and as a book chapter and (ii) published as working and discussion paper, master and PhD thesis.

Thereafter, all existing studies that empirically investigate a certain relationship (in our case the effect of FD on growth) are collected. The variable of interest in a general MRA is the measure of the relationship between the focal predictor and the outcome of interest in the original studies. The simplest MRA is the one that regresses the reported estimates (such as t-value, coefficients or partial correlation) with its standard error (Ashenfelter *et al.,* 1999). Then, it is necessary to depict all the characteristics of the sample of studies and add them as additional variables/factors that influence the conditional expectation of the effect size (Stanley and Doucouliagos, 2012). These variables, known as moderator variables, are likely to explain the heterogeneity across studies (year of publication, type of publication, type of estimation). All these steps (selection of studies and depicting their characteristics) shall be explained more in details in the next sections.

3.2.2 Search Strategy and Selection Criteria of the Included Studies

The Meta-Regression approach is based on the premise that individual studies have used either a neoclassical production function, as already mentioned in Section 2.4.1, or an informal growth function incorporating decentralisation variables with other growth-related variables. A very general form of this function is as follows:

$$Y_{it} = f(X_{it}, FD_{it}) \tag{3.1}$$

where Y_{it} is a measure of economic growth for country i at time t, X is a vector of control variables (growth rate of population, a measure of the country's human capital stock, the investment ratio, the country's initial GDP, amongst others, the degree of openness) and FD is a measure of fiscal decentralisation.

A comprehensive search was carried out to identify all empirical studies reporting estimates of the effect of FD on economic growth. The search process included Scopus, ScienceDirect, EconBiz database, EconLit database, Google Scholar and references of the studies.[35] Keywords used in the search were "fiscal decentralisation + economic growth", "FD + economic performance", "federalism + economic growth". Whilst only publications written in English were selected, we do not expect this to be a source of bias. Stanley and Doucouliagos (2012, p.15) argue that such bias, if any, from omitting non-English studies shall not be of particular importance. Further, according to them (p.15), the translation of these non-English papers might be insufficient and often imprecisely understood.

The full search identified 117 potential papers. However, not all of them are included in our meta-sample. Only papers that conduct an empirical analysis and explicitly report the effect size of the economic effect of FD (either the *t*-statistics or the coefficient and the standard errors) are considered as primary studies. In addition to the papers that did not report any estimation of the FD-economic growth relationship, we excluded all papers which are very different in terms of either the dependent or independent variables included in their regressions[36]. Otherwise, the meta-sample would be excessively heterogeneous, which in turn would hamper the ability to draw conclusions on the presence of genuine effect or publication bias. Also, from the sample, we excluded other three empirical papers of Bodman *et al.* (2009b), McLure, (2006), Asatryan (2011) and Asatryan and Feld (2013) that use Bayesian and Paretian approaches, from which it is not possible to identify an effect size of the economic effect of FD. Finally, this led us to a sample of 49 empirical papers, as shown in Table 3.1, which sourced 1001 point estimates.

[35] The search was conducted in March 2013 and revised in September 2017, where the meta-sample was also updated by 12 new papers (from 37 studies that were found in 2013 to a total of 49 in 2017)

[36] The studies that did not report any t-ratios: Oates 1993, Huther and Shah 1998, Xin-Qiao 2000, Wescott and Porter 2002, Breuss and Eller 2004, Vo 2006, Pepinsky and Wihardja 2009, Tabata 2009, Feld and Schnellenbach 2010, Qarri and Mishtaku 2010, Esteban-Laleona 2011, Aristovnik 2012. On the other hand, Enkilopov and Zhuravskaya 2007, Hallwood and McDonald 2008, Yakita 2011 estimate the effect of fiscal decentralization on income inequality, macroeconomic stability, agglomeration, migration etc.

Table 3.1. List of primary studies used in the MRA database chronologically ordered

Davoodi and Zou (1998)	Huang and Cheng (2005)	Bodman *et al.* (2009a)
Woller and Philips (1998)	Iimi (2005)	Cantarero and Gonzales (2009)
Zhang and Zou (1998)	Jin and Zou (2005)	Feld *et al.* (2009)
Yilmaz (1999)	Thiessen (2005)	Rodriguez-Pose and Kroijer (2009)
Lin and Liu (2000)	Wilgender (2005)	Sagbas *et al.* (2009)
Im and Lee (2001)	Ismail and Hamzah (2006)	Khattak et al. (2010)
Ebel and Yilmaz (2002)	Kim (2006)	Rodriguez-Pose and Ezcurra (2010)
Akai and Sakata (2002)	Malik et al. (2006)	Samimi *et al.* (2010)
Naumets (2003)	Martinez-Vazquez and McNab (2006)	Bodman and Ford (2011)
Thiessen (2003)	Akai *et al.* (2007)	Buser (2011)
Eller (2004)	Ding (2007)	Devkota (2011)
Feld *et al.* (2004)	Khamaladze (2007)	Faridi (2011)
Ismail *et al.* (2004)	Rodriguez-Pose et al. (2007)	Philip and Isah (2012)
Meloche *et al.* (2004)	Thornton (2007)	Stoilova and Patonov (2012)
Desai *et al.* (2005)	Qiao *et al.* (2008)	Gemmell *et al.* (2013)
Feltenstein and Iwata (2005)	Tosun and Yilmaz (2008)	
Gil-Serrate and Lopez-Lobarda (2006)	Baskaran and Feld (2009)	

3.3 The Meta-Regression Methodology

3.3.1 Effect Size

Different from other datasets, the meta-sample consists of economic estimates of a certain relationship, in our case the economic effect of FD, which are connected to different characteristics of the research process (Stanley and Doucouliagos, 2012). In order to have estimates, also known as effect sizes, comparable across our meta-sample, it is necessary to rely on best practices of MRA in economics. Although the MRA literature offers a wide variety of measuring the effect sizes, the most commonly used are the partial correlation coefficients, t-statistics and elasticities.[37] Whilst intuitively one might think of the plain coefficient as the effect size (given that the economic interpretation relies on the size of such coefficients), this, however, is not considered appropriate in an MRA.

Following Costa-Font *et al.* (2011), Genc *et al.* (2011), and Stanley and Doucouliagos (2012), the use of regression coefficients as a measure of the effect size jeopardises the comparability of estimates across studies, which is particularly aggravated by the abundance measure of the variable of interest. With reference to our research,

[37] See Stanley and Doucouliagos (2012, p.29) on overview of measures of effect sizes used in economics.

measuring FD in many ways generates effect sizes that are difficult to compare and, foremost, are not dimensionless. Such comparability is also hampered by the differences in the scale of measurement of FD. For instance, expenditure decentralization might be measured either as a share of local government's expenditure to general government expenditure or as a change in this share. Hence, it is necessary to standardise such effect sizes so that they can be compared across studies. Stanley and Doucouliagos (2012, p.24) suggest the use of a unitless measure of the association between variables: Partial Correlation Coefficient (PCC). The PCC is a standardised measure of the degree of association between a dependent and independent variable (Greene, 2008) while holding all other variables constant. Such measure shows the strength and the direction of an association between the two abovementioned variables. PCC produces unitless effect sizes, which in turn allows for comparison among each independent study (Efendic *et al.,* 2011; Alptekin and Levine, 2012). Although it is not a common practice for the empirical research to report PCCs, they can be calculated using the conventionally reported regression statistics. The PCC, along with its standard errors (SE) are calculated using the following formula:

$$\text{PCC} = \frac{t}{\sqrt{(t^2+df)}} \tag{3.1}$$

$$\text{SE} = \sqrt{\frac{(1- PCC^2)}{df}} \tag{3.2}$$

where *PCC* represents the partial correlation coefficient between FD and its effect on growth, *t* denotes the t-value of the regression coefficient (on the independent variable FD) *df* is the regression's degrees of freedom. Therefore, the t-statistics (if not, we have calculated them given the coefficient and the standard error and/or have approximated from the reported levels of statistical significance) should be collected from each primary study of our meta-sample. Eventually, all the PCCs from the j^{th} specification of the i^{th} study are straightforwardly calculated.

However, due to some mild critics regarding the non-normality distributions of the PCC (Stanley and Doucouliagos, 2012, p.25), many MRA studies opt for a different measure of the effect size: the t-values. Similar to PCC, the t-statistic is a standardised measure of the parameter of interest (Stanley and Jarell, 1989, p.304), though, it has been criticised for three main drawbacks. Following Becker and Wu (2007), the use of t-values indicates neither the magnitude of the effect of interest, nor the economic significance of the effect of a variable of interest. All it represents is the statistical significance for the null hypothesis about the parameter slope. Although, the t-statistics improves the problem of dimensionless (Feld *et al.,* 2009b; Yeung, 2009 and Genc *et al.,* 2011), still, it is difficult to be interpreted, nor it has a predictable statistical power (Stanley and Doucouliagos, 2012, p.28). Hence, PCC appears superior to regression coefficients, t-values or any other measure of the effect size, while also being consistent with the best practices regarding the MRA (i.e. Doucouliagos and Laroche, 2003; Efendic *et al.,* 2011; Doucouliagos and Paldam, 2012, Stanley and Doucouliagos, 2012).

Another concern related to the effect size is the overrepresentation of studies that report multiple estimates compared to those that report only a few. Such variation in the number of estimates from study to study appear to be very common in economics in general and in the FD-economic growth literature in particular.[38] To address this issue, estimates are weighted as to ensure that each study is equally represented in the dataset, irrespective of number of estimates supplied, as suggested by the best practices in the MRA literature (Stanley and Doucouliagos, 2012; Efendic *et al.,* 2011). The weights are calculated using the formula: weights=1/(number of reported estimates). However, additional need for caution should be taken in our meta-sample where variations are observed not only in the number of estimates but also in the number of specifications. For instance, the studies of Davoodi and Zou (1998) and Buser (2011) both report 30 effect sizes, however they come from a different number of specifications, more specifically from 30 and 15 specifications, respectively. It is argued that such pronounced heterogeneity between specifications and studies comes from the difference in the number of FD measures (e.g. the Davoodi and Zou, 1998 uses only one measure of FD, Buser, 2011 uses two measures of FD). Hence, it is necessary to consider a specific weighting, different from the conventional one, so that effect size will be equally represented within specifications of the same study, irrespective of the number of FD used. To the best of author's knowledge this the first study that accounts for such weighting in MRA, more specifically for equal representation of effect size across specifications (*specification weights*) and studies

[38] This has been amplied when studies started reporting estimates from the robustness check.

(*study weights*)[39]. For example, in the case of Davoodi and Zou's (1998) study, which reports 30 estimates from specification using only one measure, the study weight will be 1/30, whereas the specification weight will be 1 (given that each specification report only one estimate). Alternatively, if these 30 estimates come from 15 specifications (2 measures per specification) as in the case of Buser (2011), then the specification weights and the study weights will be different from each other. Namely, the specification weights will be 1/2, so as each estimate will be equally represented within the same specification. Consequently, the study weights will be calculated as the ratio of specification weights divided by the total number of specifications in the study, namely 0.5/15. In the end, each estimate from both studies will have a weight of 1/30 (or equivalently to 0.5/15), thus assuring that estimates of these two studies will be equally represented in the meta-sample.

3.3.2 Bivariate MRA Methodology

a) Detecting Publication Bias

The predisposition of researcher and reviewers towards statistically significant results and consistent with the conventional view, namely publication bias, appears to be a major problem in economics, which can distort any qualitative or quantitative literature review (Stanley and Doucouliagos, 2012). However, it is possible to identify and correct the contamination of a literature by the presence of the publication selection bias. An initial method of detecting this problem is the visual analysis of a funnel plot (Stanley and Doucouliagos, 2010) of the inverse of the standard error (1/SE) of the point estimates, also referred as the precision, against the non-standardised estimates (PCC). Whilst the precision, a measure of variability, is placed at the vertical axis, it is expected that large sample studies will yield relatively more precise estimates, distributed around the true effect, than small sample studies with less accurate estimates, asymmetrically dispersed around the true effect. Graphically, there will be no presence of publication bias if these estimates will vary randomly and symmetrically around the real effect. Contrary, the asymmetric dispersion of estimates

[39] As an example, the double weighting procedure calculations for two papers are presented in Appendix 3.1.

around the true effect will signal the presence of publication bias.[40] Such graphical analysis would resemble, generally, an inverted funnel.[41]

b) FAT-PET using WLS

Although the funnel graph is considered a useful instrument in MRA, it still does not provide any reliable statistical evidence for detecting publication bias. By using more systematic tools in identifying publication bias, Egger *et al.* (1997) and Stanley and Doucouliagos (2012) utilise a linear regression as presented in Equation (3.3).

$$effect_i = \widehat{\beta_0} + \widehat{\beta_1}\, SE_i + \widehat{\varepsilon_i} \tag{3.3}$$

where $effect_i$ denotes the reported coefficient of the effect of FD on growth, derived from the s^{th} study, SE_i denotes the standard error of the estimates. However, as argued before, the effect size should not be measured by the plain coefficients, nor by the elasticities or any other measure not used in economics. Rather, recalling Section 3.3.1, the use of PCC is considered as more appropriate in the context of our investigation. Thus, the base regression, although we estimate a modification of it for reasons explained below, is:

$$PCC_i = \widehat{\beta_0} + \widehat{\beta_1}\, SE_i + \widehat{\varepsilon_i} \tag{3.4}$$

The estimated intercept term ($\widehat{\beta_0}$) provides an estimate of the real effect, while the slope of this equation ($\widehat{\beta_1}$) measures the presence of publication bias and $\varepsilon_i$is the estimated error term. In the presence of publication bias, the estimated intercept will be statistically significant with a sign signalling the direction of the publication bias. While SE_i converges to zero, the expected value of the effect size will converge to $\widehat{\beta_0}$. Hence, testing for $\widehat{\beta_1}$= 0 implies a test for the presence of publication bias (Dimos

[40] The real effect is also known as the "true" effect or the effect size and is the representative of estimates collected in the primary studies.

[41] The literature also suggests the use of other types of funnels such as the scatter plot of the non-standardised estimates and the sample size. This graphical technique, different from the abovementioned, assumes that larger sample studies offer more precise estimates than small sample studies. This is because the latter are more likely to re-estimate until they find significant estimates, because the large standard errors vary randomly around the real effect.

and Pugh, 2016, p.803). Alternatively, testing for $\widehat{\beta_0}$=0 constitutes a test for the existence of the genuine effect.

However, a glaring problem with Equation (3.4) is the presence of heteroscedasticity. The variation of PCC, consequently $\widehat{\varepsilon_i}$, is not constant (Stanley, 2005; 2008). The difference in the sample sizes used in primary studies and estimation methods are likely to produce heteroscedastic random estimation errors (Stanley and Jarell, 2006). To correct for any potential heteroscedasticity, Weighted Least Squares (WLS) is usually employed by using the inverse standard errors as weights (Stanley and Doucouliagos, 2012; Pugh *et al.,* 2012). Thus, Equation (3.4) is divided by the standard error of the partial correlation coefficient (or multiplied by the inverse standard errors), as shown below:

$$\frac{PCCi}{SE_i} = \widehat{\beta_1} + \widehat{\beta_0}\frac{1}{SE_i} + \frac{\widehat{\varepsilon_i}}{SE_i} \tag{3.5}$$

Following the mathematical transformation provided in Pugh (2012), it is important to note that the ratio of PCC to SE_i yields the same t-statistics as extracted from the primary studies.[42] Therefore, Equation (3.5) can be written as:

$$t_i = \widehat{\beta_1} + \widehat{\beta_0}\frac{1}{SE_i} + \widehat{v_i} \tag{3.6}$$

Dividing Equation (3.4) by the standard errors of the PCC reverses the slope and the intercept, while parameters $\widehat{\beta_0}$ and $\widehat{\beta_1}$ remain the same. Thus, the former is a measure of a genuine effect, whereas the latter provides a measure of the presence of publication bias. Finally, following Stanley (2005; 2008), testing whether these two coefficients are different from zero becomes a test of the Funnel Asymmetry Test (FAT) and the Precision Effect Test (PET). Equation (3.6), namely FAT-PET, is also known as the bivariate MRA.

Before any further explanation of the procedure, it is important to note that the MRA literature (Stanley, 2008; Stanley and Doucouliagos, 2011) pays particular focus to diagnostics, mostly, related to the functional form. A linear approximation of this equation might produce a biased estimate of the real effect, which could be inflated when standard errors are very high. Also, additional bias might rise, especially in the

[42] See Appendix 3.1.2 for mathematical transformation of Equation (3.3) to (3.4).

PET coefficient due to the presence of publication bias. To confirm the consistency of the PET estimate, the literature suggests an additional test, such as the Precision Effect Estimate Standard Error (PEESE), which will be introduced below.[43]

c) FAT-PET using FE

As anticipated in the previous section, all the primary studies in our meta-sample report more than one effect size, namely, from 2 in Devkota (2011) to 86 in Rodriguez Pose *et al.* (2007). Whilst we addressed the problem of multiple measures per study by using a specific form of weighting across specifications and studies, there might still be some unmodelled between-study heterogeneity not considered. Such problem, known also as the dependence among the reported estimates, might be considered a threat in an MRA, especially when the estimates coming from multiple measures within the same study share common effects such as the researcher' idiosyncratic choice of data and methods, quality of the research, amongst others, funding source (Stanley and Doucouliagos, 2012, p.68, 113). This multi-estimate research structure appears to be common in economics, especially when studies report robustness check to prove the validity of their prefered estimated results. A possible solution to this problem is to average the within-study estimates. However, this would drastically reduce the statistical power and the degrees of freedom (Stanley, 2001), as well the information on some study's characteristics. Hence, following Bateman and Jones (2003), and Stanley and Doucouliagos (2012), an unbalanced panel of bivariate MRA in Equation (3.6) is used to explicitly account for the within-study heterogeneity by including study level effects for the i^{th} estimate in the s^{th} study:

$$t_{is} = \widehat{\beta_1} + \widehat{\beta_0}\frac{1}{SE_{is}} + \widehat{\mu_s} + \widehat{v_{is}} \tag{3.7}$$

where the $\widehat{\mu_s}$ denotes the unobserved study effects (assumed to be either "fixed" or "random") and the $\widehat{v_{is}}$ denotes the error term.[44] At this stage, it is important to note that the terms fixed and random are not used as in standard panel models, rather in an MRA they are simple weighted averages. The fixed-effect estimator assumes that the

[43] Since the problem is the potential biased estimate of the real effect, the new equation is run only for confirming PET estimate and not publication bias (FAT).

[44] Technically speaking, the former can be replaced by a fixed-effect term, δD, where D is a matrix of study dummy variables.

effect sizes, which are drawn from the same population, are identical across studies and have a single mean effect (homogeneity assumption). Differences in the estimates are only due to sampling variation. In this case, each reported estimate is weighted by the inverse of the square of its standard error ($1/SE_i^2$), which is considered as the within-study variance (Stanley and Doucouliagos, 2012 p.46). Contrary, the between-study variance is zero, given that all studies have identical expected effect size.

When the homogeneity assumption does not hold, thus estimates are drawn from different populations, the fixed-effects weights change into a more complex one by accommodating both the within- and between-study variance. The new weights, used in a random-effect estimator, are calculated as the sum of the $1/SE_i^2$ and the between study variance of S_s^2 (s^{th} study). In this case, the differences in the estimated effect comes not only from the sampling variation, as in the fixed-effects, but also from genuine differences in the underlying effects between studies (Harbord and Higgins, 2008; Stanley and Doucouliagos, 2012, p.46; Reed *et al.,* 2015).

A note of caution seems to be in order when including study effects and its correlation with the control variables. Whilst the random-effects FAT-PET assumes that study effects are uncorrelated with the control variables (in our case the precision term), the fixed-effects estimator relaxes this assumption by allowing correlation between these variables. However, the random-effects estimator has been increasingly criticised for the constant violation of the above assumption, especially in the presence of publication bias (as reported in a simulation of Stanley, 2008). If unobservable study effects are correlated with the independent variable, the model will suffer from additional bias imposed by using a random-effects estimator. With special reference to the MRA conducted in economics and business, evidence from simulations and best practices in the MRA, it is argued that fixed-effect estimator is considered superior to the random-effect estimator (Stanley, 2008; Stanley and Doucouliagos, 2012). Simulations of Stanley (2008) and Stanley *et al.* (2010) show that the latter generally reintroduces bias in the model, especially in the presence of publication bias. Although the above authors argue that this might be true also for the fixed-effect estimator, they assure that such bias is much larger for the random- rather than fixed-effect estimator. To the best of author's knowledge there is no comprehensive research conducted in economics, which has used random-effects panel MRA. Thereby, this leads us to use only fixed-effects MRA. Technically speaking, the bivariate WLS panel model is estimated by weighting Equation (3.7) by the squared of the inverse standard error of each study ($1/SE^2_{is}$) or using the analytical weights in Stata.[45]

An additional note of caution seems to be in order regarding the threat of dependency, rising from the presence of multiple measures within-study. If not properly accounted, the statistical significance of the standard errors and the t-values might be miscalculated. Although the efficiency impacted by ignoring the structure of our data is not considered severe in the MRA (Stanley and Doucouliagos, 2012, p.71), it still needs to be addressed. Following the same authors (p.71), the dependency threat shall be addressed by using cluster-robust standard errors (clustering by study), instead of conventional standard errors.[46]

Also, having studies written by the same author(s) required some attention. Whilst one might think of clustering estimates within authors, this seems to be inappropriate given that such studies are different from each other regarding the set of countries under investigation, time span, amongst others, estimation techniques (Disdier and Head, 2008; Costa-Font *et al.,* 2011; Ringquist, 2009; 2013). Therefore, we proceed with the suggested cluster in the MRA literature: by study.

Intuitively, estimating the FAT-PET by WLS and FE begs for explanations regarding their superiority. Although such answer is addressed, particularly, when accounting for excess heterogeneity in the literature, we follow the suggestions of Stanley and Doucouliagos (2013) and Dimos and Pugh (2016) by reporting both FAT-PET WLS and FAT-PET FE, while the former considered as the baseline model.

d) Precision Effect Estimate Standard Error

Whilst usually the PET is amongst the least biased estimator (Stanley and Doucouliagos, 2007; Moreno *et al.,* 2009), there are cases when it identifies a false genuine effect by over rejecting the null hypothesis. Simulations have shown that

[45] Alternatively this can be automatically done in Stata using the command: *xi: reg t SE i.studyid [aweight=precision_sq]*

[46] The two-way clustering, by study and specification, was also used in this research through the command *cluster2*. However, this command does not allow weighting of the estimates by the specific weights (or any other weights). Hence, we compared the single clustered Unweighted FAT-PET results with the clustered one. Interestingly, the results are almost identical (See Appendix 3.3.4), which might be due the fact that most studies report similar number of effects from each model.

PEESE yields a better estimate of the genuine effect when there are reasons to believe that such effect exists (Stanley and Doucouliagos, 2012, p.66), but which might be inflated by PET. Hence, the Precision Effect Estimate Standard Error (PEESE) is used as a confirmation for the PET coefficient in the presence of publication bias (Stanley and Doucouliagos, 2011). In Section 3.5.1, the estimate of PEESE is reported and then is compared to PET, as a confirmation of the consistency of latter.

The initial equation to start with, and the transformation due to the potential heteroscedasticity, are as follows:

$$PCC_i = \widehat{\omega_0} + \widehat{\omega_1}(SE_i)^2 + \widehat{\varepsilon_i} \quad (3.8)$$

$$t_i = \widehat{\omega_1}\ SE_{ij} + \widehat{\omega_0}\ \ 1/SE_{ij} + \widehat{v_i} \quad (3.9)$$

For the same reasons explained above in the FAT-PET regarding heteroscedasticity, it is argued that this problem might still be present when estimating Equation (3.8). Therefore, both sides this Equation are divided by the standard errors of the PCC, which derives Equation (3.9), also known as the Heckman MRA (Stanley and Doucouliagos, 2012). However, it should be noted that such procedure should be undertaken only if (i) there are reasons to believe that the literature has a non-zero genuine effect which PET fails to identify, and (ii) in the presence of publication bias and no genuine effect from FAT-PET. The interest is on the estimated ω_0, which denotes the value of the genuine effect corrected for publication bias. Similar to the FAT-PET, the PEESE can be estimated by an WLS or FE, while in both cases using the cluster-robust standard errors and the specific weights.

e) Meta Significance Testing

Economists have taken a very keen interest in going beyond publication bias and detecting the genuine effect from different perspective. A pronounced characteristic of the genuine effect, although not explicitly claimed before, is the relation of the statistical power and the sample size. Namely, the standardised effect, mostly measured by the t-value, increases with larger samples or greater precision (Stanley and Doucouliagos, 2012, p.76). Initially, Card and Krueger (1995) argued that the statistical power increases with the square root of the sample size, a relationship which could be tested using an alternative measure of the sample size, as shown in Equation (3.10):

$$ln\left| t_i \right| = \widehat{\rho_0} + \widehat{\rho_1} lndf_i + \widehat{\varepsilon_i} \tag{3.10}$$

Where $ln\left| t_{ij} \right|$ and $lndf_i$ denotes respectively the natural logarithm of t-value and the natural logarithm of the degrees of freedom from the i^{th} study. This test, known as the Meta-Significance Test (MST) shows that if there is no real empirical effect, the test statistic will be independent of the degrees of freedom[47] and the slope coefficient ($\widehat{\rho_1}$) will be zero. Otherwise, in the presence of a genuine effect, the above coefficient will be statistically different from zero (Stanley, 2008), more precisely, because of the 'double natural logarithm' $\widehat{\rho_1}$ should be close to 0.5 (Stanley, 2005). Although this test tackles the problem of genuine effect from different perspective than the FAT-PET or PEESE, it has many limitations. First, it is still ambiguous whether the MST "works" in the presence of publication bias. Stanley and Doucouliagos (2012) argue that this test fails to properly investigate the presence of genuine effect because the relationship between the t-values and the degrees of freedom is likely to fade away in the presence of publication bias (Stanley and Doucouliagos, 2012). To compound the problem further, Stanley and Doucouliagos (2012) and Doucouliagos and Paldam (2012) argue that the MST often reveals type I error inflation (Stanley, 2008), namely, finding a genuine effect when there is none. The problem comes from the use of the absolute value of t-statistics before taking the natural logarithm. Consequently, taking the absolute value of t-statistics will cause both positive and negative t-statistics to be positive and large. In the presence of unexplained heterogeneity, these t-values are more likely to be found in large samples than in small ones; hence, escalating into a possible positive $\widehat{\rho_1}$. The former happens only in the presence of publication bias, otherwise MST may straightforwardly reveal the existence of a genuine effect in the literature.

[47] Initially, Card and Krueger (1995) suggested the regression of the natural logarithm of t-statistics on the natural logarithm of the square root of sample size. However, nowadays the latter is substituted with the natural logarithm of degrees of freedom since it considers the number of variables into the regression, although they both represent statistical power.

Given all this limitation, which does not support the superiority of MST towards FAT-PET and/or PEESE, the presence of publication bias and genuine effect will be tested through the conventional test of FAT-PET, and if needed, PEESE.

f) Investigating Publication Bias across Time

Whilst the chronological ordering of the meta-data might not necessarily capture any particular trend of the evolution of the FD-economic growth literature, more systematic tools to investigate potential "economic research cycle" in our field might be needed. Goldfarb (1995) argues that economics research has a predictable time trend of novelty and fashion. Initially, editors, reviewers and/or researchers are more likely to publish statistically significant results and in accordance with theory. After a certain time, when studies confirming theory are less interesting, new contradictable studies become a fashion, while also impacting the publication bias across time. Empirically, this is tested by regressing the effect size on the publication year and its squared term.

$$t_{ij} = \widehat{\varphi_0} + \widehat{\varphi_1} time_i + \widehat{\varphi_2} time_i^2 + \widehat{\varepsilon_i} \quad (3.11)$$

Where t_{ij} denotes the t-value of study i, *time* and $time^2$ denote the publication year and its square term. In this case, one should consider the significance of both $\widehat{\varphi_1}$ and $\widehat{\varphi_2}$ and report whether there is any (inverse) hump-shaped relationship between the t-value and publication year.

3.3.3 Multivariate MRA Methodology

Given the presence of a pronounced heterogeneity between studies, as suggested by the empirical literature review in Section 2.4, it is necessary to identify the sources of variation in effect sizes and then investigate these across the meta-sample (Efendic *et al.,* 2011, Pugh et *al.,* 2012, Antonis *et al.,* 2012). First, two statistical tests are used to confirm the presence of heterogeneity in the FD-economic growth literature: the Cochran's Q-test and I^2-test (Higgins *et al.,* 2003; Borenstien *et al*., 2009; Ringquist, 2013). The Q-test is calculated as the weighted sum of squared differences between individual study effects and the pooled effect across studies (Harris *et al.,* 2008), though this can be easily detected by the sum of squared errors of the bivariate MRA without constant term.[48] Whilst the Q-test statistically confirms the presence of heterogeneity (its significance suggests that the sample of studies suffers from *definite* heterogeneity), the I^2-test measures the percentage of variation across studies that is due to heterogeneity rather than chance (Higgins and Thompson, 2002).[49] As such, the latter quantifies the excess variation shown in the Q-test, where 0% shows no excess heterogeneity and larger values indicate the presence of great variation of estimates in the literature.

By using the sum of squared errors, as suggested above, the Q-test claims the presence of excess heterogeneity (*p-value* = 0.000, while more details are presented in Appendix 3.3.3). Also, the I^2-test reports a large value of the heterogeneity ($I^2 = 87\%$), which again confirms the doubts that the FD-economic growth literature contains excess heterogeneity.

Hence, further investigations regarding the sources of this heterogeneity are required, otherwise if not counted, the MRA estimates will be biased. To explicitly account for this excess variation, the research dimensions, assumed to impact the estimates, are included in the regression together with the precision term (Stanley and Doucouliagos, 2012). Technically speaking, the bivariate MRA is expanded by incorporating a vector of independent moderator variables, which are relevant study characteristics, coded as dummy variables (Efendic *et al.,* 2011, Pugh *et al.,* 2012, Antonis *et al.,* 2012). The best practices in the MRA distinguish between two groups of moderator variables: (i) K-moderator variables capturing contextual factors influencing publication bias and (ii) Z-moderator variables capturing the excess heterogeneity due to different contexts of investigation, research design and methodological issues. This implies that both publication bias and genuine effect will allow for greater complexity by accommodating factors that influence them. Consequently, the bivariate MRA is transformed into a multivariate MRA as follows:

[48] The Q-test [$Q = \sum w_i (y_{ij} - \theta)^2$] measures the deviation of observed effect size (y) in a regression j of a study i, from an underlying overall effect size (θ), giving a weight (w_i) to each study. This test is distributed as a chi-squared statistic with number of estimates minus 1 as degrees of freedom. This test has considerable power when the number of studies in the dataset is large (Higgins *et al.* 2003; Stanley and Doucouliagos, 2012, p.45).

[49] $I^2 = ([Q - df] / Q) \times 100\%$ (Higgins *et al.* 2003).

$$t_i = \widehat{\beta_1} + \sum \widehat{\delta_j} K_{ji} + \widehat{\beta_0} \frac{1}{SE_i} + \sum \widehat{\beta_k} \frac{Z_{ki}}{SE_i} + \widehat{\upsilon_i} \tag{3.12}$$

where K_{ji} and Z_{ki} are J K-moderator and K Z-moderator variables, and their coefficients $\widehat{\delta_j}$ and $\widehat{\beta_k}$, respectively. If the unobserved study effects are taken into account, Equation (3.12) can be rewritten as:

$$t_i = \widehat{\beta_1} + \sum \widehat{\delta_j} K_{jis} + \widehat{\beta_0} \frac{1}{SE_{is}} + \sum \widehat{\beta_k} \frac{Z_{kis}}{SE_{kis}} + \widehat{\mu_s} + \widehat{\upsilon_{is}} \tag{3.13}$$

Equivalently to the bivariate MRA using FE, $\widehat{\mu_s}$ denotes the unobserved study effects, which can be replaced by either a fixed- or a random-effects term. By expanding the discussion of Section 3.3.2*,* simulations of Stanley and Doucouliagos (2012; 2013) show that neither the FE, nor the RE outperform the WLS in the presence of excess heterogeneity. Moreover, in the presence of both excess heterogeneity and publication bias, the WLS appears to perform significantly better than the panel MRA. However, the authors (ibid, p.8) suggest that the RE seems to perform better than the WLS only when there is excess heterogeneity in the literature, but no publication bias. Irrespective of the result of the publication bias test, in a comprehensive MRA, it is necessary to always assume publication bias because of the low power of this test (ibid, p.11).

3.3.4 Moderator Variables used in MRA

Several moderator variables identified in the primary literature are assumed to explain the differences in the reported effect size. These variables, listed and defined in Table 3.2, are also classified into K- and Z-moderator variables, influencing the publication bias and the excess heterogeneity, respectively (see detailed descriptive statistics in Appendix 3.2.2). It is worth noting that moderator variables are included in the dataset if there is sufficient variation between studies. Although we might think of various moderator variables, partly suggested by abundant MRA studies, not all of them might be applicable to our context of investigation. The frequency of a specific moderator variable across studies is used as the criteria to objectively decide on the inclusion of moderator variables in the dataset.[50] More specifically, if a particular source of

[50] If a specific moderator variable is used (or found in) at least from two papers, we consider the inclusion of this moderator variable in our dataset

heterogeneity can be observed in at least two studies, the moderator variable is included in the dataset; otherwise, it is not considered as relevant.

An important contextual variable influencing the publication bias is the direct comparison of the effect sizes between studies published as journal articles and those published as working paper, PhD or master thesis. More specifically in our dataset, peer-reviewed published studies tend to report smaller effect size than the second group of studies, with an average t-value of -0.08 and -0.19, respectively (recall Table 3.2). To control for potential differences in the estimates arising due to the article's publication status, two dummy variables are included: ***published*** (1 when a study is published in a peer-reviewed journal) and ***unpublished*** (0 when a study is published as working paper, discussion paper, PhD and Master Thesis).

Professional association (authors influencing each other's works) and funding sources have been found to be a significant influence regarding publication bias in some MRA (see Doucouliagos and Laroche, 2003). We may argue that studies that explicitly acknowledge having received a financial support (***financial***) for their research might be more likely to publish significant and larger effect sizes than the ones that do not receive funding (***nonfinancial***). Although there is no evident indication of this influence, it is worth investigating through an MRA.

To gauge the effects of different contexts of investigation related to the stages of development, it is necessary to make a distinction between developed, developing, transition and mixed countries. The dummy moderator variables ***transition, developing, developed*** and ***mixed*** should indicate whether there is a difference in empirical research results from transition versus non-transition countries (developed and developing). Although other MRA studies on FD have group transition economies with developing ones, this seems to be inappropriate in our research given the particular focus of this thesis on this set of countries. Although ideally, we would have preferred to carry out an MRA only for transition economies, this was not possible in the presence of limited primary studies for transition economies. Therefore, including these dummy variables in the model will help to better understand the excess variation between different groups of countries.

An important characteristic of our meta-sample relates to the measurement of the dependent variable. Although the majority of studies used a growth-related variable (recall Table 3.3), it is essential to acknowledge the differences in the estimated results of studies that used level-related variables or entirely different measures. Hence, three dummy variables, related to the economic performance measure, are coded: ***growth, level*** and ***other***. However, Efendic *et al. (*2011) conducted on economic growth argue that the output-growth studies and output-level studies should be considered as two different subsamples if they share different characteristics regarding publication bias, genuine effect and heterogeneity. Hence, in addition to the first approach, including output related dummy variables, this research will investigate the differences by splitting the dataset into two subsamples: output-growth and output-level studies.

A general concern is whether the differences in the type of data (cross-sectional data, time-series data and longitudinal/panel data) influence the findings. Dummy variables for controlling such heterogeneity are included: ***cross, timeseries*** and ***panel***. Also, potential differences in the estimates that might arise due to different estimation techniques are captured by classifying the studies into those that use OLS, fixed-effects estimation, random-effects estimation, dynamic estimation, instrumental variable approach and other techniques different from the abovementioned, ***ols, paneltech, dynamic, iv*** and ***othertech,*** respectively. An additional estimation method characteristic is whether a study controls for endogeneity, which is common in IV approaches or GMM dynamic models. To explicitly account for excess heterogeneity arising from addressing endogeneity in the FD-economic growth relationship, two dummy variables (***endog*** and ***nonendog)*** are included, due to potential collinearity with one of the above estimation method dummies.

Because of the importance that data availability has on the FD-economic growth literature, it is neccessary to distinguish between data sources from which the FD measures are obtained/calculated. Whilst the OECD database and other individual country statistics databases (***othersource***) regarding FD data are deemed to provide rich information on the FD measures, the IMF (***imf***) appear limited especially for studies aiming to investigate the relationship between the autonomy of local government and economic growth (Sacchi and Salotti, 2014). However, the IMF data has the broadest coverage regarding countries and time, which is why the majority of primary studies has used this data source.

One of the most used explanatory variables in an MRA concerns the differences in measuring the main variable of interest, FD. Despite the continuous improvement in adequately measuring FD through all its dimensions (using multiple measures), a lot of studies still rely on a limited number of FD measures. These differences are captured by classifying the studies into those that used only expenditure decentralization (***fdexp***), only revenue decentralization or tax decentralization (***fdrev***), both revenue and expenditure dimension of the FD (***fdexprev***), the three suggested measures of FD (expenditure decentralization, revenue/tax decentralization and vertical imbalance, which are coded as ***threefd***) and other measures not as abovementioned such as indeces or retention rate (***otherfd***). Indications from the empirical literature review reveal that studies might use more than one measure of the same category (for instance two measure of expenditure decentralisation). Hence, the number of FD, a continuous variable, is included accordingly in the MRA. However, any attempt of studies to control for the nonlinearity of the economic effect of FD, by using the square term of one of the FD measures, is coded as a different dummy variable (***nonlinear*** and ***linear***, when a study accounts for nonlinearity and when a study does not account for it, respectively).

With respect to the main variable of interest, a moderator variable that might exert influences on the FD-economic growth relationship is the distinction between federalism and decentralisation. The primary studies do provide evidence from both constitutions separately and jointly, though the evidence appears mixed and inconclusive. Hence, accounting for this difference through three dummy variables (***federal, unitary,*** and ***mixedconst***) might help to explain the excess heterogeneity which might arise from different governing constitutions.

The previous chapter revealed significant variations of estimates due to different level of investigation (national vs regional). It was argued that studies conducted at regional level tend to report higher effect sizes than the ones conducted at more aggregated levels. To capture potential differences arising from the level of investigation, studies are classified into those that conduct research at the national level (***national***) and regional level (***regional***). In the same vein, it might be argued that studies conducted for a single country tend to report larger estimates than cross-country investigations, which are also coded accordingly (***single*** and ***multi***). The rationale is that the economic effect of FD is likely to be more visible in a single-country investigation rather than in a multiple-country investigation in which the individual country effect might be obscured by countries dominating the dataset.

Many primary studies stress the importance of distinguishing between short-run and long-run economic effect, while arguing that FD might be considered as an institutional change in certain contexts of investigation which materialises into growth only with considerable lags. In order to investigate whether the FD-economic growth relationship is time-varying, studies are classified into those that investigate such relationship in long-run and those that investigate it in short-run, through dummy variables, ***longrun*** and ***shortrun***, respectively. It should be noted, that this variable can control for any temporal trend in the effect sizes of FD on economic growth. Size, policies and visions of government change from time to time and would be of high interest to investigate whether these changes create variation/heterogeneity in the studies that estimate such effect. Alternatively, differences in reported results coming from a change in "fashion" (preferences of editors and publishers to publish fashionable results) can be controlled by publication year (***puby)***.[51] Hence, at the crux of the debate is whether the differences are due to "fashion" change or different time-period effects (short-run and long-run). However, it is worth noting that the publication might as well be considered as a variable explaining the heterogeneity of studies over time, rather than the publication bias due to "fashion" change, which is why ***puby*** will be considered as K and also as Z in our analysis.

[51] For the purpose of distinguishing between the Simple MRA and MRA with moderator variables we named this variable differently than *time*, which is used in Section 3.3.2.

Table 3.2 MRA moderator variables

Characteristics	Variable	Definition	Classification
Publication Characteristics	***published***	Dummy, 1 if the study is published in a journal, 0 otherwise.	K
	puby	The year a study is published (1=1998, 2=1999 ...)	Z and K
Financial Support	***financial support***	1 if study acknowledges receiving financial support for the research, 0 otherwise.	K
Quality of Publication	***quality***	1 is published in a high-impact journal, 0 otherwise	K
Structure of the Data	***cross***	Dummy, 1 if study employs cross-section data, 0 otherwise.	Z
	panel*	Dummy, 1 if study employs panel data, 0 otherwise.	Z
	timeseries	Dummy, 1 if study employs time series data, 0 otherwise.	Z
Estimation Technique	***ols***	Dummy, 1 if study uses OLS, 0 otherwise.	Z
	paneltech*	Dummy, 1 if study uses either Fixed Effect or Random Effect Estimator, 0 otherwise.	Z
	dynamic	Dummy, 1 if study uses dynamic modelling (i.e. GMM, using lags), 0 otherwise.	Z
	iv	Dummy, 1 if study uses IV approach, 0 otherwise.	Z
	othertech	Dummy, 1 if study uses other techniques than the abovementioned, 0 otherwise.	Z
Endogeneity	***endog***	Dummy, 1 if study treats the endogeneity problem, 0 otherwise.	Z
	nonendog*	Dummy, 1 if study does not treat the endogeneity problem, 0 otherwise.	Z
Non-linearity	***nonlinear***	Dummy, 1 if study investigates the nonlinearity of the FD-economic growth relationship, 0 otherwise.	Z
Stages of Development	***developing***	Dummy, 1 if sample of the primary study is for developing countries, 0 otherwise.	Z
	developed*	Dummy, 1 if sample of the primary study is for developed country, 0 otherwise.	Z
	mixed	Dummy, 1 if sample of the primary study is for mixed country, 0 otherwise.	Z
	transition	Dummy, 1 if sample of the primary study is for transition countries, 0 otherwise	Z
Dependent Variable	***growth****	Dummy, 1 if the dependent variable is growth related variable, 0 otherwise	Z
	level	Dummy, 1 if the dependent variable is a level related variable, 0 otherwise.	Z
	othery	Dummy, 1 if the dependent variable is neither ***growth*** nor ***level***, otherwise 0.	Z
	unitary	Dummy, 1 if the study conducts research for unitary government, 0 otherwise.	Z
	federal*	Dummy, 1 if the study conducts research for federal government, 0 otherwise.	Z

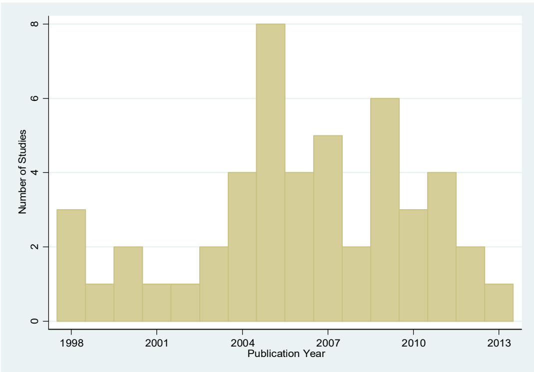
Government constitution	***mixedconst****	Dummy, 1 if the study conducts research for both unitary and federal government, 0 otherwise.	Z
Level of Investigation	***national***	Dummy, 1 if the study conducts research at national level, 0 otherwise.	Z
	regional*	Dummy, 1 if the study conducts research at regional level, 0 otherwise.	Z
Number of Countries	***single***	Dummy, 1 if the study conducts research only for one country, 0 otherwise.	Z
	multi*	Dummy, 1 if the study conducts research only for multiple countries, 0 otherwise.	Z
Data Source	***imf***	Dummy, 1 if the study uses IMF data, 0 otherwise.	Z
	othersource*	Dummy, 1 if the study uses OECD or othersources than IMF, 0 otherwise.	Z
Measure of FD	***fdexp****	Dummy, 1 if the study measures FD with an expenditure decentralization measure(s), 0 otherwise.	Z
	fdrev	Dummy, 1 if the study measures FD with a revenue decentralization measure(s), 0 otherwise.	Z
	fdexprev	Dummy, 1 if the study uses both expenditure and revenue decentralization to measure FD, 0 otherwise.	Z
	threefd	Dummy, 1 if the three conventional FD measures are used as the measure of FD, 0 otherwise.	Z
	otherfd	Dummy, 1 if the study uses other measures than ***fdexp***, ***fdrev***, ***fdexprev*** or ***threefd***, otherwise 0.	Z
	numberfd	Number of FD measures used in the regression from which the effect size is obtained	Z
Lags	***lags***	Dummy, 1 if the study uses lags of the FD measures in their regressions, 0 otherwise.	Z
Long-Run	***longrun***	Dummy, 1 if the study estimates long-run relationship between FD and growth, 0 otherwise.	Z
	shortrun*	Dummy, 1 if the study estimates short-run relationship between FD and growth, 0 otherwise.	Z

* dummy variable considered as the base group

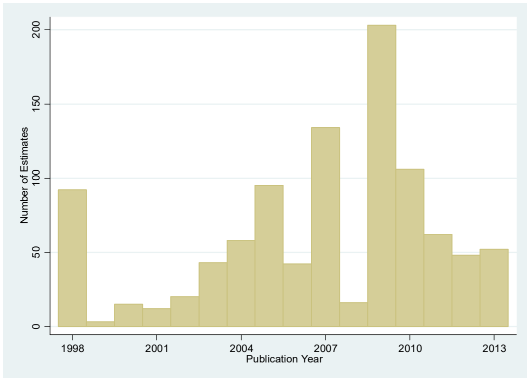
Note: In the case of ***federal*** and ***mixedconst*** there are two stars given that we might consider grouping these two dummies together.

3.4 Descriptive Statistics

The oldest study in our database was published in 1998 (the study of Davoodi and Zou, 1998), whereas the most recent one was published in 2013 (Gemmell *et al.,* 2013).[52] Appendix 3.2.1 provides more details regarding the number of estimates by study. It seems that the boom of the publishing FD-economic growth research was during the 2004-2010 period (Figure 3.1*a*), which also yielded the largest number of estimates (Figure 3.1*b*).



(a) Number of studies by year



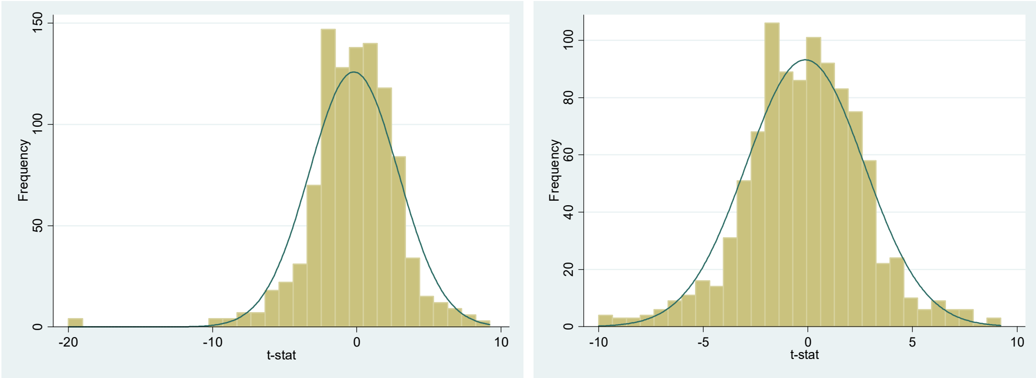
(b) Number of estimates by year

Figure 3.1 Number of studies and estimates by year

With regards to estimates obtained from the primary studies, it seems that there is also a great degree of heterogeneity, with t-values ranging from -20 to 9.5 (see Figure 3.2). Visibly, the histogram casts doubts on some aberrant values of the effect size, which are likely to distort the distribution of the estimated effect of our variable of interest. Also, confirmed by the letter-value approach[53], all observations that lie outside the inner fence of -7.14 and +6.97 shall be deemed as outliers. By avoiding the effects of all abnormal values, the total number of observations reduces from 1001 to 966, reporting a mean of -0.08 and a median of -0.06. The maximum value in our dataset is 6.93 and the minimum is -7.04, which suggests a high heterogeneity in the reported estimates.

[52] Although the study of Gemmell *et al.* (2013) was published in 2013, an early version of the same article can be found back in 2001.

[53] The letter-value approach is applied using Stata command "lv" developed by Tukey (1977) and Hoaglin (1983). More details are provided in Appendix 3.3.1



(a) Including outliers (b) Excluding outliers

Figure 3.2 Distribution of t- statistics

To show the heterogeneity in the reported effect size by study, the t-values, sorted by publication year, are plotted in Figure 3.3. Unsurprisingly, this figure suggests a considerable variation of the effect of FD on economic growth, while the majority of them lie inside the red lines (between the -1.96 and +1.96), indicating the insignificance of the FD-economic growth estimates. Also, it must be noted that the standard deviation reported for the t-values is quite high (3.08), which leads us to question the causes of differences and heterogeneity in the empirical results. The latter, as being an important purpose of this chapter are going to be deeply investigated in the next sections.

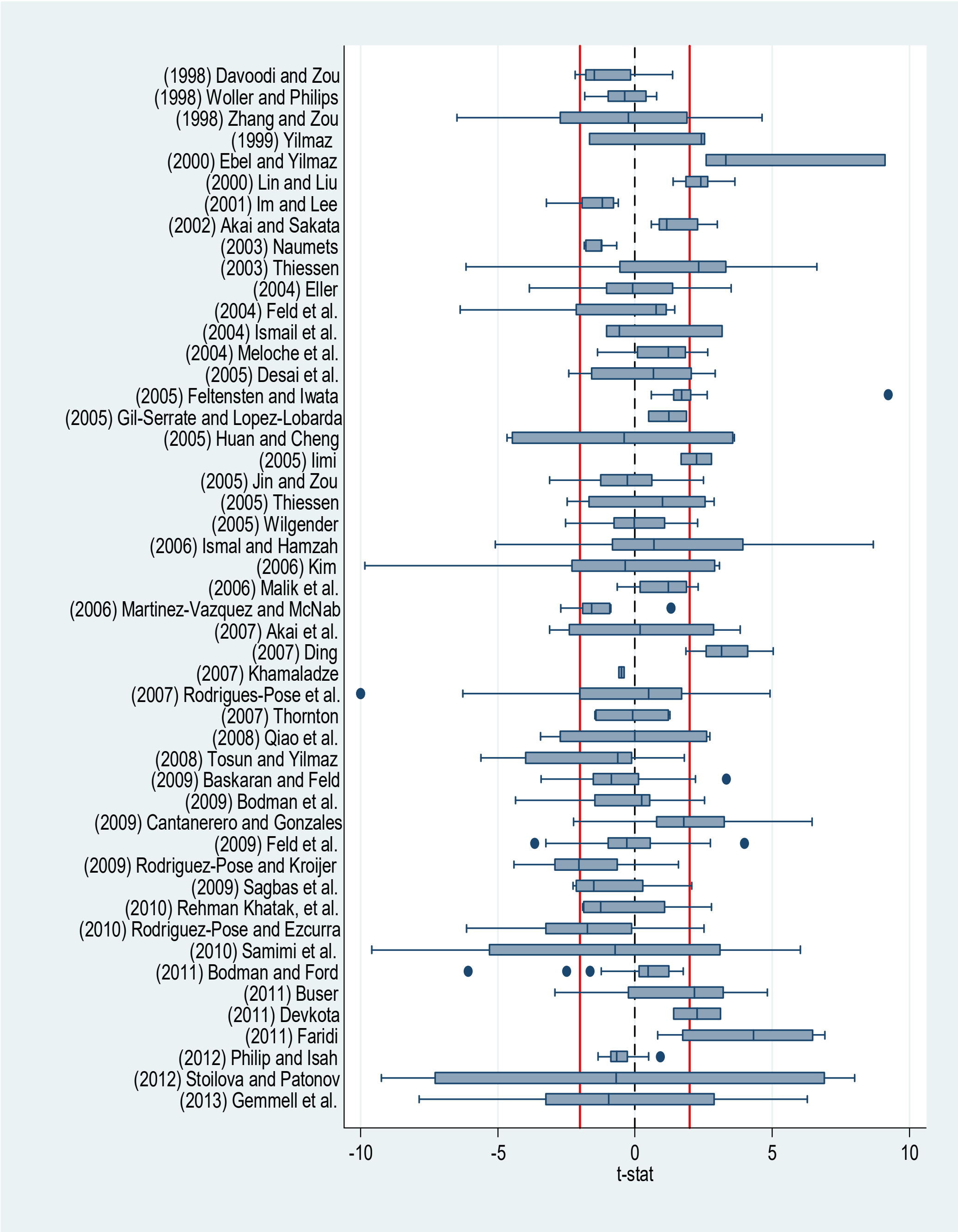


Figure 3.3 Box Plot of the t-values reported by study

Figure 3.3 might also be helpful to visually depict any potential time-series pattern of the FD-growth effect. Sorting the studies by the year of publication (from Davoodi and Zou, 1998 to Gemmell *et al.*, 2013) gives a mixed picture of the fluctuations over time of the t-values. Whilst the initial effect (see year 1998) appears to be negative, accompanied by low volatility in the upcoming years, the subsequent literature reports relatively larger t-values, as seen by the length of bars. However, it seems difficult to depict a particular trend (either positive or negative) of the estimates reported over years. Consequently, more advanced techniques are required to investigate such "fashion cycle" of our effect sizes, which will be elaborated in the next sections.

As mentioned in Section 3.2.2, central to our MRA decisions is accounting for the pronounced differences in the FD measures used across studies. Whilst this was addressed by introducing weights (see Stanley and Doucouliagos, 2012), it is important to devote attention to some descriptive statistics related to this issue. As shown in Table 3.3, there is a vast variety of the FD measures used by the primary studies, partly due to its changing characteristics over time and partly due to specification differences. In general, FD is measured by either expenditure decentralisation, revenue/tax decentralisation, different measures of vertical imbalance and other measures that combine either local expenditure and local revenues into one index or entirely avant-garde measures.[54] Surprisingly, such heterogeneity is observed not only within studies, but also within specifications of the same study. According to our meta-sample, 34% of the estimates are from specification that used only expenditure decentralisation as a measure of FD, 21% of the estimates come from specifications using only revenue/tax decentralisation measure, 15.5% of estimates are supplied by specifications using both expenditure and revenue decentralisation, 7.2% of the estimates are from specifications using the three conventional measures of FD, while surprisingly 22.3% of the studies used other measures of FD than the abovementioned. The latter seems to be a combination of the conventional measures with additional ones such as the transfers from other levels of government, local government autonomy, the squared term of local expenditure/revenue and retention rate.[55] We classified the latter as other measures because of too many measures of FD that apparently would not help in distinguishing the sources of such pronounced heterogeneity between specifications and studies.

[54] Revenue decentralization is the share of local revenue in percentage of total revenue or GDP. Expenditure decentralization is the share of sub-national expenditure in percentage of total expenditure or GDP. Vertical imbalance is defined as the ratio of inter-governmental transfers to total tax revenue of sub-national governments (De Mello, 2000).

[55] The share of tax revenue generated from a certain territory obtained by the subnational government.

Table 3.3 Descriptive statistics

Variable	Observations	Mean	Min	Max
Expenditure Decentralization	339	-0.36	-10	8.68
Revenue Decentralization	212	-0.25	-9.85	9.11
Expenditure and Revenue Decentralization	156	0.011	-9.6	9.22
Three Conventional Measures of FD	66	-0.80	-4.42	4.00
Other Measures of FD	224	0.47	-6.49	6.93
GDP Growth Variable	879	-0.17	-10	9.22
GDP Level Variable	102	0.30	-6.38	6.93
Other Measures of economics performance	14	0.06	-5.62	2.92
Developed Countries	678	-0.15	-10	9.22
Developing Countries	104	0.21	-9.6	8.68
Transition Economies	193	-0.10	-9.24	9.11
Mixed Sample	22	-0.88	-2.35	2.79
Published	670	-0.08	-9.6	9.22
Unpublished	327	-0.19	-10	8.68

Another observable heterogeneity of the estimates across studies could be due to differences in measuring the dependent variable: economic performance (see Table 3.3. Whilst the majority of the studies used variables related to growth (growth of real GDP, or difference in natural logarithm of per capita GDP, GDP per employee growth), only few of them used independent variables related to the level of output (real GDP, GDP per capita, GDP per employee, GNP) or other measurements but level or growth variables (i.e. development index, industrial output per region), 88.2%, 10.3% and 1.5%, respectively.

Attention is also devoted to differences in the number of estimates supplied by different context of investigation. As shown in Table 3.3, the majority of the estimates (68%) are supplied by studies conducted in developed countries.[56] Next, it seems that studies on transition economies also offer a considerable number of estimates (20%) when compared to developing (10%) or mixed samples (2%).

Moreover, differences could be also observed in the studies' publication status. 670 point estimates out of 997 are obtained from published studies as journal articles, while the rest (327 out of 997) are obtained from PhD, master thesis, discussion and working papers. Overall, these brief descriptive statistics (additional descriptive statistics provided in Appendix 3.2.2) suggest that empirical research is scattered throughout a

[56] The reported numbers in Table 3.3 show the percentage of estimates provided by different type of countries. Accordingly, 4.2% of estimates are generated from mixed sample studies; 21.4% from transition countries; 23.3% from developing countries and 51.10% from developed countries.

diverse research context, while stressing, at the same time, the need to thoroughly take into account such differences.

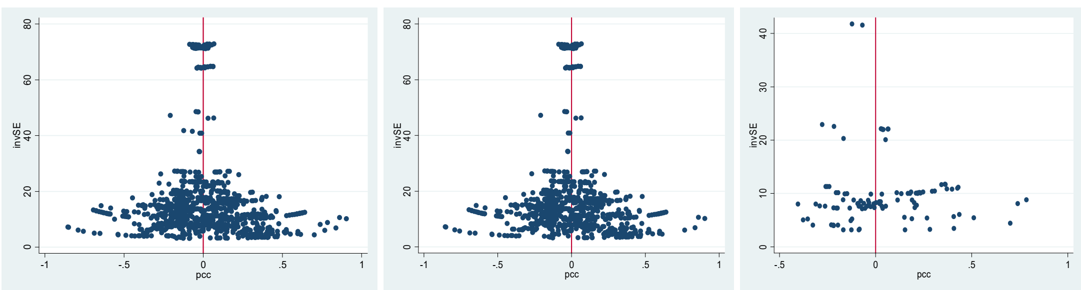
3.5 Results

3.5.1 Results from Bivariate MRA

a) Funnel Plot

To graphically observe whether publication bias is present in this literature, the scatter plot of PCCs and the inverse standard errors are plotted in Figure 3.4a for the full sample, and Figure 3.4*b* and Figure 3.4.*c* for the two subsamples, the output-growth and output level, respectively. It is expected that the least precise estimates, placed at the bottom of the funnel plot, will be widely dispersed. Contrary, the most precise estimates, placed at the top of the funnel plot, will have a more compact dispersion. According to Stanley *et al.* (2010), these estimates are the least affected by the publication bias, which generally denotes 10% of all estimates. Simulations have shown that their average provides a statistic beyond publication bias.

Apparently, the full sample literature provides a rough approximation to the inverted funnel shape, in which the estimates are randomly distributed around the "true" effect. Whilst the left tail of the funnel appears to be more condensed than the right one, the opposite happens when it comes to the number of estimates on the right side of the funnel, where the funnel seems to be more dispersed and biased towards the positive values. Interestingly, these strange characteristics of the funnel plot seem to suggest that studies tend to inflate the positive effect size, while underreporting the negative ones. Such mild, if not unobservable, positive preference towards positive effect appears in accordance with the theory, which mostly stresses the positive association between FD and economic performance.



(a) Full Sample **(b) Output-growth** **(c) Output-level studies**

Figure 3.4 Funnel Plots

When splitting the full sample into output-growth studies and output-level studies, the funnel plots appear more informative. The output-growth studies funnel plot (Figure 3.4*b*) seems to be quite identical to the one of full sample, this may be due to the large number of estimates provided by this subsample, whereas the output-level studies funnel plot (Figure 3.4*c*) appears to be very scattered and not symmetrical around the real effect. Rather, the visual analysis of the funnel plot for the output-level suggests a stronger bias towards positive values than in the first subsample, by pointing towards a greater publication bias in this literature.

Averaging the top 10% of estimates, considered as the most precise one, yields an average PCC of -0.017 which is smaller than the overall average when all estimates are taken into account of -0.0002. Whilst the same results appear in output-growth studies (average of top estimates of -0.017, whereas the overall average of -0.005), there is no comparison made in output-level studies given that there are no estimates from the top 10% of the full sample. Such comparison points towards a positive publication bias, which was also visually depicted in the funnel plots. However, any graphical examination is subject to subjective interpretation and cannot lead to a definite conclusion, especially in the presence of doubt and uncertainty as in Figure 3.4 and simple comparison as the case of the top 10% estimates. It is thus essential to carry out regression analyses and to further investigate this problem through FAT-PET.

b) FAT-PET

Although there might not be much difference between the full sample and the output-growth studies, which was partially suggested by the funnel plot, the risk of comparing "apples with oranges" (Glass *et al.,* 1981) might still be present. Such danger targets the correct effect size especially in the presence of wide boundaries of research, where studies noticeably different from each other. While theoretically there is a clear distinction between the effect of FD on economic growth and economic performance measured in levels, it might be considered wise to split the dataset into two subsamples subject to the measurement of economic performance, thus, combining oranges with oranges, and apples with apples. Researchers may warrant such critics by combining different effects, with the justification that it is the task of the Multivariate MRA to shed light on these differences. Alternatively, this chapter will split the dataset on the most noticeable difference when investigating the economic effect of FD – measurement of economic performance- and then compare it with the full sample. Hence, Table 3.4 reports the estimated results of the FAT-PET for the full sample, output-growth studies and the output-level studies, both using WLS and FE.[57] The interpretation will start from the full sample, followed by the two subsamples, with more emphasis put on the latter.

The estimated results for the full sample, weighted (by the specific weights and the precision term), and clustered-robust, support the evidence of a positive publication bias, significant at only 5%. An intercept smaller than 1, as shown in Table 3.4, indicates the presence of a "little to modest" publication bias (Doucouliagos and Stanley, 2013) However, this is not the case of the output-growth sample in which the intercept becomes insignificant both in the WLS and FE (Columns 3 and 4). Contrary, in the output-level studies the intercept becomes significant at 5% level of significance only when using WLS, suggesting that the estimates of FD on growth are skewed towards positive values. The intercept being larger than 1 lend support to a stronger bias than it was in the full sample, namely, to "substantial" selectivity among the output-level studies. The results seem to be consistent across different estimators (see Columns 5 and 6). In addition to the two preferred estimation techniques, the Robust Estimator, which is presented in Appendix 3.2.3 for brevity, strongly confirms the FAT-PET results. It might be argued that such consistency between the three estimators might be due to the rigorous approach taken regarding outliers.

Table 3.4 FAT and PET Baseline Meta-Regression Analysis

	(1) WLS	(2) FE	(3) WLS	(4) FE	(5) WLS	(6) FE
VARIABLES	Full Sample	Full Sample	Output-Growth	Output-Growth	Output-Level	Output-Level
invSE	-0.0189	-0.0249*	-0.00814	-0.0283*	-0.0995**	-0.0854***
	(0.0130)	(0.0136)	(0.0104)	(0.0131)	(0.0370)	(0.025)
Constant	0.565**	0.0468	0.341	0.2035	1.728*	1.619*
	(0.255)	(0.219)	(0.246)	(0.215)	(0.780)	(0.537)
Observations	966	966	850	850	104	104
R-squared	0.008	0.327	0.002	0.280	0.105	0.520

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

[57] The Stata printouts are presented in Appendix 3.2.

Despite the presence of a positive publication bias in the literature, the PET can identify the presence of genuine effect beyond such selection bias, as argued before in Section 3.3.2. Testing the null hypothesis of β_0=0, in our case the coefficient on the ***invSE***, serves as a test for the presence of genuine effect. The results (reported in Table 3.4) suggest that there is weak evidence of genuine effect when the two subsamples are combined, though only when using FE. A negative genuine effect is found to prevail also in output-growth studies when using FE, and in output-level studies both when using WLS and FE. The robustness check by estimating the FAT-PET equation by Robust Regression have indicated that both the constant and the ***invSE*** are very robust, while the magnitude and the significance are not markedly different from our preferred results of Table 3.4 (see Appendix 3.4.3 for Stata printouts).

Interestingly, these results suggest that the genuine effect in the FD-economic performance literature appears to be (weakly) negative, though researchers are biased towards positive effect sizes. Finding that this literature is infected by publication bias should come as no surprise given that the empirical research is mostly driven by the Oates Theorem, which predicts devolution to have a positive effect. Despite the limited theoretical guidance on the mechanism by which FD affects growth, it seems that most of the studies did not question this Theorem, rather endeavoured to prove it.

As to the output-level literature, where the genuine effect appears to be strong, it seems that researchers are reluctant to publish negative results. Whilst the majority and most cited papers in the FD-economic performance literature are part of the output-growth studies, the minority group of output-level might be easily influenced by them. Accordingly, the latter are more prone to underreport the negative effect sizes, which in turn explains the presence of a more severe publication bias in the output-level than output-growth studies.

c) PEESE

Despite the confirmation of the graphical diagnostics and the consistency of the results across different estimators, Stanley (2008) and Stanley and Doucouliagos (2012) argue that the coefficient on the precision might be biased in the presence of publication bias and excess heterogeneity. Whilst usually the PET is among the least biased estimators (Stanley and Doucouliagos, 2007; Moreno *et al.,* 2009), there are cases when it identifies a false genuine effect by over rejecting the null hypothesis. Therefore, as introduced in Section 3.3.2, an improved correction has to be used by estimating Equation 3.9, while results are reported in Table 3.5. The estimated coefficient on the ***invSE*** appears to be insignificant across all samples, suggesting that there is no genuine effect in this literature.

Table 3.5 PEESE Results

	(1)	(2)	(3)
	WLS	WLS	WLS
VARIABLES	Full Sample	Output-Growth	Output-Level
sepcc	2.802**	1.966	5.201
	(1.220)	(1.223)	(3.152)
invSE	-0.00334	0.000352	-0.0284
	(0.00960)	(0.00918)	(0.0395)
Observations	966	850	104
R-squared	0.023	0.012	0.103

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

d) Fashion Cycle

Table 3.6 report the estimates of Equation 3.8, which investigates whether publication bias follows a fashion cycle. The two set of results, with and without outliers, are compared with each other, the first three columns and last three columns, respectively. The estimated results with outliers, irrespective of the sample used, do not confirm the Goldfarb's concept on the predictable pattern of empirical research. However, when outliers are dropped, the two variables (***time*** and ***time2***) becomes statistically significant. This suggests that initially, the output-growth studies tend to report estimates confirming the theory, but after time elapses, in our case after 8 years of the first study in 1998, contradicting the above results becomes a fashion. Reporting contradictory results do not appear to be only as a fashion trend in academia, but also as a tool which increases the probability of a paper to be published due to the presumed "novelty" argument. However, such fashion cycles are not found to be statistically significant in output-level studies.

Table 3.6 Fashion Cycle Testing

	(1)	(2)	(3)
VARIABLES	Full Sample	Output-growth	Output-level
time	0.0839	0.131*	-0.575
	(0.0731)	(0.0753)	(0.832)
time2	-0.00664	-0.0108**	0.0377
	(0.00426)	(0.00446)	(0.0373)
Constant	-0.161	-0.226	1.453
	(0.295)	(0.297)	(4.493)
Observations	966	850	104
R-squared	0.004	0.012	0.075

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

3.5.2 Results from Multivariate MRA

Before interpreting the results from the Multivariate MRA, it is useful to discuss the diagnostics of the econometric models. First, based on the results of the correlation matrix (see Appendix 3.2.3) it seems that although we collected 40 moderator variables, as described in Table 3.3, not all of them can be used in the same model. The ***national/regional*** and ***single/multi*** moderator variables appear to be highly correlated with each other (correlation of -0.9306; 0.9306), hence we use only the first set of variables given our main concern on the level of investigation as a source of heterogeneity. However, the latter will be used as a robustness check to see whether results change due to the inclusion of ***single/multi*** instead of ***national/regional*** and moderator variables.

Whilst the correlation between other moderator variables is not considered problematic, inclusion of the study fixed effect appears to create substantial multicollinearity problem in the model (VIF up to 1230). Hence, based on the suggestion of Stanley and Doucouliagos (2012, p. 91), a general-to-specific approach is followed. Namely, a model with all potential explanatory variables is estimated for each specification separately and the least significant variables are removed one at a time until only statistically significant variables. Concerning the other diagnostics, the Ramsey RESET test results suggest that models are mostly well specified, though in some specifications this test is not rejected (see Appendix 3.4.2). However, it is important to note that the explanatory power of the multivariate regression rises significantly (from 0.2% in the FAT-PET to 64.5% in the Multivariate MRA) when the moderator variables are included. Also, the null hypothesis that regressors are jointly insignificant is strongly rejected in all the models.

Table 3.7 presents the results of multivariate MRA for which different estimation methods are employed to explain the excess heterogeneity of the economic effect of FD reported in the primary studies. Estimations of Equations (3.12) and (3.13) and the estimation results from the Robust Regression, used as a robustness check, on full sample of the primary studies and the two subsamples (output-growth and output-level studies) are reported in Table 3.7: the full sample results in the first three columns (Columns 1-3), followed by the output-growth studies (Columns 4-6) and output-level studies (Columns 7-9), estimated by WLS, FE and Robust Regression.

Unlike other regressions, the interpretation of the significant variables appears different in an MRA analysis. Positive and significant coefficients suggest that certain study characteristics coded as a dummy variable typically increases the effect size between FD and growth, while negative and significant coefficients decrease the reported effect sizes. Whilst such analysis is undertaken only for the moderator variables, the interpretation of the publication bias and genuine effect is based on estimating the average magnitudes of each K-variable weighted by its mean value on the intercept term, and Z-variable weighted by its mean value on ***invSE***, respectively (Stanley and Doucouliagos, 2012; Dimos and Pugh, 2016). Table 3.8 reports the results, while the Stata printouts are presented in Appendix 3.5.

Explicitly acknowledging any form of financial support by governmental and non-governmental organisations appears to influence publication bias significantly. *Prima facie*, the negative coefficient on the ***finsupport*** across specification and samples suggest that studies that have received funding typically have stronger publication bias. However, taking a closer look at the studies (i.e. Martinez-Vazquez and McNab, 2006; Rodriguez-Pose and Ezcurra, 2010), it might be argued that rather than financial support, it is the quality of research that might affect publication bias. The authors of these papers appear to be amongst the most cited ones in FD-economic growth literature, which also signal the popularity and the influence of their research.

In line with many MRA studies (see Stanley and Doucouliagos, 2012), our results suggest that the effect size increases with the year of publication of the study in the full sample and output-growth studies, while decreases in the output-level sample. However, it should be noted that the results do not appear to be consistent in the full sample and the output-growth studies, while ***puby*** becomes significant only when using FE estimation. The positive coefficient in the first two samples, only in the FE, might be attributed to the additional unobservable effects related to the improvement of data quality and methodology in these primary studies. Alternatively, possible changes in the FD level might be a possible reason for the decrease in the effect size in the output-level studies, while the majority of these studies focus on developing countries. Interesting, if we were to consider the year of publication as a variable influencing the publication bias over time (recalling Sections 3.3.2*f* and 3.5.1*d*), the significance and the sign of all moderator variables would not change. However, following the good practices (see Stanley and Doucouliagos, 2012; Dimos and Pugh, 2016), ***puby*** is fixed as Z-moderator variable. Appendix 3.5 provides the estimated results (replication of Table 3.7) claiming ***puby*** as a K-moderator variable, which overall can be considered as an additional robustness check of our preferred results. Regarding the span of the data (***span***), the results suggest no significant variation in the estimates. Namely, there is no difference in the effect size between studies that use recent and old-time span of data.

Perhaps, the most striking result is the significant negative coefficient on the ***national*** variable, suggesting that the difference in the level of investigation (national vs regional level) has a great systematic effect on the reported excess heterogeneity, though being consistent only for the full sample and output-growth studies (Columns 1-6). Contrary, this variable had to be dropped in the second subsample due to high multicollinearity, as we followed the general-to-specific approach. Apparently, this finding appears to confirm our arguments in the previous chapter, where it was argued that variations in the economic effect of FD are likely to exist due to the different level of investigations. Also, this seems to be consistent with Akai and Sakata (2002) study, who argue that the effect of FD on economic growth at national level might be difficult to capture because of the complexity and multidimensionality of decentralisation and substantial historical and/or cultural differences across countries, and thus yielding a smaller effect compared to the one at lower level of aggregation.

Table 3.7 Multivariate MRA Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	WLS	FE	Robust Reg	WLS	FE	Robust Reg	WLS	FE	Robust Reg
VARIABLES	Full Sample	Full Sample	Full Sample	Output-Growth	Output-Growth	Output-Growth	Output-Level	Output-Level	Output-Level
invSE	-0.0328	-0.0961***	0.160***	-0.00257	-0.0984***	0.222***	0.0423	0.150***	0.301***
	(0.0501)	(0.0239)	(0.0268)	(0.0522)	(0.0299)	(0.0290)	(0.0814)	(0.0186)	(0.0497)
published	0.727*	1.211***	1.158***	0.836**	1.330***	1.138***	-1.520*	-2.783***	-1.073***
	(0.372)	(0.348)	(0.219)	(0.400)	(0.378)	(0.259)	(0.781)	(0.176)	(0.373)
puby	0.00591	0.0108***	-0.00401	0.00338	0.0110***	-0.0105***	-0.0169*	-0.0286***	-0.0397***
	(0.00504)	(0.00241)	(0.00253)	(0.00568)	(0.00289)	(0.00281)	(0.00909)	(0.00245)	(0.00561)
finsupport	-2.447***	-2.195***	-1.195***	-2.372***	-2.231***	-1.216***			
	(0.603)	(0.254)	(0.454)	(0.668)	(0.278)	(0.463)			
developing	0.0213*	0.0141	0.0202**	0.0153	0.0145	0.0178*			
	(0.0110)	(0.00913)	(0.00944)	(0.0113)	(0.0103)	(0.00947)			
national	-0.0874**	-0.127***	-0.123***	-0.0583	-0.126***	-0.0903***			
	(0.0422)	(0.0212)	(0.0244)	(0.0417)	(0.0234)	(0.0255)			
imf	0.0678	0.143***	-0.0314	0.0205	0.148***	-0.0852***	0.201*	0.338***	0.453***
	(0.0449)	(0.0203)	(0.0265)	(0.0467)	(0.0251)	(0.0289)	(0.0915)	(0.0207)	(0.0331)
threefd	-0.219***	-0.228***	0.0353	-0.197**	-0.236***	0.101**	-0.270***	-0.146***	-0.160**
	(0.0696)	(0.0394)	(0.0397)	(0.0775)	(0.0407)	(0.0442)	(0.0796)	(0.00149)	(0.0614)
level	-0.0624**	-0.0463***	-0.0412						
	(0.0256)	(0.0171)	(0.0275)						
othery	-0.117***	-0.183***	-0.0989						
	(0.0390)	(0.0232)	(0.0820)						
cross	-0.118		-0.0307	-0.138		-0.0250	-0.855***	-1.048***	-0.913***
	(0.0810)		(0.0591)	(0.0862)		(0.0642)	(0.116)	(0.0264)	(0.161)
timeseries	0.232		0.138	-0.0262		-0.0161			
	(0.172)		(0.104)	(0.126)		(0.136)			
ols	-0.0264		-0.0988***	-0.0306		-0.0921***	0.702***	0.816***	0.847***
	(0.0310)		(0.0182)	(0.0303)		(0.0184)	(0.0713)	(0.0270)	(0.103)

dynamic	0.000616		0.0337	-0.0159		0.0141			
	(0.0685)		(0.0273)	(0.0705)		(0.0275)			
iv	-0.00128		0.0323	0.0296		0.0755			
	(0.0487)		(0.0437)	(0.0463)		(0.0607)			
othertech	-0.0293		-0.0342	0.0617		0.104			
	(0.0942)		(0.0903)	(0.0424)		(0.103)			
longrun	-0.0192		0.00931	-0.0380		-0.00611			
	(0.0348)		(0.0212)	(0.0325)		(0.0224)			
mixed	0.0259		0.0148	0.00552		-0.000109			
	(0.0237)		(0.0297)	(0.0201)		(0.0301)			
transition	0.0343		-0.0568*	0.0256		-0.103***			
	(0.0511)		(0.0291)	(0.0470)		(0.0297)			
endog	0.0173		-0.0819***	0.0225		-0.0483**			
	(0.0295)		(0.0221)	(0.0296)		(0.0226)			
nonlinear	0.0108		0.0951***	0.000945		0.0833***			
	(0.0326)		(0.0176)	(0.0313)		(0.0180)			
unitary	-0.0248		-0.0957***	-0.0297		-0.0661**			
	(0.0418)		(0.0248)	(0.0415)		(0.0260)			
fdrev	-0.0307		-0.00733	-0.0398		-0.00672	0.0642**	0.0534***	0.0128
	(0.0238)		(0.0175)	(0.0238)		(0.0180)	(0.0239)	(0.0162)	(0.0384)
fdexprev	-0.0364		0.0161	-0.0258		0.0406			
	(0.0419)		(0.0243)	(0.0437)		(0.0260)			
otherfd	0.00450		0.0332*	0.0171		0.0472**			
	(0.0365)		(0.0195)	(0.0393)		(0.0208)			
span	0.0217		0.00664	0.0183		0.00544			
	(0.0158)		(0.00821)	(0.0152)		(0.00826)			
nexplanatory	-0.00189**		-0.00248***	- 0.00183**	0.000296	-0.00248***			
	(0.000898)		(0.000871)	(0.000907)	(0.000942)	(0.000880)			
Constant	0.246	-0.292	-0.766***	0.192	-0.458	-0.993***	2.335**	3.163***	1.541***
	(0.429)	(0.258)	(0.264)	(0.432)	(0.282)	(0.305)	(0.777)	(0.137)	(0.421)
Observations	966	966	1,001	850	850	884	104	104	104

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

It is surprising to find that the moderator variables capturing the context of investigation appear weakly significant. The only variable significant at 10% level is ***developing,*** which appears consistent across the full sample and the output-growth, though weakly consistent across estimations. More specifically, studies investigating the economic effect of FD, belonging to the abovementioned group of studies, tend to report larger effect than studies conducted in developed economies, though this finding disappears when the MRA is estimated by a WLS (see Columns 1 and 4). With respect to the other categories, it seems that in general there is no significant effect, with the only exception on the ***transition*** variable in the output-growth subsample when using Robust Regression (see Columns 6). However, a note of caution is in order when relying only on the results from Robust Regression given its inability to address the dependency and the different number of estimates per study.

In accordance with the expectations, the estimated effect of FD on economic growth depends largely on the measurement of FD, a finding which appears strongly consistent across specifications, estimations and samples. Compared to studies that used only expenditure decentralisation as a measure of FD, the estimated effect of FD is found to be, on average, smaller in studies using three measures of FD. There are several reasons that might explain this difference in the effect size. First, recalling Section 2.4, measuring FD by only one measure is less likely to capture the real level of FD taking into account the multidimensionality of this process especially when investigating cross-country studies. Consequently, the use of one measure is likely to inflate the economic effect of FD and produce biased results when compared to measures that capture all the dimensions of FD (expenditure, revenue/tax dimensions and vertical imbalance). Second, the use of only one measure of FD is likely to capture all the economic effect of FD, contrary, to the use of multiple measures where each measure would capture only a part of the total effect of FD on economic growth.

Compared to studies using panel data, the estimated effect of FD is found to be, on average, smaller in studies using cross-section data. Though, this effect seems to be greater in the output-level studies compared to the full sample and output-growth studies, as suggested by the bigger coefficient of cross-section data (***cross***) on the three last columns. As to the econometric methodology employed, the results appear to diverge between the subsample. Whilst none of the estimation techniques is considered as a significant variation in the full sample and the output-growth subsample, the opposite might be observed in the second subsample. With fixed and random effect estimation as the base category, the output-level studies are more likely to report larger estimates when using an OLS estimation technique, a finding which appears consistent across different specifications (see Columns 7-9).

Further, the results partly confirm our hypothesis regarding the variation in the effect size due to different sources of data. A larger reported effect is found in the full sample and the two subsamples compared to the other dataset than the IMF (OECD and individual country's databases). Such results, which appears consistent also across estimation methods, stress the source of FD data as a significant cause of heterogeneity. Such findings appear to confirm our previous hypothesis, stated in Section 2.4.1, in which the difference in the estimated effect might be attributed not only to the methodological issues but also to the databases used. Further from our hypothesis, the positive coefficient on ***imf*** might be explained by the popularity and great coverage in terms of data and time of this database towards OECD and other databases, while accompanied by the critics of overestimating some measures of FD (revenue decentralisation and vertical imbalance).[58]

The endogeneity moderator variable is insignificant across different samples and estimators. Although *prima facie* this would sound as contrary to expectations, in the FD-economic growth literature this is somehow expected. Unfortunately, the majority of the primary studies do not tackle endogeneity at all, though being aware of it (Meloche *et al.*, 2004; Khmaladze, 2007; Khattak *et al.,* 2010; Faridi, 2011). Thus, the insufficient variation across the meta-regression sample might be a possible explanation of its insignificance. The same argument might perhaps be provided about studies controlling for the nonlinearity of the FD-economic growth relationship (***nonlinear***) and those investigating the long-run economic effect of FD (***longrun***).

Another conspicuous result is the negative and significant coefficient on the measurement of the dependent variable in the full sample. Having growth as the base category, the results suggest that studies using either level-related variables or other unconventional measures of economic performance tend to report smaller effect. Overall, the findings suggest there is considerable dependent variable heterogeneity,

[58] A detailed discussion on the advantages and disadvantages of IMF will be provided in the next chapter (Section 4.3.1).

which demands the full sample to be divided into subsamples, while at the same time confirming our approach both in bivariate and multivariate MRA.

The number of explanatory variables used in the primary study appears to be also a significant moderator variable explaining the heterogeneity of the reported effect sizes. Namely, the average estimates decrease with the number of explanatory variables. The negative coefficient of this variable in the full sample and the output-growth sample might be a signal of the quality of the research, where the greater the number of control variables used the more cautious are the studies regarding the omitted variable bias. Although there is ground for debate with the rationale of this variable, it might be considered as appropriate to control whether the estimates are derived from studies using small or large number of explanatory variables. As to the output-level studies, no conclusion can be drawn given the need to drop this variable due to high multicollinearity problems.

Table 3.8 Average Publication Bias and Average Genuine Effect

	(1) WLS	(2) FE	(3) WLS	(4) FE	(5) WLS	(6) FE
VARIABLES	Full Sample	Full Sample	Output-Growth	Output-Growth	Output-Level	Output-Level
Average Genuine Effect	-0.048* (0.026)	-0.041* (0.018)	-0.054* (0.027)	-0.032* (0.017)	-0.112** (0.037)	-0.087*** (0.016)
Average Publication Bias	0.483 (0.354)	0.295 (0.243)	0.510 (0.345)	0.204 (0.255)	1.438** (0.446)	1.521*** (0.179)
Observations	966	966	850	850	104	104
R-squared	0.1485	0.2905	0.1410	0.2243	0.4829	0.5564

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

As explained above, to allow judgment concerning the extent of publication bias and genuine effect, it is necessary not only to calculate their average coefficient, but also to split the dataset so the results from multivariate MRA reported in Table 3.8 would be comparable to the bivariate MRA results of Table 3.4. Overall, both results appear to be consistent with each other. Namely, once study characteristics are controlled for, the negative genuine effect seems to persist in all samples. The presence of a negative genuine effect might be explained by the negative estimates reported by studies using expenditure decentralisation, which contrary to the theoretical expectations, impacted growth negatively.

Allowing for greater complexity in the publication bias, through the K-moderator variables, the apparent publication bias in the full sample and output-growth studies disappears, while dominating in the output-level studies. Apparently, this confirms the discussion in Section 3.5.1, where publication bias appeared to be strong mostly in studies using level-related dependent variables. Namely, the intuition for a positive economic effect of FD among output-level studies appear very strong, partly due to theoretical ground and partly due to dominant growth-studies literature, and so researchers of output-level studies might think that results showing the opposite are difficult to reach publication. Similar to the FAT results, having a constant greater than 1 suggests the presence of substantial selectivity in this subsample of the FD-economic performance literature.

3.5.3 Contribution to the existing MRA

Despite existing MRA on the economic effect of FD of Feld *et al*. (2009b), Baskaran *et al.* (2016), Zhenfa and Wei (2016), there is still no comprehensive and systematic meta-regression study that simultaneously summarizes and quantifies the reported economic effect; correct for any potential biases in the literature; test economic theories and explain heterogeneity. Before distancing ourselves from the existing MRA, it is important to mention that the Feld *et al.*'s (2009b) paper, despite the critics regarding the methodology followed, serves as a pioneering example in the FD-economic growth MRA, which of course can be further improved regarding the methodology and enriched with the latest publication in the field.

Our MRA applies an approach that identifies the contamination of the literature by the publication bias and the presence of a potential genuine effect, by distancing from the existing studies, which does not properly control for any of the abovementioned problems. In the presence of a very comprehensive guide on MRA by Stanley and Doucouliagos (2012), ignoring the existence of a genuine effect or publication bias comes as a surprise, especially for the first two studies (Feld *et al.,* 2009b and Baskaran *et al.,* 2016).[59] However, it is worth mentioning that the latter study controls indirectly for publication bias by splitting the dataset into published and unpublished study. Unfortunately, this might be considered as a very illusionary and incomprehensive way of identifying the level of contamination in the FD-economic growth literature. Contrary, the Zhenfa and Wei's (2016) study, conducted only for China, attempts to go a step beyond the first two studies by investigating publication bias, though no inference can be made on how they controlled for this. However, it is still argued that this investigation is incomplete given the limited dataset only on China and the denial of the investigation of the genuine representative effect in the literature.

Whilst it is understandable at certain extent that early MRA in economics have borrowed methodologies from other disciplines (i.e. medicine), the new MRA should follow a more economics oriented meta-analytical approach (Stanley and Doucouliagos, 2012, p.132). Accordingly, it becomes imperative to control for the two above issues, which might in turn be misleading when deciding on the sources of heterogeneity.

A distinguishing feature of our MRA is the use of PCC to quantify the effect size, which is considered superior to the use of plain coefficients or *t*-statistics (recall Section 3.3.1). Again, we would expect that studies conducted recently would be able to find an effect size that is unitless and dimensionless, otherwise the comparability of estimates across studies would be strongly jeopardized. In the same vein, it is surprising that there is no remark on the dependency of the data, for which it is necessary to use weights as in Section 3.2.2, and also cluster-robust SEs.

Another feature of our MRA is the division of studies subject to the dependent variable. Apparently, there is a strong division between studies investigating the effect

[59] It is important to note that these studies are just updated versions of each other. They appear identical in their methodology while differing only from the sample size, changing the order of the authors and publication status. Whilst there is no reference regarding the publication status for the former, the latter is published as a working paper in the *Freiburger Diskussionspapiere zur Ordnungsökonomik*). The structure and the content of the paper remain the same. It might be easily argued that these two papers are almost identical when referring to the literature review section. However, given the different ordering of the authors' name (from Feld *et al.,* 2009b to Baskaran *et al.,* 2016) and the update in the number of papers, we will consider them as updated version of each other, more specifically, where the second paper might be considered a slightly improved version of the first paper. The authors themselves do consider these two papers as identical given that there is no reference of their previous work in their recent study of Baskaran *et al*. (2016).

on FD on economic performance measured by output-growth or by output-level. The level of heterogeneity appears to be very large, which if not considered would produce misleading results especially for the second set of studies. Last, in an MRA which primarily focuses on investigating the sources of heterogeneity, such as the one of Feld *et al.* (2009b) and Baskaran *et al.* (2016) it is imperative to categorise sources into K/Z variables, as suggested by Stanley and Doucouliagos (2012).

3.6 Conclusion

Consistent research efforts have been devoted to the investigation of the economic effect of FD, though failing to provide a clear answer on whether higher fiscal decentralisation promotes economic performance. Accordingly, through an MRA, this chapter aimed to bridge the gaps in the literature by identifying the genuine representative effect after controlling for publication bias and uncovering the factors that influence the relationship between FD and economic performance in a set of 49 primary studies, which supplied 1001 point estimates.

Categorizing studies based on the most prominent difference, the measurement of economic performance, our results suggest that output-growth studies appear notably different from the output-level studies. The second subsample appears to be substantially contaminated by publication bias, while revealing a negative genuine effect. With respect to the full sample and the output-growth sample, findings suggest similar conclusions, though no strong evidence on the contamination of the literature by the selection bias could be found.

Apart from publication bias and genuine effect, another concern of this chapter, was to explore the sources of variation in empirical results. This MRA revealed that the excess variation among and within studies could be explained by the following: (i) the level of investigation (ii) differences in the measurement of economic growth, (iii) the source of the data, (iv) measurement of FD, and (v) other methodological and context of investigation issues (developing countries, cross-section data and OLS estimation technique).

Overall, the conclusions serve as an essential guide for future empirical investigation of the relationship between FD and economic growth, especially related to the number of FD measures. Since different FD measures impact growth differently, the choice of a number of appropriate measure(s) appears to be of great importance. Namely, the FD measures usually appear to be chosen arbitrarily to either capture the “true” effect of FD on growth, or introduce new measures which could be considered a novelty. Hence, agreeing to certain measures of FD, may considerably reduce both heterogeneity and publication bias.

Despite existing MRA in this literature, our analysis appears to be superior and contribute to knowledge by (i) using specific weights to account for the data dependency and (ii) conducting a rigorous research regarding publication bias, genuine effect and uncovering heterogeneity. However, future investigation is warranted to investigate the effect of FD on growth preferable in samples of countries with similar characteristics such as transition countries. Also, another possibility for future research might be to group the variables by country instead of study, which allows running a country-specific MRA. Future research may also consider other estimation technique such as using a Bayesian model averaging, which might be considered as a validation of the WLS and FE.

Chapter 4

FISCAL DECENTRALISATION AND ECONOMIC PERFORMANCE IN TRANSITION ECONOMIES - AN EMPIRICAL INVESTIGATION

4.1 Introduction

Despite the abundance of the empirical research on the effect of FD on economic growth, there are a limited number of studies focusing on Transition Economies (TEs) in general and European Transition Economies (ETEs) in particular. The economic impact of FD has been almost ignored which is surprising given the theoretical claim and the prevalence of devolution in these countries (Dabla-Norris, 2006). Motivated by the scarcity of empirical research in these economies and the heterogeneities in both theoretical and empirical literature, which was investigated thoroughly in the previous chapter through a MRA analysis, this chapter aims to shed more light on the effect of FD on economic growth in TEs.

The devolution in these countries has often been promoted as a way of enhancing democracy, efficiency of government, providing public services more responsive to local needs and eventually, promoting economic development. However, the process of fiscal devolution has also been associated with many challenges regarding the efficiency of the public sector and economic development (Bartlett *et al*., 2013), as already discussed in Chapter 1. The majority of studies in TEs focus only on country specific problems and provide policy solutions (recalling Section 2.4.1 and 2.4.2), especially for former Communist countries of the Eastern Europe, which, unfortunately, cannot be generalised for all TEs. Hence, given this notable lack of empirical evidence, this chapter investigates this relationship in the context of TEs, more specifically for European and former Soviet Union economies.

Often FD is considered a normal good, which can be afforded only by developed countries. Some authors, such as Bahl and Linn (1992), argue that decentralisation benefits (associated with fewer disadvantages) can better be exploited at high levels of income. The dataset used in this chapter includes countries with different development stages (from laggard reforming economies to advanced reforming economies), which calls for additional investigation of the economic effect of FD. Therefore, this research aims to contribute to the existing empirical literature on the economic effect of FD by considering the stages of economic transition as a moderator; whether the FD-economic growth relationship is subject to the advancement in economic and institutional reforms. To our knowledge, no study to date has accounted for the stages of development while investigating the economic effect of FD in TEs.

The chapter is structured as follows. After the introductory part, Section 4.2 focuses on the conventional and unconventional measures of decentralisation such as spending decentralisation, revenue decentralisation, tax decentralisation and transfers from other levels of government and discusses the rationale to use them in the context of TEs. Also, this section discusses the choice of estimation techniques and the data employed to test the effect of FD on economic growth. Addressing the drawbacks identified in Chapters 2 and 3, we propose a rigorous empirical framework which takes into account several problems identified in the literature such as endogeneity, collinearity between measures of FD, etc. Section 4.3 presents the estimation results by interpreting their statistical and economic significance followed by several robustness checks. Particular focus is paid to the stages of transition as a moderator of the economic effect of FD. The penultimate section discusses the sensitivity of the results by using different explanatory variables, controlling for public sector size and investigating the nonlinearity of the FD-economic growth relationship. Finally, Section 4.5 concludes the chapter.

4.2 Data and Specification of the Variables

4.2.1 Data

To empirically test whether FD has any impact on economic growth, a panel dataset of 21 Transition Economies over the time span 1996 - 2015 is used. Substantially determined by the data availability of our main variable(s) of interest, this dataset consists of selected transition economies in Europe and the former Soviet Union, namely Albania, Armenia, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyz Republic, Latvia, Lithuania, Moldova, Poland, Romania, Republic of Serbia, Slovak Republic, Slovenia and Ukraine.[60] Regarding the time span, we restricted our dataset to the above years to avoid possible distortions of the estimated results due to conflicts or war in this

[60] According to IMF (2000), transition economies are classified into two main groups: (i) transition economies in Europe and former Soviet Union, and (ii) transition economies in Asia. However, given that this thesis focuses only on the first set of countries, we will denote TEs as only European and former Soviet Union countries.

region, while having reasonable number of observations.[61] The respective time span for each country is shown in Table 4.1.

Table 4.1. Country and time span in the dataset

Country ID	Country	Time Span
1	Albania	2002 – 2015
2	Armenia	2003 – 2015
3	Belarus	1996 – 2015
4	Bosnia & Herzegovina	2005 – 2015
5	Bulgaria	1996 – 2015
6	Croatia	2001 - 2015
7	Czech Republic	1996 – 2015
8	Estonia	1996 – 2015
9	Georgia	1997 – 2015
10	Hungary	1996 – 2015
11	Kazakhstan	1997 – 2015
12	Kyrgyz Republic	2006 – 2015
13	Latvia	1996 – 2015
14	Lithuania	1996 – 2015
15	Moldova	1996 – 2015
16	Poland	1996 – 2015
17	Romania	1996 – 2015
18	Serbia	2007 – 2015
19	Slovak Republic	1996 – 2015
20	Slovenia	1996 – 2015
21	Ukraine	1999 – 2015
n=21 and average time span = 17.33		

It should be noted that Russia was excluded from our datasets, although the data availability and the accuracy of the data did not seem to be a problem. This is because Russia stands out as an extreme outlier regarding all indicators of decentralisation, large part owing to its federation status and large geographical size, which are likely to distort the empirical results of the FD-economic growth relationship.

To assess the impact of FD on economic growth in TEs, data from the IMF Government Finance Statistics, World Bank, and UNESCO are used. The first

[61] Most of the wars in this region occurred during the first stage of transition. The wars and civil conflict considered in our dataset are the Albanian Civil War in 1997, the Bosnia War 1992-1995, Armenia War 1988-1994, Croatia 1991-1995 and Moldova War 1992.

database, used particularly for our main variable of interest, provides information on several indicators of decentralisation, permitting us to build different measures of FD (i.e. expenditure decentralisation, revenue/tax decentralisation and vertical imbalance), which will be explained in detail in the following section. Whilst for developed countries, data can be found in different data sources, which allow assessing decentralisation by various FD measures (i.e. OECD Fiscal Decentralisation Indicators, IMF Government Finance Statistics, Eurostat, World Bank Fiscal Decentralisation Indicators database etc.), the database available for transition economies is limited only to the IMF Government Finance Statistics and Eurostat for selected countries. The latter, however, suffers from considerable data limitation as it provides data only for the EU countries.

IMF Government Finance Statistics has the broadest coverage for our data, which in turn provides a consistent dataset over time and across countries. Up to now, this database represents *the state of the art* in the public finance data by being the primary source for internationally comparable data among TEs at all levels of government (subnational and national level). An update of the database with the Government Finance Statistics Manual (GFSM2001) enhanced the comparability of fiscal data in general and decentralisation in particular (Dziobek *et al*., 2011). Furthermore, by using IMF Government Finance Statistics database, our empirical results are more likely to be comparable to other studies using the same database for a similar set of countries (i.e. Rodriguez-Pose and Kroijer's, 2009 study).

Despite being our preferred source of data, it is worth mentioning some deficiencies accompanying the IMF dataset. Ebel and Yilmaz (2002), Stegarescu (2005, p.305), and Bodman and Ford (2006, p.16-17) argue that these data do not allow to identify the sources of local government revenues (i.e. own taxes vs shared taxes), the composition of local government expenditure (i.e. expenditure for education, social protection, health, environmental protection etc.) and do not reveal the nature of the transfers from other levels of government (conditional vs unconditional transfers, and the criteria by which transfers are distributed from national government to subnational ones). Concerning the data retrieved for our countries, there seems to be still considerable lack of information regarding the type of transfers from central government to the local ones and the shared taxes. The GFS database could be utilised better if local revenue would be distinguished between devolved and delegated functions such as whether a tax is collected for central government or local government is operating as an agent for central government (as an outsourced agent).[62] Further, the inability of the IMF Government Finance Statistics to differentiate between types of transfer (conditional versus unconditional transfer) remains an unsolved data problem related to public finance in general and FD in particular. Addressing these limitations would contribute to the quality and ability of FD measures to capture the real degree of decentralisation in many aspects related to autonomy, efficiency and fiscal performance of local governments.

In the absence of such measures, with detailed disaggregated information, studies have been limited to the conventional measures of FD (expenditure decentralisation, revenue decentralisation or a combination of each with transfers from national government) and few additional measures (tax decentralization and two measures of fiscal performance) elaborated more in the following section.

Although IMF data has substantially been improved during the last years, there are still some missing observations for selected countries of our main variable of interest. The lack of data is more evident for the Balkan and the Southern Caucasus countries. Thus, different IMF's individual country reports and Ministries of Finance data were utilized in order to fill the gaps.[63]

Another concern in our dataset is the potential inconsistency of the reporting practices regarding the FD data over time. A major change took place with the introduction of the GFSM2001 reporting system, where the recording system changed from cash basis (GFSM1986) to mostly accrual basis64 (Dziobek *et al.,* 2011). Some of the countries switched entirely to the new reporting system, whereas others either prepared Government Finance Statistics reports on both reporting system (accrual basis and cash flow statements), or did not switch at all. Under the new reporting system, the

[62] The failure to distinguish between different types of function and taxes, would misestimate (more likely overestimate) decentralisation measured with the conventional measures of FD.

[63] Ministry of Finance of Albania and Ministry of Finance of Belarus have been used to fill the gaps in the main variable of interest for the two countries: local expenditure and local revenue. Whereas, in the case of Moldova in 2001, local expenditure is calculated by summing up all the subcategories of local expenditure.

[64] Under accrual basis, transactions are recorded at the time the transaction occurs, independently of the cash flow. Whereas, under cash basis transactions are recorded at the time cash flows.

categorisation of expenditures changed as well: under the GFSM1986, public sector expenditures were classified into 14 categories, whereas under the new system, expenditures are classified into ten categories following the Classification of Functional of Government (COFOG).[65]

Fortunately, the majority of our selected TEs (12 countries out of 17) did not switch at all to the new recording system, while the rest either reported in both systems (3 countries out of 17) or switched to accrual system in the year 2000/2001 (6 countries out of 17). By dropping the countries that have switched to the new recording system, our observations would significantly decrease and thereby would affect the estimated results. Given that there is no technically sophisticated method to convert cash data to accrual or vice versa, Seiferling (2013, p.9) suggest to merge the data and additionally include a dummy variable in order to control for any possible differences that might exist between the two recording systems: in this case accrual data could be seen as a proxy for cash data.[66]

4.2.2 Specification of the variables

a) The independent variable(s) of interest: Fiscal Decentralisation measures

This section uses the critical literature review and MRA results to accurately model the FD-economic growth relationship in the context of TEs. The MRA results suggested that the economic effect of FD is subject to different measures of FD, which in turn contributes to the heterogeneity of this effect. Namely, if a study employs too many measures of FD (additional measures of FD than the conventional ones) or only one measure of FD, the effect size is likely to be distorted.

[65] COFOG is based on the System of National Accounts in accrual basis.

[66] Gebregziabher and Niño-Zarazúa (2014) suggest merging the two datasets (cash and accrual), but instead of including a dummy variable, they impute the cash data using the annual growth rates for the accrual data. However, we follow the Seiferling's (2013) approach as it is more recognizable and conventional for GFS data. It should be noted that it would have been impossible to reconcile the two datasets if our focus would have been the composition of local government expenditure or revenues (see for more details Arze del Granado *et al*., 2012 and Seiferling, 2013). If this was the case, the comparability of the FD over time would be hampered by inconsistencies between reporting practices of individual countries. Given that our focus is not on the COFOG, it seems reasonable to proceed forward by finalising our cross-country datasets with data reported in cash or accrual basis.

Unfortunately, the MRA did not specify which combination of measures is the most appropriate to be used while investigating the economic growth effect of FD. This is because it is beyond the scope of an MRA and the selection of decentralisation measures depends mostly on the theoretical rationale and data availability. For instance, papers that rely on the IMF Government Financial Statistics database are more limited in the use of FD measures compared to the ones using OECD database, although the latter has a narrower coverage in terms of countries included in the database.

Thus, few considerations need to be taken into account when choosing the FD measures for our empirical research. As argued before in Section 2.4, the use of only one measure of FD has been criticised for being unable to capture the complex nature of decentralisation. The solely use of expenditure decentralisation, will not reflect the autonomy of the local government and the vertical structure of the decision-making and thereby, FD will be misrepresented (Stegarescu, 2004). Alternatively, focusing on both expenditure and revenue side of FD will better reflect the level of FD by accounting for the decentralisation of functions at local level and autonomy of local governments, as two main pillars of FD (Schneider, 2003, p.36). Despite the continuous emphasis on revenue and expenditure aspects of FD, importance should also be given to the conceptual problems involved in the measurement of FD through these two conventional measures. In most of the cases, they yield insignificant effect of decentralisation as it lumps together two opposite effects: (i) revenue decentralisation and (ii) grant-financed expenditure decentralisation (Martinez-Vazques and Timofeev, 2009, p.7; Rooden, 2003). A note of caution seems to be in order when interpreting the economic effect of these two measures given the imbalance that might exist between expenditure and revenue decentralisation and their different (individual and joint) effects on economic growth. Thereby, a measure of intergovernmental transfers (vertical fiscal imbalance), in addition to the orthodox measures, might be considered as appropriate given the complexity of vertical structure and relationship between the subnational and national government.

In the context of TEs, the vertical fiscal imbalance, also known as the common pool problem (De Mello, 2000), is crucial in assessing FD given the decentralised responsibility on one side, and centralised resources on the other side (Rodriguez-Pose and Kroijer, 2009). In the context of our dataset, it is argued that many TEs (Albania, Croatia, Estonia, Georgia, Hungary, Lithuania, Poland and Romania) suffer from considerable lack of own financial resource, while being dependent on transfers from central government. By ignoring such imbalance, the size of decentralisation might be misrepresented, which in turn might produce biased results, distort the long-term trends (Stegarescu, 2004, p.1) and suggest problematic conclusions. However, the decision of the final measures must also depend on the collinearity between different FD measures. In some cases, empirical research (Neyapti, 2003) report severe multicollinearity between conventional measures. As a conclusion, it is important to acknowledge the vertical imbalance of local government, while accounting for possible multicollinearity problems between FD measures.

Whilst decentralization literature (recall Section 1.2) refers to national/total and subnational government when measuring FD, the IMF Government Finance Statistics database refer to central, state and local government, to represent all levels for both federal and unitary governments. Hence, an additional and important need for caution has to be taken when extracting information from this database. Henceforward, the national level of governance involves the first level of government, central, whereas the subnational level of governance comprises state and local government(s). For all our countries, except Bosnia and Herzegovina, the subnational level is represented only by the local level, given their unitary forms of government in which there is no state level.[67]

Taking into account the above considerations and following the theoretical and empirical literature review, the first FD measure we make use is the *expenditure decentralisation* ***(fdexp)**,* measured by the subnational government expenditure as a share of general government expenditure (see Equation 1). Referring to the terminology of IMF Government Financial Statistics, expenditure decentralisation is measured as the sum of local and state expenditures minus grants from state to local level of government divided by the sum of national, state and local government expenditure. Grants from state to local level are deducted from the total amount of

[67] See Box 5.1 for detailed description of the levels of government. Different from the other countries, Bosnia and Herzegovina is a federal government, for which both state and local level has to be taken into account when measuring the expenditure, revenue, tax or grants at subnational level.

transfers in order to avoid double counting (i.e. moving from a disaggregated level to a more aggregate one.

$$Expenditure\ decentralisation = \frac{Subnational\ government\ expenditure}{Total\ government\ expenditure} \quad (1)$$

Next, the IMF Government Finance Statistics database offers the possibility to measure the revenue dimension of FD through various measures: *revenue decentralisation (**fdrev**), tax decentralisation (**fdtax**) and tax decentralisation local (**fdtax_l**)*. The first one, considered as a conventional measure of FD, is measured by the subnational government as share of general government revenue, as shown in Equation (2). Alternatively, the second measure takes into account only taxes from both subnational and national level. Thus, ***fdtax*** is measured as the subnational government share of tax revenue, shown in Equation (3). As to the third measure, ***fdtax_l*** is measured as the subnational government revenue share of tax revenue.

$$Revenue\ decentralisation = \frac{Subnational\ government\ revenue}{Total\ government\ revenue} \quad (2)$$

$$Tax\ decentralisation = \frac{Subnational\ government\ tax\ revenue}{Total\ government\ tax\ revenue} \quad (3)$$

$$Tax\ decentralization\ local = \frac{Subnational\ government\ tax\ revenue}{Subnational\ government\ revenue} \quad (4)$$

It is important to note that the use of all the above measures in the same model is not appropriate as multicorrelation might be present, which in turn, might lead to imprecise estimates (Wooldridge, 2009, pp.94-95). It is argued that ***fdtax_l*** might be considered a superior measure relative to the revenue decentralisation or tax decentralization. This is because of the inability of the last two measures to properly measure the real decentralization level regarding revenues. An increase or decrease in one of these measures (***fdrev*** or ***fdtax***) does not necessarily imply an increase or decrease in the level of decentralisation. Such change in the above shares might also occur from a shrink in general government revenue/tax. Thus, any inferences about the degree of decentralisation based on these two measures would mislead the interpretation of the economic effect of FD. Additional drawbacks acknowledged in the literature relates to the fact that the revenue decentralisation fails to distinguish among different types of revenues: revenues collected through shared taxes, piggybacked taxes etc. Accordingly, revenue or tax decentralisation measures tend to overestimate the extent of fiscal decentralisation within a given country (Ebel and Yilmaz, 2002). In contrast, tax decentralisation measures try to incorporate the tax-raising power of subnational governments by accounting for the own autonomous taxes at the local level (Stegarescu, 2004, p.5). Thereby, it is argued that the autonomy of local governments is better measured by ***fdtax_l***, rather than ***fdrev*** or ***fdtax***.

Transfer from central government is the most common indicator of subnational government dependency to a national one, measured as either as a share of subnational revenues (Rodriguez-Pose and Kroijer, 2009) or as a share of subnational expenditure (Baskaran, 2010; Eyraud and Lusinyan, 2011). More specifically, the two measures (*Vertical Imbalance 1* and *2*) are explained as follows:

*Vertical Imbalance 1 (**imbalance1**)* is measured by the grants/transfers from other levels of governments as a percentage of total subnational revenues, as shown in Equation (6). Alternatively, the dependency of local government to central governments can be measured by the share of grants to subnational expenditure. Whilst the former is a mere measure of the dependency of local government to the central one, the latter informs us whether grants are used to finance growth enhancing expenditures. Since both measures (***imbalance1*** and ***imbalance2***) take into account transfers from central government, there is little to distinguish which measure is superior. Therefore, the decision will rely on the correlation matrix given that all these measures are likely to be highly correlated with each other and also to be correlated with either expenditure decentralisation or revenue decentralisation.[68]

$$\textit{Vertical Imbalance 1} = \frac{Vertical\ grants}{Subnational\ government\ revenue} \qquad (5)$$

$$\textit{Vertical Imbalance 2} = \frac{Vertical\ grants}{Subnational\ government\ expenditure} \qquad (6)$$

[68] This is because the nominator of revenue decentralisation is the same as the denominator of *Vertical Imbalance 1* measure. Similarly, the nominator of expenditure decentralisation measure is the same as the denominator of the *Vertical Imbalance 2*.

In the attempt to use only one measure of FD, as an aggregate indicator of the fiscal performance, the empirical literature (Akai and Sakata, 2002) suggests the use of the subnational spending share of either (i) own revenue or (ii) tax revenues, *Fiscal Performance 1* and *Fiscal Performance 2*, respectively.[69] The rationale for using these measures is to indirectly quantify the efficiency of own/tax sources of subnational governments by measuring the percentage of expenditures financed with subnational governments' own funds. Generally speaking, they measure the degree to which local fiscal needs are maintained by the local government's own revenue (Akai and Sakata, 2002, p.97).

$$\text{Fiscal Performance 1} = \frac{\text{Subnational government own revenue}}{\text{Subnational government expenditure}} \tag{7}$$

$$\text{Fiscal Performance 2} = \frac{\text{Subnational government tax revenue}}{\text{Subnational government expenditure}} \tag{8}$$

Whilst FD measures remain a challenge when investigating the economic effect of decentralisation, the non-monotonicity of this relationship seems to be an intriguing possibility. Hence, recalling Chapter 2, various studies suggested that the FD-economic growth relationship is non-monotonic/(inverse) hump-shaped (Thiessen, 2003; Eller, 204; Thiessen, 2005; Akai *et al.*, 2007), where FD initially affects economic growth negatively and after a critical value turns to have a positive effect or vice versa. This suggests the existence of an optimal level of FD which maximises economic growth Hence, the squared terms of FD measures are considered in the model.

b) The dependent variable: economic growth

Another concern regarding our model specification is the measurement of the dependent variable: economic performance. Based on the comprehensive discussion in Section 2.2.2, the theoretical model of Davoodi and Zou (1998) argued over the rationale of estimating the impact of FD on output growth rather than output level.

[69] See World Bank Fiscal Decentralization Indicator summary, derived by IMF's Government Finance Statistics. (http://www1.worldbank.org/publicsector/decentralization/fiscalindicators.htm, date of access 08/09/2017).

75% of the studies in our MRA sample (recall Section 3.3)[70] used output growth as a dependent variable (growth of real GDP, the difference in logarithm of GDP per capita, GDP growth in PPP, GDP growth in PPP constant prices, etc.), while only few studies, mainly investigating this effect on a single country, used variables related to the level of output (real GDP, GDP per capita, GDP/GNI per employee, GNP).[71] In addition, the latter group of studies are profoundly criticized for omitted variable bias and the lack of theoretical justification of using level of GDP (recall Section 2.4.1). Therefore, following best practices in cross-country research at the national level (Davoodi and Zou, 1998; Iimi, 2005; Rodriguez-Pose and Kroijer, 2009; Gemmell *et al*., 2013), our investigation uses output growth as a measure of economic performance.

The dependent variable (***growth***) is measured by taking the first difference of purchasing power parity (PPP) adjusted real GDP per capita in logarithmic form.[72] By using PPP, GDP per capita is converted to international dollars, as a common currency, using PPP rates. This adjustment takes into account inflation and possible variation in economic growth due to changes in prices across countries under investigation. Instead, the use of other adjustments, such as market exchange rate, would only convert GDP per capita to a common currency, while there would be no conversion of GDP valued at a common price level. In this case, GDP converted to a common currency remain valued at national price level, with differences in the level of GDP between countries reflecting the differences in volumes of goods and services and the differences in price levels. Given this inability of exchange rates to properly reflect the differences in prices between countries, especially high- or low-income countries (Temple, 1999), the use of PPP to convert GDP per capita into a common currency, international dollars, while accounting for price differences between countries (World Bank, 2015) is considered superior. In addition, the use of exchange rate has been continuously criticised due to the inability to properly estimate the

---

[70] Our sample includes studies that conducted an empirical investigation and have reported at least one effect size of the growth effect of FD.
[71] See Faridi (2011), Philip and Isah (2012) and Shahdani *et al.* (2012).
[72] The 2011 international dollars are used in calculating GDP per capita.

irregular/unpredictable movements of capital flows (Filippetti and Peyrache, 2015, p.553; World Bank, 2015, p.14).[73]

b) Control Variables

Amongst the commonly used explanatory variables in the growth literature, population growth is considered a basic determinant of growth, present in all cross-country investigations. Despite some contradicting theoretical and empirical evidence, it is argued that high rates of population growth decrease economic growth, where each worker will have less productive factors to work with (Pritchett, 1996; Barro and Sala-i-Martin, 2004; Romer, 2011).[74] In our investigation, population growth ***(popgrowth)*** is measured by the annual growth rate of midyear population in percentages.

Another important variable, as suggested by the theoretical and empirical literature, is the rate of accumulation of physical capital accounted through investment to GDP ratio. Theoretically, it is argued that high rate of investment leads to high rates of economic growth (Solow, 1962, p.86), though its effects might be subject to the extent to which technological innovation is embodied in the new capital (Bassanini and Scarpetta, 2001). In our empirical research, investment is measured by the gross fixed capital formation as a percentage of GDP ***(gfcf_gdp)***.

Theoretical and empirical literature have highlighted the role of human capital as a prerequisite for economic growth (Lucas, 1988; Barro, 1991; Barro and Lee, 1993; Mankiw *et al*., 1992). However, difficulties in measuring it properly and lack of consistent data across various countries (especially for TEs) has generated mixed results. The role of human capital appears to be either overestimated (Pritchett, 2001) or underestimated (Kumar, 2006; Sunde and Vischer, 2011). In this regard, different proxies for human capital are suggested by the literature such as gross- and net-enrolment rate in primary, secondary and tertiary education, literacy rate (Le *et al.,* 2005; Islam, 2009), average years of schooling and level of students' cognitive skills (Hanushek and Woessmann, 2009a; 2009b; 2011; Barro and Lee, 2013).

---

[73] Given that exchange rates mirror the purchasing power of tradable goods, the unpredictable movements of capital flows might be difficult to capture.
[74] See Section 3.2.1 for a more detailed explanation on the effect of population growth on a country's growth rate.

Whilst gross- and net-enrolment rates in secondary and tertiary education are mostly used as proxies for human capital, the appropriateness of these measures is often questioned in a cross-country research. Using enrolment rates as proxies for human capital has been criticized due to its inability to adequately proxy human capital endowment. Enrolment rates measure the current investment in human capital, by representing, therefore, a flow of investment in human capital. Further, because investment in human capital needs time to be reflected in the human capital stock, these measures fail to represent the current human capital of the labour force (Le *et al.*, 2005, p.19). Further, it may be argued that the (gross- or net-) enrolment rates fail to measure the quality of human capital. High enrolment rates do not necessarily indicate high level of human capital quality (the skills obtained in schools), especially in TEs where the level of enrolment rates is relatively high (Campos and Kinoshita, 2002, p.12). Ideally, human capital would be proxied by the students' cognitive skills, a qualitative measure of human capital. Unfortunately, this is not possible due to considerable lack of continuous data for TEs; limited data can be found only in Hanushek and Woessmann (2011) and Altinok *et al.* (2014).

In an attempt to remedy the majority of the above shortcomings, we opt for the *average years of schooling*. Average years of schooling are measured as the number of years of education of population aged 15 and over. The data, provided by the UNDP annually, are calculated using the same methodology of Barro and Lee (2013; 2014), but augmented with the UNESCO's educational attainment figures.[75] Thereby, we introduce ***schooling*** as our main variable of human capital. However, for comparison and to address potential measurement error problems, we make use of two alternative measures of human capital: gross enrolment rates in secondary education (***educ2***) and tertiary education (***educ3***).[76]

The integration of countries into the world economy is often deemed an important determinant of growth. Overall, the literature (Barro and Sala-i-Martin, 1995; 2004; Chang *et al.*, 2005) suggest a positive relationship between trade and economic

[75] The average years of schooling can also be found in Barro and Lee (2013) dataset, but information is incomplete for some countries in terms of time span covered (data are quadrennial) and geographical coverage (data are missing for the majority of countries in the Southern Caucasus).
[76] Instead of the two variables, one can use the combined gross enrolment rate of UNDP. However, this seems impossible in the case of TEs given the large missing data especially for Southern Caucasus countries.

growth. It is argued that exposure to international competition and efficent allocation of resources through trade openness are the potential mechanisms of trade to economic growth (Gries and Redlin, 2012). Alternatively, some authors (Krugman, 1994; and Rodriguez and Rodrik, 2001) are sceptic about the positive effect of trade on growth, while arguing for the importance of measuring trade consistently. Thus, following the best practices in the empirical growth literature, we measure trade by the sum of exports and imports of goods and services as a percentage of GDP (***trade***).

An important variable included in a growth regression is the country's initial conditions. Unanimously, the literature (Abramovitz, 1986; Baumol, 1986; Dowrick and Nguyen, 1989; Verspagen, 1991) claims the importance of initial conditions in explaining why some countries are catching-up to a high level of economic growth and others are lagging behind (recall Section 2.2.1 for more details). Mankiw *et al.* (1992) claim that economies will grow faster the further they are from the steady-state; namely, (relatively) poor economies will grow faster in per capita terms than the (relatively) rich ones. To isolate the possible convergence effects between countries in our investigation, the initial level of GDP per capita in purchasing power parity at constant prices (***gdpini***) is entered in the model. A negative correlation should exist between economic growth rates and initial income if catch-up effect occurs. However, the Fixed Effect estimator will wipe out time-invariant variables, as such ***gdpini***. Thereby, to accurately measure the existence of a possible convergence process, we include an alternative measure to account for the convergence process as suggested by Barro and Sala-i-Martin (2004): the lagged level of income measured by the first lagged level of GDP per capita in constant prices (***laggdp***).

A note of caution is required regarding the variable used to isolate such process. Following the best practice in the FD-economic growth literature (Thornton, 2007; Rodriguez-Pose and Kroijer, 2009), initial level of income is measured by output in levels (i.e. GDP per capita) Following the suggestions of Rodriguez-Pose and Fratesi (2004), the second lag of GDP (***lag2gdp***), an alternative measure of the initial conditions, is additionally included in the dataset. Whilst they argue that the second lag of GDP is superior in the presence of potential endogeneity in the regression, the empirical evidence does not support this. At this point, we continue with our two preferred variables (***gdpini*** and ***laggdp***), and use the second lag of GDP as a robustness check.

Another concern in this thesis is how to take into account the transition-specifics of the countries in our dataset and thereby to move towards an extended version of FD-growth model adjusted for transition economies. Given that the dataset encompasses different countries that experience different transition stages, controlling for the institution quality may also be an important explanatory variable in explaining the FD-growth relationship. Hence, our innovation is to estimate a FD-growth relationship by controlling for transition stages. In this regard, we utilise the EBRD transition indices to account for the success of the institution building (EBRD, 1994) and transition towards OECD standards. The indices assess the progress in transition economies through a set of indicators in six areas: large-scale privatisation, small-scale privatisation, governance and enterprise restructuring, price liberalisation, trade and foreign exchange system and competition policy (EBRD, 2005). Each EBRD index is scored from 1.0 (minimum) to 4.3 (maximum). The higher the score, the more transition progress a country has made.[77] The literature suggests the use of only one composite index instead of using all six indicators due to the high correlation of indices with each other (Hall and Jones, 1999; Alis, 2003; Eicher and Schreiber, 2010; Efendic and Pugh, 2015). Hence, following the approach of Radulescu and Barlow (2002) and Eicher and Schreiber (2010), we sum the six indicators into one aggregate index (***tindex)*** and then normalize it in a scale from 0 to 100; 0 shows that there was no progress of institution quality after the fall of Communism, whereas 100 indicates market-based standards typical of advanced industrial economies (EBRD, 2004, p.199; Falcetti *et al.,* 2006; Eicher and Schreiber, 2010, p.4).

An alternative variable suggested by the literature, although rarely used in empirical research, (and likely to be highly correlated with ***tindex*** or FD measures) is the classification of countries based on their decentralisation reform progress. UNDP classifies TEs into four categories: (i) active decentralisers, (ii) advanced intermediate

[77] Given that the Czech Republic has completed its transition phase in 2008, its test scores are not provided by the EBRD. Therefore, we assign the highest score (4.3) to the Czech Republic from 2008 to 2016.

decentralisers, (iii) early intermediate decentralisers, and (iv) non-decentralisers.[78] The control for these various decentralisation reforms might provide useful insight in explaining differences in growth effects of FD between economies. However, this does not seem appropriate to use in our sample because of the small number of observations for each category. An alternative approach is proposed by us, which will be explained in detail in Section 4.4, by using the stages of transition as a moderator for the FD-economic growth relationship.

Further, we make use of another variable, which might be considered relevant in our context of investigation. TEs that are members of the European Union are likely to progress their decentralisation reform faster than non-members, while converging towards the OECD decentralisation standards. Countries' status with respect to the process of the EU integration is considered in our model through a dummy variable, ***eu***, which takes the value 1 if a country has joined the EU and 0 otherwise. Additionally, it might be interesting to investigate whether the economic effect of FD varies due to the geographical location. The difference in the advancement of FD reforms between countries in Europe and those located in the Southern Caucasus, as explained in Section 1.3, might be also reflected in differences in economic effect of FD between these two groups of countries. In order to investigate whether location influences the economic effect of FD, a dummy variable (***europe***) is included in the dataset, which is also interacted with the main measures of FD.

Another potential variable, although not of primary concern in the FD empirical literature, is public sector size. While the majority of studies have focused mainly on the effect of fiscal decentralisation on government size[79], only a few studies are controlling for the size of the public sector while investigating the economic effect of fiscal decentralisation (Sagbas *et al.,* 2004; Rodriguez-Pose and Ezcurra, 2010). A note of caution, however, is due when considering the problem of growth maximisation explained in Sections 2.2.1 and 2.2.2. As mentioned in these sections, growth-maximizing shares of each level of government (national or subnational) can be found by maximising the growth path subject to government level interested in.

[78] Dabla-Norris (2006) has a similar categorisation of countries according to their decentralisation progress; however, this thesis does not follow her approach because the UNDP's classification of countries is more comprehensive in terms of countries and time span covered.

[79] Brennan and Buchanan (1980) claim that (fiscal) decentralisation is likely to lead to smaller public sector size.

This explains the inclusion of the share of governments at either the national or subnational level, but not both (unless the purpose is to investigate the effect of general government activity/size on economic growth). Whilst decentralisation might change due to an increase/decrease in subnational shares; the literature ignores the possible effect of public sector size fluctuations, which in turn are likely to impact fiscal decentralisation. This relates to the measurement of fiscal decentralisation. As explained in the above sections, expenditure decentralisation is measured by the share of expenditure at subnational expenditure in total expenditures of general government. Thereby, this share might vary due to (i) change in the level of expenditure at subnational level or (i) change in the level of expenditure of total government. Namely, FD can be considered as a corollary of public sector (size), where changes in FD level might be caused not by greater devolution transferred from national to subnational government, but due to a shrink or enlargement of public sector size in general. Hence, the size of public sector (***govcons***), measured by the share of general government final consumption expenditure relative to GDP, will be included in the model to investigate whether the economic effect of fiscal decentralisation is subject to the size of public sector. Nevertheless, we will use ***govcons*** only as a robustness check because we employ FD measures that strip off the effect of public sector such as ***fdtax_l*** and ***imbalance1*** and ***imbalance2***.

In conclusion, the core independent variables considered in our baseline growth regression are the FD measures (subject to the correlation matrix), initial level of GDP, population growth, human capital measured by the average years of schooling, investment to GDP ratio, trade openness and transition index. Additional measures, as mentioned above, are to be used in the growth model as robustness check or to shed more light in the FD-economic growth relationship. In what follows, Table 4.2 summarises the variables used, their definition, expected sign and data source.

Table 4.2. Potential variables and data sources

Variable name	Description	Expected Sign	Data Source
fdexp	Subnational government share of expenditure (% of total government expenditure) [percentage of total expenditure accounted for subnational government, measured as the sum of local and state total expenditure minus grants from state to local, divided by the sum of local, state and national expenditure]	+/-	IMF (GFS) from IMF Data Access to Macroeconomic & Financial Data and UK Data service, checked with Eurostat and individual Ministry of Finances such as Ministry of Finance Belarus and Ministry of Finance Albania
fdrev	Subnational government share of revenue (% of total government revenue) [percentage of total revenues accounted for subnational governments, measured as the sum of local and state total revenues minus grants from state to local government, divided by the sum of local, state and national revenues]	+	IMF (GFS) from IMF Data Access to Macroeconomic & Financial Data and UK Data service, checked with Eurostat and individual Ministry of Finances such as Ministry of Finance Belarus and Ministry of Finance Albania
fdtax	Subnational government share of tax revenues (% of total general government tax revenues) [percentage of tax revenues collected by subnational government, measured as the sum of local and state tax revenues, divided by the sum of local, state and national tax revenues]	+	IMF (GFS) from IMF Data Access to Macroeconomic & Financial Data and UK Data service, checked with Eurostat and individual Ministry of Finances such as Ministry of Finance Belarus and Ministry of Finance Albania
fdtax_l	Subnational government share of tax revenues (% of total subnational revenues) [local and state government tax revenue divided by the sum of local and state government revenue]	+	IMF (GFS) from IMF Data Access to Macroeconomic & Financial Data and UK Data service, checked with Eurostat and individual Ministry of Finances such as Ministry of Finance Belarus and Ministry of Finance Albania
fiscalperform1	Subnational government share of own revenue (% of total subnational expenditure) [local and state government own revenue (tax revenue and other revenues) divided by the sum of local and state government expenditure]	+	IMF (GFS) from IMF Data Access to Macroeconomic & Financial Data and UK Data service, checked with Eurostat and individual Ministry of Finances such as Ministry of Finance Belarus and Ministry of Finance Albania
fiscalperform2	Subnational government share of tax revenue (% of total subnational government expenditure)	+	IMF (GFS) from IMF Data Access to Macroeconomic & Financial Data and UK Data service, checked with Eurostat and

	[the sum of local and state tax revenues divided by the sum of local and state subnational government expenditure]		individual Ministry of Finances such as Ministry of Finance Belarus and Ministry of Finance Albania
imbalance1	Intergovernmental transfer share (% of subnational government revenue) [intergovernmental transfers received by central government minus grants from state divided by the sum of local and state revenues]	-	IMF (GFS) from IMF Data Access to Macroeconomic & Financial Data and UK Data service, checked with Eurostat and individual Ministry of Finances such as Ministry of Finance Belarus and Ministry of Finance Albania
imbalance2	Intergovernmental transfer share (% of subnational government expenditure) [intergovernmental transfers received by central government minus grants from state divided by the sum of local and state expenditure]	-	IMF (GFS) from IMF Data Access to Macroeconomic & Financial Data and UK Data service, checked with Eurostat and individual Ministry of Finances such as Ministry of Finance Belarus and Ministry of Finance Albania
growth	Log first-difference of GDP per capita based on purchasing power parity (PPP). PPP GDP is gross domestic product converted to international dollars using purchasing power parity rates. Data are in constant 2011 international dollars.		WB
gdpini	Initial level of GDP per capita PPP in 2011 international $ in logarithmic form	-	WB (double checked with IMF Access to Macroeconomic & Financial Data, and Eurostat)
laggdp	First lag of GDP per capita based on purchasing power parity (PPP). PPP GDP is gross domestic product converted to international dollars using purchasing power parity rates. Data are in constant 2011 international dollars.	-	WB (double checked with IMF Access to Macroeconomic & Financial Data, and Eurostat)
lag2gdp	Second lag of GDP per capita based on purchasing power parity (PPP). PPP GDP is gross domestic product converted to international dollars using purchasing power parity rates. Data are in constant 2011 international dollars.	-	WB (double checked with IMF Access to Macroeconomic & Financial Data, and Eurostat)
popgrowth	Population growth (annual %) measured as the exponential rate of growth of midyear population from year *t-1* to *t*.	-	WB

gfcf_gdp	Gross fixed capital formation measured as a share of Gross Domestic Product	+	WB (double checked with IMF Access to Macroeconomic & Financial Data, and Eurostat)
educ2	Secondary Education, total enrolment in secondary education as a percentage of the total population of the five-year age group following from primary school leaving.	+	WB
educ3	Tertiary Education, total enrolment in tertiary education as a percentage of the total population of the five-year age group following from secondary school leaving.	+	WB
schooling	Average years of schooling the population aged 15 and over	+	Barro and Lee's dataset, UNESCO and UNDP
dschooling	The difference in the average years of schooling the population aged 15 and over	+	Barro and Lee's dataset, UNESCO and UNDP
trade	The sum of exports and imports of goods and services measured as a share of Gross Domestic Product	+	WB
eu	Dummy variable: 1 if a country is a member, 0 otherwise	+	European Union
europe	Dummy variable: 1 if a country is located in Europe and 0 otherwise.	+/-	IMF
govcons	Government size measured by the share of general government final consumption expenditure relative to GDP, expressed in percentage.	-	IMF (Government Finance Statistics) through IMF Access to Macroeconomic & Financial Data
rsdummy	Dummy variable: 0 if the country reports on a cash basis and 1 if country switched to an accrual basis.		IMF
year1-20	Time dummies, in the case of unbalanced dataset year1 = year 1990, year2 = year 1996,…, year20 = year 2015		

4.3 Methodology

4.3.1 Model Specification

To empirically test whether FD has any impact on economic growth, this chapter, as already introduced in Section 4.2.1, employs panel data for selected TEs.[80] The use of panel data derives from the need to explicitly take into account the heterogeneity of countries and uncovering potential dynamic relationships (Hsiao, 2006; Greene, 2011, p.343), which otherwise would produce serious bias into the estimates (Frees, 2004). An important advantage of panel data over cross-section or time series data is the mitigation of omitted variable bias (*lurking variables*), which is likely to be a serious problem when estimating a growth model (Frees, 2004, p.7). Panel data models are often recommended in establishing the causality between variables better than cross-section or time series analysis, due to the larger number of observations and weaker collinearity between variables that result in more efficient estimates; other things being equal, as the number of observations increases standard errors become smaller (Baltagi, 1995; Hsiao, 2006).

Whilst the literature offers various types of panel data models, how best to choose between different estimators depends on the nature of our dataset (wide dataset vs long dataset) and the diagnostic testing. The starting point when modelling panel data is whether to employ a Fixed Effect (FE) or a Random Effect (RE) estimator. The former makes use of only the within-country variation, whereas the latter utilises both the within- and between variation (Hsiao, 2006, p.11). In the context of our dataset where FD does not vary much within the same country (recall Chapter 1) and where some of the variables are likely to be either time-invariant (e.g. initial level of GDP, geographical location) or slowly-moving (e.g. population growth), the RE estimators seem to be more appropriate. The initial model to start with is as follows:

$$growth_{it} = \beta_0 + \beta_1 FD_{it} + \beta_i' \ X_{it} + (u_i + \varepsilon_{it}) \tag{4.1}$$

where, β_0 is the overall intercept, FD_{it} is a vector of FD measures and X_{it} is the vector of control variables (determinants of economic growth), $(u_i + \varepsilon_{it})$ is a composite error

[80] More details regarding the countries and time span will be provided in the next section.

of an unobserved effect u_i (time-constant factor also known as country heterogeneity) and the idiosyncratic error ε_{it} (time-varying error).[81] By using an RE model, we assume that all the countries included in the model are drawn from a larger dataset and have a common mean value for the overall intercept equal to β_0. Potential differences that might exist between countries' individual intercept and the common mean are reflected in the error term u_i (Gujarati, 2004, p.647).

Although RE estimators seems more appropriate than FE estimators for the reasons explained above, a crucial assumption over the correlation between the error terms and the independent variables might question the plausibility of the former. The estimates will be biased if the individual error term and independent variables are correlated, which in turn prioritizes the FE estimator (Gujarati, 2004, p.650). Since the key criteria in choosing between an RE and FE approach is whether the assumption of the conditional independence between the intercept and independent variables holds, a Hausman test must be performed to check its validity (Gujarati, 2004, p.651 and Greene, 2012, p.421).[82] The FE model considered is as below:

$$growth_{it} = \beta_{0i} + \beta_1 FD_{it} + \beta_i' X_{it} + \varepsilon_{it} \tag{4.2}$$

Contrary to Equation (1), where countries have a common mean value, the FE model allows the intercept to vary across countries (β_{0i}). Now, each intercept is considered as unknown parameter to be estimated (Greene, 2008), while the slopes of the coefficients remain the same (Gujarati, 2004). The utilization of only within variation by the FE model, makes it preferable to the other estimates as it mitigates the bias of unobserved country specific, which are time constant. Such unobserved effect will be swept away by the first-difference approach in FE model. This seems to be important in the context of growth regressions, where some variables are considered as time invariant, amongst others, the initial conditions (Bond *et al.,* 2001).

It is important to note that the above equations are estimated by using a different combination of FD measures. Although the preferred measures will be substantially determined by the data availability and the correlation matrix, there are few suggestions from the critical literature review and MRA to be considered. Whilst the

[81] More detailed review will be provided in the next section regarding the specification of FD measures and control variables used.
[82] This assumption is also known as the *random effects assumption.*

shortcomings of using solely one FD measure are eminent in the lierature (Scheneider, 2003, p.42), the use of many FD measures pose also some crucial challenges. Potential multicollinearity might exist between FD measures of the same category (i.e. revenue and tax decentralisation) or even between different categories (i.e. revenue decentralisation with vertical imbalance, expenditure decentralization with revenue decentralization). Following the best practices in the literature and the MRA conclusions, it is argued that our model should have either two or three measures of decentralisation, subject to the correlation matrix, encompassing the expenditure decentralization, the revenue aspect of decentralisation, and the imbalance between expenditures and revenue of local government. However, the final measures chosen for the model are to be specified in Section 4.3 and decided after the collinearity check in Section 4.4. Thus, two sets of equations (4.3 and 4.4) are considered as baseline specifications.

$$growth_{it} = \beta_0 + \beta_1 fd\exp_{it} + \beta_2 fdrev_{it} + \beta_i' X_{it} + (u_i + \varepsilon_{it}) \quad (4.3)$$

$$growth_{it} = \beta_0 + \beta_1 fd\exp_{it} + \beta_2 fdrev_{it} + \beta_3 imbalance + \beta_i' X_{it} + (u_i + \varepsilon_{it}) \quad (4.4)$$

The first specification uses two measures of FD, which encompasses both the expenditure and revenue dimension of FD, whereas the second specification includes vertical imbalance as an additional aspect of decentralization. Both specifications will be estimated using both RE and FE estimators, however for simplicity, the following equations assume the use of RE estimators.

4.3.2 Potential identification problems and empirical approach

Before proceeding with the diagnostics and results, it is important to acknowledge some potential identification problems that are likely to occur. The estimation of Equations 4.3 and 4.4 pose some crucial challenges regarding the empirical methodology. First, it is likely that endogeneity might arise from the inclusion of FD as an explanatory variable in a growth model.[83] There is a theoretical possibility that some control variables, in addition to some FD measures, exhibit reverse causation. As argued intensely in Sections 2.2 and 2.3, reverse causality occurs because efficiency gains from FD appears as economies grow, and more FD is demanded at relatively higher levels of development. Literature review suggests that taxes collected locally and transfers from central government are likely to be endogenous. More specifically, the more developed localities are likely to collect more local taxes than less developed subnational governments/units due to the higher tax base (Cantarero and Gonzalez, 2009), whereas less developed subnational governments/units are likely to receive more funds than the more developed ones (Martinez-Vazquez and McNab, 2003). Ignoring such endogenous correlation would produce biased estimates and cause wrong inference about the economic effect of FD.

Preferably, this problem (also given the potential dynamics in the residuals) would be addressed by employing a difference/system-GMM by using lagged values and/or difference of lagged values of the endogenous variables as instruments (Bundell and Bond, 1998; and Roodman, 2006). Unfortunately, this method cannot be employed in the case of our dataset as it requires large *N* and small *T* (Roodman, 2006). Otherwise, the estimates will be biased.

Alternatively, in an attempt to mitigate endogeneity, the literature often recommends the inclusion of lags of the presumed endogenous variables (Baltagi, 1995). However, this seems to be economically irrational in a cross-country growth regression estimated by FE. Having the lagged GDP (to control for the convergence effect) as an explanatory variable jeopardizes the inclusion of lagged values of other control variables. The existence of all these lagged values on the same side of the growth regression will create a growth model within a growth model, which would escalate into a severe conceptual problem. For instance, including the first lag of investment in our growth model, would by definition be conceptually wrong as this lagged variable will be correlated with the lagged GDP, which is an independent variable, and both of them will be considered as control variables for ***growth.*** In addition, Bellemare *et al.,* (2015) claim that this procedure often creates bias in the absence of identification

[83] Endogeneity refers to the bias caused by omitted variables, simultaneity, or measurement errors (Wooldridge, 2002). Technically speaking, endogeneity arises when the error term is correlated with one/some of the explanatory variable(s), which in turn leads to biased estimates.

strategies over the appropriate number of lags on presumed endogenous variables. At this point, we opt for a two-stage instrumental variable (IV) estimator to address the endogeneity of some regressors claimed (theoretically) as endogenous, which will be explained in detail in the next section.

The second concern in an empirical investigation, which has recently received increased attention, is the problem of cross-sectional dependency. Cross-sectional dependency denotes the correlation of idiosyncratic errors across panels, which may arise due to the presence of common shocks (omitted unobserved components), spatial correlation and/or economic distance (Sarafidis *et al*., 2009, p.2). Whilst early application of panel data models assumed that disturbances in panel data are cross-sectionally independent (Pesaran, 2004; Sarafidis *et al*., 2009), there are potential reasons to believe that this assumption might not hold. Particular to our research, the potential reasons are as discussed below.

First, changes in the level of FD (expenditure or revenue decentralisation) are likely to occur simultaneously in TEs, or at least display similar trends among countries in Europe and those in the Caucasus and Central Asia. One can observe that even within the same group, there is still some similarities of the FD trend observed among some countries that share similar characteristics. For instance, the Czech Republic, Hungary and Poland, all part of the EU, have been following more advanced reforms regarding (fiscal) decentralisation (whether by coincidence or designed) compared to the Balkan countries (Davey and Peteri, 2008; Rodriguez-Pose and Kroijer, 2009). Next, FD measures might vary not only due to the change in the local expenditure/revenue, but also due to contracting or expansion fiscal policies of central governments (i.e. economic crisis, austerity etc.), which might impact FD simultaneously across all countries.[84] Further, the geographical vicinity of these countries might be considered as a potential factor for the presence of cross-country correlation.

Ignoring these potential causes, if cross-sectional dependence is present, will lead to biased estimators and invalidate the conventional *t*-test and *F*-test due to incorrect standard errors (De Hoyos and Sarafidis, 2006; Hoechle, 2007). Also, Lee (2002) claims that, in certain cases, such dependency might lead to inconsistent estimators.

[84] Recalling Section 4.3, an increase/decrease in the national government expenditure due to financial/fiscal crisis or fiscal policies will decrease/increase the ***fdexp***.

This seems to be an important potential identification problem in the FD-growth research, where to the best of our knowledge, the existing FD-economic growth empirical studies ignored the dependency of errors between countries.[85] In this regard, this thesis will test whether cross-sectional dependence is present in our dataset of TEs and potential estimators (Driscoll-Kraay SEs) to account for this problem.

In case of the presence of cross-sectional dependence, it is necessary to rely on standard errors which are robust to cross-sectional dependence. The econometrics literature (Cameron *et al.,* 2011 and Thompson, 2011) suggests double-clustering[86] or multi-way clustering of SEs to account for correlated residuals across time (common shocks) and space (cross-sectional correlation). This estimator relies on the one-way cluster-robust variance estimator of Arellano (1989) and extends it to two or more non-nested dimensions (i.e. two- or multi-clustering). However, a concern which arises with this procedure is the large number of clusters needed to avoid additional bias in the SEs. Whilst the literature (Cameron *et al.,* 2011, p.8) offers two small-sample adjustments (options in Stata: *cgmreg* and *small*), there is no evidence that SEs will not be biased in the case of our dataset, where the number of clusters is relatively small (21 countries and 17 years).[87] As such in an attempt to mitigate the dependence across time and space, the two-way clustering SEs might additionally bias the result due to the small number of clusters.

In an attempt to adress the drawback of a small number of clusters in the data, Driscoll and Kraay (1998) propose a superior estimator by transforming the nonparametric time series covariance matrix estimator contemporaneously robust to both temporal and spatial dependence.[88] Their Monte-Carlo simulations show that the performance of the Driscoll-Kraay SEs are similar to Newey-West, but the former is superior given that it takes into account the spatial dependence and relies on large-T asymptotic. Thus, considering the drawbacks of the two-way clustering of SEs and the Newey-West SEs,

---

[85] Unless studies employ spatial model(s).

[86] Double clustering is calculated by summing up the time- and group-clustering, and subtracting the White estimator to avoid double counting (Thompson, 2011, p.1).

[87] Pfaff (2013) argues that bias can be found even on datasets with 100 clusters, whereas Gonzales (2014) argues that bias is severe in a state-year context.

[88] Another available estimator which controls for cross-sectional dependence is the Panel Corrected Standard Errors (PCSE). This estimator uses either OLS or Prais-Winsten parameter estimates and usually it relies on large-scale panel regressions, which is not the case of our dataset. Additionally, this estimator is robust to cross sectional correlation, first-order autocorrelation and heteroscedasticity.

the models in this chapter are estimated using the Driscoll-Kraay SEs, using the adjustment offered by Hoechle (2007) for unbalanced panel data.

Another concern in our empirical approach is the presence of variables with very little- or constant-longitudinal variance, which will be "wiped out" in FE estimation. The estimation of these variables is likely to be unreliable and "produce wrong inferences in the same way a biased estimator could" (Plümper and Troeger, 2007, p.125). Accordingly, a Fixed Effect Vector Decomposition (FEVD) approach of Plümper and Troeger (2007) is proposed to overcome the loss of information and efficiency that occurs when using a FE approach in estimating time-invariant or rarely-changing variables. As shown in Plümper and Troeger (2007), the FEVD utilises a three-stage procedure for the estimation of such variables in panel data with unit effects. First, a standard FE model is estimated with variables that have high longitudinal variance, while time-invariant and slowly moving variables are excluded. In stage two, the unit effects, obtained from the regression of the previous stage, are regressed on slowly-moving variables and time-constant variables. The unit effects are decomposed into two parts: the explained component by the slowly-moving and time-constant variables and the unexplained component. In stage three, the full model, including time variant, time-constant and slowly-changing variables, and the unexplained component of stage two instead of the unit effects, is estimated by pooled OLS.[89]

Despite the increasing popularity that has gained among economists, this estimator has been criticised for its ostensive efficiency, which according to Greene (2011), are illusory. More specifically, he (p.135) elaborates on this as follows:

> *The FEVD simply reproduces (identically) the linear FE (dummy variable) estimator then substitutes an inappropriate covariance matrix for the correct one…. The efficiency gains are illusory. The claim that the estimator provides an estimator for the coefficients on time-invariant variables in an FE model is also incorrect.*

It is argued that this procedure manipulates the dataset since there are no instrumental variables introduced, neither through Hausman and Taylor's (1981) approach nor through other procedures which take into account the endogeneity of the (time-

[89] This is implemented in Stata using the *ado* files provided by the authors. More details on this three-stage procedure is provided in Appendix 4.3.

invariant) variables.[90] Similarly, Breusch *et al.* (2011, p.133), based on a Monte Carlo evidence, demonstrate that the FEVD coefficients after the three stages are the same as in a standard FE. Further, the authors claim that these estimators would be inefficient in the presence of endogeneity, especially if time-invariant and/or slowly moving variables are known as endogenous. On the other hand, Plümper and Troeger (2011) claim that these critics are either incomplete or wrong as this procedure produces efficient estimators and has both asymptotic and finite sample reasonable properties.

4.3.3 Diagnostic testing

The first standard diagnostic is about the assumption of a normally distributed error term (Wooldridge, 2002). The graphical diagnostic (Appendix 4.2.4) suggests violation of this assumption. In order to address this problem, the literature suggests either use of a logarithmic transformation of the dependent variable or/and detection of outliers (Wooldridge, 2002). Unfortunately, the former seems to be not possible in this thesis, where the dependent variable is measured in growth rates. By using a logarithmic transformation, we risk the validity of the economic interpretation of our results. Also, our research appears to challenge the use of logarithmic transformation given the existence of negative and zero values. Instead, checking for outliers seems to better address the non-normality.

In order to avoid the effects of abnormal values in the estimation results, graphical diagnostics and more advanced techniques are used. The box plot and the letter-value displays approaches suggest presence of some aberrant values of growth. Whilst the former is based on visual detection of outliers, the letter-value displays approach is based on a more systematic observation of outliers. This approach displays a collection

[90] Hausman and Taylor (1981) suggest a new approach to estimate the time-invariant variables, which is superior to the conventional FE model only if some of the explanatory variables are not correlated with the unobserved group effects. Namely, if the variables are known to be exogenous, Hausman-Taylor approach seems to be more appropriate than the other estimators. However, identifying the exogeneity/endogeneity of all the variables in the model (time-varying and time-invariant variables) seems very difficult (Breusch *et al.*, 2011 and Wooldrige 2002). Based on Monte Carlo evidence, Plümper and Troeger (2007) argue about the superiority of FEVD in estimating efficiently the time-invariant and slowly moving variables compared to the Hausman-Taylor procedure, the RE model and pooled OLS.

of observations drawn from the sample in the tails rather than the middle of the distribution in an attempt to identify observations that are outside some predetermined cut-off called fences (Hoaglin, 1893; Emerson and Stoto, 1983; StataCorp, 2013). Based on the visual diagnostic through box plot and especially on the latter value approach, Models 5.3 and 5.4 are estimated within the recommended fences for the growth rate of -12.55 and 21.20 (see Appendix 4.2.3).[91] As to the independent variables, the observations seem to be within the suggested inner and outer border, with no serious threat to our analysis (see Appendix 4.2.4). We rely on the Tukey Ladder of Power test (Tukey, 1977) to decide on the appropriate transformation of independent variables once the normality assumption is rejected.

As second check, the collinearity diagnostics show relatively low correlation between the control variables and FD measures, but as expected, there is high correlation between the main variables of interest with each other (see Appendix 4.1). Following the correlation matrix and based on the review provided in Section 4.3.2, there are several decisions to be taken regarding the FD measures. The first one is the inclusion of a measure that captures the expenditure dimension of FD. Given that ***fdexp*** is the only available measure capturing this dimension, it seems reasonable to consider it as the first selected FD measure. Next, given the appropriateness of tax rather than revenue decentralization, and the high correlation of the later with ***fdexp*** (0.94), we include ***fdtax_l*** to measure the revenue dimension of FD.[92] Next, a decision regarding the third dimension of FD (vertical imbalance) has to be taken. Whilst the two vertical imbalance measures do not seem to be highly correlated with the first selected measure (***fdexp)***, contrary they appear to be highly correlated with ***fdtax_l***. The correlation between ***fdtax_l*** with ***imbalance1*** and ***imbalance2*** is -0.88 and -0.76, respectively. Hence, it is argued that the second measure of vertical imbalance is superior to the first one. As to the fiscal performance measures, the correlation between (***fiscalperform1*** or ***fiscalperform2***) and other FD measures appear to be severely high (above 0.80), which questions their appropriateness. Also, in case one of the above measures would be used in a growth regression, that would be as a single measure

[91] Denoting the interquartile range as the IQR, defined as the spread of the fourths, the inner fence is defined as (3/2)IQR, whereas the outer fence as 3IQR above and below the F-summaries (StataCorp 2013, p.3).
[92] The correlation between ***fdtax_l*** and ***fdexp*** is 0.1166 (see Appendix 4.1 for more Stata printouts).

(due to the high correlation with other FD measures), powerless to capture all the dimensions of FD. Hence, we rule out the two fiscal performance measures.

Summing up, the final FD measures are ***fdexp*** to measure the expenditure dimension of FD, ***fdtax_l*** to measure the revenue dimension (chosen between ***fdrev, fdtax*** and ***fdtax_l***) ***imbalance2*** to measure the dependency of local governments to central one (chosen between ***imbalance1*** and ***imbalance2***). Thus, Model 5.4 becomes our preferred specification. However, given the presence of mild multicollinearity between ***imbalance2*** and the other selected FD measures, it will be interesting to contrast the results of this model with the one including only ***fdexp*** and ***fdtax_l*** (Equation 4.3). Turning back to the collinearity between all independent variables, the mean VIF seem to be very low (1.85 when using Equation 4.3 and 2.05 when using Equation 4.4), suggesting that the inclusion of our control variables do not cause a problem of multicollinearity.[93]

In terms of standard diagnostics test, a RESET, as suggested by Wooldridge (2009, p.306), is performed. Accordingly, we do not reject the null hypothesis of a correctly specified form in Equation (the p-value on the *chi2* test is 0.903).[94] However, the question is not only which FD measures to use, but also whether to include a squared term of FD to account for its nonlinear effect. Although mostly ignored, few studies (Thiessen, 2003; Asatryan and Feld, 2013) argue that the relationship between FD and economic growth might exhibit an inverse U-shape. This points towards an optimal size of FD, above which the effect of FD on growth becomes negative. Estimation outputs provided in Appendix 4.4.1 suggest the existence of a linear relationship, rather than an inverse U-shape and an optimal size. Same results seem to be suggested even when having only two measures of FD (where Equation 4.3 is augmented with the squared terms of ***fdexp*** and ***fdtax_l***).

The modified Wald's test (Baum, 2006) and the Wooldridge test for panel data (Drukker, 2003) are performed to test the presence of group-wise heterogeneity and autocorrelation, respectively. As expected in a cross-country regression, the above tests suggest that the model suffers from group-wise heteroskedasticity and autocorrelation (see Appendix 4.2.6 and 4.2.7 for Stata printouts). Next, a unit root

[93] Mode details are provided in the Appendix 4.2.2.
[94] Similarly, we fail to reject the null hypothesis when this test is performed on Equation 4.3.

test is conducted to decide whether there is need to test for a cointegration relationship. The Maddala and Wu's (1999) Phillips-Perron type test is performed on all variables, while using the *demean* option to mitigate the effect of cross-sectional dependence (Phillips and Perron, 1998; Levin *et al.,* 2002; StataCorp, 2013).[95] This test is a Fisher-type test, where p-values from individual tests are combined together to obtain the overall test statistics on whether panels have unit roots. Based on the p-values from individual tests and the overall Fisher-type unit root test (see Appendix 4.2.5), it is suggested to not proceed further with conducting a cointegration relationship test.

Another important test performed is the Pesaran test of cross-sectional dependence (Pesaran, 2004). The null hypothesis that the cross-section units are independent is strongly rejected with a p-value of 0.002.[96] If this dependence is coming from the exposure of countries to common/homogenous shocks, eventually the inclusion of time dummies would remove it completely (Sarafidis *et al.*, 2009; Gaibulloev *et al.*, 2014). Consequently, Equations 4.3 and 4.4 are augmented and re-estimated with time dummies. In this case, it is wise to test again for the presence of cross-sectional dependence, however this time originating from non-homogenous effect, which does not show pattern of common components (i.e. economic distance) and spatial dependence (Sarafidis *et al*., 2009, p.150). Again, the test indicates the existence of cross-sectional dependence, which was not able to be absorbed by time-dummies (p-value after including time dummies of 0.003).[97] Therefore, it is necessary to rely on standard errors which are simultaneously robust to autocorrelation, heteroscedasticity and cross-sectional dependence by using the Driscoll-Kraay SEs and the adjustment offered by Hoechle (2007) for unbalanced panel data (recall Section 4.3.2).

To test whether a FE- or a RE-estimator with Driscoll-Kraay SEs will be used, a Hausman test is performed. Unfortunately, this test becomes invalid and does not have any statistical inference once the panels are correlated (Hoechle, 2007, p.25). However, a modified Hausman test proposed by Wooldridge (2002, p.288) is used as an alternative to the standard Hausman test. This test, robust to general forms of spatial and temporal dependence, suggests that the null hypothesis can be soundly rejected

---

[95] The *demean* option is suggested by Levin *et al*. (2002) to mitigate the impact of cross-sectional dependence in pane data. Technically speaking, this option requests the *xtunitroot* to first subtract the cross-sectional averages from the series (StataCorp, 2013).
[96] More details provided in Appendix 4.2.9.
[97] See Appendix 4.2.9 for more details.

with a p-value of 0.000 (see Appendix 4.2.9 for Stata printouts).[98] Thereby, it appears that FE estimation is preferred relative to the RE-estimators, which appear to be inconsistent. Additionally, based on the *F*-test, it is argued that the OLS estimation relative to the FE is likely to produce inconsistent estimates. Hence, we conclude that the FE using Driscoll-Kraay SEs is the most appropriate estimator as it is simultaneously robust to cross-sectional correlation, autocorrelation and heteroscedasticity.[99]

Regarding our next identification problem, the presence of time-invariant or slowly changing variables requires the use of FEVD. However, the discussion in the previous section on the appropriateness of FEVD gives us sufficient reasons to not rely solely on this estimator but also to report other estimators (i.e. FE with Driscoll-Kraay SEs). However, to ensure the inference of the economic estimates it is important to investigate whether the FEVD is well specified. Following the suggestion of Plümper and Troeger (2007), the coefficient of the unobserved unit effects h_i should be equal to 1.0 for the estimates to be valid. In all the estimation, this coefficient (see Appendix 4.3) equals 1. At this point, it is necessary to identify the slowly moving variables. If the between-to-within SEs ratio of a variable is above 2.8, then this variable is considered with very little longitudinal variance (Plümper and Troeger, 2007, p.20; Greene, 2012, p.9). Nevertheless, they claim that this threshold relies heavily on not only the between-to-within variation but also on the correlation between the unit effects and the slowly moving variables. In the context of our dataset, one variable appears to be slowly-moving (***tindex***) and two as time-invariant (***lngdpini*** and ***europe***), while the calculations for all the variables are presented in Table 4.3. Additionally, ***fdexp*** (with a ratio of 2.40), which despite being lower than 2.8 stands out from the rest of the other ratios. Given that the decision to treat a variable does not rely only on the above ratio, but also on other economic consideration, it is worth treating ***fdexp*** as slowly-moving variable and observe whether this influences the estimation.[100]

[98] This is performed in Stata through performing a Hausman test using the option *sigmamore* (see Hoechle 2007, p.24 for further details).
[99] The Stata command *xtscc* compute standard errors robust to temporal and spatial dependence for linear panel models.
[100] Taking a look at the descriptive statistics and the trend of expenditure decentralisation over time and across countries, one can easily distinguish that this variable does not have a high within variation, which is likely to be imprecisely (less efficient and less reliable) estimated with conventional FE model.

Table 4.3 Identifying the time-invariant and the slowly moving variables

Variable	Between SEs	Within SEs	Between/Within ratio
fdexp	9.15	3.81	2.40
fdrev*	9.74	4.08	2.38
fdtax	11.21	6.31	1.77
fdtax_l	16.70	12.49	1.33
imbalance1*	17.67	12.73	1.38
imbalance2	17.29	16.80	1.03
fiscalperform1*	22.36	12.88	1.74
fiscalperform2*	20.19	12.86	1.57
Popgrowth	0.53	0.45	1.18
educ2*	6.22	5.91	1.05
educ3*	11.07	12.75	0.86
schooling	0.80	0.64	1.25
dschooling	0.05	0.44	0.11
gfcf_gdp	3.63	4.22	0.87
trade	25.23	17.12	1.47
tindex	14.02	4.92	2.85
laggdp	6777.67	3547.25	1.91
lag2gdp*	6722.24	3446.85	1.95
lngdpini	0.624	0	Time-Invariant
Govcons*	3.13	2.09	1.49
europe*	0.48	0	Time-Invariant
eu*	0.28	0.37	0.76

*Variables used for the robustness check

Turning back to the diagnostics of the FEVD model, it seems that Equations 4.3 and 4.4 display satisfactory diagnosis statistics (the value of h_i = 1.0, see Appendices 4.3.1 and 4.3.2 for Stata printouts). As to one of the main variables of interest, ***fdexp***, it seems that treating this variable as slowly-moving does not change either the sign or the significance. Therefore, specification of the following estimations will be based on the between-to-within SEs ratio and thus, ***fdexp*** will not be considerd as a slowly-moving variable.

However, the above estimation procedures do not eliminate the biases stemming from the potentially endogenous variable(s), where, as argued before, there are sufficent reasons to believe that not only FD (recall section 4.2.3), but also other variables, such as investment and trade openness, might be endogenous. Based on the discussion of Section 4.3.2, the use of two-stage instrumental variable (IV) estimator to address the endogeneity of some regressors appeared superior to other estimators. Four variables are considered as endogenous in our model: ***fdtax_l***, ***imbalance2***, ***gfcf_gdp*** and ***trade***.

Given the difficulty of finding external instruments for our claimed endogenous variables, we use the lagged values of these variables as instruments (lag structure from 1 to 4, with more details provided in Appendices 4.3.1 and 4.3.2).

Attention has been paid to the underidentification test, weak identification test, Sargan test (also known as the overidentifying restrictions test) and endogeneity test. The underidentification test is essentially a test of whether the excluded instruments are correlated with the endogenous regressors; a test of whether instruments are relevant. In the reported regressions in Appendices 4.3.1-4.3.4, the rejection of null hypothesis indicates that the instruments are relevant (p-values range from 0.000 to 0.0757). However, when the dataset is split into two subsets (refer to Appendix 4.3.4), the null hypothesis could not be rejected (p-value of 0.884), a failure that might be attributed to the drastic reduction of the number of observations.[101] Similar results are obtained when performing the weak identification test, a test of whether the instruments are weak (more details reported in Appendices 4.3.1-4.3.4). Next, testing whether the instruments are valid (not correlated with the error term), the Sargan test supports the validity of each model specification, where we fail to reject the null hypothesis (p-values from 0.3 to 0.8).[102] Last, the endogeneity test confirms that the variables considered as endogenous ***(fdtax_l***, ***imbalance2***, ***gfcf_gdp*** and ***trade)*** are indeed endogenous. The null hypothesis is rejected in all specifications with a p-value of 0.000.

In what follows, we shall use three estimation methods to estimate Equations 4.3 and 4.4: (i) the FE with Driscoll-Kraay SEs, (ii) FEVD, and (iii) IV approach.

4.4 Results

4.4.1 The Baseline Model

Because FD appears to be a multidimensional process among TEs, this section reports two sets of results using a combination of two and three measures of FD, respectively ***fdexp*** and ***fdtax_l***, and ***fdexp***, ***fdtax_l*** and ***imbalance2***. Although it was argued before that the preferred specification is the latter, it is interesting to investigate changes in the economic effect when adding vertical imbalance to the model. Additionally, given

[101] Number of observations dropped from 328 to 89.
[102] More detailed reported in Appendices 4.3.1-4.3.4.

that there is (to some extent) ground of multicollinearity between ***imbalance2*** and other FD measures, we report and contrast the results from the two specifications, though ultimately the one with three measures of FD are interpreted. The results from (i) FE with Driscoll-Kraay SEs, (ii) FEVD and (iii) IV approach are reported in Table 4.4. The first three columns present the results when employing two measures of FD estimated by FE with Driscoll-Kraay SEs (Column 1), FEVD (Column 2) and IV approach (Column 3), whereas the next three columns report results using three FD measures with corresponding estimation methods.

As explained in the previous section, none of the proposed estimation approaches (FE with Driscoll-Kraay SEs, IV estimator and FEVD) can simultaneously address the problems that this dataset faces: cross-sectional dependence, endogeneity, and time-invariant and slowly-moving variables. Contrary, each estimation approach can address only one of the above problems, which leaves us with no preferred estimator. We will start by interpreting the results from the first estimator, followed by any changes in the coefficient and size obtained by the IV approach.

Table 4.4 Estimated results of Equations 4.3 and 4.4

	(1)	(2)	(3)	(4)	(5)	(6)
		Equation 4.3			*Equation 4.4*	
VARIABLES	FE with D-K SEs	FEVD	IV	FE with D-K SEs	FEVD	IV
fdexp	0.063*	0.024	0.025	0.066*	0.021	0.088
	(0.035)	(0.037)	(0.049)	(0.035)	(0.037)	(0.075)
fdtax_l	-0.018*	-0.007	-0.037	-0.004	0.007	0.206
	(0.009)	(0.018)	(0.032)	(0.028)	(0.049)	(0.156)
imbalance2				0.013	0.014	0.199
				(0.024)	(0.039)	(0.125)
popgrowth	-0.348	-0.859*	-0.802	-0.379	-0.893*	0.105
	(0.352)	(0.517)	(0.524)	(0.357)	(0.529)	(0.662)
gfcf_gdp	0.209***	0.204***	0.031	0.209***	0.205***	0.115
	(0.031)	(0.054)	(0.076)	(0.031)	(0.053)	(0.109)
dschooling	1.024***	1.420***	1.402	1.021***	1.415***	2.609*
	(0.351)	(0.472)	(1.073)	(0.348)	(0.469)	(1.402)
trade	0.049***	0.039*	0.044**	0.049***	0.041**	0.081***
	(0.013)	(0.021)	(0.021)	(0.012)	(0.021)	(0.028)
tindex	-0.041	-0.027	0.076	-0.033	-0.024	0.129
	(0.053)	(0.032)	(0.086)	(0.051)	(0.032)	(0.119)
laggdp	-0.0006***		-0.0004***	-0.0006***		-0.0005***
	(0.0002)		(0.0001)	(0.0002)		(0.0002)
lngdpini		-1.393**			-1.236	
		(0.659)			(0.874)	
constant	5.304	7.500		3.321	4.569	
	(5.759)	(6.170)		(6.717)	(11.46)	
No. of observations	328	328	247	328	328	250
R-squared		0.673	0.623		0.674	0.610
Number of groups/country	21	21	21	21	21	21
eta/standard deviation		1/(0)			1/(0)	
Under identification test (p-value)			0.000			0.0014
Weak identification test (value)			21.565			2.486
Sargan test (p-value)			0.811			0.6047
Endogeneity test			0.001			0.0048
Instrumented variables			***fdtax_l*, *gfcf_gdp*, *trade***			***fdtax_l, imbalance2, gfcf_gdp, trade***

Note: time dummies not included in the table
Standard errors in parentheses
*** p<0.01, ** p <0.05 and * p <0.1

Regarding the main variables of interest, the results, in terms of sign and size, are overall consistent across different specifications, though the significance vanishes when shifting from one estimator to the other. Obtained results from the FEVD and IV approach seem to be more consistent than those from FE with Driscoll-Kraay SEs.

Surprisingly, inclusion of ***imbalance2*** wipes out the negative coefficient of ***fdtax_l*** (see Columns 1 and 4), while there is no change in the ***fdexp*** coefficient and sign.

Obtained results from the first estimator indicate a positive impact of expenditure decentralisation on economic growth, although weakly significant at 10%. Irrespective of the number of FD measures used (Equation 4.3 or Equation 4.4), the results seem to support the hypothesis that the more spending carried at local level, the higher the national economic growth, with local governments being sufficiently able to determine the "productive" expenditure that enhances growth. Nonetheless, the coefficient of ***fdexp*** is relatively small, such that a 10 percentage points increase in expenditure decentralisation will have a small effect on economic growth by approximately 0.6 percentage points, ceteris paribus. However, the statistical significance vanishes when opting for an IV approach, though the sign and the size of the coefficient remain the same. A note of caution seems to be in order when using the IV approach in small datasets. The number of observations reduces drastically, which in turn weakens its performance. As to the weak statistical significance of ***fdexp***, this might be attributed to the existence of high level of transfer dependency in these countries, which is likely to impact the use of expenditure assignments conditional to the transfer received. As such, it may hinder the full effect of local spending.

Our results contradict the findings of Rodriguez-Pose and Kroijer's (2009) research in which it was suggested that spending decentralisation deteriorates growth. A possible rationale for such differences, in addition to the larger dataset in our research at longer time span and different estimation techniques, might be attributed to the distinct decentralisation phase experienced by the local government. The above study is conducted in a different time span (1990-2004), which captures the initial and relatively moderate phase of expenditure decentralisation. Such period is characterized by high fluctuations in expenditure decentralisation, which were claimed as outliers in our research (data before 1996). While we focus on a more recent time span and ignore potential distortion due to conflicts and war, the economic effect of FD is likely to change over time. Over the years, local governments tend to be more accountable and experienced in financing productive spending that are likely to boost economic growth. Also, the EU membership aspiration has contributed to many European countries in further advancing the local reform, while being more accountable and efficient (Davey and Peteri, 2008).[103] Given the positive coefficient of ***fdexp***, although sensitive to different estimators, it might be argued that local governments are entering a more mature phase of decentralisation compared to the two last decades.

Contrary to the expectations, tax decentralisation does not have any impact on economic growth. The only exception is when FD is proxied by two measures, and FE estimator with Driscoll-Kraay SEs is used. However, when this variable is treated as endogenous (either when using two or three measures), the positive effect ceases to exist. Possible reason for this result might be attributed to the low degree of local tax-raising powers which might dampen the direct effect of FD on growth. Whilst some of the countries have relied on shared taxes (part of income collected by the central government), the contribution of own revenues to the local budget remains modest, emphasising the lack of financial capacity. Also, the majority of countries are more expenditure than revenue decentralized, while still struggling with finding a balance between financial resources delegated from the national government or locally raised funds through tax revenues or fees. Despite the theoretical expectations that ***fdtax_l*** is positively correlated with economic growth, our context of investigation seems to challenge these expectations. Some subnational government units among TEs, especially in South East Europe, are faced with various challenges related to the financial and technical capacity (Bartlett *et al.*, 2013). Generally speaking, local governments in TEs have limited power to determine the tax base and tax rate. However, few exceptions are observed within Southern Caucasus countries and new EU member states, which have been keen to decentralise rapidly. Thus, it may be argued that the effect of these countries has offset one of less developed countries that face the above challenges.

Another significant concern in this chapter was the inclusion of all dimensions of FD in the growth model, amongst them ***imbalance2***[104], which measures the extent to which subnational government's expenditure is financed by transfers from central government. This variable appears insignificant across all estimators. It seems that the

---

[103] 11 European TEs have joined the EU (Bulgaria in 2007, Croatia in 2013, the Czech Republic in 2004, Estonia in 2004, Hungary in 2004, Latvia in 2004, Lithuania in 2004, Poland in 2004, Romania in 2007, Slovakia in 2004 and Slovenia in 2004).

[104] See Appendix 4.1 on the decision, based on a correlation matrix, on the appropriate vertical imbalance measure. The decision was made between three measures of vertical imbalance (***imbalance1***, ***imbalance2*** and ***imbalance3***).

inclusion of vertical imbalance did not provide much insight regarding the imbalance-economic growth relationship. Potential reasons why such effect does not become visible might relate to the heterogeneity of TEs regarding the dependency on central governments. The overall result might be offset by the heterogeneities among three different groups of countries: those that have high vertical imbalance (i.e. Albania, Lithuania, Romania), the group that rely mostly on their own revenue (i.e. the Czech Republic, Bosnia & Herzegovina, Moldova), and the third group characterized by a more balanced relationship between transfers and own revenue (i.e. Hungary, Romania).[105]

However, the sign reported does not indicate our theoretical expectations. In general, the literature leans towards a negative impact of transfers to growth. Subnational governments might be less incentivised to responsibly distribute the local revenues (Rodden et *al.,* 2003), as they know that they will be financed by intergovernmental transfers, even if local taxes are not efficiently collected. Moreover, subnational governments, relying on intergovernmental transfers to heavily finance their spending are likely to be more incentivised to overfish (Fiva, 2006), which in turn, lead to a higher competition for these grants rather than for tax base or tax rate. Consequently, this deterioration of the fiscal discipline, stemming from imbalanced decentralisation, may negatively affect the economic performance. However, contradicting views argue that such competition increases the local government efficiency to spend the funds in enhancing economic growth functions. Though, such distinction (between competitive vs non-competitive or conditional vs unconditional) is not possible with our data.

As to the control variables included in the growth model, gross fixed capital formation measured as a percentage of GDP (***gfcf_gdp***) is found to have a positive and significant effect on national economic growth, though becoming insignificant when opting for the IV approach. Accordingly, a 1 percentage point increase in investment, on average, is associated with an increase of annual economic growth by 0.21 percentage points, ceteris paribus. Despite the differences among transition economies, their average performance suggests that investment has played a significant role in the national economic growth. Even when employing FEVD procedure, which is criticized for inflated standard errors, ***gfcf_gdp*** appears to be positive and highly significant (1%

[105] The mean value of the ***imbalance2*** of the first group of countries is 70.75, whereas of the second group is 54.50 and of the third group is 40.15.

level of significance). This result seems to be in line not only with the theoretical expectations but also with the other empirical research on economic growth for TEs (see Mileva, 2008) Despite the different utilization rate of capital flow in these countries, the rate of investment has been quite high with desirable pace (Sohinger, 2004), which seems to have played a significant role in helping them prosper and have higher rates of economic growth. However, when investment is treated as endogenous, the positive effect vanishes, though the sign of the coefficient does not change. Different from other control variables, investments seem to be highly sensitive to endogeneity. The decrease in the number of observations when using IV and the possible omitted dynamics might influence its statistical significance.

As expected, education is positively and significantly (from 1 to 10% level of significance) associated with the growth rate, across all specifications and estimation techniques. Accordingly, an increase of one year in the change in average years of schooling boosts the economic performance by 1.1 to 2.6 percentage points, all other factors being constant.[106]

The significant and positive coefficient of the trade variable across all the specifications and estimators suggests that the more outward-oriented the economies are, the higher the growth rate will be. Namely, an increase in trade shares (***trade)*** by 1 percentage point, ceteris paribus will increase the average growth rate by 0.04 to 0.08 percentage points annually. Interestingly, the obtained coefficient and significance do not seem to be hampered by the endogeneity nature of trade when using the IV approach (see Columns 3 and 6).

Among other factors, population growth appears to be statistically insignificant, except when using FEVD. Such effect might be due to the use of different specification when using FEVD (***gdpini*** is used instead of ***laggdp***). (recall Table 4.2). In general, the obtained results do not confirm the Solow's (1956) argument on population growth.[107]

---

[106] Also, it has to be noted that when we change the education measure to the *average years of schooling* instead of its first difference, coefficient becomes negative, although not robust (see Appendix 4.4). Insignificant effect of education is reported across all specifications and estimators (see Appendix 4.4) when using enrolment rates in secondary and tertiary education.

[107] According to the neoclassical growth model, Solow (1956) argues that population growth reduces economic growth due to capital dilution.

In conformity with the expectation from the neoclassical growth theory, the coefficient of ***laggdp*** is negative and significant, suggesting the presence of conditional convergence, where lower-income countries tend to grow faster than higher-income countries. Different from the other estimators, FEVD allows the estimation of the time-invariant variable, which permits us to substitute ***laggdp*** with ***lngdpini*** (Initial level of GDP per capita PPP in 2011 international $ in logarithmic form). Following the suggestions of Rodriguez-Pose and Fratesi (2004), the second lag of GDP was used as an alternative measure of catch-up effect to avoid potential endogeneity in the regression. However, the second lag did not seem to change our results; both the coefficients and the sign remain the same as our preferred specification with one lag of GDP. Overall, the obtained results suggest a consistent catch-up effect between TEs, though it may be argued that the transition path to the long-run growth might not be the same for all TEs. Given the heterogeneity of these economies, the catch-up effect might be slow for some countries which fail to pass the poverty trap (as such having low levels of income) in comparison to others that grow faster. However, it seems that the transition stage might be largely influenced by economic fundamentals (education, investment etc.).[108]

4.4.2 The moderating role of stages of transition and geography

In the jargon of public sector economics, FD is considered a luxury good (also known as a superior good) which can be afforded only when income increases. Bahl and Linn (1992) and Martinez-Vazquez and McNab (2003), amongst other authors, argue that high-income countries can better utilize the decentralisation benefits (associated with fewer disadvantages). As income increases, FD becomes desirable and countries become able to use its benefits. Contrary, low-income countries are faced with many challenges and burdens, while benefits come relatively slowly. Yilmaz and Meloche (1999) complement this view by arguing that in the presence of a positive correlation between FD and economic growth, decentralisation either can be considered a superior good or otherwise help the economic development.

[108] See Dufrénot *et al*. (2009) for a detailed review related to the catch-up effect.

However, a note of caution is required regarding the definition of the luxury good in the context of FD. From a microeconomic perspective, a luxury good is a good for which demand increases more proportionally than an increase in income, when income rises. However, there is no discussion in the literature about the superiority nature of FD and whether FD as a "good" involves a more than proportionate increase compared to the increase of FD by assessing the income elasticity of FD. Instead, the dominant definition in the theoretical literature of FD, the presence of a positive correlation between FD and economic growth, is that of a normal rather than luxury good. Therefore, in the context of this thesis, we will pay attention to these two terms (luxury and normal) by not using them interchangeably with each other.

Using a dataset that includes countries with substantial differences regarding transition stages, geographical location, culture or institutions, it is likely that the genuine effect of FD on economic performance is hidden, or at least undershot. While we account for the economic and institutional reforms through ***tindex***, it seems that this is not fully accounting for stages of transition. It does indeed consider the direct effect of ***tindex*** on economic growth, but it does not account for any differences of the economic effect of FD due to different stages of transition. Some countries have developed very fast in contrast to some others that have been stagnating for years. It is likely that the economic effect of FD follows a similar trend, which might be invisible when not differentiating between stages of transition. This might be a possible explanation for the weakly significant, up to insignificant, effect of ***fdexp*** in the previous set of results (recall Table 4.4). In order to shed more light on this relationship, this thesis contributes to the existing literature by investigating the economic effect of FD across different stages of transition and geographical location of countries. These two differences seem to be the most visible in our dataset. To the best of our knowledge, up to date, this is the first study that accounts for stages of transition while investigating the economic effect of FD. The use of marginal effects appears to be a novelty not only in a transition context, but also in all other contexts. Only two studies (Martinez-Vazques and McNab, 2003; Iimi, 2005) have distinguished between developed and developing countries, however no distinction has been made regarding the development stage within the same group of countries.

a) Is FD a normal good?

To answer this question, it is necessary to differentiate countries by their transition stages. Ideally, we would replicate the results of Table 4.4 by using an interaction term between each of FD measures and ***tindex***. Unfortunately, none of our preferred estimators allows the use of interactions. Therefore, we shift to conventional FE with cluster-robust SEs and use interaction terms. Whilst we are aware of potential problems arising from this estimator, such as cross-sectional dependency and endogeneity, we validate the results by using two approaches.

The first approach uses our preferred estimators across two subsamples, which are split based on the average value of the ***tindex*** in our sample (subsample 1 with ***tindex*** greater than 74 and subsample 2 with ***tindex*** lower than or equal to 74).[109] It should be noted that countries do not necessarily fall under one subsample. Instead, they fall on both. Countries that have advanced fast in terms of economic and institutional reforms, thus having more observations for which ***tindex*** is greater than the average, dominate the first group. In contrast, the second subsample includes fewer observations from developed countries (mainly observations from the early stage of transition) and more from laggard economies.[110]

The second approach consists of augmenting Equation 4.5 by three variables that are generated by multiplying each of the FD measures with ***tindex***, namely, ***interaction_exp***, ***interaction_tax*** and ***interaction_imb***. Being unable to include interaction terms properly in the regression, as it was possible in the FE with cluster-robust SEs, we calculate the marginal effects by hand, while assuming different stages of transition. However, we can only observe the variation of the FD measures coefficents due to stages of transition, but no inference can be made regarding the SEs and thus, the statistical significance. Therefore, the results from the FE cluster-robust SEs seem to be superior to the two approaches used for validation.

---

[109] The average is similar to the median value (75.70).

[110] The first subsample includes countries such as Albania, Armenia, Belarus, Bosnia & Herzegovina, Bulgaria, Croatia, the Czech Republic, Estonia, Georgia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia, whereas the second subsample includes Albania, Armenia, Belarus, Bosnia & Herzegovina, Belarus, Georgia, Kazakhstan, Kyrgyz Republic, Latvia, Lithuania, Moldova, Romina, Serbia, Slovenia and Ukraine. Kazakhstan, Kyrgyz Republic, Moldova, Serbia and Ukraine have only one observation in the first subsample.

Overall, in investigating the moderating role of transition on economic growth three sets of results are to be presented: (i) results from FE with cluster-robust SEs (ii) results from FE with Driscoll-Kraay SEs and IV approach across two subsamples (split by the average value of ***tindex)*** and (iii) results from FE with Driscoll-Kraay SEs and IV approach of our preferred specifications (Equation 4.5) augmented with interaction terms of ***tindex*** and FD measures. For brevity, the results reported in Table 4.5 are only for the preferred specification with three FD measures. Results from FE with robust-cluster SEs are presented in Column 1; results from the first approach are presented in Columns 2- 5, respectively using the FE with Driscoll-Kraay SEs (Columns 2 and 3) and the IV approach (Columns 4 and 5). Whereas, results for the second approach are presented separately in Table 4.6, which also are compared with the results from FE with cluster-robust SEs. The first set of results is also displayed in Figure 4.1. More specifically, the results for all the FD measures are shown in Figure 4.1 A, whereas those for each measure is shown in Figures 4.1 B, C and, respectively for ***fdexp***, ***fdtax_l*** and ***imbalance2***. In order to avoid repetition, our primary focus will be only on the FD measures rather than on the control variables, which seem to meet all the theoretical expectations and are in line with the results reported in Table 4.4.

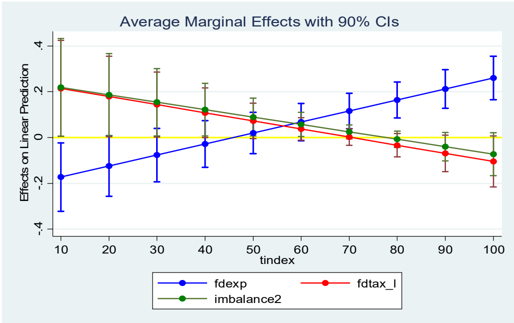
Table 4.5 Results using different subsamples based on transition index score and European union membership

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	3 measures (FE)	t>=74 (FE with D-K SEs)	t<74 (FE with D-K SEs)	t>=74 (IV)	t<74 (IV)	Europe=1 (FE with D-K SEs)	Europe=0 (FE with D-K SEs)	Europe=1 (IV)	Europe=0 (IV)
fdexp	-0.221**	0.125*	0.0260	0.165	-0.0436	0.137**	-0.00659	0.148	-0.089
	(0.102)	(0.067)	(0.056)	(0.114)	(0.113)	(0.052)	(0.078)	(0.103)	(0.322)
tindex*fdexp	0.004***								
	(0.001)								
tindex	0.136	0.081	-0.224***	0.108	-0.673	0.033	-0.097	0.141	-0.469
	(0.179)	(0.089)	(0.045)	(0.106)	(0.520)	(0.083)	(0.155)	(0.091)	(1.305)
fdtax_l	0.250	-0.0016	-0.011	0.150	-0.263	0.015	-0.016	0.216	-1.033
	(0.148)	(0.039)	(0.058)	(0.098)	(0.228)	(0.033)	(0.062)	(0.189)	(1.595)
tindex*fdtax_l	-0.003								
	(0.002)								
imbalance2	0.251	-0.0039	0.009	0.166*	-0.241	0.023	0.003	0.204	-0.619
	(0.150)	(0.031)	(0.051)	(0.084)	(0.190)	(0.023)	(0.043)	(0.167)	(1.022)
tindex*imbalance2	-0.003								
	(0.002)								
laggdp	-0.001***	-0.001*	-0.001**	-0.0004*	-0.0005	-0.0006**	-0.0005*	-0.0005***	-0.0008
	(0.001)	(0.001)	(0.001)	(0.0002)	(0.0003)	(0.0002)	(0.0002)	(0.0001)	(0.00101)
popgrowth	-0.149	-0.918***	-0.554	-1.254*	0.051	-0.790*	-0.377	-0.982	4.542
	(0.549)	(0.310)	(0.575)	(0.746)	(1.806)	(0.400)	(0.905)	(0.661)	(9.772)
dschooling	1.086**	0.514	0.548	0.620	-1.419	0.033	1.551*	0.768	-4.223
	(0.390)	(0.378)	(0.553)	(1.533)	(3.060)	(0.384)	(0.834)	(1.340)	(7.910)
gfcf_gdp	0.201**	0.264***	0.172**	0.053	0.039	0.239***	0.162**	0.315	0.521
	(0.074)	(0.072)	(0.067)	(0.128)	(0.210)	(0.029)	(0.075)	(0.217)	(0.937)
trade	0.065***	0.069***	0.005	0.087	-0.0069	0.069***	0.004	0.102***	-0.022
	(0.021)	(0.017)	(0.025)	(0.055)	(0.091)	(0.021)	(0.030)	(0.033)	(0.177)
constant	-8.898	-9.476**	19.71***			-4.907	11.03		
	(15.95)	(4.212)	(6.807)			(8.133)	(10.43)		
No of observations	333	200	128	179	96	227	101	187	86
R-squared	0.676			0.575	0.580			0.660	-1.431
Number of id_country/groups	21	14	15	14	11	14	7	14	7
Under identification test (p-value)				0.0025	0.0274			0.0757	0.884
Weak identification test				2.153	1.232			1.074	0.074
Sargan statistics (p-value)				0.8082	0.4552			0.3763	0.4550
Endogeneity test of				0.000	0.0418			0.0003	0.0220

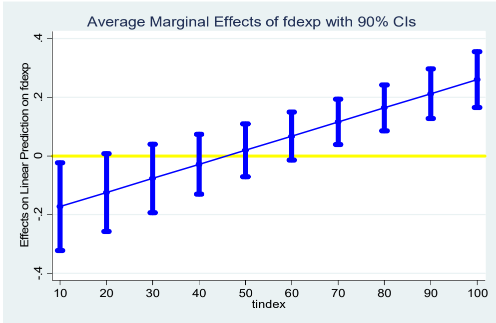
the regressors						
Instrumented variables	***gfcf_gdp, trade, fdtax_l, imabalnce2***	***gfcf_gdp, trade, fdtax_l, imabalnce2***			***gfcf_gdp, trade, fdtax_l, imabalnce2***	***gfcf_gdp, trade, fdtax_l, imabalnce2***

Note: time dummies not included in the table.
Standard errors in parentheses
*** p<0.01, ** p <0.05 and * p <0.1

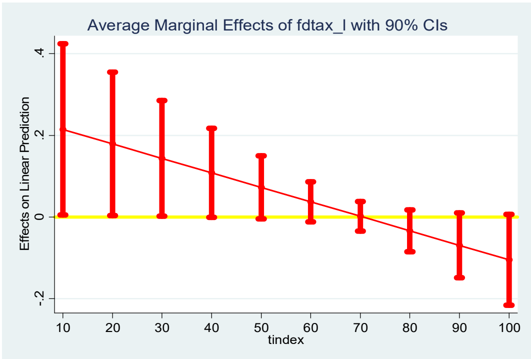
A



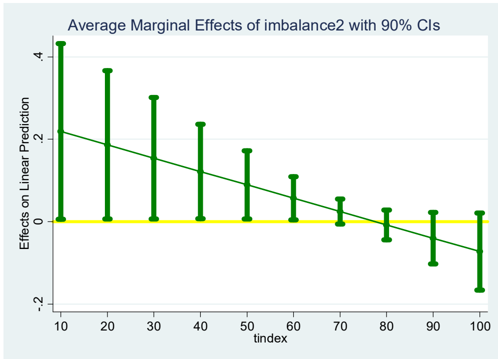
B



C



D



Note: The average marginal effect of transition stages and all FD measures is displayed in Figure A, of *fdexp* in Figure B, of *fdtax_l* in Figure C and *imbalance2* in Figure D), with 90 CIs.

Figure 4.1 Average marginal effects of FD moderated by transition stages

Table 4.6 Average marginal effects of transition stages and FD measures from the second approach compared with the FE cluster robust SEs

	FE with Driscoll-Kraay SEs calculated coefficents			FE cluster robust SEs reported coefficient and SEs from Stata		
Stages of Transition	(1) *fdexp*	(2) *fdtax_l*	(3) *imbalance2*	(4) *fdexp*	(5) *fdtax_l*	(6) *imbalance2*
tindex = 10	-0.11	0.18	0.18	-0.17* (0.09)	0.21* (0.12)	0.21* (0.12)
tindex = 20	-0.08	0.15	0.16	-0.12 (0.08)	0.17* (0.10)	0.18* (0.10)
tindex = 30	-0.04	0.12	0.13	-0.07 (0.07)	0.14* (0.08)	0.15* (0.08)
tindex = 40	-0.01	0.09	0.11	-0.02 (0.06)	0.10 (0.06)	0.12* (0.06)
tindex = 50	0.02	0.06	0.08	0.02 (0.06)	0.07 (0.04)	0.08* (0.05)
tindex = 60	0.06	0.03	0.05	0.06 (0.04)	0.03 (0.30)	0.05* (0.03)
tindex = 70	0.10	0.00	0.03	0.11* (0.04)	0.01 (0.02)	0.02 (0.01)
tindex = 80	0.13	-0.03	0.00	0.16* (0.04)	-0.03 (0.03)	-0.01 (0.03)
tindex = 90	0.17	-0.06	-0.02	0.21* (0.05)	-0.06 (0.04)	-0.04 (0.03)
tindex = 100	0.21	-0.09	-0.05	0.25 (0.05)	-0.10 (0.06)	-0.07 (0.05)

Note: See Calculations of the Stata printouts and the average marginal effects calculated by hand in Appendix 4.3.3 *C*.
Standard errors in parentheses
*** p<0.01, ** p <0.05 and * p <0.1

Empirical findings strongly support the moderating role of stages of transition in the economic effect of ***fdexp,*** with the interaction variable being highly significant at 1% level of significance. This significant effect is also confirmed by the results from the first subsample (see Column 2 and Figure 4.1 B), though only when using FE with Driscoll-Kraay SEs. Given that the latter estimator was used only as a validation to the FE with cluster robust SEs and results from it are less informative (as do not distinguish between different transition stages), we will interpret only the first set of results.

Interestingly, the results suggest that at the very early stages of transition (***tindex*** lower than 20) the effect of expenditure decentralisation on growth is negative. Misuse of funds, lack of clarity of spending assignments, unaccountable and incompetent local governments are potential reasons for this early effect. As a country progresses (***tindex*** increases up to its average) the adverse effect becomes fragile and ceases to exist. However, at more advanced stages of transition, spending decentralisation culminates in a positive and significant effect on economic growth. As a country advances its economic and institutional reforms, the positive effect reinforces and becomes larger (from 0.11 to 0.25).[111] When comparing coefficents with the ones from the second approach of using interactions (see Column 1 and 4 of Table 4.6), it seems that they are almost identical. The sign changes from negative to positive exactly when tindex is equal to 50. And the effect becomes positive (see Figure 4.1 B) after tindex becomes larger than 70. Overall, the findings suggest the presence of a critical level of development after which the economic effect of ***fdexp*** becomes positive. This suggests that only advanced economies can benefit from the advantages of FD. Contrary, its benefit comes slowly to less developed economies, accompanied by high costs in further spending decentralisation. A similar view was argued theoretically by Bahl (2007; 2013), who claims that the lack of institutional capacity and economic reforms deteriorate the ability of less developed countries to consider FD as an elixir to development.

Contrary, the interaction variable between tax decentralisation and economic growth appears insignificant. A closer look at the marginal effects (see Figure 4.1 C) informs us about a changing effect of ***fdtax_l*** across different stages of transition, though being mostly insignificant. Tax decentralisation is conducive to growth only in the early stages of transition. Eventually, as a country moves to more advanced stages of transition, the effect disappears; the sign changes from positive to negative, with borderline significance. Namely, this effect changes from positive at lower values of transition index to negative at higher levels of transition index.. The weak positive effect of higher tax decentralisation confirms the need for a closer match between spending and own revenue in these countries. Advances in economic and institutional reforms increase the tax raising capacity of local government, which appears ephemeral if not associated with higher local taxing power. Unfortunately, this is far from reality for many countries, which either do not have the tax raising capacity at all or rely on limited taxes, which usually have a small tax rate and/or base.[112] Surprisngly, there are also few countries (Albania, Bulgaria, Kosova etc.) that do not yet fully utilise shared taxes, especially of important taxes such as Personal Income

[111] See Table 4.6 and Appendix 4.3.3 for Stata printouts.
[112] Examples of this type of taxes are property tax, city planning tax, landholding tax, hotel tax and fees applied at local level.

Tax or Business Tax. In this case, intergovernmental transfers seem to be a safer option in financing local spending.

As to the vertical imbalance, the findings seem to complement the above scenario. In early stages of transition, countries tend to expenditure rather than revenue decentralise. The need to cope with the functions relies, as a safer option, on intergovernmental transfers. Whilst the initial effect of ***imbalance2*** is positive and statistically significant (see Figure 4.1 D and Table 4.6), at more advanced stages, this variable changes its sign (from positive to negative values close to zero), with borderline signficance. Again, the coefficents seem to be validated by the first approach (see Column 3). The need to rely on its own fund rather than intergovernmental transfers becomes urgent only at higher stages of development.

b) Is FD a good "made in Europe"?

Another intriguing question in the context of our investigation is whether the economic effect is subject to the geographical location of TEs. Thereby, emphasis will also be given to whether the economic growth effect of FD is substantially different between ETEs and Southern Caucasus TEs. The findings reported in Column 6 (using FE with Driscoll-Kraay SEs) suggest that the positive effect of FD on economic growth is evidenced only among European countries. However, this effect becomes extinct when using the IV approach. Another method to validate this result was using the interaction between dummy variables and FD measures. Accordingly, the findings suggest that location does not determine the economic effect of FD (See Appendix 4.3.4).

4.4.3 Robustness Check

a) Controlling for public sector size

As anticipated in Section 4.3.2, the public sector size is used as a moderator of the relationship between FD and economic growth. The economics of decentralization argues, although rarely, that the economic effect of FD might be influenced by the size of public sector measured by the general government consumption as a percentage of GDP. The estimated results presented in Table 4.7, both using two and three measures of FD, suggest that the economic effect of FD, irrespective of the measure used, is not subject to the size of public sector. ***govcons*** appears insignificant across all specifications and estimation methods, which surprisingly does not influence the significance and the sign of the FD measures (see Appendix 4.4).

Table 4.7 Controlling for public sector size

VARIABLES	FE with D-K SEs	FEVD	IV	FE with D-K SEs	FEVD	IV
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	growth	growth	growth	growth	growth	growth
fdexp	0.0678	0.0222	0.0213	0.0609*	0.0197	0.117*
	(0.0393)	(0.0381)	(0.0527)	(0.0320)	(0.0382)	(0.0660)
fdtax_1	-0.0214*	-0.00619	-0.0476	-0.00200	0.00627	0.214
	(0.0103)	(0.0199)	(0.0335)	(0.0281)	(0.0528)	(0.132)
imbalance2				0.0210	0.0122	0.224**
				(0.0216)	(0.0435)	(0.110)
Govcons	-0.146	0.0701	-0.309	-0.104	0.0638	-0.261
	(0.0987)	(0.110)	(0.187)	(0.0760)	(0.115)	(0.200)
Observations	328	328	247	328	328	267
R-squared		0.674	0.554		0.675	0.472
Number of groups	21	21	21	21	21	21

a) Using Worldwide Governance Indicator as a proxy for institutions

Another robustness check consists of different proxies for institutions. The Worldwide Governance Indicators (WGI) of World Bank provide different indices related to voice and accountability of governance, political stability and absence of violence, government effectiveness, regulatory quality, the rule of law and control of corruption. In the context of this thesis, we consider the penultimate index, which we name ***wdi***, as the more appropriate and close to the transition index. The use of the rank of ***wdi*** as a control variable for institution quality does not perform better; nor is statistically significant across all specification and estimation methods (see Appendix 4.4). However, with respect to our main variables of interest, the results of Table 4.7 appear similar regarding the coefficient, sign and significance level with the one presented in Table 4.5, confirming once again the robustness of the preferred estimated results.

4.5 Conclusions

Motivated by the scarcity of empirical research in general and transition economies in particular, this chapter explored the effect of FD on economic growth across a sample of 21 TEs during the period 1996-2015. Attention was given to the stages and transition and geographical location as moderators of the economic effect of FD. To the best of our knowledge, no empirical analysis has been undertaken to this date on such large dataset of TEs, encompassing both the ETEs and the Southern Caucuses TEs, and most importantly answering the question whether FD is a normal good, through the moderating role of stages of transition. The appropriate choice of FD measures and important identification problems such as endogeneity and cross-sectional dependence, appear as crucial while investigating the economic effect in TEs, which suggests that previous empirical studies have produced biased results in the presence of these problems.

The results of the baseline regression analysis suggest that FD, measured by expenditure decentralization, has a positive effect on national economic growth, though these results seem to vanish when FD is treated as endogenous. No supportive evidence, on the other hand, was found for the contribution of tax decentralization and vertical imbalance on national economic growth. A potential reason for such insignificant effect, except expenditure decentralization in some specification, might be attributed to the inability to account for countries' heterogeneity regarding the development stage.

In order to shed more light on the economic effect of FD, this chapter differentiated countries by their transition stages. Our findings suggest that FD, measured by expenditure decentralization, has a negative effect at a country's initial stage of transition, while its growth inducing benefits becomes visible at moderate stages when countries advance in their economic and institutional reforms. As to the other variables of interest, tax decentralization appears as conducive to growth only at early stages of transition, while highlighting the need of local governments to finance expenditure by their own funds and not transfers from central government, which is also confirmed when FD is measured by vertical imbalance. Overall, the results from this original investigation confirm the theoretical claim, empirically ignored up to now, that FD is a normal good. Namely, FD measured by expenditure decentralisation can be afforded and exploited only by countries at advanced stages of transition. In contrast, countries at early stage of transition appear to experience either a deteriorating or insignificant economic effect of FD, with FD benefits coming very slowly. The moderating effects of the economic and institutional reform points towards a critical mass of income (transition stage), above which FD becomes desirable and countries utilize its advantages. In terms of policy implications, although elaborated in detail in Section 6.4, these findings highlight the need to address policy recommendations regarding the three dimensions of FD (expenditure, tax or vertical imbalance) differently subject to the country stage of transition. To further utilise growth inducing benefits of FD, countries at advanced stages of transition need to focus on increasing the efficiency of their local expenditure and increasing the local autonomy, while countries at intermediate or early stages of transition need to face some fundamental problems of local government, from clarifying the roles and functions of subnational governments to utilise local and central taxation (through their own taxes and shared taxes). With respect to the geographical location, the findings do not suggest any moderating effect of location (Europe vs Southern Caucasus) on the FD-economic growth relationship irrespective of FD measure. Also, the results do not lend support for an optimal size of FD or moderating effect of public sector size.

These findings stress the importance of studying the economic effect of FD on a more homogenous dataset and most importantly analysing this issue more systematically at a lower level of investigation. Given the high cross-country variation, it may be argued that the country's effect of FD on growth might cancel out the overall effect, which makes it difficult for FD, especially measured by tax decentralization and vertical imbalance, to be noticed. This brings out the necessity to analyse the issue more systematically at the subnational level. Hence, the following chapter will focus on the investigation of the impact of FD on economic growth from a regional perspective and will use a more homogenous dataset than the one in this chapter.

Chapter 5

AN EMPIRICAL INVESTIGATION OF THE EFFECT OF FISCAL DECENTRALIZATION ON ECONOMIC GROWTH AT REGIONAL LEVEL FOR SELECTED ETEs

5.1. Introduction

The empirical investigation of Chapter 4 did not provide conclusive evidence in support of the hypothesis that high level of FD positively impacts economic growth in TEs, a result which is consistent with the lack of a genuine effect suggested by the meta-regression analysis presented in Chapter 3. As argued previously in Chapter 4, the use of aggregate FD measures and conducting research for heterogeneous datasets at aggregate (national) level are one potential explanation for the lack of the empirical evidence on the economic effect of FD. Therefore, this chapter uses a more homogeneous dataset and conducts empirical analysis on a more disaggregated level than national one. By doing so, this thesis seeks to fill the gap in the literature by providing empirical evidence on the economic effect of FD from a regional perspective in ETEs. Accordingly, it focuses on 64 sub-national regions of five selected countries: Albania, the Czech Republic, Hungary, Estonia and Poland. The selection is based on the availability of data at regional level. Furthermore, we seek to fill the gap in the literature by delving into new issues that hitherto has not received attention. Namely, this chapter aims to investigate the FD-economic growth relationship subject to country size and identify potential reasons why the effect size varies between small and large size countries. Following a similar methodology as in the previous chapter, an economic growth model will be used to estimate the relationship between FD and economic performance at the regional level using both static and dynamic panel models. Attention will be paid to the regional characteristics within a country and national characteristics across the selected countries.

The remainder of the chapter is organised as follows. Based on the theoretical and empirical considerations provided in Chapters 2 and 4, Section 5.2 will briefly review and discuss the similarities and differences between the FD-economic growth relationship at national and subnational level. Moreover, this section will discuss the characteristics of the dataset and the variables to be used in the empirical model. Section 5.3 will discuss the empirical assessment strategy, whereas Section 5.4 will carry out the diagnostics and robustness check. The main findings of the empirical investigation are discussed in Section 5.5 and 5.6. Section 5.7 will summarise the main findings of this chapter.

5.2. Model Specification, Variable Description and Data

5.2.1. Model Specification

The disaggregation level

The previous chapter, despite the variety of the estimation techniques and FD measures used, provided limited support for the hypothesis that higher share of FD positively affects economic growth. A statistical significant effect was found only when FD was measured through expenditure decentralisation, whereas higher tax autonomy of subnational governments and transfers from national to subnational governments were found to have a statistically insignificant effect on economic growth. As argued in Chapters 2 and 4, these results could be attributed to the inability to properly measure the complexity of the FD process through conventional measures. Further, differences across countries, such as economic, cultural etc., might highlight this inability especially when investigating the economic effect of FD at national level, which according to Akai and Sakata (2002) is due to the multidimensional nature of decentralisation.

As already argued in Chapter 4, investigating the FD-economic growth relationship at a national level and pooling all the countries into one dataset might have limited the ability to deeply and systematically investigate this effect, which is likely to have been cancelled out by the individual countries' economic effect of FD. Moreover, the insights provided about the aggregate economic effects of FD are difficult to be attributed to a specific country or group of regions, especially when it comes to TEs, which have experienced different paces of decentralization process during the last two decades and most likely with different impacts on individual country's economic growth. As such, to estimate its economic effect, it is necessary to analyse this issue more systematically for individual countries. Nevertheless, this approach does not fully guarantee that the effect of FD on economic growth for a specific country is deeply analysed. National level- rather than subnational level- economic effects of FD and the use of aggregate measures might mask the (potential) effects that FD has at a more disaggregated level. Focusing on individual countries, but not peering into more disaggregated levels than the national one might hide the possible variation of the economic effect of FD across different subnational units (i.e. regions) within a country. In the context of this thesis, variation of FD (decentralization of expenditure, revenue and transfers) are visible not only across countries but also across subnational units within a country[113]; some subnational units (i.e. regions where capital city is located) are more decentralized, in terms of expenditure and/or revenues than some others. This variation might induce a non-symmetric relationship between FD and economic growth across units, which in turn might cancel out the overall/aggregate economic effect of FD (especially when substantial differences across subnational units exist) or reinforce (when no substantial differences across subnational units exist) when shifting the investigation to an aggregate level. Therefore, it seems sensible to also focus on disaggregated levels of governance within a country to thoroughly investigate the FD-economic growth relationship.

An ideal approach would be to focus on individual country(ies) and disaggregate the data at the lowest level of devolution that is observed within a country. However, given that the regional data for any TE[114] starts at earliest in year 2000 (for some countries it starts even later, in 2005), it is difficult to produce sensible results with a severely number of observations.[115] Therefore, the unavailability of a longer period drives us to select multiple countries (from the sample of the previous chapter) for which data are available at the subnational level. The selected countries (further details will be provided in the following section) are Albania, the Czech Republic, Hungary, Estonia and Poland.

The countries under investigation are former socialist countries which have embarked on the process of transformation to a market economy since 1990, with four of them having almost completed the process and joined the European Union and the fifth (Albania) in the early stages of preparing for accession. Although there are still differences between the five selected counties, their recent common history of nearly fifty years of planned economy and twenty-five years of similar transition policies, means that they constitute a more homogenous group than those studied in Chapter 4.

Disaggregation of data at subnational level can be in accordance with either the administrative organisation/decentralisation of a country's territory or Eurostat

[113] FD measures (expenditure decentralization, revenue decentralization and transfers from national to subnational governments) for regions where capital city is located outperforms other regions.
[114] Data can be found only for the abovementioned ETEs, whereas for the other TEs, part of the Caucasus and Central Asia, data are not available.
[115] For instance, the time span for the Czech Republic is 2006-2013.

classification of regions (NUTS2, NUTS3 or lower territorial organisations).[116] Either way, the data availability for the dependent and control variables allows us to descend to the NUTS3 classification. Hence, we might either investigate at the lowest level at which the data are available in accordance with Eurostat classification (either NUTS3 or NUTS2 level) or use a mixture of regions at NUTS2 and NUTS3 level depending on the administrative level of decentralisation (i.e. county, municipality etc.). Disaggregating data up to the same NUTS level does not produce much relevant insight into the FD-economic growth relationship at the subnational level. This is because in the case of our sample some small countries such as Estonia constitute a single statistical region according to NUTS2 classification, which is the same as at country level. On the other hand, large countries such as Poland are divided into greater territorial units than small countries at the same statistical classification. This is because the NUTS classification is based on the population of each region and size of the country. Namely, if we choose to disaggregate data at the NUTS2 level, the database could be biased since some countries (i.e. Estonia) would still be at national level whereas others would be highly disaggregated due to the large geographical size. Likewise, if we choose to disaggregate data at a lower level, NUTS3 level, the dataset would still be very diverse and biased towards large size countries such as Poland, which would dominate the whole dataset (Poland consists of 64 regions out of 127 regions of all countries at a NUTS3 level in our dataset).

As such, countries either at NUTS2 or NUTS3 will be diversely fragmentized, where small local governments, mainly of small countries, are required to provide a broad range of local public services (Rodriguez-Pose and Kroijer, 2009) and vice versa, the large size local governments (because of the large surface) are required to provide small range of local services. We argue that what matters in the context of decentralisation (of any form, administrative, fiscal etc.) is whether, at a certain level of disaggregation/fragmentation, regions are granted a certain degree of autonomy and can manage their subnational expenditure irrespective of their size and populations.

In light of this heterogeneity of countries in our dataset with respect to their sizes (small and large size countries), and given the relevance of this thesis, we prioritise the first approach where countries are divided based on the administrative-territorial

[116] NUTS stands as an abbreviation in French of the Nomenclature of Territorial Units for Statistics. NUTS are a geographical division of EU territory into regions for statistical proposes.

fragmentation and regions are granted a certain degree of autonomy. While we prefer to conduct analysis at the lowest level at which local governments have autonomy (based on the administrative decentralisation), the data availability limits to choose *the county* as our geographical unit of analysis. By mixing NUTS levels in accordance to the county level of each country, our estimated results are likely to be more informative than in the second approach in which the results are likely to be biased towards large countries with a large number of regions. Accordingly, the estimated results are likely to be more comparable across countries. Given that counties fall under different NUTS classification (some are part of NUTS2 and other of NUTS3), throughout this chapter, we will refer to them as *regions.*

The choice of the administrative level in this research is in line with other studies that focus on the subnational level (Lin and Liu, 2000; Akai and Sakata, 2002; Cantarero and Gonzales, 2009). These studies (recall Table 2.2 for a detailed summary of the review of the main empirical studies at subnational level) have used the first subnational administrative level as their level of disaggregation. This level corresponds largely to county or a level analogue to county.[117] This is partly justified due to data limitation and partly because this is the first level at which subnational governments have a certain degree of autonomy/power to set tax rates and bases. Nevertheless, it is important to note that the use of the first subnational administrative level at which local governments have some power (of any type) does not imply that the level of decentralisation of lower administrative levels is ignored. More specifically, we measure FD at regional level by disaggregating all dimensions of FD up to the first subnational administrative level, in other words, aggregating all dimensions of FD (expenditure, revenue and grants) from subnational units level up to the first administrative level that is the county level.

[117] Either way, subnational governments enjoy a certain degree of decision-making power regarding taxes and/or expenditures at the level of disaggregation chosen for the empirical research. The majority of this research has focused on federal countries such as Switzerland, Australia, the United States etc., whereas others have focused on Italy, Spain, Germany and China.

Model Specification

The basic analytical framework used to investigate the FD-economic growth relationship is an endogenous growth model, same as in Chapter 4, which predicts that for a given government size, FD affects economic growth. This framework consists of regressing economic growth on a list of country characteristics including measures of FD and a set of control variables.

The empirical literature review provided in Chapter 2 concluded that there are no major differences in terms of theoretical approach followed, FD measures used and estimation techniques between studies focusing on national level and those at subnational level. Nevertheless, the latter group of studies have been more helpful in shedding light on the 'black box' of the economic effect of FD. Accordingly, it was argued that the effect of FD on economic growth (irrespective of the FD measure used) is more observable at subnational level. While in most of the cases this effect is positive and linear, few studies do report a nonlinear (mostly inverse U-shaped) relationship. This relationship has been mainly investigated in individual countries with large geographical area and/or population (i.e. Russia, Germany, Spain, etc.) or for countries with heterogeneous characteristics in their populations (i.e. Russia) (Behnisch *et al.,* 2003; Desai *et al.,* 2003; Feld *et al.,* 2004; Solé-Ollé and Esteller-Moré, 2005; Enkilopov and Zhuravskaya, 2007).Whilst there is considerable empirical research on the effect of FD on economic growth that focuses on subnational level for developed and developing countries, there are only a limited number of empirical investigations focusing on TEs in general and ETEs in particular.

Given that our focus of investigation is on ETEs, it is important to rely on Chapter 4 (by taking into account transition specifics of the countries in our dataset) and move towards an extended version of FD-growth relationship adjusted for transition economies and regional level. Accordingly, the specification adopted in this chapter is similar to that introduced in Chapter 2 and developed in Chapter 4, except that the dependent variable and some of the independent variables are now measured at a higher level of disaggregation: at the regional level.[118] The model used is as follows:

[118] We denote regional level as the county level.

$$growth_{it} = \beta_0 + \beta_1 FD_{it} + \gamma_i X_{it} + \eta_i Z_{jt} + \varepsilon_{it} \quad (5.1)$$

Where, *i* denotes the region, *j* denotes the country, *t* denotes time, *growth* is the dependent variable, β_0 is the overall intercept, FD_{it} is a vector of fiscal decentralization measures and X_{it} is a vector of control variables at regional level (determinants of economic growth), Z_{jt} is a vector of control variables at national level and ε_{it} is the idiosyncratic error (time-varying error). In the context of growth models, the overall intercept reflects the productivity changes that are similar across all countries (Bond *et al.,* 2001, p.15). In addition to the time-varying error, Equation (5.1) can be augmented with a time-constant factor, also known as the regional heterogeneity, to better reflect the differences in the initial level of efficiency between cross-sectional units (Bond *et al.,* 2001), in our case the differences between regions. The augmented equation is as follows:

$$growth_{it} = \beta_0 + \beta_1 FD_{it} + \gamma_i X_{it} + \eta_i Z_{jt} + (\varepsilon_{it} + u_i) \quad (5.2)$$

5.2.2 Specification of Variables

Dependent variable

In line with the theoretical literature review and most empirical studies reviewed in Chapters 2 and 4, economic performance is measured by taking the first difference of the real GDP per capita for each region in 2001 constant prices in logarithmic form. Regional GDP per capita which is provided by Eurostat Regional Statistics[119], is the level of income divided by the regional population. In order to take into account the possible variation of economic growth due to changes in prices, we used regional GDP per capita in constant prices. This variable was easily accessible at the regional level for Hungary and Poland, but not for Albania, the Czech Republic and Estonia. For the latter group of countries, we extracted the nominal regional GDP per capita[120] instead

[119] Whilst Eurostat represents our prime source of the data (Regional Statistic, Url: http://ec.europa.eu/eurostat/web/regions/data/database), data at regional level can also be found at OECD, which does provide regional statistics, but it is very limited in terms country coverage (especially for our sample under investigation); data can hardly be found for all TEs.
[120] For Albania and the Czech Republic data are converted in million Euros using the respective Central Banks' annual exchange rate.

and then converted it into real terms using the country's GDP deflator.[121] Whilst disaggregated data could be easily retrieved from the Eurostat for the Czech Republic, Hungary and Poland, the Eurostat Regional Statistics does not provide information for Albania and Estonia at NUTS3 level. Hence, individual country's statistical offices (Institute of Statistics of Albania and Statistic Estonia) were used to draw data for the dependent variable. Before using other sources of information than Eurostat, importance is paid to the concepts and definitions used for regional statistics, which must be identical to the one used by the statistical offices of each country.

Fiscal Decentralization variables

As already anticipated in the previous chapters, FD involves three main dimensions: the expenditure side (the extent to which local governments choose the level of public services and determine the allocation of their expenditure within their jurisdictions/regions), the revenue side (the extent to which local governments raise their own revenue within their jurisdictions/regions and determine their level of tax base and/or tax rate) and the intergovernmental transfers (the extent to which local governments receive grants from national government). Different variations of these dimensions are the measures introduced in the previous chapter, which cannot be used in this chapter because of the difference in the context of investigation. Since this chapter investigates the FD-economic growth relationship at a subnational level, we make use of only three measures of FD that can be measured at this level (out of five introduced in the previous chapter): expenditure decentralisation/coverage, tax decentralisation and vertical imbalance.[122]

Individual country's statistical office (for the Czech Republic, Estonia, Hungary and Poland) and Ministry of Finance (for Albania)[123] are used to construct the three abovementioned measures of FD. Expenditure decentralisation/coverage (***fdexp***) is measured by the percentage share of own tax revenues collected locally/regionally in

[121] Due to lack of data at regional level, we used country's national GDP deflator instead of regional GDP deflator.
[122] The two measures ruled out in this chapter are two alternative measures of vertical imbalance (recall Chapter 5, p.11), which by construction are to be correlated with the one used here and most importantly, in the context of this chapter, are similar to expenditure decentralization and tax decentralization measured at subnational level.
[123] Contact person: Fran Brahimi (Fran.Brahimi@financa.gov.al), Department of Budget, Albanian Ministry of Finance.

subnational government expenditure. Further elaborating, ***fdexp*** is considered as a measure of the degree of expenditure discretion of subnational governments and local government capacity (Bird and Rodriguez, 1999; Uchimura and Suzuki, 2009) to finance its own expenditure. The subsequent measure is tax decentralisation (***fdtax***), which is measured by the percentage share of subnational government own tax revenues of each region in the regional subnational governments' revenue. It has been previously argued (recall Section 4.2.2 and Stegarescu, 2004 for a detailed review), that ***fdtax*** is a better measure of the revenue dimension of decentralisation in comparison to other conventional revenue measures because it takes into account the tax-raising power and autonomy of subnational governments in comparison to their total revenue.[124] Regarding the third dimension of fiscal decentralisation, vertical imbalance (***fdgrant***) measures the share of grants (transfers) from national to subnational governments in percentage of subnational governments' expenditure. The mismatch between expenditure responsibilities and revenue resources at lower levels of governance is financed by the transfers from national governments. Thus, ***fdgrant*** aims at measuring the extent to which subnational governments rely on the amount of grants received from the national government (Jin and Zou, 2002; Rodden, 2006), given that these funds are used to finance the local expenditure. Often, this measure is considered as important for the fiscal health of local governments regarding the efficiency and equity of the provision of local goods and services (World Bank, 2001).

Control variables

There are two groups of control variables used in our growth model: (i) control variables at regional level and (ii) control variables at national level. We introduced the second set of independent control variables in a regional growth regression for two main reasons. First, the data availability hampers us to use some variables (which will be elaborated below) at a regional level. Although at first sight this might be considered as a limitation in terms of our research, using such variables at national level instead of subnational level can account for country specific characteristics. Given that our dataset comprises five countries with different socio-economic

[124] The subnational government revenue consists of own sources, transfers from central government and shared taxes.

development, it seems reasonable to control for such country specific factors in addition to regional characteristics.

An important variable used in the growth model is population growth (***popgrowth***), which is measured as the annual growth rate of population size on January 1st of the given year and the corresponding level of the previous year.[125] Eurostat Regional Statistics provide population data at the beginning of the year from which we extracted data for the Czech Republic, Hungary and Poland, whereas data for Albania and Estonia were provided by their respective country's statistical offices.[126]

Following the discussion of Section 4.2.2, ideally, human capital would be measured using stock measures such as the percentage of working age who have completed secondary or/and tertiary education. Unfortunately, these data can be found and/or calculated only for the Polish regions, whereas for the other countries, data are not available at disaggregated levels. Considering this limitation, we make use of the flow measures of human capital such as enrollments in secondary and tertiary education. While for the countries disaggregated at NUTS2 level data can be found at the Eurostat Regional Statistics database, for countries disaggregated at NUTS3 level data have to be calculated using information from their statistical offices. Nevertheless, high importance has been given to the data collection and calculation of the two following measures of education in order to be consistent with the Eurostat Regional Statistics methodology and avoid potential discrepancies between the reporting practices of individual countries. The first measure of education, the secondary enrolment rate (***educ2***), is measured by the total number of students in upper secondary and post-secondary, non-tertiary education in each region expressed as a percentage of the total regional population in the age group of 15-25. The subsequent variable proxying human capital, the tertiary enrolment rate (***educ3***) is measured by the total number of students in tertiary education in each region expressed as a percentage of the total regional population in the age group of 20-24. Nevertheless, a note of caution seems to be in order when measuring ***educ3***. Whilst the Czech Republic, Hungary and Poland do report the number of students enrolled in tertiary education (which can then be

[125] This variable is measured slightly different compared to the one used in the previous chapter. In the last empirical chapter, population growth was measured using the midyear rather than the beginning year population size.
[126] Albanian Institute of Statistics and Statistics of Estonia.

easily divided by the population aged 20-24), Albania and Estonia do not. Given this substantial lack of data, the regional reports were used for both countries in order to retrieve data regarding the number of students enrolled in each regional university. However, as expected, universities are not spread equally across the country. Whilst some regions have more than one university, others have none. Hence, one might be misled into thinking that the latter implies that there are no educated students from those regions. Students of these regions (where no university is located) might be educated in the neighbour regions or most likely in a region where the capital city is located. Accordingly, this lack of data constrains us to use an alternative measure of ***educ3*** for these two countries: the tertiary enrolment rate at the national level (***educ3_n***), which provides a better approximation of human capital than the data extracted from the regional database or reports from the abovementioned countries.

Another important variable considered in the growth model is the gross fixed capital formation. Despite its importance not only for economic growth studies but also for other areas, serious data limitation exists at the regional level for some countries. This is because of the lack of data at a lower level than NUTS2 and the data limitation for countries that are not part of the EU. These problems are relatively challenging for countries such as Albania and Estonia, for which gross fixed capital formation is not available at all at any regional classification level. In the case of Estonia, data can be disaggregated at NUTS2 level, but that would be the same as national level because this country constitutes a single statistical region according to NUTS2 classification. As to Albania, gross fixed capital formation is available in neither NUTS2 nor NUT3 level. Given that this variable is a key determinant of economic growth and the national data of gross fixed capital formation cannot be allocated to regions, the empirical research concerned with the FD-economic growth relationship at subnational level suggests the use of a weighting factor to disaggregate this variable from national to regional level. Lin and Liu (2002) and Gil-Serrata and Lopez-Laborda (2006) used regional population and/or number of firms as weights for investments. In the context of transition economies, the number of regional population might be less accurate than the number of firms due to high internal migration within these countries, especially in Albania. Therefore, we use *the number of firms* in each region as a weighting factor to disaggregate gross fixed capital formation for Albania and Estonia. Whilst data are easily accessible for Hungary and Poland in the Eurostat database, data for the Czech Republic had to be extracted from the Czech Statistical Office. Accordingly, the gross fixed capital formation is now disaggregated at the regional level for the all the five countries in the dataset.

The empirical literature (Basannini and Scarpeta, 2001) on economic growth suggest the use of either the gross fixed capital formation as a percentage of GDP (***gfcf_gdp***) or the logarithm of gross fixed capital formation (***lngfcf_gdp***). The former is considered as more appropriate when the investigation is conducted in multiple countries because it takes into account the size of the economy (GDP). This variable is further transformed into logarithmic form given its skewed distribution and suggestions by the ladder command in Stata (see Appendix 5.3.1).

Among the variables strongly suggested by the economic theory and included in empirical research (Mankiw *et al.,* 1992; Verspagen, 1991; Barro and Sala-i-Martin, 2004) are the initial conditions. In order to capture the different inherited initial conditions across regions, the initial level of GDP per capita in logarithmic form (***reallngdpini***) is included in the model. As already explained in Section 4.3.2, a negative correlation between this variable and the growth rate of GDP per capita should exist if catch-up effect occurs. In the context of this chapter, this effect states that poor regions will grow faster the further they are from their steady-state compared to richer regions (Mankiw *et al.,* 1992). Nevertheless, due to different estimation techniques used in this chapter, there is a risk that this variable, being time-invariant, might drop out. Hence, in some of the specifications used in this chapter, we use the first lag of GDP per capita (***lag1realgdp***) instead of ***reallngdpini*** to control for the convergence effect (following the same arguments provided in Chapter 4, which were based on Barro and Sala-i-Martin (2004)). Namely, the choice of the estimation technique employed in this chapter depends on which of these variables are used to control for the initial conditions.

Expenditure decentralisation and tax decentralisation measures are systematically higher in capital city regions than others across all countries under investigation. As to the other measure of FD, vertical imbalance, the region where the capital city is located stands beyond the averages of all other regions. Therefore, it seems sensible to control for any differences in the economic effect of FD between capital and non-capital regions. A dummy variable (***capital***) and an interaction term of this variable with expenditure decentralization (***expcapital***), tax decentralization (***taxcapital***) and transfers from local government (***grantcapital***) are additionally included in the dataset in order to investigate whether the FD-economic growth relationship is different for capital-regions.

Whilst size of the country has been largely recognized as one of the main determinants of FD (Panizza, 1999), the theoretical and empirical literature investigating the economic effect of FD has never detangled this relationship through this determinant. The rationale is that large countries are predisposed to have a higher level of FD and vice versa and thus, its economic impact might be better manifested than in a small size country. Hence, it might be likely that the size of the country can determine or/and alter the economic effect of FD. Accordingly, this chapter aims to fill the gap in the literature by investigating differing economic effects of FD given different country sizes. In a dataset with a mixed sample of countries, this might be explained by dividing countries according to their geographical size: small and large. To distinguish between these two groups, we can either include a dummy variable for country size or split the dataset into two subsamples. In the former approach, a dummy variable ***size***, is included in the model, which takes the value of 1 if a country is large (the Czech Republic, Hungary and Poland) and 0 otherwise (Albania and Estonia). While creating this dummy variable, surface area (measured in square kilometres) and population of countries were used to determine the size of a country.[127] In order to somehow identify the threshold at which size influences the FD-economic growth relationship, we question our pre-set threshold. Hence, the Czech Republic, which is ranked third out of the five given countries (being in between small and large size countries in the context of our dataset), is considered a small country in an alternative variable ***size1***, which takes the value 1 if a country is large (Hungary and Poland) and 0 otherwise (Albania, the Czech Republic and Estonia). Alternative to the above measures, the surface area of a country (***surf***) is included into the model in order to determine more precisely the square kilometres (if any threshold) at which the FD-economic growth relationship becomes visible.

[127] If the surface of a country is over 50000 (sq. km), a country is considered (relatively) large, otherwise a country is considered (relatively) small. In case of population size, we used the threshold of 5 million inhabitants. In both cases, Albania and Estonia were considered as small size countries, whereas the Czech Republic, Hungary and Poland were considered large size countries.

Countries with large geographical area are likely to be more decentralised than countries with small geographical area. Thus, large countries may better exploit local public provisions at regional level due to economies of scale (Arzaghi and Henderson, 2005) and be more efficient in expenditure assignments and revenue collection given that central government is less likely to serve distant regions due to high transportation costs, poor information and attention to other (key) regions. Further, the economic effect of FD might vary not only due to country's size but also to the way FD is defined (expenditure decentralization, tax decentralization or vertical imbalance). A recent approach would be to interact ***size (size1 or surf)*** with all the FD measures and calculate the marginal effects to properly identify the statistical significance and economic rationale (StataCorp, 2013).

Considering the possibility of a curvilinear relationship (either positively accelerated or negatively accelerated) between FD and economic growth, three additional variables are created by using the quadratic term of expenditure decentralization, tax decentralization and vertical imbalance, respectively ***fdexp2 fdtax2*** and ***fdgrant2.*** Whilst the main research regarding a nonlinear relationship has been conducted mostly at national level (Eller, 2004; Thiessen, 2005), attention should be given also to the local level, whether this relationship takes the inverted U-shaped curve.[128]

In line with the theoretical and empirical evidence on the main determinants of economic growth, integration of countries into the world economy is often considered an important determinant. However, it is impossible to disaggregate data at a regional level for any country. This limits us to use the sum of exports and imports as a share of GDP at national level (***trade***).[129] Despite the inability to disaggregate this variable at a lower level, having trade at national level helps to capture the differences between countries, which up to now were not considered in our analysis and regional growth literature.

---

[128] The inverted U-shaped curve is also known as the BARS curve, referring to Barro, Armey, Rahn and Fox, and Scully (Di Liddo *et al.,* 2015).

[129] The most common measure used in the growth regressions (especially in the analysis of the relationship between trade and economic growth) is the sum of exports and imports (both goods and services) as a share of GDP, which is the preferred measure for our analysis as well. Additionally, we used exports as a share of the sum of exports and imports as an alternative measure for openness. In line with the majority of the empirical studies on trade-economic growth effect, we report the results using the first measure of trade.

Also, featured among the potential explanatory variables in the FD-growth regression is a dummy variable ***eu***, which takes the value of one when countries are members of the European Union, zero otherwise. By including this variable, we aim to control for possible political integration effect on economic growth rates in the selected ETEs. In order to investigate potential variations of the FD-economic growth effect due to the membership in the European Union, we can either split the dataset into subset subject to the country's membership status or include in the model interactions of ***eu*** with the FD measures (***expeu, taxeu*** and ***granteu***).

Another concern in the previous chapter (Chapter 4) was how to better take into account the transition specifics of the countries in our dataset. This was made possible through a transition index. Nonetheless, in the context of this chapter, inclusion of a transition index in the analysis seems to be less of a concern for two main reasons. First, the dataset of Chapter 4 comprises almost all TEs in which there was a need to differentiate between stages of transition, whereas in the case of this chapter the dataset is more homogenous comprising a small number of ETEs. Further and most importantly, institutions and/or political differences between countries are likely to be more visible at national rather than at subnational level. In the context of this chapter, where the focus of investigation is at the subnational level, there seems to be less need to control for such differences between regions. A similar argument was also given by Hammond and Tosun (2009) in a subnational investigation of the effect of FD on economic growth in the USA.

In order to account for homogenous shocks affecting fiscal decentralization (due to the financial crisis, austerity etc.) in our sample and simultaneously for potential cross-sectional dependence, a full set of ***time dummies*** is included, with the first year omitted as the reference category. Table 5.1 presents the list of variables together with their description, expected effects on economic performance and the data source.

Table 5.1 Variables, expected sign and data sources

Variable Name	Description	Expected Sign	Data Source
fdexp	Subnational government share of own tax revenues (% of subnational government expenditure) [percentage of own tax revenues collected by subnational government, measured as the sum of local and state tax revenues, divided by the sum of local and state expenditure]	+	Individual country's statistical office and IMF
fdtax	Subnational government share of own tax revenues (% of subnational government revenue) [percentage of tax revenues collected by subnational government, measured as the sum of local and state tax revenues, divided by the sum of local and state revenue]	+	Individual country's statistical office and IMF
fdgrant	A measure of vertical imbalance, measured as a share of grants (transfers) to subnational government expenditure [grants (transfers) received from other levels of government received by local and state governments minus grants from state to local level, divided by total subnational expenditure]	-	Individual country's statistical office and IMF
fdexp2†	The square term of ***ownlexp*** ***ownlexp^2***	-	Individual country's statistical office and IMF
fdtax2†	The square term of ***ownlrev*** ***ownlrev^2***	-	Individual country's statistical office and IMF
fdgrant2†	The square term of ***grantlexp*** ***grantlexp^2***	-	Individual country's statistical office and IMF
growth	First-difference of natural logarithm of GDP per capita in Euro constant prices for each region.		Eurostat, Institute of Statistics of Albania and Statistics office of Estonia
gdpcapita	Natural logarithm of GDP per capita in in Euro constant prices for each region.		Eurostat, Institute of Statistics of Albania and Statistics office of Estonia
reallngdpini	Initial level of the natural logarithm of GDP per capita in Euro constant prices for each region.	-	Eurostat, Institute of Statistics of Albania and Statistics office of Estonia
lag1realgdp	GDP per capita in Euro constant prices for each region, first lag.	-	Eurostat, Institute of Statistics of Albania and Statistics office of Estonia

popgrowth	Population growth (annual %) measured by the annual growth rate of population.	-	Eurostat and Individual country's statistical office
lngfcf_gdp	Natural logarithm of the regional gross fixed capital formation in Euro as a share of regional GDP. [the number of firms in each region is used as weights in the case where gross fixed capital formation is not disaggregated at a regional level]	+	Eurostat and Individual country's statistical office
educ2	Pupils and Students in upper secondary and post-secondary non-tertiary education (ISCED 3-4) - as % of the population aged 15-24 years at regional level.	+	Eurostat and Individual country's statistical office
educ3	Students in tertiary education (ISCED 5-6) - as % of the population aged 20-24 years at regional level.	+	Eurostat and Individual country's statistical office
trade	Trade as a share of GDP. [the sum of exports and imports at national level divided by the value of GDP at national level]		WB
eu†	Dummy variable: 1 if a country is a member, 0 otherwise.	+	European Union
size	Dummy variable: 1 if a country is a large country (the Czech Republic, Hungary and Poland), 0 otherwise (Albania and Estonia). [Surface area (sq. km) of countries and population were used to determine the size of a country]	+	WB and Eurostat
size1†	Dummy variable: 1 if a country is a large country (Hungary and Poland), 0 otherwise (Albania, the Czech Republic and Estonia).	+	WB and Eurostat
surf†	Surface is measured in square kilometers which takes the value of 28,748 for Albania; 78,866 for the Czech Republic; 45,339 for Estonia; 93,030 for Hungary and 312,679 for Poland.	+	
capital†	Dummy variable: 1 if the capital city is located in that region, 0 otherwise.	+	
govcons†	General government final consumption expenditure as a % of GDP (includes all government current expenditure for purchases of goods and services, compensation of employees, national defense and security expenses etc.	+/-	WB
year1-13	Time dummies, in the case of the unbalanced dataset year1 = year 2000, year2 = year 2001,…, year13 = year 2013		

† Not in the baseline specification

5.2.3 Data

Our main dataset includes ***64 regions*** listed in Table 5.2. Data availability limits our sample to unbalanced panels. For the majority of regions/countries data starts in 2001 and ends in 2014, while data series of Albania and Hungary end in 2013 (see Table 5.2 for more details).

Table 5.2 Countries, their respective regions/counties included in the dataset and time span

Country	Country ID	NUTS level	Number of Regions	Regions (counties)	Time Span
Albania	1	3	12	Dibër, Berat, Durrës, Elbasan, Fier, Gjirokastër, Korçë, Lezhë, Kukës, Shkodër, Tirana and Vlorë.	2002- 2013
The Czech Republic	2	3	14	HlavníměstoPraha, Středočeskýkraj, Jihočeskýkraj, Plzeňskýkraj, Karlovarskýkraj, Ústeckýkraj, Libereckýkraj, Královéhradeckýkraj, Pardubickýkraj, Vysočina, Jihomoravskýkraj, Olomouckýkraj, Zlínskýkraj, Moravskoslezskýkraj.	2005-2014
Hungary	3	2	7	Közép-Magyarország, Közép-Dunántúl, Nyugat-Dunántúl, Dél-Dunántúl, Észak-Magyarország, Észak-Alföld, Dél-Alföld.	2001-2013
Estonia	4	3	15	Põhja-Eesti, Lääne-Eesti, Kesk-Eesti, Kirde-Eesti, Lõuna-Eesti.	2003-2014
Poland	5	2	16	Łódzkie, Mazowieckie, Małopolskie, Śląskie, Lubelskie, Podkarpackie, Świętokrzyskie, Podlaskie, Wielkopolskie, Zachodniopomorskie, Lubuskie, Dolnośląskie, Opolskie, Kujawsko-pomorskie, Warmińsko-mazurskie, Pomorskie.	2001-2014

Source: Eurostat (2006)

Before turning to the empirical analysis, a short preview of the FD measures and control variables is provided in Table 5.3. In general, there is considerable variation in most of the variables. Also, detailed summary statistics (see Appendix 5.2.2) show that there is substantial heterogeneity in sample size across different regions and countries. There is substantial variation in FD and some of the main control variables, except those that are considered time-invariant.

Table 5.3 Descriptive statistics (mean, standard deviation, minimum and maximum value)

Variable	Observations	Mean	Standard Deviations	Min	Max
growth	766	5.95	8.64	-39.10	29.80
lag1realgdp	766	6730.93	4060.26	679.36	29976.58
reallngdpini	766	4886.57	3505.01	687.82	24029.87
fdexp	720	39.60	18.53	4.92	90.41
fdgrant	720	36.20	19.21	3.97	95.07
fdtax	720	39.08	18.58	4.922	87.73
popgrowth	766	-0.51	2.38	-26.84	15.42
lngfcf_gdp	750	3.30	0.37	0.93	4.32
educ2	713	63.07	25.81	28.8	162.07
educ3_n	713	54.58	25.62	4.90	222.70
trade	766	111.58	34.53	58.08	170.42
size	766	0.39	0.48	0	1
capital	766	0.07	.27	0	1
eu	766	0.70	0.45	0	1

Note: Detailed summary statistics about these variables are provided in Appendix 5.2.2.

A closer look at the descriptive statistics provided above indicates that some independent variables (including some of the FD measures) do not have high within-group variation. Following Plümper and Troeger (2007, p.19-20), all control variables, having a between-to-within SE ratio above 2.8, are considered as either slowly moving variables or time-invariant (see Table 5.4). This ratio is above 2.8 for tertiary education enrolment rate, gross fixed capital formation, and the first lag of GDP. Conversely, ***reallngdpini***, which has a zero within SEs, is considered a time-invariant variable.

Table 5.4. Identifying the time-invariant and the slowly moving variables

Variable	Between SE	Within SE	Between/Within ratio
fdexp	17.06	9.42	1.81
fdtax	16.93	9.68	1.74
fdgrant	17.81	7.06	2.50
popgrowth	0.96	2.17	0.44
educ2	23.61	9.30	2.55
educ3_n	25.50	8.77	2.91
lngfcf_gdp	10.17	5.24	2.00
lag1realgdp	4489.05	1364.05	3.29
reallngdpini	0.73	0	Time-Invariant
trade	31.42	13.71	2.29
size	0.48	0	Time-Invariant
expsize†	25.74	8.42	3.05
taxsize†	25.68	8.41	3.05
grantsize†	16.23	5.61	2.89
eu†	3.45	0.85	1.20
capital†	0.27	0	Time-Invariant
govcons†	3.46	0.88	3.93

†Not included in the baseline specification

5.3 Empirical Strategy

In evaluating the relationship between FD and economic growth through an unbalanced dataset with 64 regions, we restrict our estimation to panel data techniques. This chapter will follow the same empirical strategy as the previous chapter (recall Section 4.3) given that both chapters use panel data. However, a detailed discussion regarding new potential estimation techniques that can best fit the nature of the new dataset used in this chapter will be additionally introduced here.

The starting point when modelling panel data is whether to employ a Fixed Effects (FE) or a Random Effects (RE) estimator. How to best choose between FE and RE depends on the judgment over the appropriateness of each model, as well as on the Hausman test result on the random effects assumption (Gujarati, 2004, p.651; Greene, 2012, p.421). As argued in the previous chapter, RE seems to be more appropriate than

FE in the context of our dataset where some of the variables are slowly-moving or time-invariant variables.

Several identification problems such as multicollinearity, heterogeneity, spatial dependence, the presence of variables with very little or no longitudinal variance, and endogeneity, which are reviewed in Chapter 4, are likely to occur also when testing the FD-economic growth relationship from a regional perspective.

It is important to note that there is no superlative method which can, simultaneously, tackle all the anticipated identification problems. In Chapter 4, the FD-economic growth relationship was estimated using FE with Driscoll-Kraay SEs, FEVD, and IV approaches, which will be also employed in this chapter given the same structure of the data and potentially similar identification problems. Whilst these methods are thoroughly analysed in the previous chapter, the focus here will be on the appropriateness of these methods in the context of regional dataset and on additional estimation technique(s), if any, that can better approach the identification problems based on the new structure of the dataset. The use of FE with Driscoll-Kraay SEs was justified by the presence of cross-sectional correlation, autocorrelation, and heteroscedasticity (Hoechle, 2007), which all are very likely to occur also at a regional level. On the other hand, FEVD was proposed to overcome the loss in efficiency that occurs when using fixed effect models while estimating time-invariant and slowly-changing variables (Plümper and Troeger, 2007); variables that are also present in the regional dataset. Nevertheless, both methods fail to explicitly take into account the endogeneity problem. Neglecting such problems might jeopardise the above techniques itself and thus, their estimated results. Breusch *et al.* (2011) argue that the FEVD estimator becomes inconsistent when the time-invariant and slowly-changing variables are endogenous. Therefore, as in Chapter 4, IV approach is selected as a preferred estimation method in order to overcome any potential problem of endogeneity occurring.

However, given the new structure of the dataset in this chapter, there is a need to recall any additional estimation technique suitable for the sample under investigation. The disaggregation of the data at regional level increased significantly the number of cross-sectional units from 5 (if the investigation would be conducted at the national level) to 64. This increase in the cross-section (*N*) dimension points to the GMM estimators.

Following Roodman's (2006, p.35) suggestion on the appropriate number of cross-section and time series, we meet the requirements of *N* larger than 20 and time series larger than 3. Despite the suitable nature/structure of the dataset in this chapter, it is necessary to assess (i) the rationale for a dynamic model and (ii) the merits of the (System) GMM in better taking into account the anticipated identification problems.

In the context of the FD-economic growth relationship, irrespective of the specification used[130], it is important to acknowledge the policy inertia of FD and the dynamic aspect of the relationship (if any) with economic growth. It seems that not only FD but also other independent variables used in the model are likely to manifest their effect on economic growth with time lags. It is often argued in the economic growth literature (Hoenack, 1993; Baldaci *et al.,* 2004; Delgado *et al.,* 2012) that an increase in the current level of human capital (***educ2*** and ***educ3***) and investment (***lngfcf_gdp***) do not necessarily affect the current level of economic growth; contrary, it may take some time for the effect to be perceptible to economic growth.[131] Similarly, FD is likely to manifest itself gradually in increased economic growth rates given its slow change over time (Sow and Razafimahefa, 2015). Eventually, any fixed effect estimation method employed on this data might hide any potential long run variation and thus, ignore its dynamic nature. One would argue in favour of using lagged explanatory variables (employing FE with Driscoll-Kraay SEs, FEVD and IV) to account for dynamics of these variables, which would, at the same time, address the endogeneity problem. Regrettably, this seems to be inappropriate in our case for two reasons:

First, existence of a lagged GDP per capita as an independent variable does seem to jeopardise the use of any other lagged explanatory variable. Otherwise, a lagged GDP per capita and lagged explanatory variables on the same side of the regression would create a growth model within a growth model, generating a conceptual problem in terms of a growth model estimation. Second, the sole use of lagged values to tackle endogeneity does seem to be hazardous in terms of statistical inference. Bellemare *et al.* (2015) argue that this strategy often produces bias in the absence of identification strategies for the number of lags on endogenous variables.

[130] Economic performance might be measured either in growth rates or in levels.
[131] See Middendorf (2005) for a detailed discussion on the lagged effect of education on economic growth and Barro *et al.* (2004) on the lagged effect of investment on economic growth.

While the first problem seems to be avoided when employing FEVD, in which the lagged GDP per capita is substituted with the initial level of GDP, the problem of endogeneity and policy inertia persists. Regarding the main variable of interest, as previously argued in Chapters 2 and 4, it seems that the FD-economic growth relationship might suffer from reverse causality. Despite the small number of empirical studies claiming this, it is argued that efficiency gains from FD emerge as the economic development of country increases, and thus more decentralisation is required. Although this thesis uses economic growth and not GDP per capita as its dependent variable, endogeneity still might prevail.

As Bodman and Ford (2006, p.41) argue, the FD-growth literature needs to explicitly take into account the endogeneity of the regressors, amongst which the endogenous nature of all variables of FD needs to be thoroughly discussed. A significant body of empirical literature suggests that the level of income is a determinant of FD (Panniza, 1999). Development stimulates demand for variety and quality in the range of public services being provided while increasing the revenue raising capacity of governments, making decentralisation affordable and needed. If FD has a high-income elasticity, then higher income per capita may allow the constitution of a new level of decentralisation. If FD affects economic growth, then the new level of decentralisation will, in turn, have an impact on the level of income. This suggests a potential bidirectional relationship between FD and economic growth. However, it is argued that when FD is measured by grants from central government, there can be a reverse causality between this variable and economic growth as poorer regions are more prone to receive larger amount of grants (Feld *et al.,* 2004) in order for them to catch up with other regions.

Whilst endogeneity may be tackled through an IV approach in a static model, it does give rise to biased and inconsistent estimates in the presence of time-invariant and slowly-moving variables, and cross-sectional dependence. Independent variables with little within variation have little explanatory power and thus produce imprecise estimations with large SEs (Plümper and Troeger, 2007; Breusch *et al.,* 2011). Accordingly, FEVD is used to properly estimate coefficients for such variables. Nevertheless, it is important to recall the debate in the literature about the appropriateness of this method (Breusch *et al.,* 2011; Greene, 2011) and whether indeed FEVD is a solution to time-invariant and slowly moving variables in FE models. Despite the critics, FEVD seems to be very popular in the empirical research regarding the estimates of little within variation variables, but among the existing empirical research on the FD-economic growth relationship.

The last concern in the empirical strategy is the persistence of the data series. As suggested in the economic growth literature, growth regressions are usually examples of time series with a persistent dependent variable, where past observations might influence the current value of a variable of interest. Whilst GDP per capita is expected to be persistent (Bond *et al.,* 2001, p.3), economic growth might not necessarily be. However, a note of caution seems to be in order when referring to the economic growth in the context of this thesis. Economic growth is measured as the difference in logarithm of GDP per capita, which per se is persistent. Accordingly, the potential for accounting for the likely persistence of the dependent variable, or variables generated by the difference of a persistent time series, lead us to consider additional estimation technique and control for any possible dynamics.

In an attempt to address the majority of all the abovementioned problems simultaneously (except cross-sectional dependence), a System GMM estimator seems to be in place. In addition to the System GMM, the literature on the GMM estimator also acknowledges the first-differenced GMM estimator as a possible estimation technique when employing a dynamic panel model. This method first-differences the data in order to remove the fixed effects (Roodman, 2009a, p.3). Despite the influential work of Caselli, Esquivel and Lefort (1996) on estimating empirical growth models with first-differenced GMM estimator, this has to be ruled out because of the concern of the finite sample bias occurring due to the weak instruments, a problem which seems to be worsen particularly in (i) small sample, (ii) presence of persistent explanatory variables (Blundell and Bond, 1998; Bond *et al.,* 2001) and (iii) cross-country growth regressions (Bond *et al.,* 2001; Dornetshumer, 2007). Contrary, the proposed System GMM is known to be superior compared to first-differenced GMM in terms of precision and reduced finite sample bias. This is mainly attributed to the ability of the System GMM to use more instruments not only from the model in first-differences but also from the model in levels. The two equations (in differences and levels) are simultaneously estimated and instrumented for the lagged dependent variables and all other independent variables. This appears to be a crucial advantage of the System GMM, particularly for the time-invariant variables, which would have been wiped out if one would have used the first-differenced GMM (Roodman, 2009b).

In order to increase the moment conditions, an alternative approach suggested in the growth literature by Bond *et al.* (2001) is to use external instruments such as lags of school enrollment as instruments. However, this variable is already included in our model and thus, used as instruments. Regarding other external instruments that can be used, it seems that they are difficult to be found/constructed at regional level for the countries under analysis.

Next, System GMM appears to perform better than first-differenced GMM in the case of unbalanced panels. Roodman (2009a) suggests that the former maximises the sample size, whereas the latter magnifies the gaps in the data. Another advantage of the System GMM compared to the other abovementioned estimation techniques (FE with Driscoll-Kraay SEs, FEVD and IV) is that this method does not rely on strict assumption regarding the normality of error terms (Verbeek, 2004, p.152) and accommodates very easily the interactions between variables (through the marginal effects option in Stata). Also, System GMM allows for heteroscedasticity and serial correlation of unknown form (Roodman, 2009a, p.99).

Despite the superiority of the System GMM, a critical shortcoming of this method, which needs to be pointed out, is the problem of instrument proliferation. Roodman (2009b, p.8) argue that particularly in small-sample size, the number of instruments can rapidly grow large relative to the number of observations, which in turn overfit the endogenous variables and provide imprecise estimates of the weighting matrix of the moments. While there is no precise guidance on the preferred number of instruments, except that the number of instruments should not exceed the number of cross-sectional units, we follow the advice of Roodman (2009b, p.17) for "using only certain lags instead of available lags for instruments… and combine instruments through addition into smaller sets". Finally, the application into Stata offers the possibility to use the two-step System GMM with the *Windemeijer* correction in case of heteroscedasticity and autocorrelation problem through the *xtabond2* syntax and *collapse* option to avoid instrument proliferation (Windemeijer, 2005; Roodman, 2009b).

In terms of model specification, this thesis relies on the best practices regarding growth regressions employing a System GMM, amongst which the reputable guidance provided by Bond *et al.* (2001). Generally, the literature on economic growth using dynamic panel procedure (Bond *et al.,* 2001; Forbes, 2001; Carkovic and Levine, 2002) estimates a model with averaged year periods (either five- or three-year averaged data) in order to remove business cycle fluctuations. A typical cross-country growth model regresses economic growth on the lagged level of GDP (on each starting period of averaged data) denoted by ***reallngdpini***, main variable of interest ***FD*** and other control variables denoted by ***X*** and ***Z*** as shown in Equation 5.3.

$$growth_{it} = \beta_0 + real\ln gdpini + \beta_1 FD_{it} + \gamma_i X_{it} + \eta_i Z_{jt} + (\varepsilon_{it} + u_i) \quad (5.3)$$

Nevertheless, different from standard cross-country growth regressions, our study is using annual data. Any attempt to opt for three-year or five-year averaged data would drastically reduce the number of observations, which in turn would undermine the reliability of the estimated results. Given that our investigation is conducted at the regional level, the business cycle fluctuation might be less visible relative to the national level. Therefore, in line with similar cross-country growth regressions using annual data (Di Liddo *et al.,* 2015), the growth equation to be estimated by a System GMM is amended to:

$$growth_{it} = \beta_0 + growth_{it-1} + real\ln gdpini + \beta_1 FD_{it} + \gamma_i X_{it} + \eta_i Z_{jt} + (\varepsilon_{it} + u_i) \quad (5.4)$$

Compared to Equation (5.2), the equation above is augmented with a lagged dependent variable and the first lag of per capita GDP (***lag1realgdp***) in Equation 5.1 is substituted by the initial level of GDP (***reallngdpini***) in Equation 5.4 in order to control for convergence between regions. Before presenting the results, it is important to clarify the rationale of this equation in the context of GMM estimation of empirical growth models. Given that the initial level of GDP is measured at the starting year of the data, this variable measures *permanent or final convergence* of a region. Namely, it measures the convergence occurring from the first year until the last year in the dataset. Whereas, the lagged growth measures the *intermediate or recent convergence* from year-to-year (between two consecutive periods). With reference to Equation 6.4, this variable controls also for the cumulative growth (known as cumulative causation), a concept introduced by Myrdal (1957). Although underreported in the economic growth empirical research, this theory as stated by Monastiristis (2011, p.10) argues that "*cumulative causation is about a positive relationship between past and current rates of growth, irrespective of initial incomes…because initial incomes capture only the initial advantage in regional conditions and characteristics*". In other words, the lagged growth controls for potential cumulative mechanism occurring at regional level, where relatively rich regions grow faster than relatively poor regions.

Two more advantages of the dynamic analysis compared with the static analysis are that it allows discriminating between short- and long-run effects of the independent variables, in this case of FD, on economic growth, and uses weights to better take into account any possible discrepancies in terms of good representation of each country in the dataset. Because the lagged growth is included as a regressor in Equation 5.4, the coefficients from any of the estimators represent the short-run impact of the determinants of regional economic growth. The rationale behind the estimation of long-run coefficients is the assumption that the historical effect of the determinants of growth is captured by the lagged growth. Therefore, there is need to differentiate between the short- and long-run effects of FD on economic growth. The System GMM allows also the estimation of long-run effects through the formula presented in Equation (5.5) below.[132] As to the second issue, the rationale for using weights in our regressions, a detailed discussion will be provided in the following sections.

Coefficient of the regressor/(1- coefficient of the lagged dependent variable) (5.5)

5.4. Diagnostics and Robustness Check

5.4.1 Diagnostics and Robustness Check for the Static Model

Before proceeding with the estimation of the model introduced above, it is necessary to perform various diagnostics checks. First, a unit root test is performed in order to determine whether a cointegration relationship exists between variables. However, in the context of this chapter, this test has low power given the short time series of our data. This is also confirmed by the Fisher test of Maddala and Wu (1999), which suggests that the variables in our model do not contain a unit root. Therefore, a

[132] The *nlcom* command in Stata is used to calculate the long-run effects.

cointegration relationship between variables, which requires that the variables show co-movement over time, is ruled out (Stata printouts of the tests performed for unit root for each of the independent variables are presented in Appendix 5.3.2).

Another concern in this chapter is the degree of correlation between FD measures. A note of caution seems to be in order when using the FD measures altogether because of potential correlation between them. The theoretical and empirical literature review (recall Chapter 2) suggested that the use of only one measure of FD is unable to capture the complexity of FD, instead it is necessary to take into account all three dimensions of decentralization: expenditure, tax (or revenue) and grants from central government. Whilst this suggestion was followed in Chapter 4, this chapter uses only combinations of two FD measures due to multicollinearity problems. In the context of this chapter, the criticisms of using less than three measures seem to be less of a concern for several reasons. First, in Chapter 4, it was relatively difficult to measure FD due to the complexity and multidimensionality of decentralisation in a heterogeneous set of countries such as TEs. Contrary to this, the current chapter uses a more homogeneous dataset, ETEs, which share common characteristics of FD during the transition, which in turn makes it easier to define FD and measure its nature. Additionally, the degree of decentralisation is likely to be distorted at higher aggregate levels of investigation given that it lumps together many dimensions of FD occurring at different aggregation levels (i.e. counties, cities, etc.). Contrary to this, the current chapter, which focuses at regional level, adapts the conventional measures of FD (as used in the previous chapter) to a regional context without taking into account the central government share (as this is the same across regions of the same country).[133] Despite the great variation of FD at regional level, the unconventional FD measures require some caution. By definition, (some) of the FD measure employed in the current chapter (recall Table 5.2) are constructed in such way that either a nominator for one measure is the denominator for another measure, or two measures have the same nominator. For instance, both expenditure decentralization and tax decentralization measures have the same nominator: own tax revenue of subnational government. Hence, the use of all

[133] Nevertheless, the public sector size is taken into consideration later on in this chapter through the government consumption variable.

three measures in the same model would, by definition, create problems of multicollinearity.

In order to assess the presence of multicollinearity between all variables we additionally rely on the correlation matrix and VIF (see Appendix 5.1.1 and 5.1.2). Following the rule of thumb of VIF being less than 10 and correlation between two variables being less than 0.70, our results show no serious problem of multicollinearity, except the correlation between the FD measures, which is higher compared to the other variables and above the suggested VIF of 10 (VIF of 39.58 for ***fdtax*** and 36.73 for ***fdexp***). As abovementioned, the high correlation between the three FD measures suggest a (relatively) severe problem in the model if all these measures are used together. However, it seems that the correlation between ***fdexp*** and ***fdgrant***, and ***fdtax*** and ***fdgrant*** are not problematic, respectively 0.03 and -0.02. Therefore, in estimating the FD-economic growth relationship at subnational level, the equation (5.2) is estimated by using a combination of ***fdgrant*** with either ***fdexp*** or ***fdtax***.

In addition to the VIF, we make use of the pairwise correlation test, which examines multicollinearity for each cross-sectional unit (regions in the context of this chapter). Overall, this test suggests similar multicollinearity as VIF and the correlation matrix. Consequently, Equation (6.1) was initially estimated using the FE- and RE- estimators repeated for each of the FD measure combinations. Graphical diagnostics and a normality test (skewness and kurtosis) on the error terms suggest a non-normality problem (see Appendix 5.3.4). However, based on the discussion in Section 4.3.1, we address non-normality by checking for outliers and estimating the model within the suggested border rather than using a logarithmic transformation. In addition, Wooldridge test for autocorrelation in panel data and modified Wald's test (Baum, 2006, p. 222) suggest that the model suffers from group-wise heteroskedasticity and autocorrelation (see Appendix 5.3.5 and 5.3.6 for Stata printouts). Consequently, we follow the *letter-value approach*, which displays a collection of observations of the dependent variable focusing on the tails rather than the middle of distributions (Hoaglin, 1893 and Emerson and Stoto, 1983). In the context of this chapter, an observation of the dependent variable is considered as an outlier if it stands beyond the suggested inner fences of -29.94 and 43.19. Thus, the model is estimated within these borders.

Another important diagnostic test is the presence of cross-sectional dependence. The assumption that the units in a panel are cross-sectionally independent seems to be a strong and restrictive assumption when referring to FD. Indeed, violating this assumption would lead to large bias and inefficiency (De Hoyos and Sarafidis, 2006, p. 483), which in turn, will produce dramatic effects on the estimated impacts of FD on economic growth. Similarly to national level, cross-sectional dependence is (more) likely to occur also at a lower level of governance, at subnational level. Regions, especially within the same country, may share common (socio-economic) characteristics and be exposed to homogenous shocks or trends (i.e. austerity). In order to test for the presence of cross-sectional dependence, the Frees's (1995) and Pesaran's (2004) tests for cross-sectional dependence are performed. Both tests strongly reject the null hypothesis of no cross-sectional dependence in the panel (see Appendix 5.3.7 for Stata printouts). At this stage, we follow the suggestions of Sarafidis *et al*. (2009), elaborated in Section 5.3.2, to include year dummies[134] in the model in order to "catch" common shocks affecting FD in our sample.

Subsequently, the abovementioned tests are re-performed to check whether year dummies could absorb the common shocks. These tests again indicate existence of cross-sectional dependence. However, the null hypothesis is weakly rejected at 5 percent level of significance (p-value of 0.021), which suggests that our model exhibits a cross-sectional dependence of errors across countries which arises by the non-homogenous shocks such as economic distance and/or spatial dependence. When data contain cross-sectional dependence, conventional FE- and/or RE-estimators are inefficient, and the standard errors are biased (De Hoyos and Sarafidis, 2006).

Given the existence of cross-sectional correlation between regions, heteroscedasticity and autocorrelation, it is reasonable to rely on standard errors which are robust to all these problems simultaneously. In order to address these issues simultaneously, Hoechle (2007) suggests the use of the Driscoll and Kraay's (1998) and/or Two-Way cluster-robust estimator, which renders errors robust to the temporal and spatial dependence of any kind. However, following the justification provided in Chapter 4, the former is more appropriate than the latter given the inability of the Two-Way cluster-robust estimator to properly mitigate cross-sectional dependence on small

[134] The first year is omitted as the reference category.

samples of less than 100 cross units/clusters (Baum *et al.,* 2011). Accordingly, equation (5.1) is estimated using FE- and RE-estimators with Driscoll-Kraay's SEs. The modified Hausman test, which is robust to temporal and spatial dependence, suggests that RE-estimators are not the preferred estimators (the null hypothesis is rejected at 5 percent level of significance as shown in Appendix 5.4.2). Whilst OLS would produce inconsistent estimators, it is argued that FE using Driscoll-Kraay estimator is more appropriate than OLS and RE-estimators.[135]

Another diagnostic check, relevant in the presence of FE-estimators (of any kind), is how to best address the loss in efficiency from time-invariant and the slowly moving variables. As introduced in the previous chapter, FE models are inconvenient in an empirical analysis as it "wipe out" the effect of variables with no longitudinal variance and it is inefficient in estimating the effect of slowly-moving variables (Plümper and Troeger, 2007). To overcome this loss, Plümper and Troeger (2007; 2011) propose the use of FEVD (recall Section 4.4). Given the above discussions, there is little to distinguish which model specification is preferable in terms of diagnostics and rationale in the context of FD-economic growth relationship, both FE estimator using Driscoll-Kraay SEs and FEVD approach will be reported, compared and interpreted in the next section.

Next, a Panel Data Regression Specification Error Test (RESET) is performed in order to test whether the functional form imposed on the FD-economic growth relationship is supported by Equation (5.2). Whilst RESET can easily be performed in cross-sectional and time-series analysis, various limitations exist when it is performed on panel data regression model. An adjusted RESET for panel model (Ramsey test, DeBenedictis-Giles Specification Reset test and White Functional Form test) can be performed only on conventional panel data models and few on contemporary panel models (Shehata and Mickaiel, 2015). This thesis, as argued previously, uses either a FE/RE estimator with Driscoll-Kraay's SEs or FEVD approach. Unfortunately, these estimation techniques are not supported by the RESET test for panel data. One

[135] In addition, we have considered other estimations such as Generalized Least Squares (GLS) and Panel-Corrected Standard Error estimator (PCSE). However, the former cannot be used in our dataset given that GLS (with an option of panels correlated) can be performed only under balanced dataset (see Appendix 5.4.6). As to the PCSE, the results seem to be similar to the FE using D-K SE. Though, the results (see Appendix 5.4.6) are presented only as a robustness check given the inability of the PCSE estimator to account for autocorrelation (StataCorp, 2013).

possibility would be to perform this test for conventional panel models and FE using Panel Corrected SEs which corrects only for heteroscedasticity and cross-sectional correlation (Driscoll-Kraay SEs are, in addition, robust to any form of serial correlation).

However, a note of caution seems to be in order when interpreting the Ramsey and DeBenedictis Giles tests, and the White Functional Form test because they are not performed on the preferred model, but on alternative ones. One possibility, which seems to be safer compared to the above ones, would be to perform the RESET Test manually based on the strategy provided by Wooldridge (2009, p.306).[136] Accordingly, this test suggests (the p-value for the $\hat{y}^2$ and $\hat{y}^3$ is respectively 0.537 and 0.516) no severe problem of misspecification in terms of functional form (see Appendix 5.3.8 for this test conducted when using pooled OLS, FEVD, System GMM, etc.) and thus, we may proceed with the selected variables as described in the previous sections.

Finally, the IV-GMM estimations of the FE and first-differenced panel data models are employed.[137] In terms of diagnostics, attention has been paid to the underidentification test, weak identification test, endogeneity test and the test of overidentifying restrictions, also known as Sargan test, using the same empirical strategy regarding the IV estimation as in Section 4.3.3. The underidentification test indicates that the instruments are all relevant; the null hypothesis was rejected with a p-value of 0.000. Next, the rejection of the null hypothesis for the weak identification test confirms that the instruments are not weak. The overidentifying restrictions could not be rejected (with a p-value of 0.3502), and the endogeneity test suggests the presence of endogeneity in some variables such as ***educ2***, ***educ3_n***, ***fdgran***t (p-values of 0.000).[138]

[136] The squared and cubes fitted values of the initial estimation are to be included as explanatory variables.
[137] The command in Stata is *xtivreg2* introduced by Schaffer (2015).
[138] See Appendix 5.4.4 for more details on the underidentification test, weak identification test, Sargan test and endogeneity test.

5.4.2. Diagnostics and Robustness Check for the Dynamic Model

The choice regarding the preferred dynamic model specification is based on several tests such as the first-order serial correlation (*m1* test), the second-order correlation (*m2* test), the Sargan test, Hansen test, the difference-in-Hansen test of exogeneity of instruments (also known as C-test), and comparison of the coefficient of the lagged dependent variable from those obtained by OLS and Fixed Effects.

As to the first two tests, the GMM estimator requires the rejection of the *m1* null, but not of the *m2* null (See Stata printouts in Appendix 5.5). The corresponding p-values suggest that there is sufficient evidence to reject the former, but not the latter. Second, similar as in the IV approach, the System GMM tests for the validity of instruments through Sargan test (not robust to heteroscedasticity, but not weakened by many instruments) and Hansen test (robust to heteroscedasticity, but weakened by many instruments). In both cases, the tests of overidentifying restrictions' p-values range between 0.3 and 0.7, which are within the boundaries suggested by Roodman (2008; 2009a; 2009b). Consequently, the validity of instruments cannot be rejected.

Another important test, although usually under-reported in the empirical literature, is the difference in Hansen test, which tests the exogeneity of the instruments used in the regression. In all the instrument subsets (GMM-instrument for the levels, the lagged dependent variable and other variables claimed as endogenous), the corresponding p-values suggest that there is no sufficient evidence to reject the null hypothesis of the validity/exogeneity of instruments. The p-value for the second subset is also used to test for the presence of cross-sectional dependence. Likewise static panel models, the presence of year dummies seems to significantly absorb cross-sectional dependence yielded by homogenous shocks (p-value of 0.596).

Finally, the coefficients of the lagged dependent variable obtained by OLS, System GMM and FE are compared between each other. According to Bond *et al.* (2001), the coefficient of the lagged growth should lie below the estimator obtained by OLS and above the corresponding FE estimator Table 5.5 shows that the coefficient of the lagged growth for the baseline model using ***fdtax*** and ***fdgrant*** lies near (slightly above) the coefficient estimated by FE and below the coefficient estimated by OLS (see Appendix 5.3.9 for Stata printouts). Similarly, this is also proved for the model when FD is measured by ***fdexp*** and ***fdgrant***.

Table 5.5 Comparison of the coefficient of the lagged dependent variable of the baseline model when FD is measured with *fdtax* and *fdgrant*

	FE	System GMM	OLS
Coefficient of the lagged growth (Baseline Model using *fdexp* and *fdgrant*)	-0.14	-0.02	-0.07
Coefficient of the lagged growth (Baseline Model using *fdtax* and *fdgrant*)	**-0.145**	**-0.141**	**-0.07**

The last issue to be raised in terms of diagnostics is the use of weights. One might argue that even though we combined NUTS2 and NUTS3 in order to avoid overrepresentation of large size countries in comparison to the small size countries, there might still be a need to use, or at least double check for "good representation" of each country's regions. System GMM, different from the abovementioned techniques, accommodates weights. Accordingly, the data are weighted using the number of regions in each country. Nevertheless, the estimated results from System GMM estimator with and without weights are very similar, while being almost unchanged in some specifications (see Appendix 5.5.9). Therefore, we report the unweighted estimation results and consider the weighted one as a robustness check.

Also, another concern in our estimations (both in the static and dynamic approach) is whether a particular country drives the results. For example, there might be reasons to believe that Poland (being the largest size country in our sample) might drive the overall results. Hence, we repeated the estimations by excluding one country at a time and re-running the regressions with the remaining sample of countries. In all cases, expenditure decentralisation was still significant, whereas no pattern could be observed for the other FD measures.

5.5. Estimated Results - Static Approach

As anticipated previously in the empirical methodology section, three main sets of estimates are to be presented in this section: estimates using (i) FE with Driscoll-Kraay SEs (ii) FEVD, and (iii) IV. The results are reported in Table 5.6, in which the estimated results from the first empirical approach are reported in Column (1) and (2), whereas those from FEVD in Column (3) and (4), and from IV in Column (5) and (6).

The odd columns (1, 3 and 5) report the results when FD is measured through ***fdexp*** and ***fdgrant***, whereas the even ones (2, 4 and 6) report the results when ***fdtax*** and ***fdgrant*** are used.

Table 5.6 Estimated Results using FE with Driscoll-Kraay SEs, FEVD and IV of the FD-economic growth relationship (dependent variable: Growth)

VARIABLES	(1) FE with D-K	(2) FE with D-K	(3) FEVD	(4) FEVD	(5) IV	(6) IV
fdexp	0.208**		0.159***		0.0521	
	(0.0922)		(0.0316)		(0.0545)	
fdgrant	-0.0881	-0.0649	-0.157***	-0.159***	-0.809***	-0.704**
	(0.117)	(0.113)	(0.0524)	(0.0493)	(0.263)	(0.340)
fdtax		0.268**		0.171***		0.915***
		(0.106)		(0.0323)		(0.239)
popgrowth	-0.237*	-0.280**	-0.263**	-0.291***	-0.285**	-0.560***
	(0.127)	(0.118)	(0.107)	(0.106)	(0.129)	(0.153)
educ2	0.138*	0.158**	0.112**	0.119**	0.137**	0.479***
	(0.0699)	(0.0676)	(0.0517)	(0.0489)	(0.0619)	(0.105)
educ3_n	-0.177**	-0.122	0.00946	0.0120	-0.133	0.0835
	(0.0779)	(0.0730)	(0.0255)	(0.0239)	(0.0905)	(0.0970)
lag1realgdp	-0.00292***	-0.00323***			-0.00336***	-0.00580***
	(0.000650)	(0.000664)			(0.000532)	(0.000919)
gfcf_gdp	-0.665	-1.894	-0.968	-1.772	-5.008	-7.803
	(3.089)	(2.747)	(2.102)	(2.153)	(4.605)	(5.296)
trade	-0.121	-0.122	-0.0581	-0.0559	-0.138	0.0478
	(0.131)	(0.129)	(0.0412)	(0.0407)	(0.129)	(0.101)
reallngdpini			-3.177*	-3.647**		
			(1.694)	(1.637)		
eta			1.000	1.000		
			(0)	(0)		
constant	34.13	33.06	39.57***	45.45***		
	(23.34)	(22.96)	(13.46)	(13.38)		
Observations	669	669	661	661	541	542
R-squared			0.518	0.520	0.367	0.108
Number of groups	64	64			64	64
Under identification test (p-value)					0.000	0.000
Weak identification test (F-stastics)					7.807	3.612
Sargan statistics (p-value)					0.3502	0.6450
Endogeneity test of the regressors					0.000	0.000
Instrumented variables					Lngfcf_gdp, trade, educ2_n, educ3_n, fdgrant	Lngfcf_gdp, trade, educ2_n, educ3_n, fdgrant, fdtax

Note: year dummies included
Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

As the main aim of this thesis is to identify the impact of FD on economic growth, we begin first by interpreting the coefficient of this variable followed by the interpretation of the other independent variables. The results of FE using Driscoll-Kraay SEs,- and FEVD- estimator appears to support the hypothesis that the FD-economic growth relationship is subject to the measurements of FD and some extent to the estimation strategy. When FD is proxied by tax decentralisation, FD exerts a positive and significant effect on economic growth irrespective of the methodology used. In contrast, the statistical significance of the expenditure decentralisation (***fdexp***) and vertical imbalance (***fdgrant***) is subject to the estimation method used.

Starting with the first estimation method, FE using Driscoll-Kraay SEs, we note that the results reported in Column (1) and (3) suggest a positive and significant effect (at 5 percent level of significance) of ***fdexp*** on the regional economic growth. As theoretically expected, a 1 percentage point increase in the share of ***fdexp*** is, on average, associated with 0.21 percentage points increase in the regional economic growth, all else being equal. This FD measure is the share of own revenue in percentage of subnational government's expenditure, which assesses the degree of reliance of local expenditure on its own revenue, thus taking into account both the expenditure and tax dimension. The higher this share, the greater the capacity of a local government to rely on its own expenditure. This in turn, as suggested by the results (when estimated by FE using Driscoll-Kraay SEs and FEVD), has a positive effect on the region's economic growth. A possible rationale is that local government units that are characterised by high shares of ***fdexp*** are better able to finance their own expenditure through their own funding. By doing so, these units are also likely to match better (in terms of quantity and quality) the provision of local services to the citizens' preferences. Contrary, local government units that cannot rely on their own taxes, but for instance on transfers from central government (or borrowing) are conditioned to use these funds on specific local services, which are homogenous across all regions (as determined by the central government) of the country and not tailored to the preferences of their specific region. However, this measure is unable to identify the efficiency of specific local government expenditures, namely, whether local government expenditures are spent on growth-enhancing functions. Next, it is important to note, that both the statistical and economic significance of ***fdexp*** do depend on the estimation approach. This variable is no longer significant when an estimation method is an IV approach.

Whilst FE with Driscoll-Kraay SEs is employed, vertical imbalance does not seem to lend support to the hypothesis that higher level of dependency of local governments to central government is growth depressing. The coefficient of this variable is found to be statistically insignificant. A possible reason for the lack of significant results might be the inability to distinguish between types of grants (conditional and unconditional grants) and the little longitudinal variance of this variable (Recall Table 5.4). With respect to the former, grants to subnational governments are argued to have two opposing effects, which is difficult to tackle through conventional measures. First, grants may provide adverse incentives to poorer regions to compete with other regions, not efficiently allocate these funds and rely on funds from central government. Second, grants might boost competition between regions and make them more competitive to existing and potential investors (Feld *et al.,* 2004). However, in the context of ETEs, the former effect might be argued to dominate the latter due to potential overspending tendency of subnational government than what is socially optimal given the disposition of central government to finance local governments.

As to the second reason, the little longitudinal variance, it seems that when FEVD is employed, ***fdgrant*** becomes significant suggesting an adverse effect on economic growth. A 1 percent increase in the share of grants received by central government over the region's local expenditure is, on average, associated with 0.15 percentage points decrease in the regional economic growth, all else being equal. A similar coefficient is obtained also when ***fdgrant*** is used together with ***fdtax*** instead of ***fdexp***, and when its endogeneity is taken into consideration (Columns 5 and 6).

On the other hand, tax decentralization is found to have a statistical significant effect across all specifications and combinations of FD variables from 5 to 1 percent level of significance (Columns 2, 4 and 6). Namely, a 1 percent increase in the share of ***fdtax,*** all else being equal, appears to enhance economic growth in the selected ETEs' regions by approximately 0.27 percentage points in the case of FE with Driscoll-Kraay SEs up to 0.9 percentage points when IV approach is employed. As argued in Chapter 2, tax decentralization rather than revenue decentralization is a better measure of the autonomy of local governments as it takes into account the tax-raising power (but not the decision-making over tax rates and base) and the autonomy from central government. As argued by Stegarescu (2005) and Boetti *et al.* (2010), the provision of goods and services using own financial resources makes subnational governments more autonomous and efficient.

Overall, the conclusions regarding the main variable of interest are consistent with recent papers on the relationship between FD-regional economic growth conducted in Columbia, Italy, Spain, Russia, etc.[139] As to the control variables, the panel data results, both using FE with Driscoll-Kraay SEs and FEVD, also seem to confirm the established finding in the growth literature over the main determinants of economic growth.

The significance and size of population growth are statistically significant across all estimation methods and combinations of the FD measures. Although population growth is generally considered as a slowly moving variable, it is not considered as such in the current chapter (recall Table 5.4 on the between/within SEs ratio of population growth).[140] This is because, in a regional context, there is much more variation between and within regions (amongst others due to internal migration) than in between and within countries at aggregated levels. In line with the theoretical expectations (the Malthusian analysis) and the vast majority of empirical studies, an increase by 1 percentage point the rate of population growth, will result in an adverse effect on the regional economic growth by 0.23 percentage points.[141] In general, both the coefficient and the level of significance are consistent across different estimation approaches used (see from Columns 2 to 6).

With respect to the control variables, the economic effect of human capital appears to be subject to the human capital measure adopted (***educ2*** and ***educ3***). When human capital is measured by the enrolment in secondary education, the result suggests that an increase in human capital would boost regional economic growth possibly due to increase in labour productivity. This result, being consistent across all specifications and in line with both theoretical expectations and empirical evidence, suggests that a rise in the secondary school enrolment by 1 percentage point will increase, ceteris

[139] Desai *et al.* (2003); Gil-Serrate and Lopez-Laborda (2006); Lozano and Julio (2015); Bartolini *et al.* (2016).
[140] In the previous chapter, population growth was considered a slowly moving variable.
[141] See Headey and Hodge (2009) for a more detailed overview on the effect of population growth on economic growth.

paribus, GDP growth from 13 to 47 percent depending on the specification used.[142] Contrary to the *a priori* expectations, ***educ3*** is found to have either an insignificant or a negative effect on regional economic growth. The latter is found only when a combination of ***fdexp*** and ***fdgrant*** is used and the method of estimation is FE with Driscoll-Kraay SEs. In all the other specifications (Column 2 to 6), this variable is insignificant irrespective of the FD measures used. Accordingly, 1 percentage point increase in tertiary school enrolment rate, all else being equal, is associated with a decrease in the regional economic growth by 0.17 percentage points. However, this negative coefficient does not contradict the entire empirical evidence. The empirical literature on the relationship between human capital and economic growth argue that the negative sign might be attributed to the difficulty in properly measuring human capital due to quantitative nature of these measures. According to Le *et al.* (2005), (gross- and net-) secondary and/or tertiary school enrollments, although being among the most used proxies for human capital, measure neither the human capital endowments nor the quality.[143] Despite the arguments in favour of these contradictory results, what seems interesting is the fact that high enrolment rates, especially for tertiary education, tend to be found in capital cities and large/richer regions. Hence, in the context of our research, an increase in high enrollment rates does not necessarily mean that more educated students will contribute to the corresponding region's economic growth, but it might be that the effect is concentrated only to the region they study (usually capital city because of high numbers of schools and universities). This, in turn, might under- or over- estimate the overall impact of ***educ3*** on regional economic growth. Another potential reason, which can explain to some extent the counterintuitive effect of enrolment in tertiary education on economic growth, is the static perspective in this model. Having a contemporaneous value of ***educ3*** neglects the potential lagged effect of this variable. As argued in the previous section, the effect of education on growth is likely to occur at later periods, at a relatively slow pace.

Another important control variable included in Equation (5.2) is the initial condition of a region, which is proxied by the lag of regional GDP per capita (***lag1realgdp***) or the initial level of GDP (***reallngdpini***) depending on the estimation method employed. The estimated results presented in Table 5.6 suggest the existence of catch-up effect

[142] See Hanushek and Woessmann (2011) for more details.
[143] Secondary and/or tertiary enrolments rate are considered as flow measures of investment in human capital.

of (relatively) poor regions to (relatively) rich regions. Irrespective of the FD measure and estimation method used, the ***lag1realgdp/reallngdpini*** is always significant across estimations at 1 percent level of significance and they have the expected sign.

Another key determinant of regional economic growth is the rate of investment, proxied by the rate of gross fixed capital formation. Investment is found to have an insignificant effect across all specifications and combination of FD measures. This might be attributed to the measurement error of this variable and the inability to take into account any lagged effect of investment on growth. Recalling section 5.3, the use of lagged investment (first lag and/or second lag) together with the lagged GDP per capita, used to isolate the convergence effect, would produce a misspecification error. Therefore, our results suggest that the current value of investment does not affect the current value of regional growth from a static perspective.

The variable ***trade*** representing a country's measure of openness to international markets appears to be insignificant across all estimations. Attention has to be devoted to this variable given that it is measured at the national level due to the lack of data. Regions as spatial units differ economically and is likely that trade would have a different effect on each region's economic growth. However, the results from the static model suggest that such effect is not visible. Indeed, a more thorough investigation is required at subnational level in order to properly analyse the ***trade***-economic growth relationship at regional level and shifting to a dynamic perspective by investigating the lagged effect of trade on economic growth.

Another concern in the above estimations, especially in the one reported in Table 5.6, is the inability to properly distinguish the individual country's economic effect of FD at regional level. Namely, pooling all the regions of all countries into one dataset might hinder the individual country's effect. However, as argued in Section 5.2, the unavailability of the longer time period, and thus a number of observations, drives us to select multiple countries. The small number of observations (in particular for the Czech Republic and Hungary) makes it difficult to produce sensible results from individual country regressions. Appendix 5.4.5*A* provides the estimated results for individual countries. Nonetheless, it is difficult to rely on these results for which the number of observations is small and there is not much additional information provided by this approach of splitting countries into small sub-datasets.

Therefore, as argued before in this chapter, the relationship between FD and regional economic growth might be mediated by country size. Namely, regions of large size countries are likely to better exploit the economies of scale of FD relative to the regions of small countries. In this context, our understanding of the economic effect of FD can be improved by considering country size as a potential factor that influences the FD-growth relationship. In order to test the hypothesis that the regional economic effect of FD is sensitive to the country's size, we augment the baseline model (5.5) with size dummies and their respective interactions with FD measures. Following Section 5.2.2, countries and their respective regions are divided according to the country's surface area and population; thus, by considering the country size not only as a geographical dimension but also that encompasses other dimensions such as population. In addition to these two criteria, we divided countries according to their economic development stage based on their OECD membership. The Czech Republic, Hungary and Poland comprise the first group (also are part of the large size country group), whereas Estonia and Albania are part of the second group of countries that are either (very) recently part of OECD countries, or not a member at all (part of the small size country group).

In order to avoid repetition and in the interest of brevity, the interpretation of the estimated results from these two approaches will focus only on the main variable of interest, FD. The first approach is to split the dataset subject to size and compare the results between the first and second group of countries. Given that the results are a replication of the one presented in Table 5.6, the methods employed here shall be the same: FE with Driscoll-Kraay SEs, FEVD and IV. The results reported in Table 5.7 are found to differ substantially between small size and large size country group not only in terms of FD measures but also regarding control variables. Interestingly, the economic effect of FD is statistically significant only in the large size country sample, suggesting that an increase by 1 percentage points in the ***fdexp***, all else being equal, would increase regional economic growth 0.08 to 0.1 percentage points, depending on the specification used. However, this effect seems to disappear in the case of IV approach. The effect of FD is found to be statistically insignificant among small size countries. These results suggest that large size countries can better exploit the benefits of FD than small size countries, by better translating these benefits in growth maximising. In contrast, Albania and Estonia, being small size countries, are found to be unable to affect regional economic growth by decentralisation expenditure. Similar results are reported when FD is measured by tax autonomy and vertical imbalance (Stata printouts reported in Appendix 5.4.5*B*).

Recalling Section 5.3, the second approach to test for the differences in the FD economic impact due to country's size is by making use of a dummy variable (***size***) and its interaction with all the measures of FD. Thus, Equation (5.2) is augmented simultaneously with two additional variables: size and its interactions either with expenditure decentralisation, tax decentralisation or vertical imbalance. However, it should be noted that these techniques do not allow the inclusion of the interaction term through the marginal effect approach, while some of them do not allow the inclusion of ***size*** as a time-invariant dummy variable. The FE with Driscoll-Kraay SES and FEVD, being fixed effect estimators, will drop out size as a dummy variable. Therefore, the results using FE with Driscoll-Kraay SEs and FEVD do not contain the size variable, but only the interactions with the FD measures. The estimated results are reported in Table 5.8 (more details in Appendix 5.4.5*C*).

With regard to the main variable of interest, FD is found to vary across estimations and combination of FD measures. As to the first measure, ***fdexp*** is found to be either insignificant or negative and significant when the model is estimated with FE with Driscoll-Kraay SEs and FEVD, contrary to the approach where the dataset is divided into two sub-datasets. As to the second measure, the increase in local governments' fiscal autonomy, as expected, is suggested to contribute positively to regional economic growth, however, the size of the country does not alter such relationship. The interaction of size with ***fdtax*** is found insignificant across all estimations. Higher transfers from central government to finance the local governments' expenditure is indicated to have a negative effect (at 10 level of significance) only when IV approach is employed. Interestingly, the interaction term of this variable with size is found to be insignificant in this specification, but significant in other specification where ***fdgrant*** itself is not significant (see Column 2). The results suggest somehow that economic effect of vertical imbalance is caught either by this variable itself or by its interaction with size, but not by both.

Table 5.7 Estimation results using FE with Driscoll-Kraay SEs, FEVD and IV from large and small size country group by splitting the dataset

Method	FE with Driscoll-Kraay SEs				FEVD				IV			
FD measures used	*fdexp + fdgrant*	*fdtax + fdgrant*	*fdexp + fdgrant*	*fdtax + fdgrant*	*fdexp + fdgrant*	*fdtax + fdgrant*	*fdexp + fdgrant*	*fdtax + fdgrant*	*fdexp + fdgrant*	*fdtax + fdgrant*	*fdexp + fdgrant*	*fdtax + fdgrant*
Sample	Large	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large	Small
Variables												
fdexp	0.08**	0.23			0.14***	-0.01			0.02	1.491		
	(0.03)	(0.19)			(0.05)	(0.17)			(0.05)	(1.71)		
fdtax			0.13**	0.078			0.19***	-0.08			0.244	-1.33
			(0.05)	(0.17)			(0.05)	(0.22)			(0.407)	(1.71)
fdgrant	-0.25*	0.05	-0.21	-0.08	-0.34***	0.03	-0.29***	-0.03	-1.15***	1.60	-1.070*	-1.245
Observations	359	310	359	310	353	308	353	308	285	256	286	256
R-squared					0.827	0.50	0.83	0.50	0.79	0.38	0.77	0.35
Number of groups/regions	37	27	37	27	37	27	37	27	37	27	37	27

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 5.8 Estimation results from large and small size country group using size dummy variable and interactions with FD measures

Method	FE with Driscoll-Kraay SEs		FEVD		IV	
FD measures used	*fdexp + fdgrant*	*fdtax + fdgrant*	*fdexp + fdgrant*	*fdtax + fdgrant*	*fdexp + fdgrant*	*fdtax + fdgrant*
Variables						
fdexp	0.298		0.305*		-1.634***	
	(0.264)		(0.177)		(0.300)	
fdtax		0.401**		0.146		1.181*
		(0.135)		(0.108)		(0.681)
fdgrant	0.0784	0.116	-0.0231	-0.0895	-1.808***	-0.640
	(0.199)	(0.0911)	(0.172)	(0.0945)	(0.313)	(0.724)
size	0	0	16.42	4.316		
	(0)	(0)	(15.29)	(8.907)		
expsize	-0.0985		-0.153		1.903***	
	(0.209)		(0.179)		(0.322)	
grantsize	-0.249	-0.273**	-0.136	-0.148		0.458
	(0.172)	(0.115)	(0.176)	(0.104)		(0.729)
taxsize		-0.154		0.0313		-0.902
		(0.118)		(0.105)		(0.644)
Observations	669	669	661	661	541	541
R-squared			0.519	0.561	0.216	0.265
Number of groups/regions	64	64	64	64	64	64

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Control variables included in the estimations, but not reported in the table

5.6. Estimation Results - Dynamic Approach

Table 5.9 presents the results of the growth equation in a dynamic setting (Equation 5.4). The analysis of baseline results (Columns 1 and 2) is followed by the investigation of country size as a determinant of the FD-growth relationship (Columns 3 and 4), next by claiming some of our main variables of interest as endogenous (Columns 5 and 6) and their interaction with country size (Columns 7 and 8). In order to avoid repetition, this section will focus only on the difference of the System GMM results compared to those from the static panel model.

However, a note of caution is required before jumping to the differences between the two approaches. Different from the static panel model, the dynamic model includes the lagged dependent variable, which captures the entire history of the right-hand side variables and their influence on the current level of the growth rate (Greene, 2008, p.469). According to our results presented in Table 5.9, lagged growth appears to be insignificant across specifications, which shows no persistence of the growth rate over the periods. Namely, the insignificance of lagged growth implies that the regional growth rate in the current year is not related to the regional growth rate in the previous year.

Whilst the presence of a significant lagged dependent variable is important in a dynamic model, it should be noted that in this empirical investigation it is not the persistence of the regional growth rate *per se* that is of interest. However, such dynamics should be modelled and interpreted. Although the "history" is not significantly reflected in the lagged growth rate, it is important to mention that its coefficient lie between 0 and 1, and also in the credible range of LSDV and OLS estimates (see Table 5.9).

As to our greatest concern, the relationship between FD and economic growth, the estimated results from a System GMM provide a similar, but more informative picture than the results from a static panel. The results from baseline specification (Columns 1 and 2) indicate that FD, when measured by ***fdexp*** and ***fdtax***, has a positive impact on regional economic growth. Contrary, ***fdgrant*** does not have any significant effect on the regional economic growth either in the first specification (Column 1) or in the second (Column 2).

Table 5.9 Estimated results from dynamic panel system GMM estimations of the FD-economic growth relationship at regional level (dependent variable: Growth)

Variables	(1) *fdexp + fdgrant*	(2) *fdtax + fdgrant*	(3) *fdexp + fdgrant*	(4) *fdtax + fdgrant*	(5) *fdexp + fdgrant*	(6) *fdtax + fdgrant*	(7) *fdexp + fdgrant*	(8) *fdtax + fdgrant*
$growth_{t-1}$	-0.0215	-0.142	0.0374	0.382	0.103	-0.303	0.293	0.405
	(0.258)	(0.260)	(0.172)	(0.553)	(0.319)	(0.197)	(0.472)	(0.532)
fdexp	0.129***				0.0295			
	(0.0412)				(0.0492)			
fdgrant	0.0390	0.0206						
	(0.0367)	(0.0414)						
fdtax		0.186***						
		(0.0462)						
reallngdpini	-14.24***	-15.73***	-12.18**	-18.56***	-5.694**	-13.04***	-3.838	4.568
	(2.348)	(2.480)	(4.890)	(5.041)	(2.255)	(3.642)	(3.860)	(9.092)
popgrowth	0.0323	-0.0116	0.0852	0.255	0.0459	-0.0940	0.115	0.0665
	(0.146)	(0.177)	(0.123)	(0.286)	(0.176)	(0.177)	(0.220)	(0.309)
educ2†	-0.242***	-0.227***	-0.175	-0.176	-0.0965*	-0.0232	-0.0897*	-0.200**
	(0.0555)	(0.0585)	(0.105)	(0.125)	(0.0560)	(0.0579)	(0.0495)	(0.0832)
educ3†	0.153***	0.150***	0.136***	0.171***	0.0492*	0.0898**	0.0205	-0.0164
	(0.0318)	(0.0301)	(0.0445)	(0.0439)	(0.0281)	(0.0386)	(0.0322)	(0.0446)
lngfcf_gdp	9.449**	8.158**	12.17*	10.59	9.902*	-3.997	2.582	14.25**
	(4.547)	(3.800)	(6.777)	(6.524)	(5.367)	(6.279)	(4.776)	(5.936)
1size			37.88	23.11				3.138
			(55.46)	(50.81)				(74.42)
0b.size#c.fdgrant			0.452	0.267				
			(0.592)	(0.502)				
1.size#c.fdgrant			-0.115	-0.152				
			(0.233)	(0.207)				
0b.size#c.fdexp			0.402				-0.0631	
			(0.582)				(0.163)	
1size#c.fdexp			0.170*				0.147**	
			(0.0954)				(0.0722)	
trade†	0.128***	0.128***	0.120**	0.177***	0.0244	0.109	0.0273	-0.0456
	(0.0378)	(0.0392)	(0.0510)	(0.0579)	(0.0315)	(0.0652)	(0.0469)	(0.0532)
0b.size#c.fdtax				0.244				
				(0.554)				
1.size#c.fdtax				0.309***				
				(0.109)				
fdgrant†					-0.0167	-0.123***		
					(0.0419)	(0.0409)		
fdtax†						0.189***		
						(0.0518)		
size							-4.241	
							(12.59)	
0b.size#c.fdgrant†							0.00633	0.147
							(0.0965)	(0.754)
1.size#c.fdgrant†							-0.287***	-0.171*

							(0.101)	(0.1000)
0b.size#c.fdtax†								-0.0560
								(0.814)
1.size1#c.fdtax†								-0.0820
								(0.204)
Constant	89.55***	106.4***	27.60	87.17	25.52	124.2***	40.27	-62.74
	(20.37)	(21.64)	(88.83)	(70.34)	(23.79)	(38.62)	(30.11)	(145.2)
Model Diagnostics								
Observations	667	667	667	667	652	666	652	666
Number of regions	64	64	64	64	64	64	64	64
AR(1) p-value	0.009	0.025	0.003	0.067	0.024	0.044	0.058	0.0409
AR(2) p-value	0.346	0.604	0.130	0.195	0.232	0.574	0.237	0.209
Sargan test p-value	0.689	0.337	0.259	0.710	0.685	0.685	0.254	0.493
Hansen test p-value	0.596	0.372	0.359	0.725	0.452	0.585	0.410	0.312

†Different lags of the variables are used
Note: year dummies included
Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Looking more in detail at the first measure of decentralisation, ***fdexp*** is found to have a positive and statistically significant effect on economic growth. An increase by 1 percentage point in the share of expenditure covered by own local government expenditure increases regional economic growth by 0.12 percentage points, ceteris paribus. Similar findings were also reported in the previous estimations (recall Table 5.6). With respect to ***fdtax***, ceteris paribus, the results suggest that on average a 1 percentage point increase in this share increases regional economic growth by 0.18 percentage points. In terms of economic rationale, the contribution to economic growth for both ***fdexp*** and ***fdtax*** seems sensible given the high variation of regional economic growth (minimum -30% (excluding outliers) and maximum 29.8%). Last, as previously reported, the effect of ***fdgrant*** appears to be insignificant.

In order to shed more light on the FD-economic growth relationship, our focus of investigation shifts to the interaction between country size and our main variable of interest. Different from the static panel, the two-step System GMM does allow the use of interactions and time-invariant variables such as ***size***. The results from Equation (5.2) augmented with **size**, seems to stress the importance of an in-depth investigation of any measure of FD given the variation it had due to ***size***. Otherwise, one would risk to over generalise the conclusion and not expose the factors that are likely to drive the FD-economic growth relationship. In order to avoid this risk of overshooting when concluding about the economic relevance of the FD measures, our focus shifts to Columns (3) and (4), which are replication of the two baseline models (Columns 1 and 2) with ***size*** interacted with FD measures. Graphically, the average marginal effect size of ***size*** and FD measures are presented in Figure 5.1.

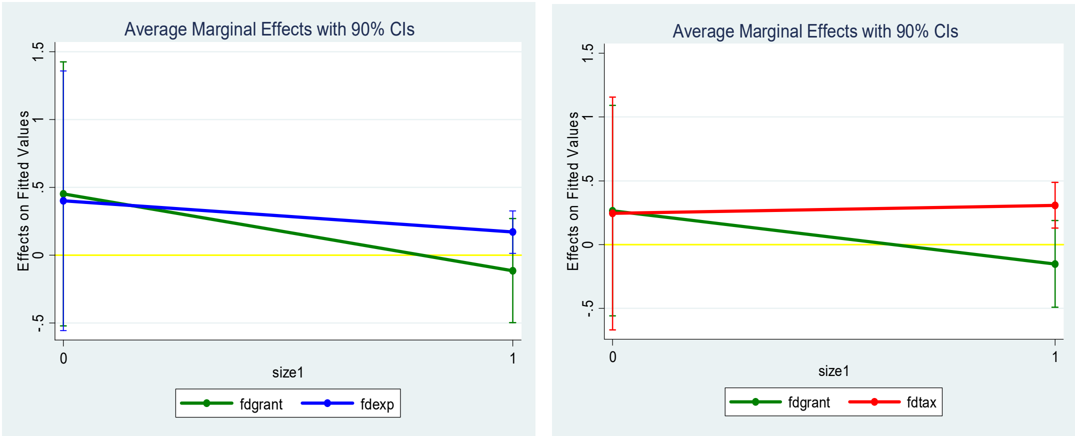


Figure 5.1 Average Marginal Effects of size and FDexp and FDgrant (on the left), and FDtax and FDgrant (on the right), with 90 CIs.

Whilst the country size *per se* has no significant effect on regional growth, an interaction with FD measures sheds light on their economic effect at regional level. The results from Column 3 suggest that expenditure decentralization exhibits a positive and significant effect at the10 percent conventional level only for large countries. Accordingly, a 1 percentage point increase in ***fdexp*** increases regional economic growth rate in the large country group by 0.17 percentage points, ceteris paribus. In contrast, there is no effect of expenditure decentralization on the regional growth for small countries.[144] As such, it is argued that the expenditure decentralization-economic growth relationship at the regional level is subject to the country size. Such conclusions are consistent across specifications (See Column 7). Thus, if a country is large enough in terms of surface area and population size, then expenditure decentralization can exploit its benefit better and affect economic growth.

[144] A possible reason for the insignificant effect of the expenditure decentralisation on regional growth in small size countries might be the large standard errors or small variation in this sample, which in turn lead to unprecise estimation of the coefficients. Referring to the descriptive statistics (see Appendix 5.2), the sample size of small size country (Albania and Estonia) is relatively smaller compared to the one of large size countries (the Czech Republic, Hungary and Poland), 324 and 455 observations, respectively.

Similar results are also reported for tax decentralization (Column 4), where the effect of large countries out weighted the effect of small countries. A 1 percentage point increase in the local government share of own tax revenues as a percentage of total local revenue increases regional economic growth by 0.3 percentage points, all else being equal. However, this effect seems to disappear when this variable is claimed as endogenous. Looking more in detail and across other variables of FD, the results suggest that now the positive effect of ***fdtax*** in large countries is shifted to ***fdgrant***, which was insignificant before (Column 3). Only after grant decentralization are treated as endogenous, its effect becomes significant (p-value changes from 0.46 to 0.09)[145] Columns 7 and 8 and graphically presented in Figure 5.2). As *a priori* expected, the higher the dependence of local government on central government funds, the lower the regional economic growth, which seem to be in line with the majority of empirical research (Berthold *et al.,* 2004; Feld *et al.,* 2004; Feld *et al.,* 2009a). Thus, a 1 percent increase in the vertical imbalance of local governments decreases regional growth by 0.28 percentage points (if ***fdgrant*** combined with ***fdexp***) and 0.17 percentage points (if ***fdgrant*** combined with ***fdtax***), ceteris paribus.

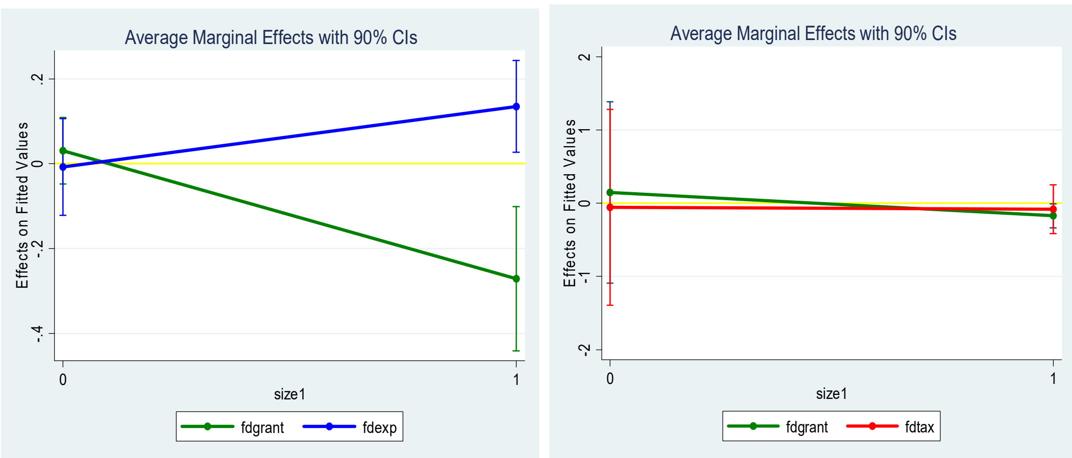


Figure 5.2 Average Marginal Effects of size and *fdexp* and *fdgrant* (on the left), and *fdtax* and *fdgrant* (on the right), when claiming *fdtax* and *fdgrant* as endogenous, with 90 CIs.

[145] See Columns 7 and 8 and Figure 5.2 for graphical presentation.

Such an effect is also found by a similar study by Cevik (2017), although the focus of investigation is different from ours. Cevik argues that size matters when referring to vertical fiscal imbalances of Moldova. In terms of the degrees of novelty, our study is focusing on a completely different area, countries, level of investigation and has a different definition of size. The above study defines size as the subnational government's population, whereas our study uses the country geographical and demographical size, as well as OECD and EU membership to categorise countries.

Although the lagged depepdent variable is not significant, as already discussed earlier, there is strong evidence (at 1 percent level of significance) of a permanent or final catch-up process that took place from the first to the last year of investigation, while being consistent across all specifications (from column 1 to 8).[146] The inability to find an intermediate convergence seems reasonable and expected when dealing with annual data. Contrary, if we would have five-year averaged data, the catch-up process would likely to be more visible relative to our case. As to the initial GDP, the results appear to be consistent across all specifications (static and dynamic) and estimation methods. The negative correlation between the initial level of GDP and the subsequent regional growth rates is also supported by a recent study of IMF (2016) on regional economic growth in CESEE. Despite the slow pace of convergence in the recent year, regions of CESEE show evidence of a significant convergence process during their transition phase.

With regard to the other control variables used in the model, it seems that the results have the expected sign and are consistent with the majority of empirical growth literature. Though, our results appear to be slightly different (for some variables only) when compared to those of the static analysis. Accordingly, the regional population growth does not provide any longer evidence of its negative effect on the regional economic growth.

Investment, measured by the share of gross fixed capital formation as a percentage of the regional GDP, is found to have a positive and significant effect on economic growth. Apparently, the coefficient of this variable in the static model did hide important information in the static analysis, which could not be revealed if the lagged effect of investment was not taken into consideration and this relationship shifted to a

[146] Stata printouts are provided in Appendix 5.5 (from 5.5.1 to 5.5.8).

dynamic approach. The system GMM estimated result suggests that a 1 percentage point increase in the share of investment to GDP, leads to a 9.4 percentage points increase in the regional economic growth, all else being equal. In the context of the regional economic growth, it is important to note that this coefficient is economically meaningful and not that large as it gives the first impression. The regional economic growth rates are higher and more fluctuating compared to the rates at the aggregate level (the average economic growth of our sample is approximately 6%, while the maximum growth rate is 29%). This result seems to be consistent also in the second baseline specification where the second combination of FD measures is used (***fdtax*** and ***fdgrant***), and somewhat in the other estimations when FD measures are claimed as endogenous or interacted with country size. Though, in some specification (Columns 4, 6 and 7) investment loses its statistical significance (See Appendices 5.5.4, 5.5.6 and 5.5.7).

Interestingly, human capital variables, namely ***educ2*** and ***educ3***, swapped their signs compared to the static model. As argued before in Section 5.3, it is important in the case of human capital to consider its lagged effect, since this variable (irrespective of the way measured ***educ2*** or ***educ3***) takes time to manifest its effect on growth. In addition to the lagged effect, the System GMM did take into account also the possible endogenous relationship between human capital and economic growth.[147] The first measure of human capital, namely ***educ2***, exhibits a negative effect on economic growth across all estimations, though the level of significance changes drastically across specifications (p-value from 0.690 to 0.000). Referring to the first specification (see Column 1), a 1 percentage point increase in the enrolment rate in secondary education, decreases the regional growth rate by 0.24 percentage points, all else being equal. Nevertheless, the results seem to be more in line with the theoretical and empirical research when human capital is proxied by the enrolment rate in tertiary education. In the two baseline specifications, ***educ3*** is highly significant at 1 percent level of significance and has the expected positive sign. Accordingly, a 1 percentage point increase in the enrolment rate at tertiary education increases regional growth by 0.15 percentage points, ceteris paribus.

[147] In all the specification, ***educ2*** and ***educ3*** are considered as endogenous.

A different picture emerges in the case of trade, which from being insignificant before in the static model becomes now highly significant and in line with the majority of empirical research. The results suggest that country's trade openness contributes to the regional economic growth, where 1 percentage point increase in this variable increases regional growth by 0.12 percentage points, all else being equal. Consequently, the higher a country is opened to international markets, the greater are the benefits for individual regions.

5.7 Sensitivity of the results

Although the nonlinearity of the FD-economic growth relationship is not a vital point in the empirical research (recall Chapter 2), we hypothesise an (inverted) U-shaped relationship in order to control for possible variations over time of the economic effect of FD. Such hypothesis can point to the optimal size of decentralization, namely, to the level of FD that maximises growth. Although largely ignored, this is thought to be a common practice among research conducted at national level, because it answers the question of whether a country should decentralise more or less in order to benefit from FD. To do so, one should take into account the size of the central government in the analysis, contrary to this chapter, which has adapted the FD measures at a regional context. Nevertheless, we assume such counteracting economic effect of FD also in research conducted at regional level in order to shed more light on the relationship between FD and economic growth.

Equations 5.2 and 5.4 are both augmented with a quadratic term of each measure of FD (used combinations similar to the linear specifications). Estimated results are reported in Table 5.10 and Table 5.11, respectively for static and dynamic panel models. In the interest of brevity, we focus only on the main variable of interest, FD measures. The positive sign of ***fdexp*** and the negative sign of its quadratic term suggest that the increase of this measure can be beneficial for the regional economic growth until FD reaches the critical value that ranges from 55.7% to 65.3%. Any increase of the ***fdexp*** beyond this point would harm regional economic growth. The optimal size of FD from the regional perspective seems to be confirmed only for ***fdexp***, whereas ***fdtax*** and ***fdgrant*** mostly seem to suggest a linear effect on regional economic growth. Similar results are also found in the System GMM (see Table 5.11), except when FD is claimed as endogenous. Different from the other measures, the sign of the ***fdgrant*** and its quadratic terms suggest a U-shaped relationship between FDgrant and regional growth, where the minimum of FD is reached at 41% (see Appendix 5.6.1 for Stata printouts). Nevertheless, as pointed out previously, pooling different countries of different sizes in one dataset, might expose us to the risk of overshooting the economic effect of FD. Given that in terms of policy implications this is not of special relevance (recalling the debate in the first paragraph), we will leave this for future research and not include an interaction term between FD measures, size and squared term of FD.

Table 5.10 Optimal Size of FD (static panel models)

Method	Combination of FD measures	Measure of FD	Optimal size
FE with Driscoll Kraay SEs	***fdexp*** and ***fdgrant***	fdexp	65.3%
		fdgrant	Insignificant
	fdtax and ***fdgrant***	fdtax	71%
		fdgrant	Insignificant
FEVD	***fdexp*** and ***fdgrant***	fdexp	60.7%
		fdgrant	Insignificant
	fdtax and ***fdgrant***	fdtax	61.7%
		fdgrant	Insignificant
IV	***fdexp*** and ***fdgrant***	fdexp	55.7%
		fdgrant	Insignificant
	fdtax and ***fdgrant***	fdtax	Insignificant
		fdgrant	Insignificant

Table 5.11 Optimal Size of FD (dynamic panel models)

Method	Combination of FD measures	Measure of FD	Optimal size
Baseline Specification	***fdexp*** and ***fdgrant***	fdexp	63.6%
		fdgrant	Insignificant
	fdtax and ***fdgrant***	fdtax	63.4%
		fdgrant	Insignificant
Claiming FD Measures as Endogenous	***fdexp*** and ***fdgrant***	fdexp	68%
		fdgrant	Insignificant
	fdtax and ***fdgrant***	fdtax	Insignificant
		fdgrant	41%

Another issue raised in Chapters 2 and 4 was whether the size of a government, measured by the government final consumption (recall Table 5.1 for the precise definition of this variable), should be taken into consideration when investigating the economic effect of FD. We argued before in this thesis that there is no underlying theoretical justification of including government size due to likelihood of double counting the local government expenditures once in the FD measures and then in the government consumption. Nevertheless, the estimated results reported in Appendix 5.6.2 suggest that the size of a general government, almost across all estimation methods and specifications, is insignificant.

With respect to the regions where the capital city is located, FD does not seem to have a different (larger/smaller) effect relative to the other regions. Contrary to our expectations, although capital regions are more decentralized, there is not enough evidence that such higher decentralization would be conducive to regional economic growth (see Appendix 5.6.3 for Stata printouts). Though, it should be noted that the estimation results are only from the static models.

In general, the country's membership in the European Union appears insignificant when using interaction terms of EU with FD measures (***expeu, taxeu*** and ***granteu***). However, this seems to be contradicted by the second approach when dataset is split into two sub-datasets subject to their EU membership status: (i) the Czech Republic, Hungary, Estonia and Poland, which are all part of the EU, and (ii) Albania, which is not yet a member of EU (see Appendix 5.6.4 for more details). A possible rationale for this contradiction might be because when splitting the dataset, instead of interaction terms, the significance of FD measures does not necessarily state that the EU membership has contributed to its economic effect, but it is likely that we are capturing factors other than the EU membership.

Table 5.12 Long-run coefficients of the economic effect of FD

Combinations of FD measures	***fdexp*** **and** ***fdgrant***		***fdtax*** **and** ***fdgrant***	
FD measure	***fdexp***	***fdgrant***	***fdtax***	***fdgrant***
Coefficient (Standard Error)	0.032 (0.054)	(-0.018) (0.044)	(0.14)*** (0.04)	(-0.09)** (0.03)

Finally, the long run coefficients of the effect of FD on economic growth are presented in Table 5.12. We would expect the economic effect of FD to be stronger in the long-run relative to the short-run. A possible rationale behind this is with time, local governance can better benefit, amongst others, from economies of scale and experience (and other channels of transmission elaborated in Chapter 2) and be more efficient in offering local public goods and services, which eventually would be conducive to higher regional economic growth.

However, the estimated coefficients are found to differ between the baseline specification and the second specification where FD is claimed as endogenous. Given that the second specification might be considered as more appropriate in the presence of endogeneity, we will prioritise this type of coefficients, while the former being reported in Appendix 5.6.5. The results, reported in Table 5.12, suggest there is no long-run economic effect of ***fdexp***, whereas there is a significant effect on regional economic growth of ***fdtax*** and ***fdgrant***. Regarding the sign and magnitude of the coefficient for these two variables, they are as expected: positive for ***fdtax*** and negative for ***fdgrant***, while having weaker effect than in the short-run effect.

5.8 Conclusions

In the previous chapter, it was argued that conducting research on a heterogenous dataset at a higher level of aggregation (i.e. national level) and the use of heterogenous datasets with countries at different stages of development is considered a weakness when investigating the economic effect of FD in a cross-country context. Therefore, this chapter seeks to fill the gap in the literature by studying the economic effect of FD from a regional perspective in selected ETEs. Despite the abundance of the empirical research on the effect of fiscal decentralization on economic growth, there are only a limited number of empirical investigations focusing on European Transition Economies (ETEs) in general and at regional level in these countries in particular. To the best of our knowledge and up to date this is the first study investigating this relationship at regional level (defined as the first level of administrative decentralisation within each county).

Using an endogenous growth model, the panel data analysis over the 2000-2014 period suggests that the relationship between FD and regional economic growth depends largely on the measurement of FD and size of the country. With regard to the former, the results appear to be consistent across all specifications and estimations, suggesting that the relationship between FD and regional growth is subject to the FD measures used. When FD is proxied by either ***fdexp*** or ***fdtax***, the economic effect of FD appears to be positive and significant. Contrary, ***fdgrant*** either has an insignificant effect or it is detrimental for growth when claiming it as an endogenous variable.

As to the size of the country, our results are more emphasized when employing a dynamic model (System GMM). The effect of FD on economic growth is statistically significant and positive in larger countries (the Czech Republic, Hungary and Poland) and insignificant in smaller countries (Albania and Estonia), which suggest that the size of the country matters in explaining the FD-economic growth relationship. Large size countries are able to decentralize economic decision making (especially over tax and spending) to lower levels of administration better and make the process more effective – thus the better economic results. Smaller countries cannot decentralise very much because of the limited scope for decentralization (indeed, in EU regional decentralization classification terminology -NUTS2 level- the smaller countries constitute only one region). Larger countries are likely to be able to exploit the benefits of FD better if the diverse preferences across distant regions of large countries (especially of hinterland regions with ethnic backgrounds) are matched to local public services and there is greater local accountability and competition among subnational governments. Consequently, the regions can better assess the amount and type of public goods offered to diverse regions and thus, benefit from FD.

Additional extensions to the core investigation, which included investigating for an optimal size of FD, controlling for the size of the general government, EU membership status, did not appear to alter significantly the results from the baseline specification and the one when FD is claimed as endogenous, neither in the static, nor in the dynamic approach. Contrary, the long-run effect of FD on economic growth was found to vary subject to the specification used.

In summary, this chapter pointed out the importance of considering homogenous dataset in the analysis when investigating the economic effect of FD and particularly investigating this relationship more systematically at lower levels of aggregation. In the context of future research, our analyses could be extended to larger dataset of

ETEs, which would shed more light on the other determinates impacting the FD-economic growth relationship. The inclusion of political decentralization in addition to FD might reveal another dimension of decentralization worth investigating.

Chapter 6

CONCLUSIONS AND RECOMMANDATIONS

6.1 Introduction

The aim of this thesis was to examine the effect of Fiscal Decentralisation (FD) on economic growth in TEs, with special reference to European TEs (ETEs). While these countries have been progressing in their transition from the centrally planned system to decentralised market economies, the process of political, administrative and economic decentralisation and its implications have varied from country to country (Bird *et al.,* 1995). An important aspect, critical to the transition process, is the decentralisation of government itself, which has not received much attention (mostly from the empirical perspective) in TEs in general and in ETEs in particular. The renewed focus on decentralisation in these countries has been mainly driven by either (i) the failure of the centrally planned system accompanied by the expectation that devolution will deliver efficiency gains and promote economic development, or (ii) the need to adapt to new international and political conditions in the post-socialist period (Rodriguez-Pose and Kroijer, 2009, p.7). Whilst facing many challenges in successfully implementing (fiscal) decentralisation reforms (Prud'homme, 1995), the nature of transition raises particular issues in terms of FD and its implications for economic development for TEs.

Once the rationale for investigating the relationship between FD and economic performance is elaborated, this research embarked on a critical review of the theoretical and empirical studies on the relationship between FD and economic growth. Having found no solid economic arguments to explain the mechanism by which FD contributes to growth, this research expanded the existing knowledge of transmission by elaborating in more detail the existing channels and introducing new channels. The literature appears to be unable to provide conclusive empirical evidence concerning the impact of FD on growth, on either the magnitude or the sign of this relationship, though some weak evidence of a positive economic relationship had been found only when the relationship was investigated at subnational levels. Despite the abundant empirical research, it was surprising to find that studies focusing on TEs are rather scarce.

Motivated by the ambiguity of the empirical literature and their scarcity in TEs, several research questions were posed for this thesis. The first two research questions, elaborated in Chapter 3, concerned whether *the heterogeneity among the FD-*

economic growth empirical studies can be identified by the characteristics of the previous empirical studies and *whether a publication bias as well as an authentic effect can be identified*. Next, the analysis moved to the empirical investigation of the economic impact of FD in TEs as a cross-country investigation. Based on a critical review of alternative measures of FD, the next research questions, discussed in Chapter 4 were *whether FD has any impact on economic growth in TEs* and *whether FD is considered a normal good and/or "made in Europe"*. This analysis highlighted the need to investigate the FD-economic growth relationship in more details at lower levels of aggregation and for a more homogeneous set of countries. Using a panel data of ETEs at regional level, the next set of research questions, elaborated in Chapter 5, concerned *whether the economic effect of FD becomes more visible at lower levels of aggregation* and *whether country size has any effect on the FD-economic growth relationship*.

Overall, the aim of this concluding chapter is to synthesise the key findings of this research and highlight its contribution to knowledge and public policy. The rest of this chapter is organised as follows. Section 6.2 lists and presents the main empirical findings by explicitly answering the abovementioned research questions. Section 6.3 appraises the contribution to knowledge, both with regard to the findings on the economic effect of FD in TEs and the more general methodological findings of interest related to the FD-economic growth relationship. Section 6.4 provides policy recommendations on the basis of the empirical findings. Section 6.5 points out the limitations of this research and, finally, Section 6.6 discusses the venues for debate and further research on FD-economic growth relationship.

6.2 Main findings

The aim of this thesis was to explore the concept of FD and its impact on economic growth in TEs. More specifically, the objectives related to the critically review the theoretical and empirical literature and fill the gaps in knowledge; to provide evidence on publication bias as well as genuine effect of FD on economic growth; to investigate this relationship in a transition context from both national and subnational (regional) level.

6.2.1 Theoretical and empirical evidence and the gaps in knowledge

The review of literature on the relationship between FD and economic growth showed that whilst this relationship has been extensively investigated from an empirical perspective, the theoretical literature remains limited. Hitherto, there is no clear and unique theoretical framework that justifies the inclusion of FD in a growth model. The existing (endogenous and neoclassical) FD-growth models lack explanation and comprehensible economic arguments on the mechanism and transmission channels of FD to economic growth.

The exploration of channels of transmission have generally been neglected in the last decades, while being limited only to traditional channels (consumer heterogeneity and producer channels of transmission), which appear to be indefinite and unclear about uncovering the mechanism by which FD contributes to growth. The failure to recognise the multidimensional nature and complexity of FD is considered as the main cause of the vague underlying relationship between FD and economic growth. To address this knowledge gap, this thesis has reformulated the existing channels of transmission and introduced new ones to better disentangle the economic effect of FD on economic growth from different perspectives. By departing from the traditional approach of considering subnational governments as a provider of local public goods to a facilitator of the economic agents' activities, two direct channels of transmission, the pro-business agenda channel and the fiscal response channel, as well as two indirect channels, government size and corruption channels are introduced to the literature. The pro-business agenda channel relies on the ability of local governments to create a friendly business environment by altering spending and local taxation, which stimulate the existing entrepreneurial activity and attract new business. Whilst the above channel targets only businesses, the fiscal response targets both business and consumers through altering tax policy (changes in tax rate and tax base) and local expenditure and taxes (productive vs unproductive). On the other hand, the hypothesised economic effect of increased FD can be explained indirectly through the effect of FD on macroeconomic stability, corruption and the size of government, which in turn affect economic growth.

Despite the lack of a universal theoretical framework, an extensive number of studies have assessed the FD-economic growth relationship empirically. However, the empirical evidence remains inconclusive. The diverse and contradictory findings in some cases regarding the sign and magnitude of the economic effect of FD raised the debate on the appropriateness of FD measures for best depicting the relationship between FD and economic growth. The lack of robust evidence has been attributed to the inconsistent measurement of FD and to some extent to the lack of theoretical framework, misspecification errors and the methodology used. However, it is pertinent to note that categorising the economic effect of FD subject to the level of investigation (national vs subnational level) has shed some light on the ambiguity of the empirical effects. A slight majority of studies at subnational level are similar in terms of the significance of factors, suggesting that the economic effect of FD (irrespective of the measurement) is more visible at lower levels of investigation than at national level.

6.2.2 Publication bias or genuine effect?

Having found no or little consensus on the economic effect of FD, after a review of the empirical research, the first empirical chapter in this research was conducted to objectively summarise and estimate the consistency of the FD-economic growth empirical results?. The meta regression analysis of the empirical studies in Chapter 3 revealed a wide range of estimates scattered throughout a multidimensional landscape of research, differing widely in terms of FD measurement, country characteristics (i.e. stages of development), methodology employed, time span and data sources. To the heterogeneity of estimated results is also added the complexity and multidimensionality of FD, which makes deriving precise inferences on the economic effect of FD difficult. To take a step beyond the literature review's qualitative judgments, the MRA was employed to synthesise, integrate and evaluate the results of previous empirical literature. More precisely, in the context of this thesis, the MRA was used to: (i) determine the presence of a publication bias and quantify it, (ii) determine the existence of a genuine economic effect of FD and quantify it, and (iii) uncover the potential factors that influence the FD-economic growth relationship, using a set of 49 primary studies with 1001 point estimates.

The graphical examination of the presence of publication bias, through funnel plots, revealed the mild contamination of the FD-economic growth literature by positive publication bias, where studies tend to inflate the positive effects while underreporting the negative ones. Moving to more objective tools to test publication bias, the bivariate

MRA, using WLS and FE, confirms the results of the funnel plot, and suggest the presence of a positive "little to modest" publication bias in the full sample of primary studies. The bivariate MRA also tested the existence of an authentic effect of FD on economic growth beyond publication bias. The findings suggest the presence of a weak negative genuine effect, which might be attributed to a large number of studies using expenditure decentralisation as the only measure of FD. On the other hand, the contamination of this literature by a positive publication bias should not come as a surprise especially when the real economic effect of FD appears to be negative, contrary to the theoretical underpinnings of the presumed positive effect of FD.

To avoid comparing different studies with each other, our next MRA categorises studies by the measurement of economic performance (output-level and output-growth) as the most prominent difference across the primary studies. The results suggest that these two groups of studies are notably different from each other. A negative genuine effect appears to persist in all subsamples irrespective of the measurement of economic performance. Stronger contamination up to "substantial bias" is found in output-level studies, whereas no strong evidence of publication bias is found in output-growth studies. The presence of a positive publication bias, significant only in output-level studies, reconfirms the above discussion on the predisposition of this subsample to report positive results due to the positive theoretical prediction of devolution on growth and influence of the output-growth studies, both in numbers and visibility as most-cited papers, in the FD-economic growth literature.

In addition to the publication bias and genuine effect, the multivariate MRA accounts for any source of excess variation in the primary studies. In this regard, the multiple MRA findings revealed four main sources of the excess heterogeneity between and within empirical literature: (i) the level of investigation, (ii) differences in measuring economic performance, (iii) differences in measuring FD and (iv) methodological and context of investigation. The level of investigation appears as one of the most striking results of our MRA, suggesting that the difference in the level of investigation (whether a study is conducted at national or subnational/regional level) is a great source of heterogeneity. The effect size of studies conducted at national level appears to be smaller than the ones conducted at regional level. Again, as anticipated, the heterogeneity between studies measuring economic performance in growth rates and levels is substantial, begging for distinct examination of the two samples. The estimated effect of FD on economic growth depends mainly on the measurement of FD, also blamed throughout Chapter 2 as a great source of heterogeneity. The effect size in the selected empirical literature is found to be significantly lower in studies using cross-section data, but larger in studies conducted in developing countries and in those using large number of control variables, while no significant variation is found within studies testing for nonlinearity, endogeneity, long-run relationship and other differences in estimation techniques.

Our MRA results, superior to the existing ones, have implications for research practice. The conclusions of the multivariate MRA warrant a more in-depth analysis of how FD affects economic growth and whether this relationship is subject to the FD measures used. Agreeing on the appropriate measures of FD, by including all its dimensions, and including the necessary control variables is crucial in empirical research to identify the economic effect of FD.

6.2.3 Does FD affect economic growth in TEs?

Based on the discussion of Chapters 2 and 3 and motivated by the scarcity of empirical research in TEs despite the prevalence of decentralisation in these countries, Chapter 4 examined the effect of FD on economic growth in a macro level investigation using panel data for 21 countries during the period 1996-2015. Addressing the identified shortcomings of the empirical studies, the growth model based on Davoodi and Zou's approach, adapted to the transition context, was used to estimate the economic effect of FD. Because FD appeared as a multidimensional process especially in TEs which encompassed the expenditure, revenue/tax and intergovernmental transfers dimensions, our model used a combination of three measures of FD, namely, *expenditure decentralisation*, *tax decentralisation* and *vertical imbalance*. However, due to the presence of collinearity between the last measure and *expenditure decentralisation*, results using the first two measures of decentralisation were contrasted with the first set of results.

Overall, the empirical findings suggested a weak positive effect of FD, measured by *expenditure decentralisation*, on economic growth. The results from FE estimations with Driscoll-Kraay SEs revealed the positive effect of higher subnational expenditure as a share of general government expenditure on economic growth in TEs, irrespective of the number of other FD measures employed. Accounting for potential endogeneity of *tax decentralisation* and *vertical imbalance*, the findings suggested that the inclusion of the above measures impacts neither the significance nor the magnitude of the effect of expenditure decentralisation on economic growth. The weak significance of this effect might be attributed to a few possible reasons. First, existence of high level of transfer dependency in the majority of TEs, likely to impact the expenditure assignments conditional to the transfers received, might hinder the full effect of local spending on economic performance. The insignificance of *tax decentralisation*, on the other hand, does not come as a surprise. The low degree of local tax-raising power and the dependence mostly on shared taxes emphasise the lack of local financial capacity, both regarding tax base and rate, and the inability of the latter to impact economic growth. Although the Southern Caucasus countries seem to be more advanced in terms of their revenue/tax decentralisation reform than the European countries, the dominance of the latter group might hide or offset the potential effect from the former group of countries. The inclusion of *vertical imbalance* to measure the local governments' dependency to the central one highlights, once again, the heterogeneity of TEs regarding this issue: from countries that are highly dependent on intergovernmental transfers to countries that rely mostly on their own revenues. Lastly, the complexity and multidimensionality of FD, despite using appropriate measures, might be still present when the focus of investigation is at national level, rather than at lower levels of aggregation where this process originates.

Using a dataset of countries with substantial differences in FD, stages of transition, geographical location, institutions and socio-cultural characteristics, confronted us with the risk of undershooting the genuine economic effect of FD. In spite of including transition index to account for potential differences in economic and institutional reforms in different countries, it seems that the heterogeneity of transition stages (from laggard to advanced reformers) is not entirely captured. Indeed, this index considers the potential direct effect of transition on economic growth, but it does bypass any differences of the economic effect of FD due to different development stages. To provide further insight into the relationship between FD and economic growth, the stages of transition and geographical location (as the most visible differences among

TEs) will be considered as moderating factors on the economic effect of FD, also formulated as the next research question.

6.2.4 Is FD a "normal" good or "made in Europe" good?

In the jargon of public economics, FD is often considered as a luxury good, the demand for which grows with the increase of per capita income (Tanzi, 2000). It is argued that the decentralisation benefits can better be exploited at high levels of income, different from low-income countries which, instead of benefits, witness many challenges and burdens from decentralisation. Whilst from a theoretical perspective this is a well-known concept, empirical research has ignored this characteristic of FD. However, the above definition, from a microeconomic perspective, represents a normal rather than a luxury good. Therefore, given this vague distinction between the luxury and normal good in the literature, this thesis tested whether FD is a normal good.

Using an interaction term of stages of transition and FD, our empirical findings reveal the strong moderating role of stages of transition on the economic effect of *expenditure decentralisation* and the weak role in *tax decentralisation* and *vertical imbalance*. Namely, at very early stages of transition, the effect of FD on economic growth is negative, mainly attributed to misuse of local funds, unaccountable and incompetent local governments, lack of clarity of spending assignments and the potential homogeneity of preferences at lower levels of government that does exploit the benefits of FD. As economic and institutional reforms progress up to an average stage, the economic effect of FD dissolves into a zero effect. However, at further stages of transition, eventually, the economic effect reappears with a strong positive impact. Overall, these findings highlight the existence of a critical level of development, proxied in our case by the transition index, after which FD becomes desirable and growth benefits from higher expenditure devolution.

With respect to the other variables of interest, FD measured by *tax decentralisation*, although being mostly insignificant, stresses the different economic effect of FD over various stages of development. Whilst at early stages of transition, *tax decentralisation* is conducive to growth, at more advanced stages, its economic effect becomes non-existent. The weak positive effect of *tax decentralisation* further reinforces the importance of a closer match between own revenue and spending at local level. Otherwise, the positive effect, irrespective of advances in economic and institutional reform, are likely to be ephemeral, with intergovernmental transfers being a safer option in financing local spending. This is also confirmed by the marginal effects obtained from the interaction of transition index and *vertical imbalance*, which are mostly insignificant except at lower levels of development. The need to rely on transfers rather than own funds becomes urgent only at lower stages of development, whereas at higher stages of transition transfers appear to be substituted easily and safely by own funds of local governments.

Another intriguing research question in the context of TEs, which has also gone untested, is whether the economic effect of FD is subject to the geographical location. When differentiating between European and non-European economies (Southern Caucasus TEs), the interaction term of a geographic location dummy variable and each FD measure (as well as the coefficient of the FD after splitting the dataset) appears insignificant, revealing no variation of the economic effect of FD subject to location.

Investigating for any potential effect of public sector size, measured by government consumption as a share of GDP, this study finds that public sector size does not impact economic growth and its inclusion in the model impacts neither the significance nor the sign of FD measures. Also, the nonlinearity of FD does not seem to hold in our sample, suggesting a linear direct relationship between FD and economic growth, rather than the existence of an optimal size.

6.2.5 Does the economic effect of FD become (more) visible at lower levels of aggregation?

The weak evidence on the economic effect of FD, which could be disentangled only when using interaction terms, might be attributed to the complexity of measuring FD through conventional measures and conducting research for heterogenous datasets at national (aggregate) level. Investigating the FD-economic growth relationship at national level and pooling all the counties into one dataset might have limited the ability to deeply investigate the economic effect of FD, and is likely to have cancelled out individual countries' economic effect. With the purpose of modelling and testing the economic effect of FD more systematically at lower levels of aggregation and filling the gap in the literature at regional level, Chapter 5 analyses 64 regions in five European countries (Albania, the Czech Republic, Hungary, Estonia and Poland) for the period 2001-2014.

Disaggregating data according to the country's administrative organisation (at the first level of administrative decentralisation within each country), an endogenous growth model, same as in Chapter 4, is used to estimate the economic effect of FD at regional level, both from static and dynamic perspective. The FD measures are adapted to this new level of investigation, to better account for the country and regional characteristics of *expenditure decentralisation* (subnational own tax revenues as a percentage of subnational government expenditure), *tax decentralisation* (subnational own tax revenues as a share of subnational government revenue) and *vertical imbalance* (intergovernmental transfers as a share of subnational government expenditure).

Overall, the findings from both static and dynamic estimation reveal a positive and significant effect for FD, proxied by *expenditure decentralisation* and *tax decentralisation,* on regional economic growth. Alternatively, *vertical imbalance* has either no effect or it is detrimental to growth when it is claimed as endogenous.

As to the first measure of FD, which assesses the degree of reliance of local expenditure on its own revenue, while taking into account both the expenditure and tax dimension, the highly significant results suggest that the increased capacity of a local government to rely on its own expenditure will exert a positive effect on the region's economic growth. Local governments with high shares of *expenditure decentralisation* are better able to finance their own expenditure through own funding, which gives them the freedom to determine the quantity and quality of local services that best suit citizens' preferences. Alternatively, relying on intergovernmental transfers (or borrowing) to finance local spending are conditioned to use these funds on specific local services, determined by the central government, and not (necessarily) tailored to the local preferences of a specific region. Whilst this variable does not directly measure the local government efficiency, it provides insights into the direct link between increased fiscal performance and increased regional growth. As to tax decentralisation, a superior measure of the local tax-raising power and the autonomy from central government, the findings suggest that the provision of goods and services using own financial resources makes subnational governments more autonomous and efficient. However, the insignificance of intergovernmental transfers at regional level might be attributed to the inability to distinguish between types of grants (conditional and unconditional grants) and the little longitudinal variance of this variable.

The regional approach allowed us to delve deeper into the FD-economic growth relationship and highlighted the importance of FD in the regional growth. Only disaggregating at lower levels of aggregation, the economic effect of FD became (more) visible. However, having a dataset with countries of different stages of development and country size, which demands different processes of decentralisation, emphasises the need to separate countries based on the above characteristics. To shed more light on the above relationship, countries and their respective regions are divided according to the country's size (measured by their surface areas and population), a separation which coincides with the division according to the development stages based on the country's OECD membership status. Accordingly, our understanding of the economic effect of FD can be improved by considering country size as a potential factor that mediates the FD-growth relationship, elaborated as the next research question.

6.2.6 Does country size matter?

Whilst the country size *per se* has no significant effect on regional growth, its interaction (large vs small size countries) with the FD measures seems to shed light on their economic effect at regional level. The empirical findings revealed that one of the most crucial determinant of FD, country size, moderates its economic effect. More precisely, the results suggest that large size countries can better exploit the benefit of FD (measured by *expenditure decentralisation* and *tax decentralisation*) and boost economic growth in comparison to small size countries. Contrary, FD in small countries does not seem to be conducive to regional economic growth. Intergovernmental transfers, on the other hand, appear to have an adverse effect on regional growth of large countries.

It is argued that large size countries, being better at exploiting the benefits of FD than small size countries, can translate these benefits to growth-maximising functions and local fiscal policies (local taxes) which support the regional growth. Intuitively, the economic results are expected to be more visible in countries where preferences are more heterogeneous and countries are larger. Conversely, in small size countries, which in our case happened to be two countries with relatively medium level of FD in comparison to the ETEs, FD does not seem to have any impact on regional growth.

6.3 Contribution to knowledge

This thesis has made several contributions to the existing theoretical and empirical literature on the relationship between FD and economic growth.

First, this thesis established new channels of transmission. The main criticism of the theoretical and empirical literature on this relationship is the lack of a universal theoretical framework. Many questions were raised about whether the well-known theoretical claim that FD contributes to economic growth through enhanced matching of public policies to local needs is sufficient to explain the economic effect of FD. The failure to recognise the multidimensionality and complexity of FD is blamed throughout this thesis as the primary source of vague arguments provided in the literature on the mechanism by which FD contributes to growth. Whilst the existing transmission channels are not highly explored and generally-accepted in the literature, new cogent channels (both direct and indirect) followed by a novel classification, have been introduced in this thesis to disentagle better the mechanism through which FD impacts economic performance. More specifically, this thesis departs from the conventional approach of considering subnational government as a provider of efficient local goods and services to a more innovative approach where the subnational government is considered as a facilitator of all economic agents. Introducing the pro-business agenda and fiscal response as direct channels and size of government and corruption as indirect channels are contributions to the existing theoretical foundation linking FD and economic growth.

These insights further amplify the problem of measuring FD, which raises the need to consider all dimensions of FD (expenditure, revenue/tax and intergovernmental transfers) in an empirical approach and policy perspective. Ignoring one of these aspects is argued to be inappropriate as it truncates the understanding of the economic effect of FD. It was argued that this arbitrary selection of FD measures has given rise to mixed and contradictory empirical results regarding the sign and magnitude of the economic effect of FD. However, reviewing the empirical literature subject to the level of investigation (national vs subnational), different from the other literature reviews in the field, has shed some light on the ambiguity of empirical findings, otherwise impossible to be observed.

The second contribution is related to the synthesis of results from the previous empirical research. Left with no or very little clear answers regarding the magnitude and the sign of the relationship between FD and economic growth, this thesis takes a step beyond by synthesising and assessing the consistency of the empirical research through an MRA. Despite existing meta-regression studies on the effect of FD on economic growth (Feld *et al.,* 2009b; Baskaran *et al.,* 2016; Zhenfa and Wei, 2006), this thesis provides a comprehensive and systematic analysis, with several contributions not only to the existing MRA but also to the FD-economic growth literature. By rigorously following the MRA procedure suggested by Stanley and Doucouliagos (2012), our research simultaneously quantifies the reported effect size; correct for any potential publication bias and explain the sources of heterogeneity in the FD-economic growth literature. Whilst the other studies of MRA in the field ignore the first two issues, our research considers them as an integral part of an MRA. More precisely, by synthesising 49 studies, which supplied 1001 point estimates, and categorising studies subject to the measurement of economic performance (growth and level), our MRA identified the presence of publication bias in the FD-economic growth literature as a threat (positive selectivity) to the validity of the effect size. Whilst the output-level studies, having a negative genuine effect, appeared substantially contaminated by publication bias, the output-growth studies and the full sample of studies show no strong evidence of a genuine effect. Another contribution of this research is related to the identification of excess variation among and within previous empirical research. Accordingly, it was found that the economic effect of FD is likely to be linked to (i) differences in the level of investigation (national vs subnational level), (ii) differences in measuring economic performance (growth vs level) (iii) measurement of FD, (iv) source of the data (IMF vs other data) and (v) country and methodological characteristics.

An important contribution to knowledge, related to MRA, regards the use of a unique weighting of the data. To the best of our knowledge, this is the first MRA not only in the FD-economic growth literature but also in other disciplines that use a specific weight to address the problem of dependency of the effect sizes within and between studies. Namely, the problem of overrepresentation of studies with multiple FD measures is addressed by using an innovative weighting that simultaneously accounts for equal representation of effect sizes across specifications and studies, which we named *specific weighting*. In addition, the use of PCC, as a superior measure of the effect size, and the adaption of a wide range of estimation techniques precisely for MRA in economics (not like the other studies which adapted estimation techniques from medicine or other disciplines) represent a distinguished feature of our MRA.

The third main contribution to knowledge is the investigation of the economic effect of FD in the transition context by being, to the best of our knowledge, the first study that comprehensively explores the relationship between FD and economic growth in almost all TEs. Based on an endogenous growth model adapted for TEs, our research makes use of various FD measures, which shed light on the complexity and multidimensionality of the decentralisation process in the above countries. However, the choice of appropriate measures of FD, based on theoretical and empirical considerations and the inclusion of transition-specific control variables were considered crucial in this research programme. A distinguishing feature of our research is the importance given to the identification problem, such as endogeneity and cross-sectional dependence, which were neglected in previous cross-country empirical investigations and most likely led to biased estimates.

Given the variation in countries' development stages (from advanced to laggard transition countries) and geographical locations (Europe vs Southern Caucasus), the incorporation of these two as moderators of the economic effect of FD appears not only a contribution to disentagle the relationship between FD and economic growth, but also as an important contribution to the empirical literature by being the first study to investigate whether FD is a normal good. Whilst the theoretical literature alludes to the variation of the economic effect of FD based on country's development, the empirical literature has, to the best of our knowledge, ignored this. By using interactions of stages of transition and FD measures, our findings suggest that FD becomes affordable and better exploited only by countries at later stages of transition, contrary to countries at early stages of transition which experience either insignificant or detrimental effect of FD on economic growth. Overall, these findings confirm the theoretical claim that FD is a normal good, while the benefits of FD becomes more visible the more a country advances its economic and institutional reform. It seems that this insight critiques the relevance of conventional theory of decentralisation with regard to transition economies, emphasising the development stage as an important factor for a country to benefit from FD.

By accounting for other differences between TEs, this research contributed to knowledge by investigating whether the geographical location (ETEs vs Southern Caucasus TEs) has a moderating role on the economic effect of FD. Again, by using interaction terms, it was found that the economic effect of FD is not subject to the location of TEs.

The fourth contribution of this thesis relates the the empirical investigation of the FD-economic growth relatioship at regional level. Whilst conducting research at national level and for heterogeneous set of countries, such as TEs, was considered challenging to disentangle the relationship between FD and economic growth, our empirical investigation in Chapter 6 focussed on lower levels of aggregation (subnational/regional level). In the previous chapters, (Chapters 3, 4 and 5) it had been argued that investigating the effect of FD on economic growth at national level might be a possible explanation of the lack of conclusive empirical evidence. More specifically, investigating this relationship at national level and pooling all the countries into one dataset, might have limited the ability to systematically investigate the impact of FD on economic growth, which is likely to have been cancelled out by the individual countries' economic effect of FD. with abundant empirical literature at national level, the question of disaggregation is rarely addressed. Aiming to fill the gap in the empirical literature, we delved into new issues that hitherto have received attention in neither the theoretical nor the empirical research. Undertaking research at regional level for multiple ETEs constitutes an important contribution to knowledge of this thesis by representing a pioneering work on *regional growth in transition economies.*

Studying this relationship from regional perspective, defined as the first level of administrative decentralisation within each county, it was found that the economic effect of FD is more visible at higher levels of disaggregation, while also being subject to the measurement of FD. Our findings suggest that both expenditure and tax decentralisation are conducive to growth, contrary to transfers from central government which are detrimental to regional growth.

Embarking on a different panel model estimation (static and dynamic) of the relationship between FD and economic growth, our research revealed that one of the main determinants of FD, country size moderates the economic effect of FD. Namely, the findings suggest that FD, measured by expenditure decentralisation and tax decentralisation, is conducive to regional growth in large size countries, whereas in small size countries this effect vanishes. Intergovernmental transfers, on the other hand, appear to be detrimental to economic growth in large countries. Furthermore, accounting for the country size as a determinant of FD, while investigating the economic effect of FD, represents a core contribution of this thesis and a novelty not only in the context of TEs but also for cross-country/region investigations on the economic effect of FD.

As far as the application of methods is concerned, the research both at national and regional level carries out an extensive empirical investigation by interweaving static and dynamic estimation methods such as FE with Driscoll-Kraay SEs, FEVD, IV approach and System GMM. The use of these estimation techniques, superior to estimation techniques used in the previous empirical research, helped to ensure that the results were consistent and free of identification problems. In this regard, this is the first study that explicitly addresses the problem of cross-sectional dependency (both at country and regional level), slowly moving variables and endogeneity of all measures of FD. Unfortunately, in abundant empirical literature, it is surprising to find that the above problems remain unsolved. Finally, the provision of robustness checks ensured the reliability of our findings, which in turn can better assist policy making and guide future empirical research in the FD-growth relationship.

Last, an additional contribution to knowledge might be considered to be the discussion of the appropriateness of FD measures both at national level (reported in Chapter 5) and regional level (reported in Chapter 6). The investigation of multidimensional and complex process such as FD requires incorporation of all possible aspects (expenditure, tax and intergovernmental transfers, while the conventional measure of revenue decentralisation has to be substituted with a measure of tax autonomy). In this regard, the economic effect of FD should never be raised as a polar question. Instead, many questions with potentially different answers are in place depending on the measurement of FD. Also, to better understand the effects of this process on countries'/regions' economic performance, this research has carefully explored the nonlinearity of the FD-economic growth relationship, while also accounting for the potential endogeneity of this relationship.

However, as elaborated in Chapters 3 and 4, the nonlinearity might also be subject to the number of measures used and time span under investigation. As to the former, this research argued that when FD is measured by multiple measures, it becomes difficult to conclude on the nonlinearity of the relationship between FD and economic growth when multiple nonlinear relationships might simultaneously exist between each individual measure FD and economic growth. Also, investigating this relationship on a limited time span, such that of TEs, might limit the ability to observe the prevalence of a nonlinear relationship, different from other countries over a relatively long time.

6.4 Policy implications

Despite different pace of devolution from national to subnational governments among TEs, having decentralisation of any form on their agenda has always been tempting for ETEs and to a lesser extent for Southern Caucasus TEs. Whilst the basic problem of legacies from the former socialist regimes seems to have been overcome, the process of FD still poses many old and new challenges to these countries. Given the increased importance of FD during the last years and the ongoing process of transition and accession to the EU, the empirical evidence obtained in this research programme can improve the understanding of FD as a tool for development, and consequently help policy making in these countries. Whilst the progress in the FD process varies extensively across countries, our policy recommendations will be relatively wide, from strengthening democracy to increasing revenue autonomy. In this regard, countries are grouped into three categories, as classified in Chapter 1, so that the policy recommendations could be better addressed to the specific group of countries, namely (i) the advanced decentralisers, (ii) the intermediate decentralisers, and (iii) the laggard decentralisers. As this coincides with the advancement in economic and institutional reforms measured by the transition index, it further improves the targeting of policy recommendations to each group of countries.

Starting from the macro evidence at national level reported in Chapter 5, the findings imply that the effect of FD on economic growth across the transition stages (advanced, medium and earlier stage of transition) are different. Such differences in the economic effect of FD also represents different paths across TEs regarding their FD reform and challenges. Our policy recommendations will target the three dimensions of FD: expenditure, revenue and intergovernmental transfers.

With regard to the expenditure decentralisation, the positive effect of FD among advanced decentralisers embodies successful decentralisation process of spending occurring in these countries. These countries have been keen to decentralise and harmonise their reform to the EU standards, by increasingly promoting the role of subnational governments in the provision of goods and services. Having established a sound system of expenditure decentralisation, the advanced decentralisers seem to have overcome the lack of clarity, stability and accountability regarding the main functions devolved to subnational level. However, the need to improve the efficiency of their spending in growth-enhancing expenditure should always be considered as challenging. As argued in Chapter 3, FD, by altering the composition of public investments towards more productive spending at local level, can boost the local economic development. Analysing the efficiency (based on over/under provision) of local goods and services increases the existing conducive effect of expenditure decentralisation on economic growth. Contrary, the negative or an insignificant effect among countries at early and medium stages of transition has come as no surprise. These countries, part of the second and third group of decentralisers, lack clear assignment of responsibilities, under provision of adequate basic public goods and services for citizens, accompanied by the lack of transparency and accountability (Dabla-Norris, 2006). Despite the improvement among the intermediate group of countries, especially the new EU member countries (Rodriguez-Pose and Kroijer, 2009), policy interventions might involve the strengthening of accountability and capacity building of subnational governments at all levels (regional, municipal and village). As suggested by Wetzel and Dunn (2001), strengthening accountability among TEs is vital since it contributes directly to the efficiency of local public goods provision. Holding elections at all levels of governance, increasing citizens' participation and strengthening democracy might be considered as potential tools to utilise the advantages of FD. Further, focusing on community needs by providing required services (Wetzel and Dunn, 2001) constitutes an important aspect to be improved in the above groups regarding the expenditure assignments. However, two issues require caution when referring to the functions of local governments. First, the assignment of responsibility to local government does not necessarily match with the corresponding funds, either from own sources or intergovernmental transfers. In this regard, policymakers should engage not only in determining the functions of local government but also in analysing the composition of local spending; whether the majority of spending goes to investment or administrative expenses (social sector employees' wages). The latter problem appears to be prevalent in some countries of the second and third group of decentralisers, where according to NALAS (2017), local governments in Bulgaria, Moldova and Romania pay the full costs of pre-university education and health sector. This evidence urges caution on the intergovernmental fiscal relations between national and subnational governments.

Second, despite the persistent progress on the expenditure side, the economic effect of FD in all TEs might be compromised by the economies of scale, which is directly linked to the excessive territorial fragmentation of the country (Dabla-Norris, 2006). Policy interventions might be required to lower the cost of the provision of goods and services, especially in small municipalities, by considering the territorial organisation of the country (the Czech Republic, Slovakia and already considered in Albania), or/and by incentivising the cooperation between local government units or even the creation of micro-regions (Vigvari, 2010; Barati-Stec, 2012). In addition to the above purpose, cooperation between local governments might tackle problems of human capital shortages and weak tax bases, especially among small units (NALAS, 2017).

With respect to the second measure of FD, tax decentralisation, the empirical findings are in accordance with the evidence of the limited revenue autonomy in almost all transition countries. Irrespective of the progress regarding revenue decentralisation, all three groups of decentralisers appear to have low power to levy taxes or user fees by experiencing high dependency to central government funds. Whilst some improvements were noticed among the advanced reformers, the challenge of developing adequate revenue systems remains prevalent in all TEs. Also, based on the findings of Chapter 5, where countries are unable to utilise tax decentralisation as a development tool at all stages of transition, our results have policy implications for governments to expand the variety of taxes and fees utilised at local level. Local governments in developing and transition economies usually utilise property taxes, business taxes, personal income taxes, excises and general sales taxes (Bird, 1999). Whilst some of the countries of Eastern Europe (i.e. Poland and Hungary) have managed to receive a share of personal income tax and business tax as part of their own revenue, other countries of South Eastern Europe and Southern Caucasus are far away from considering such taxes part of their own sources. This becomes of special importance in the intermediate and laggard decentralisers where the devolution of responsibility for goods and service provision is conducted without the corresponding revenue side. Instead, the persisting weak local capacity in raising its own revenue should focus on decreasing the dependency to intergovernmental transfers. Substantial efforts, not necessarily permanent, are needed to enhance their revenue capacities, while at the same time improving the problem of tax collection and administration. Part of the answer is to enforce the existing local taxes such as property taxation, as already argued by NALAS (2017), while also ensuring the well-functioning of real estate market. On the other hand, introducing surcharges (piggybacking), such as fixed shares of personal income tax, social insurance taxes or business taxes, becomes vital to the exploitation of the benefits of FD by spending the money at the same jurisdiction they are collected. Attention, also, should be paid to the political will both at local and central level to enforce the local government administrative and financial capacity. Hence, given the uneasy relationship between the two or even three tiers of governments at local, regional and central level (Dallago, 2013), further decentralisation reforms should not only focus on augmenting revenue autonomy within a well-defined structure, but also accompany this process by training and monitoring, which would build the capacity of local governments (Ainsoo *et al.,* 2000; Wetzel and Dunn, 2001).

Third, the intergovernmental transfers, as an inevitable aspect of FD, also require special focus. Not accompanying expenditure decentralisation by revenue decentralisation has led local governments in TEs to high dependency on central governments or other institutions (i.e. EU funds). Despite the improvement in clarifying the transfer system in almost all TEs, there is still need to address issues regarding the formula-based process, transparency and monitoring of the grants and whether the latter have the desired impact. In line with the argument of Wetzel and Dunn (2001), the transfer process has been unstable and transparent in many cases, though the advanced reformers make an exception regarding the well-defined and transparent fiscal relations between the two tiers of government. In terms of policy recommendations, first, it is necessary that the top-down policies coordinate with the local level's needs. Second, the transfer schemes should be transparent both for the horizontal and vertical grants. However, a potential problem in these countries is the lack of incentives, partly generated by the transfers, which may force local governments to demand additional grants (Dethier, 2000) and consequently increase the national deficit. In the same vein, local borrowing should be regulated and in addition, monitored in order not to create excessive and uncontrolled debt.

6.5 Limitations

Despite several important contributions to the existing theoretical and empirical literature, this thesis faced various limitations that need to be acknowledged and discussed. The first limitation has resulted from the lack of data, both at national and regional level, which had implications for the empirical analysis in Chapters 5 and 6. With regard to the empirical investigation at national level, the first concern was related to the IMF database, as already elaborated in Section 5.3.1. Whilst this is the only available source for FD measures in TEs, it is rather limited regarding disaggregated information concerning the type of transfers (conditional vs unconditional) and revenue (shared taxes vs other taxes). Disaggregated information would significantly contribute to the use of FD measures which would capture the real degree of autonomy of local governments. The lack of such information did not allow to control for any potential differences in the economic effect of transfers and taxes based on their different types.

Also, the lack of data appeared as a major challenge in Chapter 6. Although information was gathered by individual country statistical offices and Ministries of Finance, the scarcity of the data forced us to select countries for which data were available at regional level. Further, in the absence of crucial data regarding some determinants of regional growth at regional level for Albania and Estonia, we had to make few assumptions. More precisely, we measured gross enrolment rates at regional level based on the definition of the Eurostat (given the substantial lack of stock or qualitative measures of education) and disaggregated gross fixed capital formation by using the number of firms at each region as a weighting factor. The inability to disaggregate some variables (i.e. trade openness) also limits the findings of this research. Indeed, having data at regional level for all ETEs would further contribute to knowledge, while findings could be easily comparable between national and regional level for the same set of countries, namely results of Chapter 5 with Chapter 6.

Also, in the absence of information regarding the main variables of interest, FD measures had to be adapted to regional level to accurately measure the expenditure decentralisation, tax autonomy and intergovernmental relations between central and local governments. Similar to the first limitation, enrichment of FD data by the type of transfers and taxes would have given more insights into the FD-economic growth relationship and consequently provided better policy recommendations.

Last, as already argued in previous sections, FD has a complex and multidimensional nature and so is the FD-economic growth relationship, therefore different channels of transmission have been proposed in the literature to disentangle this relationship from a theoretical perspective. Whilst the focus of this thesis is the investigation of direct economic effect of FD, exploring the indirect effects of FD both on regional and national economic growth and other dimensions of decentralisation (i.e. political decentralisation, territorial fragmentation) from the empirical perspective might have provided further insights into better detangling this relationship.

6.6 Directions for future research

Although this research has tackled some specific research question related to the economic effect of FD, it also raised many potential questions for future research. Several avenues for research, listed below, are suggested in this section that would further enrich the theoretical and empirical literature on FD-economic growth relationship.

First, the multidimensional nature of FD and the vague theoretical ground between FD and economic growth call for future research to move toward a more comprehensive theoretical framework. A possible extension might be the incorporation of the other two dimensions of decentralisation, the political and administrative decentralisation, and the investigation of the indirect effect of FD more in details. In this context, it might be interesting to observe the economic effect of FD from the political perspective (local political cycles, left-wing vs right-wing parties) and fragmentation of countries (number of regions, municipalities etc.), while also disaggregating this relationship at lower levels of aggregation.

Second, building upon the empirical findings of the MRA, future research may use additional estimation techniques to explore from a different perspective the heterogeneity in the literature, while also serving as a validation to the existing findings. In this regard, a Bayesian approach could be employed as an estimation technique which considers all possible model uncertainty and base inference on a weighted average of all subset of explanatory variables in an MRA (Feldkircher and Zeugner, 2009). Also, a potential extension of our MRA might be to group variables in panel by country instead of study, which would allow running a country-specific MRA instead of the conventional study-specific MRA. Alternatively, conducting an MRA only to transition economies, while the empirical research enriches, might provide more insights regarding the heterogeneity of the economic effect of FD.

Third, potentially the most interesting finding of this research, finding that FD is a normal good in TEs, could be further extended and investigated in other contexts of investigation such as developed and developing countries. Also, a similar approach could be used to test the same hypothesis at regional level, though in a limited and homogenous set of countries, by using the recently published dataset on the Quality of Data published by the Quality of Data Institute.

Another interesting research question, not directly related to the focus of this thesis is the investigation of the potential effect that FD might have on inequality. Decentralization of expenditure and revenues give rise to a variety of subnational government responses to individuals within the same country, which generates an uneven distribution of public services, regardless of their preferences. The local delivery of basic social and/or economic services is directly linked to the redistribution of income across individuals and regions within a country, and thus influences income inequality. Prud'homme (1995) suggests that FD, all else equal, is likely to lead to greater concentration of resources in certain geographic areas. Whereas, greater central provision of public services, harmonisation or a redistributive grant system are likely to lead to an equal distribution of resources across regions/jurisdictions. Whilst this and the majority of empirical research has focused on economic growth, shifting to the consequences of FD on the equity side both from aggregate level and household level using spatial econometrics, might be worth investigating in future.

Another possible extension of this research could be the investigation of the efficiency of local public services. Based on the Oates theorem regarding the preference matching and (consumer and producer) efficiency, this research could be extended by investigating the efficiency of public services delivery (i.e. education, health) instead of policy outcome such as economic growth. Focusing on TEs and using both parametric and nonparametric frontier techniques, the efficiency of public services and the potential effect of FD on the efficiency represent a highly recommended research. Similarly, the impact of FD on the composition of public expenditure or the determinants of FD in the context of TEs might also be a possible extension of our research.

References

Abramovitz, M. (1986). Catching Up, Forging Ahead, and Falling Behind, *The Journal of Economic History*, 46(2), 385-406.

Abreu, M. A, De Groot, H. L. F. & Florax, R. J. G. M. (2005). A meta-analysis of beta-convergence: The legendary 2. *Journal of Economic Surveys*, *19*, 389–420. https://doi.org/10.1111/j.0950-0804.2005.00253.x

Agundez-García, A. (2000). Fiscal Revenues Decentralization and Regional Economic Growth. *ERSA conference papers ersa00p272*, European Regional Science Association.

Ainsoo, D. A., Jaansoo, T. M., Pedastsaar, E., Sootla, G., Surva, A., Tammert, P. & Tuur, T. (2002). Local Government Budgeting: Estonia. *Local Government Budgeting.* In Hogye, M. (Eds.). 273–327. Budapest, Hungary: Open Society Institute.

Akai, N. & Sakata, M. (2002). Fiscal Decentralization Contribute to Economic Growth: Evidence from State – Level Cross – Section data for United States. *Journal of Urban Economics*, 52 (1), 93-108.

Akai, N., Nishimura, Y. & Sakata, M. (2007). Complementarity, fiscal decentralization and economic growth. *Economics of Governance*. https://doi.org/10.1007/s10101-007-0032-5

Alibegović Jurlina, D. & Slijepčević, S. (2012). Decentralization in Croatia: Problems and possible solutions, *EUGOV Working Paper*, 33, 2–35.

Alptekin, A. & Levine, P. (2012). Military expenditure and economic growth: A meta-analysis. *European Journal of Political Economy*, *28*(4), 636–650. https://doi.org/10.1016/j.ejpoleco.2012.07.002

Amin, A. (1999). An institutionalist perspective on regional economic development. *International Journal of Urban and Regional Research*, 23, 365-378.

Antonis, A., Pantelis, K. & Athina, L. (2012). The effect of globalization on capital taxation: What have we learned after 20 years of empirical studies? Available at: https://mpra.ub.uni-muenchen.de/38899/1/MPRA_paper_38899.pdf%20date%20of%20access%201.04.2013 accessed day 13.03.2013.

Arellano, M. (1989). A note on the Anderson-Hsiao estimator for panel data. *Economic Letters*, 31(4), 337-341.

Arzaghi, M. & Henderson, J. V. (2005). Why countries are fiscally decentralizing. *Journal of Public Economics*, *89*(7), 1157–1189. https://doi.org/10.1016/j.jpubeco.2003.10.009

Arze del Granado, F. Javier, C, D. & Gillingham, R. (2012). The Unequal Benefits of Fuel Subsidies: A Review of Evidence for Developing Countries, *World Development*, 40(11), 2234-2248.

Asatryan, Z. & Feld, L. P. (2013). Revisiting the link between growth and federalism: A Bayesian model averaging approach, *ZEW Discussion Papers*, 13-049.

Asatryan, Z. (2011). *Fiscal Decentralization and Economic Growth in OECD Countries: A Bayesian Model Averaging Approach.* Master Thesis. University of HU Berlin.

Ascani, A., Crescenzi, R., & Iammarino, S. (2012). Regional Economic Development: A Review. *SEARCH Working Paper*, *1*(03), 1–26. Retrieved from http://www.ub.edu/searchproject/wp-content/uploads/2012/02/WP-1.3.pdf

Ashenfelter, O., Harmon, C. & Oosterbeek, H. (1999). A Review of Estimates of the Schooling/Earnings Relationship, with Tests for Publication Bias, *Labour Economics,* 6, 453–470.

Bahl, R. (2007). Opportunities and Risks of Fiscal Decentralization: A Developing Country Perspective. In Ingram, G. & Hong, Y.-H. (Eds.). *Fiscal Decentralization and Land Policies. Proceedings of the 2007 Land Policies Conference*, Vern Associates, Massachusetts, 19-37.

Bahl, R. (2013). Implementation Rules for Fiscal Decentralization. *Annals of Economics and Finance*, *14*(January), 851–884. Retrieved from http://ideas.repec.org/a/cuf/journl/y2013v14i3bahl.html

Bahl, R. W. & Linn, J. (1992). *Urban Public Finance in Developing Countries*. New York: Oxford University Press.

Bajo-Rubio, O. (2000). A further generalization of the Solow growth model: the role of the public sector. *Economics Letters,* 68, 79–84.

Baldacci, E., Benedict, C., Sanjeev, G. & Qiang C. (2004). Social Spending, Human Capital, and Growth in Developing Countries: Implications for Achieving the MDGs. *IMF Working* Paper No. 04/127.

Baltagi, B. (1995). *Econometric analysis of panel data*. Chichester: John Wiley.

Barati-Stec, I. (2012). Hungary: An Unfinished Decentralization, *IMFG Papers on Municipal Finance and Governance.* No.11. Institute of Municipal Finance & Governance, Munk School of Global Affairs, University of Toronto.

Bardhan, P. (2002). Decentralization of Governance and Development. *Journal of Economic Perspectives,* 16 (4), 185–205.

Barro, R. (1990). Government Spending in a Simple Model of Endogenous Growth, *Journal of Political Economy*, 98(5), S103-26.

Barro, R. J. & Lee, J. (1993). International Comparions of Educational Attainment, 1960-1985, *Journal of Monetary Economics*, 32(3), 363-394.

Barro, R. J. & Lee, J. (2013). A new data set of educational attainment in the world, 1950–2010. *Journal of Development Economics*, 104, 184-198.

Barro, R. J. & Lee, J. (2014). Database: 2014 30 June Update: The new version (2.0) of data set, available at http://www.barrolee.com/ accessed day 03.08.2017.

Barro, R. J. & Sala -i-Martin, X. (1995). Economic Growth. New York: McGraw-Hill.

Barro, R. J. & Sala-i-Martin, X. (2004). *Economic Growth* – 2nd edition, The MIT Press, Cambridge, Massachusetts, London.

Bartik, T. J. (1991). Who Benefits from State and Local Economic Development Policies?, Books from Upjohn Press, W.E. Upjohn Institute for Employment Research, number wbsle, November.

Bartik, T. J. (1994). Jobs, Productivity, and Local Economic Development: What Implications Does Economic Research Have for the Role of the Government? *National Tax Journal*, *47*(4), 847–861. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=buh&AN=9501304535&site=bsi-live

Bartlett, W., Malekovic, S. & Monastiriotis, V. (2013). Decentralization Paradigms in South East Europe: An Introduction. In Bartlett, W., Malekovic, S. & Monastiriotis, V. (Eds.). *Decentralization and Local Development in South East Europe*. London, Palgrave MacMillan.

Bartolini, D., Stossberg, S., & Blöchliger, H. (2016). Fiscal Decentralisation and Regional Disparities. *OECD Department Working Papers*, No. 1330. https://doi.org/10.1787/5jlpq7v3j237-en

Baskaran, T. & Feld, L. P. (2009). Fiscal decentralization and economic growth in OECD countries: is there a relationship? *CESIFO Working Paper*, *41*(4), 1–25. https://doi.org/10.1177/1091142112463726.

Baskaran, T. (2010). On the link between fiscal decentralization and public debt in OECD countries, *Public Choice*, 145(3), 351-378.

Baskaran, T., Feld, L. P. & Schnellenbach, J. (2016). Fiscal federalism, decentralization, and economic growth: A meta-analysis. *Economic Inquiry*, *54*(3), 1445–1463. https://doi.org/10.1111/ecin.12331

Bassanini, A. & Scarpetta, S. (2001), Does Human Capital Matter for Growth in OECD Countries? Evidence from Pooled Mean-Group Estimates. *OECD Economics Working Paper* No. 282.

Bateman, I. & Jones, A. P. (2003). Contrasting Conventional with Multi-Level Modeling Approaches to Meta-Analysis: Expectation Consistency in U.K. Woodland Recreation Values. *Land Economics*, 79, issue 2, 235-258.

Baum, C., Nichols, A. & Schaffer, M. (2011). Evaluating one-way and two-way cluster-robust covariance matrix estimates. URL: https://pdfs.semanticscholar.org/presentation/493d/051237c88ab817bbecd416e72bf2b1979798.pdf accessed day 19.02.2015.

Baum, C.F. (2006). *An introduction to modern econometrics using Stata*. College Station, Texas: Stata Press.

Baumol, W. (1986). Productivity Growth, Convergence, and Welfare: What the Long-run Data Show, *American Economic Review*, 76(5), 1072-1085.

Becker B. J. & Wu, M. J. (2007). The synthesis of regression slopes in meta-analysis. *Stat. Sci,* 22, 414 – 429.

Behnisch, A., Buettner, T. & Stegarescu, D. (2003). Public Sector Centralization and Productivity Growth: Reviewng the German Experience, *zew Discussion Paper*, 02-03, Ludwig-Maximilians University of Munich.

Bektemirov, K. & E. Rahimov. (2001). Local Government in Uzbekistan. In Popa, V. M. (Eds.). *Developing New Rules in the Old Environment*. Budapest: LGI/OSI Europe, 469-520.

Bellemare, M. F., Masaki, T. & Pepinsky, T. B. (2015). Lagged Explanatory Variables and the Estimation of Causal Effects. URL: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2568724 accessed day 17.05.2017.

Berthold, N., Drews, S. & Thode, E. (2001). Die föderale Ordnung in Deutschland Motor oder Bremse des wirtschaftlichen Wachstums?, *University of Wurzburg Discussion Paper,* No. 42.

Bird, R. & Rodriguez, E. R. (1999). Decentralization and poverty alleviation. International experience and the case of the Philippines. *Public Admin. Dev.*, 19, 299-319.

Bird, R. M. (1993). Threading the Fiscal Labyrinth: Some Issues in Fiscal Decentralization. *National Tax Journal*. https://doi.org/10.1017/CBO9780511625909.009

Bird, R. M. (1995). Local Finance: Problems, Perspectives, and Possibilities. *Major Report* No. 31, Centre for Urban and Community Studies, University of Toronto.

Bird, R. M. (1999). *Rethinking Subnational Taxes*: *A New Look at Tax Assignment*. IMF Working Paper, 99/165.

Bird, R. M., Ebel, R. D. & Wallich, C. I. (1995). *Decentralization of the socialist state: intergovernmental finance in transition economies. Decentralization of the socialist state: intergovernmental finance in transition economies.* Washington, D.C.: World Bank Publications

Blundell, R. & Bond. S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics,* 87, 115–143.

Bodman, P. & Campbell, H. (2009a). Fiscal decentralisation, macroeconomic conditions and economic growth in Australia. *School of Economics,* Retrieved from http://www.uq.edu.au/economics/mrg/2609.pdf

Bodman, P. & Ford, K. (2006). Fiscal Federalism and Economic Growth in the OECD, *MRG@UQ Discussion Paper* No. 7, School of Economics, University of Queensland.

Bodman, P. & Ford, K. (2011). Fiscal decentralization and economic growth in the OECD. *Applied Economics*, *43*(23), 3021–3035. https://doi.org/10.1080/00036840903427208

Bodman, P. (2006). ISSN 1833-4474 Fiscal Decentralisation and Economic Growth in the OECD. *Working Paper*.

Bodman, P., Heaton, K. A. & Hodge, A. (2009b). Fiscal Decentralisation and Economic Growth: A Bayesian Model Averaging Approach. URL: http://www.uq.edu.au/economics/mrg/3509.pdf accessed day 20.07.2016. accessed day 05.10.2016.

Boetti, L., Piacenza, M. & Turati, G. (2010). Decentralization and Local Governments' Performance: How Does Fiscal Autonomy Affect Spending Efficiency. *University of Tourin, Department of Economics and Public Finance "G. Prato" Working Paper Series* No. 11.

Bond, S., Hoeffler, A. & Temple, J. (2001). GMM Estimation of Empirical Growth Models. *Economic Papers*, W21. Nuffield College, University of Oxford.

Borenstein, M., Hedges, L. V., Higgins, J. P. T. & Rothstein, H.R. (2009). *Introduction to meta-analysis*. John Wiley, West Sussex, UK.

Brennan, G. & Buchanan, J. (1980). *The Power to Tax*. Cambridge University Press.

Breusch, T., Ward, M.B., Nguyen, H. & Kompas T. (2011). On the fixed-effects vector decomposition. *Political Analysis*. 19(2), 147-164.

Breuss, F. & Eller, M. (2004). The Optimal Decentralisation of Government Activity: Normative Recommendations for the European Constitution, *Constitutional Political Economy*, 15(1), 27-76.

Brueckner, J. K. (2004). Fiscal decentralization with distortionary taxation: Tiebout vs. tax competition. *International Tax and Public Finance* 11, 133-53.

Buser, W. (2011). The impact of fiscal decentralization on economics performance in high-income OECD nations: an institutional approach*, Public Choice,* 149(1), 31-48.

Buss, T. F. (2001). The Effect of State Tax Incentives on Economic Growth and Firm Location Decisions: An Overview of the Literature. *Economic Development Quarterly*, 15(1), 90 – 105.

Calmfors, L. & Driffill, J. (1988). Bargaining structure, corporatism, and macroeconomic performance. *Economic Policy*, 6, 14-61.

Cameron, A. C., Gelbach, J. B. & Miller D. L. (2011). Robust inference with multiway clustering. *Journal of Business & Economic Statistics*, 29(2), 238-249.

Cantarero, D. & Gonzalez, P. P. (2009). Fiscal Decentralization and Economic Growth: Evidence from Spanish Regions. *Public Budgeting & Finance*, *29*(4), 24–44.

Carrion-i-Silvestre, J. L., Espasa, M. & Mora, T. (2008). Fiscal Decentralization and Economic Growth in Spain. *Public Finance Review*, *36*(2), 194–218.

Cevik, S. (2017). Size matters: fragmentation and vertical fiscal imbalances in Moldova. *Empirica*, *44*(2), 367–381.

Chang, R., Kaltani, L. & Loayza, N. (2005). Openness can be good for Growth: The Role of Policy Complementarities. *World Bank Policy Research Working Paper*, 3763.

Cipollina, M. & Salvatici, L. (2007). EU and developing countries: an analysis of preferential margins on agricultural trade flows. *Working Papers,* 7219, TRADEAG - Agricultural Trade Agreements.

Coric, B. & Pugh, G. (2008). The effects of exchange rate variability on international trade: a meta-regression analysis, *Applied Economics*, 42(20), 2631-2644. DOI: 10.1080/00036840801964500.

Costa-Font, J., Gammill, M. & Rubert, G. (2011). Biases in the healthcare luxury good hypothesis: A meta-regression analysis, *Journal of the Royal Statistical Society*, 174, 95- 102.

Crescenzi, R. & Rodríguez-Pose, A. (2011). Reconciling top-down and bottom-up development policies *Environment and Planning A*, 43 (4). 773-780.

Dabla-Norris, E. (2006). The Challenge of Fiscal Decentralisation in Transition Countries. *Comparative Economic Studies*, 48 (1), 100-131.

Dallago, B. (2013). Puzzles in Local Development and Transformation in South East Europe. In Bartlet T. W., Maleković, S. & Monastiriotis, V. (Eds.). *Decentralization and Local Development in South East Europe,* Palgrave Macmillan, 29–50;

Davey, K. & Peteri, G. (2008). Taxes, Transfers and Transition – Adjusting Local Finances to New Structures and Institutions: The Experience of the Czech Republic, Hungary and Slovakia. In Culson, A. & Campbell, A. (Eds*.). Local Government in Central and Eastern Europe: The Rebirth of Local Democracy*. Routledge, London and New York.

Davoodi, H. & Zou, H. (1998). Fiscal decentralization and economic growth: a cross-country study. *Journal of Urban Economics*, *43*(2), 244–257.

De Hoyos, R. E. & Sarafidis, V. (2006). Testing for cross-sectional dependence in panel-data models. *The Stata Journal*, 6(4), 482-496.

De Mello, L. R. (2000). Fiscal decentralization and intergovernmental fiscal relations: A cross-country analysis. *World Development*, *28*(2), 365–380.

Delgado, M. S., Henderson, D. J. & Parmete, C. F. (2012). Does Education Matter for Economic Growth*? IZA Discussion Paper Series*, ZA DP No. 7089.

Desai, R. M., Freinkman, L. M. & Goldberg, I. (2003). Fiscal Federalism and Regional Growth: Evidence from the Russian Federation in the 1990s. *The World Bank, Policy Research Working Paper Series: 3138, 2003*.

Desai, R., Freinkman, L. & Goldberg, I. (2005). Fiscal federalism in rentier regions: Evidence from Russia. *Journal of Comparative Economics*, 33(4), 814-834.

Devarajan, S., Vinaya, S. & Zou, H. (1996). The Composition of Public Expenditures and Economic Growth. *Journal of Monetary Economics*, 37, 313-344.

Devkota, K. L. (2011). Impact of Fiscal Decentralization on Economic Growth in the Districts of Nepal. Preliminary Draft. http://lbfc.gov.np/sites/default/files/Impact%20of%20Fiscal%20Decentralization%20on%20%20Economic%20Growth%20of%20Nepal%202013.pdf accessed day 27.03.2013.

Dimos, C. & Pugh, G. (2016). The effectiveness of R&D subsidies: A meta-regression analysis of the evaluation literature, *Research Policy*, 45(4), 797-815.

Ding, Y. (2007). Fiscal Decentralization and Economic Growth in China, 1994-2002. *Journal of Chinese Economic and Business Studies*, *5*(3), 243–260.

Disdier A. C. & Head, K. (2008). The Puzzling Persistence of the Distance Effect on Bilateral Trade, *The Review of Economics and Statistics,* 90(1), 37-48.

Dornetshumer, E. (2007). System GMM estimation of Empirical Growth Models. URL: http://homepage.univie.ac.at/robert.kunst/pan07_dornetshumer.pdf accessed day 10.01.2017.

Doucouliagos, C. & Laroche, P. (2003). What Do Unions Do to Productivity? A Meta-Analysis. *Industrial Relations*, 42, 650-691.

Doucouliagos, C. & Paldam, M. (2012).The robust result in meta-analysis of aid effectiveness: A response to Mekasha and Tarp. *Economics Series* 2012(4), Deakin University, Faculty of Business and Law, School of Accounting, Economics and Finance.

Doucouliagos, C. & Stanley, T. D. (2013). Are all economic facts greatly exaggerated? Theory competition and selectivity. *Journal of Economic Surveys*, *27*(2), 316–339.

Doucouliagos, C. & Ulubasoglu, M. (2008). Democracy and Economic Growth: A Meta- nalysis. *American Journal of Political Science,* 52(1), 61-83.

Dowrick, S. & Nguyen, D. T. (1989). OECD Comparative Economic Growth 1950-85: Catch-Up and Convergence, *American Economic Review*, 79(5), 1010-1030.

Driscoll, J. C. & Kraay, A. C. (1998). Consistent Covariance Matrix Estimation with Spatially Dependent Panel Data. *Review of Economics and Statistics*, 80, 549-560.

Dufrénot, G., Mignon, V. & Naccache, T. (2009). The slow convergence of per capita income between the developing countries: "growth resistance" and sometimes "growth tragedy". *University of Nottingham, CREDIT. Discussion Papers*.

Dziobek, C., Gutierrez, C. M. & Kufa, P. (2011). Measuring Fiscal Decentralization – Exploring the IMF's databases. *IMF Working Paper*, WP/11/126.

Ebel, R. D. & Yilmaz, S. (2002). On the Measurement and Impact of Fiscal Decentralization. *Policy Research Working Paper*, No.2809. World Bank, Washington, D.C.

EBRD (1994). Transition Report October 1994. URL: http://www.ebrd.com/documents/comms-and-bis/pdf-transition-report-1994-english.pdf accessed day 30.05.2015 accessed day 30.05.2015.

EBRD (2004), Transition Report 2004: Infrastructure, London, EBRD.

EBRD (2005). Transition Report 2005 – Business in Transition. URL: http://www.ebrd.com/documents/comms-and-bis/pdf-transition-report-2005-english.pdf accessed day 30.05.2015.

Efendic, A. & Pugh, G. (2015). Institutional Effects on Economic Performance in Transition: A Dynamic Panel Analysis. Acta Oeconomica. 65(4), 503-523.

Efendic, A., Pugh, G. & Adnett, N. (2011). Institutions and economic performance: A meta-regression analysis. *European Journal of Political Economy*, *27*(3), 586–599.

Egger, M., Smith, G. D., Schnieder, M. and Minder, C. (1997). Bias in Meta-Analysis Detected by a Simple, Graphical Test. *BMJ, British Medical Journal,* 315, 629–634.

Eicher, T. & Schreiber, T. (2010). Structural policies and growth: Time series evidence from a natural experiment, *Journal of Development Economics*, 91 (1), 169-179.

Eller, M. (2004). The determinants of fiscal decentralisation and its impact on economic growth: Empirical evidence from a panel of OECD countries. *Unpublished Master Thesis University of Vienna*, (0). Retrieved from http://www2.nes.ru/~eller/Diplomathesis_MarkusEller.pdf

Enikolopov, R. & Zhuravskaya, E. (2007). Decentralization and Political Institutions. CEFIR Working Paper; *Journal of Public Economics*, 91(11-12), 2261-2290.

Estache, A. & Sinha, S. (1995) Does Decentralization Increase Spending on Public Infrastructure?. *World Bank Policy Research* Working Paper No. 1457.

Eurostat (2017). Regional Statistics Database. URL: http://ec.europa.eu/eurostat/web/regions/data/database accessed day 07.03.2016. accessed day 10.09.2017.

Eyraud, L. & Lusinyan, L. (2011). Decentralizing Spending More than Revenue: Does it Hurt Fiscal Performance?. *IMF Working Papers* WP/11/226, 1-33.

Ezcurra, R. & Pascual, A. P. (2008). Fiscal decentralization and regional disparities: evidence from several European Union countries, *Environment and Planning A*, 40 (5), 1185-1201.

Falcetti, E., Lysenko, T. & Sanfey, P. (2006). Reforms and growth in transition: Re-examining the evidence. *Journal of Comparative Economics*, 34, 421–445.

Faridi, M. Z. (2011). Contribution of Fiscal Decentralization to Economic Growth: Evidence from Pakistan. *Pakistan Journal of Social Sciences (PJSS)*, 31(1), 1-13.

Feiock, R. C., António F. Tavares & Mark L. (2008). Policy Instruments Choices for Growth Management and Land Use Regulation. *Policy Studies Journal*, 36 (3), 461-480.

Feld, L. P., Baskaran T. & Schnellenbach, J. (2009b). Fiscal Federalism, Decentralization and Economic Growth: A Meta-Analysis, *Working Paper, University of Heidelberg, ZEW, CESifo, CREMA, SIAW-HSG.*

Feld, L. P., Baskaran, T. & Necker, S. (2009a). Decentralization, Transfers and Economic Performance – Evidence from Germany. *6th Norwegian-German Seminar on Public Economics.* 13-14 November 2009 CESifo Conference Centre, Munich.

Feld, L. P., Kirchgässner, G. & Schaltegger, C. (2004). Fiscal Federalism and Economic Performance: Evidence from Swiss Cantons. *Public Finance*.

Feld, L. P., Zimmermann, H. & Döring, T. (2007). Fiscal federalism, decentralization and economic growth. In *Public Economics and Public Choice: Contributions in Honor of Charles B. Blankart*, 103–133).

Feldkircher, M. & Zeugner, S. (2009). Benchmark Priors Revisited:on Adaptive Shrinkage and the Supermodel Effect in Bayesian Model Averaging. *IMF Working Papers*, *09*(202), 1. https://doi.org/10.5089/9781451873498.001

Feltenstein, A. & Iwata, S. (2005). Decentralization and macroeconomic performance in China: Regional autonomy has its costs. *Journal of Development Economics*. https://doi.org/10.1016/j.jdeveco.2004.01.004

Feruglio, N. & Anderson, D. (2008). Overview of Fiscal Decentralization. In Feruglio, N. & Anderson, D. (Eds.). *Fiscal Decentralization Handbook*. Chapter 1. United Nations Development Program, Bratislava Regional Center.

Filippetti, A. & Peyrache, A. (2015). Labour Productivity and Technology Gap in European Regions: A Conditional Frontier Approach. *Regional Studies*, 49(4), 532-554.

Filippetti, A. & Sacchi, A. (2013). Varieties of decentralization, institutional complementarities, and economic growth: evidence in OECD countries. *National Research Council of Italy and Birkbeck*, *44*(August), 24–26.

Fisman, R. & Gatti, R. (2002). Decentralization and corruption: evidence across countries, *Journal of Public Economics*, 83(3), 325-345.

Fiva, J. H. (2006). New Evidence on the Effect of Fiscal Decentralization on the Size and Composition of Government Spending. FinanzArchiv: *Public Finance Analysis* 62(2), 250–280.

Fox, W. F. & Murray, M. N. (1990). Local Public Policies and Interregional Business Development. *Southern Economic Journal*, 57(2), 413-27.

Frees, E. W. (1995). Assessing cross-sectional correlation in panel data. *Journal of Econometrics* 69, 393–414.

Frees, E.W. (2004). *Longitudinal and panel data: Analysis and applications for the social sciences.* Cambridge, UK: Cambridge University Press.

Frenkel M. (1986). Federal Theory. *Canberra Centre for Research on Federal Financial Relations.* Australian National University.

Fukasaku, K. & De Mello, L. (1998). Fiscal decentralization and macroeconomic stability: The experience of large developing countries and transition economies. In Fukasaka, K. & Hausmann, R. (Eds.). *Democracy, decentralization, and deficits in Latin America*. Paris, Organization for Economic Cooperation and Development.

Gaibullev, K., Sandler, T. & Sul, D. (2014). Dynamic Panel Analysis under Cross-Sectional Dependence. *Political Analysis*, 22, 258–273, doi:10.1093/pan/mpt029.

Gemmell, N., Kneller, R. & Sanz, I. (2013). Fiscal decentralization and economic growth: Spending versus revenue decentralization. *Economic Inquiry*, 51(4), 1915-1931.

Genc, M., Gheasi, M., Nijkam, P. & Pot, J. (2011). The Impact of Immigration on International Trade: A Meta-Analysis*, IZA Discussion Papers, No.* 6145.

Gil-Serrate, R. & López-Laborda, J. (2006). Revenue Decentralisation and Economic Growth in the Spanish Autonomous Communities, *ERSA conference papers*, European Regional Science Association.

Glass, G. V., McGaw, B. & Smith, M. L (1981). *Meta-Analysis in Social Research*. Beverly Hills, CA: Sage.

Goldfarb, R. (1995). The Economist-as-audience needs a methodology of plausible inference. *Journal of Economic Methodology*, 2(2), 201-22.

Goldsmith, M. (1992). Local Government. *Urban Studies*, 29 (4): 393-410.

Gonzales, L. V. (2014). Robust standard errors to spatial and time dependence when neither n nor t are very large. URL: https://editorialexpress.com/cgi-bin/conference/download.cgi?db_name=IAAE2014&paper_id=591 accessed day 02.06.2014.

Greene W. H. (2008). *Econometric analysis*, 6th Edition, Pearson Prentice Hall, Upper Saddle River.

Greene, W. H. (2011). Reply to rejoinder by Plümper and Troeger. *Political Analysis*. 19(2), 170-172.

Greene, W. H. (2012). *Econometric analysis*, 7th Edition, MPS Limited, Courier/Westford, Essex.

Gries, T. & Redlin, M. (2012). Trade Openness and Economic Growth: A Panel Causality Analysis, *Working Papers CIE*, No. 52, Paderborn University, CIE Center for International Economics.

Gujarati, D. N. (2004). *Basic Econometrics*. 4th Edition, McGraw-Hill Companies.

Hall, R. & C. I. Jones. (1999). Why Do Some Countries Produce So Much More Output per Worker than Others?" *Quarterly Journal of Economics,* 114, 83-116.

Hammond, G. W. & Tosun, M. S. (2009). The Impact of Local Decentralization on Economic Growth: Evidence from U.S. Counties. *IZA Discussion Paper Series* DP No.4574.

Hamzah, M. Z. (2005). Does Block Grant Generates Economic Growth on Province-Level in Indonesia After the Implementation of Fiscal Decentralization Policy. *Simposioum Riset Ekonomi II*.

Hanushek, E. A. & Woessmann, L. (2009a). Do better schools lead to more growth? Cognitive skills, economic outcomes, and causation. *NBER Working Paper* No. 14633.

Hanushek, E. A. & Woessmann, L. (2011). How much do educational outcomes matter in OECD countries? *Economics Policy*, 26(67), 427-491.

Hanushek, E.A. & Woessmann, L. (2009b). Schooling, cognitive skills, and the Latin American growth puzzle. *CESIFO Working Paper* No. 2667.

Harbord, R. and Higgins, J. (2008). Meta-regression in Stata. *Stata Journal,* 8(4), 493-519.

Harris, R., Bradburn, M., Deeks, J., Harbord, R., Altman, D. & Sterne, J. (2008) metan:fixed- and random-effects meta-analysis. *The Stata Journal,* 8(1), 3-28.

Hatfield, J. W. (2015). Federalism, taxation, and economic growth. *Journal of Urban Economics*, 87, 114–125.

Hausman, J. & Taylor, W. (1981). Panel Data and Unobservable Individual Effects, *Econometrica,* 49(6), 1377-98.

Headey, D. D. & Hodge, A. (2009). The Effect of Population Growth on Economic Growth: A Meta-Regression Analysis of the Macroeconomic Literature. *Population and Development Review*, 35, 221-248. doi:10.1111/j.1728-4457.2009.00274.x

Hejidra, B. J. & Van der Ploeg, F. (2002). *The Foundation of Modern Macroeconomics.* Oxford University Press, Oxford.

Helms, L. J. (1985). The Effect of State and Local Taxes on Economic Growth: A Time Series-Cross Section Approach, *The Review of Economics and Statistics*, 67(4), 574-82.

Higgins J. & Thompson, S. (2002). Quantifying heterogeneity in a meta-analysis. *Statistics in Medicine,* 21, 1539-1558.

Higgins, J. P. T., Thompson, S. G., Deeks, J. J. & Altman, D. G. (2003). Measuring inconsistency in meta-analyses. *BMJ: British Medical Journal*, *327*(7414), 557–560. https://doi.org/10.1136/bmj.327.7414.557

Hoechle, D. (2007). Robust standard errors for panel regressions with cross-sectional dependence. *The Stata Journal*, 7(3), 281-312.

Hoenack, S. A. (1993). Higher Education and Economic Growth. In Becker, W. E. & Lewis, D. (Eds.). *Higher Education and Economic Growth*. Kluwe Academic Publishers. New York. 21-50.

Hsiao, C. (2006). Panel data analysis—advantages and challenges, *Wise Working Paper Series*, URL: http://wise.xmu.edu.cn/cean/download.aspx?id=199 accessed day 16.02.2014

Huang & Cheng (2005). The Role of Fiscal Decentralization in Regional Economic Growth in China. URL: http://www3.nccu.edu.tw/~jthuang/The%20Role%20of%20Fiscal%20Decentralization.pdf accessed day 10.12.2016.

Iimi, A. (2005). Decentralization and economic growth revisited: An empirical note. *Journal of Urban Economics*, *57*(3), 449–461.

Im, T. & Lee, S. J. (2001). Time, Decentralization and Development. URL: http://www.umac.mo/fss/pa/3rd_conference/doc/all%20paper/English%20paper/1panelA/Tobin%20Im%20&%20Seung%20Jong%20Lee.pdf accessed day 10.11.2012.

International Monetary Fund (2014). Government Finance Statistics (Edition: November 2014). UK Data Service. DOI: http://dx.doi.org/10.5257/imf/gfs/2014-11

International Monetary Fund (2017). Government finance selected indicators. In Government Finance Statistics (GFS). Retrieved from http://data.imf.org/?sk=FA66D646-6438-4A65-85E5-C6C4116C4416, October 10, 2017.

Iqbal, N. & Nawaz, N. (2010). Fiscal Decentralization and Macroeconomic Stability: Theory and Evidence from Pakistan. URL: http://www.pide.org.pk/psde/pdf/agm26/Day1/Nasir%20Iqbal.pdf accessed day 21.11.2017.

Islam, N. (1995). Growth Empirics: A panel Data Approach. *The Quarterly Journal of Economics*, 1127–1170. https://doi.org/10.2307/2946651

Ismail, A. G., & Hamzah, M. Z. (2006). Fiscal decentralization and economic growth nexus: evidence from province-level cross-section data for Indonesia. *Review of Islamic Economics*. Retrieved from http://193.60.48.5/docview/36947240?accountid=15997 LA – English

Ismail, A. G., Hamzah, M. Z. & Ritonga, J. T. (2004). Fiscal Decentralization and Economic Growth: Evidence from Selected Muslim Countries. *Jurnal Ekonomi Pembangunan:* Kajian Ekonomi Negara Berkembang, 9(2), 109 – 116.

Jarrell, S. B. & Stanley, T. D. (1990). A Meta-Analysis of the Union-Nonunion Wage Gap, *ILR Review*, 44(1), 54-67.

Jin H., Y. Qian, B. & Weingast, R. (2005). Regional Decentralization and Fiscal Incentives: Federalism, Chinese Style. *Journal of Public Economics*, 89, 1719–1742.

Jin, J. & Zou, H. (2002). How does fiscal decentralization affect aggregate, national, and subnational government size?, *Journal of Urban Economics*, 52(2), 270-293.

Jin, J., & Zou, H. (2005). Fiscal Decentralization and Economic Growth in China. *Journal of Asian Economics*, *16(6)* (December), 1047–1064. https://doi.org/10.1080/14765280701656682.

Kappeler, A. & Välilä, T. (2008). Fiscal federalism and the composition of public investment in Europe. *European Journal of Political Economy*, Elsevier, 24(3), 562-570.

Kappeler, A., Solé-Ollé, A., Stephan, A. & Välilä, T. (2012). Does Fiscal Decentralization Foster Regional Investment in Productive Infrastructure? URL: https://www.diw.de/documents/publikationen/73/diw_01.c.396879.de/dp1204.pdf accessed day 10.08.2014.

Khattak, N. U. R., Ahmad, I. & Khan, J. (2010). Fiscal decentralisation in Pakistan. In *Pakistan Development Review*. 49 (4), 419–436.

Khmaladze, I. (2007). *Should Vertical Fiscal Imbalance Be Equalized? Does Fiscal Decentralization facilitate Economic Growth? Lessons for Georgia*. Master Thesis, Central European University.

Kim, H. (2006). Local decentralization and economic growth in Korea. http://www.karyiuwong.com/confer/gj06/papers/kim.pdf accessed day 10.05.2016.

Klugman, J. (1994). Decentralisation: A Survey of Literature from a Human Development Perspective. *UNDP Human Development Report Office* 1994 Occasional Papers. http://dx.doi.org/10.2139/ssrn.2294658

Kneller, R., Bleaney, M. F. & Gemmell, N. (1999). Fiscal policy and growth: evidence from OECD countries, *Journal of Public Economics*, 74 (2), 171-190.

Krivorotko, J. (2007). A destiny of local finance in Belarus: centralisation or decentralisation? Presented at the 15-th NISPAcee Annual Conference "*Leadership and Management in the Public Sector: Values, Standards and Competencies in Central and Eastern Europe*", held on May 17-19, 2007, Kiev, Ukraine.

Krugman, P. (1994). Competitiveness - a Dangerous Obsession. *Foreign Affairs*, 73(2), 28 - 44.

Kumar C. S. (2006). Human capital and growth empirics. *Journal of Development Areas*, 40(1), 153-179.

Kwon, M., Berry, F. & Feiock, R. (2009). Understanding the Adoption and Timing of Economic Development Strategies in U.S. Cities Using Innovation and Institutional Analysis. *Journal of Public Administration Research and Theory*, 19, 967-88.

Larson, A. M. (2002). Natural resources and decentralization in Nicaragua: are local government up to the job?. *World Development,* 30(1), 17-31.

Le, T., Gibson, J. & Oxley, L. (2005). Measures of human capital: A review of the literature. *New Zealand Treasury Working Paper,* No. 05/10.

Lee, J. (1992). Optimal size and composition of government spending. *Journal of the Japanese and International Economies,* 6, 423-439.

Lee, L. F. (2002). Consistency and efficiency of least squares estimation for mixed regressive, spatial autoregressive models. *Econometric Theory*, 18, 252-277.

Levine, R. & Renelt, D. (1992). A Sensitivity Analysis of Cross-Country Growth Regressions. *American Economic Review*, American Economic Association, 82(4), 942-963.

Levitas, A. (2017). Local Government Reform as State Building: What the Polish Case Says About "Decentralization". Studies in Comparative International Development, 52(1), 23-44.

Ligthart, J. & Van Oudheusden, P. (2011). In Government We Trust: The Role of Fiscal Decentralization, *Discussion Paper No 2011-073*, Tilburg University, Center for Economic Research.

Lin, J. Y. & Liu, (2000). Z. Fiscal Decentralization and Economic Growth in China. *Economic Development and Cultural Change*, 49(1), 1.

Lozano, I. & Julio, J. M. (2016). Fiscal decentralization and economic growth in Colombia: evidence from regional-level panel data, *Revista CEPAL, Naciones Unidas Comisión Económica para América Latina y el Caribe* (CEPAL), August.

Lucas, R. (1988). On the mechanics of economic development, *Journal of Monetary Economics*, 22(1), 03-42.

Luong, P. J. (2004). Economic "Decentralization" in Kazakhstan: Causes and consequences. In Luong, P. J. (Eds.). *The transformation of Central Asia: States and societies from Soviet Rule to Independence*, Cornell University Press, Ithaca, NY; London.

Lutz, G. & Linder, W. (2004). *Traditional Structures in Local Governance for Local Development.* Berne, Switzerland: University of Berne. Institute of Political Science.

Ma, J. (1997). *Intergovernmental Relations and Economic Management in China*. Macmillan Press, England.

Maddala, G. S. & Wu, S. (1999). A comparative study of unit root tests with panel data and a new simple test. *Oxford Bulletin of Economics and Statistics*, 61(0), Special Issue November, 631-652.

Malik, S., Mahmood-ul-Hassan & Hussain, S. (2006). Fiscal Decentralisation and Economic Growth in Pakistan. *The Pakistan Development Review*, 45, 845-854.

Mankiw, G. (1995). The Growth of Nations. *Brookings Papers on Economic Activity* 1 (September), 275-325.

Mankiw, G., Romer, D. & Weil, D. (1992). A Contribution to the Empirics of Economic Growth. *The Quarterly Journal of Economics*. 107(2), 407-437.

Marlow, M. (1988). Fiscal Decentralization and Government Size. *Economics*. 56. 10.1007/BF00130275.

Martinez-Vazquez, J. & McNab, R. (1997). Tax Systems in Transition Economics. *International Center for Public Policy Working Paper Series,* at AYSPS, GSU paper 9701, International Center for Public Policy, Andrew Young School of Policy Studies, Georgia State University.

Martinez-Vazquez, J. & McNab, R. (2003). Fiscal Decentralization and Economic Growth. *World Development*, *31*(9), 1597–1616.

Martinez-Vazquez, J. & McNab, R. (2006). Fiscal Decentralization, Macrostability and Growth. *Hacienda Pública Española / Revista de Economía Pública*, 179(4/2006), 25-49

Martinez-Vazquez, J. & Timofeev, A. (2009). Decentralization Measures Revisited. *International Center for Public Policy Working Paper Series*, at AYSPS, GSU paper0913, International Center for Public Policy, Andrew Young School of Policy Studies, Georgia State University.

Mauro, P. (1996). The Effects of Corruption on Growth, Investment and Government Expenditure, *IMF Working Paper*, 98, 1-27.

McLure, M. (2006). Paretian Approach to Fiscal Decentralisation and Economic Growth: a Preliminary Investigation of the Australian Experience, URL: https://www.uwa.edu.au/__data/assets/rtf_file/0020/102926/05_17_McLure.rtf accessed day 23.08.2014. accessed day 21.12.2017.

Meloche, J. P., Vaillancourt, F. & Yilmaz, S. (2004). Decentralization or Fiscal Autonomy? What Does Really Matter? Effects on Growth and Public Sector Size in European Transition Countries. *Policy Research Working Paper;* No. 3254. World Bank, Washington, DC.

Mileva, E. (2008). The impact of capital flows on domestic investment in transition economies. *Working Paper Series 871*, European Central Bank.

Mofidi, A. & Stone, J. A. (1990). Do State and Local Taxes Affect Economic Growth?. *The Review of Economics and Statistics*, 72(4), 686-691.

Monastiristis, V. (2011). Regional Growth Dynamics in Central and Eastern Europe. *LSE 'Europe in Question' Discussion Paper Series.* LEQS Paper No. 33/2011.

Moreno, S. G., Sutton, A. J., Ades, A. E., Stanley, T. D., Abrams, K. R., Peters, J. L., Cooper N. J. (2009). Assessment of regression-based methods to adjust for publication bias through a comprehensive simulation study. *Medical Research Methodology*. 9, 1–17. doi: 10.1186/1471-2288-9-2.

Myrdal G. (1957). *Economic Theory and Underdeveloped Regions*. Duck-worth. London.

NALAS (2015). Fiscal Decentralisation Indicators for South East Europe, 2006-2014. Retrieved from http://www.nalas.eu/Home/Download/2016-FD_Report, January 10, 2018.

Naumets, I. (2003). *Fiscal Decentralization and Local Public Sector Efficiency*. Master Thesis. National University of "Kyriv-Mohla Academy".

Neyapti, B. (2003). Fiscal Decentralisation and Deficits: International Evidence, *Working Papers*, No 2003/2, Turkish Economic Association.

Nijkamp, P. & Poot, J. (2004). Meta-analysis of the effect of fiscal policies on long-run growth, *European Journal of Political Economy*, 20(1), 91-124.

Nishimura, Y. (2001). Human Fallibility, Complementarity and Optimal Degree of Fiscal Decentralization for Economic Growth and Stabilization, *Conference paper, 57th Congress of the International Institute of Public Finance* (IIPF), A-Linz, 27-30.

Oates, W. E. (1993). Fiscal decentralization and economic development, *National Tax Journal*, 46, 237–243.

Oates, W. E. (1995). Comment on „Conflicts and Dilemmas of Decentralization. by Rudolf Hommes. In Bruno, M., & Pleskovic, B. (Eds.). *Annual World Bank Conference on Development Economics*, 351-53.

Oates, W. E. (1999). An Essay on Fiscal Federalism. *Journal of Economic Literature*, 37(3), 1120-1149.

Pal, S. & J. Roy. (2010). Fiscal Decentralisation and Development: How Crucial is Politics?, *IZA discussion paper*, IZA DP 5286.

Panizza, U. (1999). On the determinants of fiscal centralization: Theory and evidence. *Journal of Public Economics*, *74*(1), 97–139. https://doi.org/10.1016/S0047-2727(99)00020-1

Parkinson, M., Meegan, R. & Karecha, J. (2014). City Size and Economic Performance: Is Bigger Better, Small More Beautiful or Middling Marvellous?, European Planning Studies, 23(6), 1054-1068, DOI: 10.1080/09654313.2014.904998

Perez, P. & Cantarero, D. (2006), Descentralizaci on Fiscal y el Crecimiento Econ omico en las Regiones Espanolas. *Papeles de Trabajo del Instituto de Estudios Fiscales*, 5-06.

Pesaran, M. H. (2004). General Diagnostic Tests for Cross Section Dependence in Panels. *IZA Discussion Paper* No. 1240.

Pfaff, T. (2013). Clustered Standard Errors and Few Clusters: Some Practical Advice for Adjusting Inference. *Working Paper, University of Münster*.

Philip, A. T. & Isah, S. (2012). An Analysis of the Effect of Fiscal Decentralization on Economic Growth in Nigeria. *International Journal of Humanities and Social Science,* 2 (8), 141-149.

Pike, A., Rodriguez-Pose, A. & Tomaney, J. (2006). *Local and Regional Development*. *Economic Geography* (Vol. 84). https://doi.org/10.1111/j.1944-8287.2008.tb00407.x

Plümper, T. & Troeger, V. (2007). Efficient estimation of time-invariant and rarely changing variables in finite sample panel analyses with unit fixed effects. *Political Analysis*, 15(2), 124-139.

Plümper, T. & Troeger, V. (2011). Fixed-effects vector decomposition: Properties, reliability and instruments. *Political Analysis*, 15(2), 124-139.

Porcelli, F. (2009). Effects of fiscal decentralisation and electoral accountability efficiency evidence from the Italian health care sector. *Working Papers* 2009/29, Institut d'Economia de Barcelona (IEB).

Preteceille, E. (1990). "Political Paradoxes of Urban Restructuring: Globalization of the Economy and Localization of Politics?". In Beyond the City Limits (J. Logan and T. Swanstrom eds.). 27-59. Philadelphia: Temple University Press.

Pritchett, L. (1996). Measuring outward orientation in LDCs: Can it be done?, *Journal of Development Economics*, 49(2), 307-335.

Pritchett, L. (2001). Where has all the education gone?. *World Bank Economic Review*, 15, 367-391.

Prud'homme, R. (1995). The dangers of decentralization. *World Bank Research Observer*. https://doi.org/10.1093/wbro/10.2.201

Pugh, G., Coric, B. and Haile, M. G. (2012). An introduction to meta-regression analysis (MRA): Using the example of trade effects of exchange rate variability."

Chapter 20 of the edited Book: *Macroeconomics and Beyond in Honour of Wim Meeusen*.

Qi, J. (1992). Fiscal reform and the economic foundations of local state corporation in China. *World Politics*, 45(1), 1-50.

Qian, Y. & Weingast, B. R. (1997). Federalism as a Commitment to Reserving Market Incentives. *Journal of Economic Perspectives*, 11 (4): 83-92.

Qiao, B., Martinez-Vazquez, J., & Xu, Y. (2008). The tradeoff between growth and equity in decentralization policy: China's experience. *Journal of Development Economics*, *86*(1), 112–128. https://doi.org/10.1016/j.jdeveco.2007.05.002

Radulescu, R. & Barlow, D. (2002). The Relationship between Policies and Growth in Transition Countries. *The Economics of Transition*, 10, 719-745.

Rauch, D. & Schleicher, D. (2015). Like Uber, But for Local Governmental Policy: The Future of Local Regulation of the 'Sharing Economy'. *George Mason Law & Economics Research Paper* No. 15-01.

Rebelo, S. (1991). Long-Run Policy Analysis and Long-Run Growth, *Journal of Political Economy*, 99(3), 500-521.

Reed, R., Florax, R. & Poo, J. (2015). A Monte Carlo Analysis of Alternative Meta-Analysis Estimators in the Presence of Publication Bias. *Economics: The Open-Access, Open-Assessment E-Journal*, 9 (2015-30), 1–40.

Ringquist, E. J. (2009). Assessing Evidence of Environmental Inequities: A Meta-Analysis. In *Social Experimentation, Program Evaluation, and Public Policy,* 421–443.

Ringquist, E. J. (2013). *Meta-Analysis for Public Management and Policy*, John Wiley & Sons Inc. United States.

Rodden, J. & Rose-Ackerman, S. (1997). Does Federalism Preserve Markets? *Faculty Scholarship Series*, 590.

Rodden, J. & Wibbels, E. (2002). Beyond the Fiction of Federalism: Macroeconomic Management in Multitiered Systems. *World Politics*, *54*(04), 494–531.

Rodden, J. (2003). Reviving Leviathan: Fiscal Federalism and the Growth of Government. *International Organization*, 57(4), 695-729. doi:10.1017/S0020818303574021.

Rodden, J. (2006). *Hamilton's paradox: The promise and peril of fiscal federalism.* Cambridge: Cambridge University Press.

Rodden, J., Eskeland, G. S. & Litvack, J. (2003). *Fiscal Decentralization and the Challenges of Hard Budget Constraint,* The MIT Press.

Rodriguez, F. & Rodrik, D. (2001). Trade Policy and Economic Growth: A Skeptic's Guide to Cross-National Evidence. In Bernanke, B. & Rogoff, K. S. (Eds.). *A re-examination of the relationship between trade policy and economic growth and a critical review of the literature.* Published in Macroeconomics Annual 2000, MIT Press for NBER, Cambridge, MA, 2001.

Rodriguez-Pose, A. & Crescenzi, R. (2008). Research and development, spillovers, innovation systems, and the genesis of regional growth in Europe. *Regional studies,* 42 (1). 51-67.

Rodriguez-Pose, A. & Ezcurra, R. (2010). Does decentralization matter for regional disparities? A cross-country analysis, *Journal of Economic Geography*, 10(5), 619-644.

Rodriguez-Pose, A. & Ezcurra, R. (2011). Is fiscal decentralization harmful for economic growth? Evidence from the OECD countries. *Journal of Economic Geography*, *11*(4), 619–643.

Rodriguez-Pose, A. & Fratesi, U. (2004). Between Development and Social Policies: The Impact of European Structural Funds in Objective 1 Regions, *Regional Studies*, 38(1), 97-113.

Rodriguez-Pose, A. & Kroijer, A. (2009). Fiscal decentralization and economic growth in Central and Eastern Europe. *Growth and Change*, *40*(3), 387–417.

Rodriguez-Pose, A., Tijmstra, S. A. R. & Bwire, A. (2007). Fiscal decentralisation, efficiency, and growth. *Working Papers Series in Economics and Social Sciences,* 2007/11.

Rodriguez-Pose, A., Tijmstra, S., Bwire, A. (2009). Fiscal decentralisation, efficiency, and growth. *Environment and Planning* A, 41, 2041–2062.

Romer, D. (2011). Advanced Macroeconomics. 4th Edition, McGraw-Hill. New York.

Romer, P. (1986). Increasing Returns and Long-run Growth, *Journal of Political Economy*, 94(5), 1002-37.

Rondinelli, D. A. (1999). What Is Decentralization. Litvack, J. & Seddon, J. (eds.). Decentralization Briefing Notes. *WBI Working Papers.*

Rondinelli, D. A. (1990). Decentralization, Territorial Power and the State: A Critical Response. Development and Change, 21, 491-500. doi:10.1111/j.1467-7660.1990.tb00385.x

Rondinelli, D. A., Nellis, J. R., & Cheema, G. S. (1983). Decentralization in developing countries: a review of recent experience. *World Bank Staff Working Paper*.

Roodman, D. (2006). How to do xtabond2: An introduction to “difference” and “system” GMM in Stata. *Center for Global Development Working Paper* No. 103.

Roodman, D. (2007). A short note on the theme of too many instruments. *Centre for Global Development Working Paper* No. 125.

Roodman, D. (2009a). How to do xtabond2: An introduction to difference and system GMM in Stata. *The Stata Journal*, 9(1), 86-136.

Roodman, D. (2009b). A note on the theme of too many instruments. *Oxford Bulletin of Economics and Statistics*, *71*(1), 135–158.

Rose, A. & Stanley, T. D. (2005). A Meta-Analysis of the Effect of Common Currencies on International Trade, *Journal of Economic Surveys*, (19)3, 347-365.

Rosenthal, R. (1979). The “file drawer problem” and tolerance for null results. *Psychological Bulletin,*86, 638–641.

Rothstein, H. R., Sutton, A. J. & Bornenstein, M. (2005). *Publication Bias in Meta-Analysis: Prevention, Assessment and Adjustments*. Chichester: John Wiley and Sons.

Sacchi A. & Salotti S. (2011). Income inequality, regional disparities, and fiscal decentralization in industrialized countries. *Workshop on Regional and Urban Economics: Inequality and Regional Growth and Cohesion*, 24-25 November, Barcelona.

Sacchi, A. & Salotti, S. (2014). How Regional Inequality Affects Fiscal Decentralisation: Accounting for the Autonomy of Subcentral Governments. *Environment and Planning C: Politics and Space*. 32(1), 144-162.

Sagbas, I., Sen, H. & Kar, M. (2005). Fiscal decentralisation, the size of the public sector, and economic growth in Turkey. *Environment and Planning C: Government and Policy*. https://doi.org/10.1068/c0421

Samimi, A. J., Saeed, K. P., Gholamreza, K. H. & Mohammad, A. (2010). Fiscal Decentralization and Economic Growth: A Nonlinear Model for Provinces of Iran. *Iran Economic Review*, 15, 125–33.

Sarafidis, V., Takashi, Y. & Robertson, D. (2009). A test of cross section dependence for a linear dynamic panel model with regressors. *Journal of Econometrics,* 148(2), 149-161.

Schaffer, M. E. (2010). xtivreg2: Stata module to perform extended IV/2SLS, GMM and AC/HAC, LIML and k-class regression for panel data models. http://ideas.repec.org/c/boc/bocode/s456501.html

Schneider, A. (2003). Decentralization: Conceptualization and measurement. *Studies in Comparative International Development*, 38(3), 32-56.

Schnellenbach, J. (2007). Public entrepreneurship and the economics of reform. *Journal of Institutional Economics,* 3(2), 183–202.

Seiferling, M. (2013). Stock-Flow Adjustments, Government's Integrated Balance Sheet and Fiscal Transparency. IMF Working Paper, WP/13/63.

Sewell, D. (1996). The Dangers of Decentralization According to Prud'homme: Some Further Aspects. *The World Bank Research Observer. 11*(1), 143–150

Shahdani, M S., Komijani, A., Vafa, M. H. Z. & Fard. M. G. (2012). Fiscal decentralization, income distribution and economic growth: A Case Study for Iran. *Journal of Economic Theory*, 6 (2): 76-80.

Sheehey, E. (1993). The Effect of Government Size on Economic Growth, *Eastern Economic Journal*, 19(3), 321-328.

Shehata, E. & Mickaiel, S. (2015). RESETXT: Stata Module to Compute Panel Data Regression Specification Error Tests (RESET), https://EconPapers.repec.org/RePEc:boc:bocode:s458101.

Smoke, P. (2001). Fiscal Decentralization in Developing Countries. A Review of Current Concepts and Practice. *United Nations Research Institute for Social Development*. https://doi.org/10.1353/jda.2004.0001

Sohinger, J. (2004). Transforming Competitiveness in European Transition Economies: The Role of Foreign Direct Investment. *Working Paper Series qt5174h9b8*, Institute of European Studies, UC Berkeley.

Solé-Ollé, A. & Esteller-Moré, A. (2005). Decentralization Provision of Public Inputs, Government Responsiveness to Local Needs, and Regional Growth: Evidence from Spain. *Institut d'Economia de Barcelona Working Paper*. Barcelona: Institut d'Economia de Barcelona.

Solow, R. (1956). A Contribution to the Theory of Economic Growth, *The Quarterly Journal of Economics*, 70(1), 65–94.

Solow, R. M. (1962). A Policy for Full Employment. Industrial Relations: *A Journal of Economy and Society*, 2, 1-14. doi:10.1111/j.1468-232X.1962.tb00271.x.

Sow, M. & Razafimahefa, I. F. (2015). Fiscal Decentralization and the Efficiency of Public Service Delivery, *IMF Working Paper* WP/15/59.

Stanley T. D. & Doucouliagos, C. (2007). Identifying and correcting publication selection bias in the efficiency-wage literature: Heckman meta-regression. *School Working Paper, Economics Series* 2007-11, Deakin University.

Stanley, T. D. & Doucouliagos, C. (2011) Meta-Regression Approximations to Reduce Publication Selection Bias. *School Working Paper, Economic Series* 2011-4, Deakin University.

Stanley, T. D. & Doucouliagos, C. (2012). *Meta-regression analysis in economics and business*. *Meta-Regression Analysis in Economics and Business*. Routledge, Oxfordshire.

Stanley, T. D. & Doucouliagos, C. (2013). Neither fixed nor random: weighted least squares meta-analysis. *Working Papers, Deakin University, Department of Economics*.

Stanley, T. D. & Jarrell, S. B. (1989). Meta-Regression Analysis: A Quantitative Method of Literature Surveys. *Journal of Economic Surveys*, 3, 54-67.

Stanley, T. D. (1998). New Wine in Old Bottles: A Meta-Analysis of Ricardian Equivalence. *Southern Economic Journal*. 64 (3), 713-727.

Stanley, T. D. (2001). Wheat from chaff: Meta-analysis as quantitative literature review, *Journal of Economic Perspectives*, 15(3), pp.131-150.

Stanley, T. D. (2005). Beyond publication bias, *Journal of Economic Surveys*, 19(3), 309-345.

Stanley, T. D. (2008). Meta-regression methods for detecting and estimating empirical effects in the presence of publication selection. *Oxford bulleting of economics and statistic*, 70(1), 103-127.

Stanley, T. D., Jarell, S. B. & Doucouliagos, C. (2010). Could it be better to discard 90% of the data? A Statistical Paradox. *American Statistician*, 64, 70-77.

StataCorp (2013). *Stata 13 Base Reference Manual*. College Station, TX: Stata Press.

Stegarescu, D. (2004). Public Sector Decentralization: Measurement Concepts and Recent International Trends. *ZEW Discussion Paper* 04-74, Zentrum für Europäische Wirtschaftsforschung, Mannheim.

Stegarescu, D. (2005). Public Sector Decentralisation: Measurement Concepts and Recent International Trends. *Fiscal Studies*, 26, 301-333. doi:10.1111/j.1475-5890.2005.00014.x

Stoilova D. & Patonov, N. (2012). Fiscal Decentralization: Is It a Good Choice for the Small New Member States of the EU?. *Scientific Annals of Economics and Business*, De Gruyter Open, vol. 59(1), pages 125-137, July.

Sunde, U. & Vischer, T. (2015). Human Capital and Growth: Specification Matters. *Economica*, 82(326), 368-390.

Svejnar, J. (2002). Transition Economies: Performance and Challenges. *Journal of Economic Perspectives*, 16(1), 3–28

Swan, T. W. (1956). Economic Growth and Capital Accumulation. *The Economic Record*, 32(2), 334-361.

Tanzi, V. (1995). Fiscal Federalism and Decentralization: A Review of Some Efficiency and Macroeconomic Aspects. *Paper presented at Annual World Bank Conference on Development Economics*, 295–316.

Tanzi, V. (2000). On Fiscal Federalism: Issues to Worry About, URL: https://www.imf.org/external/pubs/ft/seminar/2000/fiscal/tanzi.pdf

Temple, J. (1999). The New Growth Evidence. *Journal of Economic Literature*, 37(1), 112-156.

Ter-Minassian, T. (1997). Decentralization and Macroeconomic Management. *IMF Working Papers* No 97/155.

Thiessen, U. (2003). Fiscal Decentralisation and Economic Growth in High-Income OECD Countries, *Fiscal Studies*, 24(3), 237-274.

Thiessen, U. (2005). Fiscal Decentralisation and Economic Growth in 'Rich' OECD Countries: Is there an Optimum?, URL: https://www.diw.de/documents/publikationen/73/diw_01.c.360224.de/diw_eb_2004-05-5.pdf accessed day 27.07.2015.

Thompson, S. B. (2011). Simple formulas for standard errors that cluster by both firm and time. *Journal of Financial Economics*, 99(1), 1-10.

Thornton, J. (2007). Fiscal decentralization and economic growth reconsidered. *Journal of Urban Economics*, *61*(1), 64–70.

Tiebout, C. M. (1956). A Pure Theory of Local Expenditures. *Journal of Political Economy*, 64.

Tirtosuharto, D. (2010). Regional competitiveness in Indonesia: The incentives of fiscal decentralization on state efficiency and economic growth. *ProQuest Dissertations and Theses*, 181–n/a. Retrieved from http://search.proquest.com/docview/230948096?accountid=13771

Tosun, M. S. & Yilmaz, S. (2008). Decentralization, Economic Development, and Growth in Turkish Provinces. *World Bank Policy Research Working Paper Series*. Available at SSRN: https://ssrn.com/abstract=1273486.

Treisman, D. (2002). Decentralization and the Quality of Government. URL: https://www.sscnet.ucla.edu/polisci/faculty/treisman/Papers/DecandGovt.pdf accessed day 13.06.2017.

Treisman, D. (2006). Fiscal decentralization, governance, and economic performance: a reconsideration. *Economics and Politics*, 18 (2), 219-235.

Treisman, D. (2007). *The Architecture of Government: Rethinking Political Decentralization*. Cambridge University Press: New York, N.Y

Tukey, J. (1977). *Exploratory Data Analysis*. Reading, MA: Addison–Wesley.

UNDP (2017). Mean Years of Schooling. http://hdr.undp.org/en/content/mean-years-schooling-adults-years accessed day 10.08.2017.

Urinboyev, R. (2015). Local Government Capacity in Post-Soviet Central Asia. *Viesoji Politika Ir Administravimas*, 14(3), 177-199.

Valdivieso, L. (1998). Macroeconomic developments in the Baltics, Russia, and other countries of the Former Soviet Union, 1992–97. *IMF Occasional paper* no. 175 International Monetary Fund: Washington.

Verbeek, M. (2004). *Modern Econometrics*. 2nd Edition. Erasmus University Rotterdam, John Wiley & Sons Ltd., Hoboken.

Verspagen, B. (1991). A New Empirical Approach to Catching up or Falling Behind. *Structural Change and Economic Dynamics*, 2, 359-380.

Vigvári, A. (2010). Is the conflict container full? Problems of fiscal sustainability at the local government level in Hungary. *Acta Oeconomica*. https://doi.org/10.1556/AOecon.60.2010.1.4

Vo, D. H. (2010). The economics of fiscal decentralization. *Journal of Economic Surveys*. https://doi.org/10.1111/j.1467-6419.2009.00600.x

Wallis, J. J. & Oates, W. (1988). Decentralization in the Public Sector: An Empirical Study of State and Local Government. *Fiscal Federalism: Quantitative Studies, National Bureau of Economic Research*, 5-32.

Wallis, J. J. (1999). Early American Federalism and Economic Development, 1790-1840, In Panagariya, A., Portnoy, P. & Schwab, R. (Eds.). *Environmental and Public Economics,* Essays in Honor of Wallace E. Oates, Cheltenham, 283 – 309.

Weingast, B. R. (2006). Second Generation Fiscal Federalism: Implications for Decentralized Democratic Governance and Economic Development. Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1153440 accessed day 02.09.2012.

Weingast, B. R. (2014). Second Generation Fiscal Federalism: Political Aspects of Decentralization and Economic Development. *World Development*, *53*, 14–25. https://doi.org/10.1016/j.worlddev.2013.01.003

Wetzel, D. & Dunn, J. (2001). *Decentralization in the transition economies: Challenges and the road ahead*". PREM Unit Europe and Central Asia. Washington, DC.: World Bank.

Wibbels, E. (2000). Federalism and the Politics of Macroeconomic Policy and Performance. *American Political Science Review*, 44, 687-702.

Wilgender, (2005). Decentralization and Economic Growth: A Case Study for Canada. *Masters Research Report WINP28028006*.

Williams, R. (2007). MFX2: Stata module to enhance mfx command for obtaining marginal effects or elasticities after estimation. http://econpapers.repec.org/software/bocbocode/s456726.html accessed day 10.08.2017.

Wilson, J. D. (1999). Theories of Tax Competition, *National Tax Journal*, 52(2), 269-304.

Woller, G. M. & Phillips, K. (1998). Fiscal decentralisation and IDC economic growth: An empirical investigation. *Journal of Development Studies*. https://doi.org/10.1080/00220389808422532

Wooldridge, J. M. (2002). *Introductory econometrics: A modern approach*. 2nd Edition. Cincinatti, OH: South-Western College Publishing.

Wooldridge, J. M. (2009). *Introductory Econometrics – A Modern Approach.* 5th Edition, South-Western Cengage Learning, Mason.

World Bank (1999). *Decentralization briefing notes*. *WBI working papers*.

Word Bank (2001). What, Why and Where. http://www1.worldbank.org/publicsector/decentralization/what.htm accessed day 13.01.2018.

World Bank (2015). Purchasing Power Parities and the Real Size of World Economies. URL: http://siteresources.worldbank.org/ICPEXT/Resources/2011-ICP-Global-Report.pdf accessed day 17.06.2017.

Xie, D., Zou, H. & Davoodi, H. (1999). Fiscal Decentralization and Economic Growth in the United States. *Journal of Urban Economics*, *45*(2), 228–239.

Yao, Y. & Zhang, X. (2008). Race to the top and race to the bottom tax competition in rural China. *IFPRI Discussion Paper 00799*, International Food Policy Research Institute, Washington, DC.

Yeung, R. (2009). The Effects of Fiscal Decentralization on the Size of Government: A Meta-Analysis. *Public Budgeting & Finance,* 29(4), 1-23.

Yilmaz, S. (1999). The Impact of Fiscal Decentralization on Macroeconomic Performance, *National Tax Association Proceedings of the 92nd Annual Conference on Taxation*. Atlanta, October, 25-260.

Young, A. (2000). The Razor's Edge: Distortions and Incremental Reform in the People's Republic of China, *NBER Working Paper,* 7828.

Young, A. (2002). *Growth and Equity Tradeoff in Decentralization Policy: China 's Experience*. Georgia State University.

Yushkov, A. (2015). Fiscal decentralization and regional economic growth: Theory, empirics, and the Russian experience. *Russian Journal of Economics*, *1*(4), 404–418.

Zhang, T. & Zou, H. F. (1998). Fiscal decentralization, public spending, and economic growth in China. *Journal of Public Economics*, *67*(2), 221–240.

Zhang, T. & Zou, H. F. (2001). The growth impact of intersectoral and intergovernmental allocation of public expenditure: With applications to China and India, *China Economic Review*, 12(1), 58-81.

Zhenfa, X. & Wei, Z. (2016). Fiscal Decentralization and Economic Growth in China: A Meta-Regression Analysis. *CNKI Journal*, 5, 435-452.

Zhu, J. (1999). Local Growth Coalition: The Context and Implications of China's Gradualist Urban Land Reforms. *International Journal of Urban and Regional Research,* 23, 534-548. doi:10.1111/1468-2427.00211.

Zhuravskaya, E. V. (2000). Incentives to provide local public goods: fiscal federalism, Russian style. *Journal of Public Economics*, *76*(3), 337–368.

Appendices

Fiscal Decentralisation and Economic Growth in Transition Economies

Appendix of Chapter 3

FISCAL DECENTRALISATION AND ECONOMIC GROWTH – A META REGRESSION ANALYSIS

Appendix 3.1 Additional Information regarding Weights and Mathematical Transformation

Appendix 3.1.1 Examples of Specific Weights

id	id study	id specification	Name of Study	No study	No specification	specification weights	study weights
1	1	1	(1998) Davoodi and Zou	30	1	1	0.03333333
2	1	2	(1998) Davoodi and Zou	30	2	1	0.03333333
3	1	3	(1998) Davoodi and Zou	30	3	1	0.03333333
4	1	4	(1998) Davoodi and Zou	30	4	1	0.03333333
5	1	5	(1998) Davoodi and Zou	30	5	1	0.03333333
6	1	6	(1998) Davoodi and Zou	30	6	1	0.03333333
7	1	7	(1998) Davoodi and Zou	30	7	1	0.03333333
8	1	8	(1998) Davoodi and Zou	30	8	1	0.03333333
9	1	9	(1998) Davoodi and Zou	30	9	1	0.03333333
10	1	10	(1998) Davoodi and Zou	30	10	1	0.03333333
11	1	11	(1998) Davoodi and Zou	30	11	1	0.03333333
12	1	12	(1998) Davoodi and Zou	30	12	1	0.03333333
13	1	13	(1998) Davoodi and Zou	30	13	1	0.03333333
14	1	14	(1998) Davoodi and Zou	30	14	1	0.03333333
15	1	15	(1998) Davoodi and Zou	30	15	1	0.03333333
16	1	16	(1998) Davoodi and Zou	30	16	1	0.03333333
17	1	17	(1998) Davoodi and Zou	30	17	1	0.03333333
18	1	18	(1998) Davoodi and Zou	30	18	1	0.03333333
19	1	19	(1998) Davoodi and Zou	30	19	1	0.03333333
20	1	20	(1998) Davoodi and Zou	30	20	1	0.03333333

21	1	21	(1998) Davoodi and Zou	30	21	1	0.03333333
22	1	22	(1998) Davoodi and Zou	30	22	1	0.03333333
23	1	23	(1998) Davoodi and Zou	30	23	1	0.03333333
24	1	24	(1998) Davoodi and Zou	30	24	1	0.03333333
25	1	25	(1998) Davoodi and Zou	30	25	1	0.03333333
26	1	26	(1998) Davoodi and Zou	30	26	1	0.03333333
27	1	27	(1998) Davoodi and Zou	30	27	1	0.03333333
28	1	28	(1998) Davoodi and Zou	30	28	1	0.03333333
29	1	29	(1998) Davoodi and Zou	30	29	1	0.03333333
30	1	30	(1998) Davoodi and Zou	30	30	1	0.03333333
…							
…							
…							
866	44	555	(2011) Buser	30	1	0.5	0.03333333
867	44	555	(2011) Buser	30	1	0.5	0.03333333
868	44	556	(2011) Buser	30	2	0.5	0.03333333
869	44	556	(2011) Buser	30	2	0.5	0.03333333
870	44	557	(2011) Buser	30	3	0.5	0.03333333
871	44	557	(2011) Buser	30	3	0.5	0.03333333
872	44	558	(2011) Buser	30	4	0.5	0.03333333
873	44	558	(2011) Buser	30	4	0.5	0.03333333
874	44	559	(2011) Buser	30	5	0.5	0.03333333
875	44	559	(2011) Buser	30	5	0.5	0.03333333
876	44	560	(2011) Buser	30	6	0.5	0.03333333
877	44	560	(2011) Buser	30	6	0.5	0.03333333
878	44	561	(2011) Buser	30	7	0.5	0.03333333
879	44	561	(2011) Buser	30	7	0.5	0.03333333

880	44	562	(2011) Buser	30	8	0.5	0.03333333
881	44	562	(2011) Buser	30	8	0.5	0.03333333
882	44	563	(2011) Buser	30	9	0.5	0.03333333
883	44	563	(2011) Buser	30	9	0.5	0.03333333
884	44	564	(2011) Buser	30	10	0.5	0.03333333
885	44	564	(2011) Buser	30	10	0.5	0.03333333
886	44	565	(2011) Buser	30	11	0.5	0.03333333
887	44	565	(2011) Buser	30	11	0.5	0.03333333
888	44	566	(2011) Buser	30	12	0.5	0.03333333
889	44	566	(2011) Buser	30	12	0.5	0.03333333
890	44	567	(2011) Buser	30	13	0.5	0.03333333
891	44	567	(2011) Buser	30	13	0.5	0.03333333
892	44	568	(2011) Buser	30	14	0.5	0.03333333
893	44	568	(2011) Buser	30	14	0.5	0.03333333
894	44	569	(2011) Buser	30	15	0.5	0.03333333
895	44	569	(2011) Buser	30	15	0.5	0.03333333
…							
…							
…							
950	49	606	(2013) Gemmell *et al.*	49	1	0.5	0.029412
951	49	606	(2013) Gemmell *et al.*	49	1	0.5	0.029412
952	49	607	(2013) Gemmell *et al.*	49	2	0.5	0.029412
953	49	607	(2013) Gemmell *et al.*	49	2	0.5	0.029412
954	49	608	(2013) Gemmell *et al.*	49	3	0.333333	0.019608
955	49	608	(2013) Gemmell *et al.*	49	3	0.333333	0.019608
956	49	608	(2013) Gemmell *et al.*	49	3	0.333333	0.019608
957	49	609	(2013) Gemmell *et al.*	49	4	0.5	0.029412

958	49	609	(2013) Gemmell *et al.*	49	4	0.5	0.029412
959	49	610	(2013) Gemmell *et al.*	49	5	0.333333	0.019608
960	49	610	(2013) Gemmell *et al.*	49	5	0.333333	0.019608
961	49	610	(2013) Gemmell *et al.*	49	5	0.333333	0.019608
962	49	611	(2013) Gemmell *et al.*	49	6	0.333333	0.019608
963	49	611	(2013) Gemmell *et al.*	49	6	0.333333	0.019608
964	49	611	(2013) Gemmell *et al.*	49	6	0.333333	0.019608
965	49	612	(2013) Gemmell *et al.*	49	7	0.333333	0.019608
966	49	612	(2013) Gemmell *et al.*	49	7	0.333333	0.019608
967	49	612	(2013) Gemmell *et al.*	49	7	0.333333	0.019608
968	49	613	(2013) Gemmell *et al.*	49	8	0.25	0.014706
969	49	613	(2013) Gemmell *et al.*	49	8	0.25	0.014706
970	49	613	(2013) Gemmell *et al.*	49	8	0.25	0.014706
971	49	613	(2013) Gemmell *et al.*	49	8	0.25	0.014706
972	49	614	(2013) Gemmell *et al.*	49	9	0.25	0.014706
973	49	614	(2013) Gemmell *et al.*	49	9	0.25	0.014706
974	49	614	(2013) Gemmell *et al.*	49	9	0.25	0.014706
975	49	614	(2013) Gemmell *et al.*	49	9	0.25	0.014706
976	49	615	(2013) Gemmell *et al.*	49	10	0.333333	0.019608
977	49	615	(2013) Gemmell *et al.*	49	10	0.333333	0.019608
978	49	615	(2013) Gemmell *et al.*	49	10	0.333333	0.019608
979	49	616	(2013) Gemmell *et al.*	49	11	0.333333	0.019608
980	49	616	(2013) Gemmell *et al.*	49	11	0.333333	0.019608
981	49	616	(2013) Gemmell *et al.*	49	11	0.333333	0.019608
982	49	617	(2013) Gemmell *et al.*	49	12	0.25	0.014706
983	49	617	(2013) Gemmell *et al.*	49	12	0.25	0.014706
984	49	617	(2013) Gemmell *et al.*	49	12	0.25	0.014706

985	49	617	(2013) Gemmell *et al.*	49	12	0.25	0.014706
986	49	618	(2013) Gemmell *et al.*	49	13	0.25	0.014706
987	49	618	(2013) Gemmell *et al.*	49	13	0.25	0.014706
988	49	618	(2013) Gemmell *et al.*	49	13	0.25	0.014706
989	49	618	(2013) Gemmell *et al.*	49	13	0.25	0.014706
990	49	619	(2013) Gemmell *et al.*	49	14	0.333333	0.019608
991	49	619	(2013) Gemmell *et al.*	49	14	0.333333	0.019608
992	49	619	(2013) Gemmell *et al.*	49	14	0.333333	0.019608
993	49	620	(2013) Gemmell *et al.*	49	15	0.333333	0.019608
994	49	620	(2013) Gemmell *et al.*	49	15	0.333333	0.019608
995	49	620	(2013) Gemmell *et al.*	49	15	0.333333	0.019608
996	49	621	(2013) Gemmell *et al.*	49	16	0.333333	0.019608
997	49	621	(2013) Gemmell *et al.*	49	16	0.333333	0.019608
998	49	621	(2013) Gemmell *et al.*	49	16	0.333333	0.019608
999	49	622	(2013) Gemmell *et al.*	49	17	0.333333	0.019608
1000	49	622	(2013) Gemmell *et al.*	49	17	0.333333	0.019608
1001	49	622	(2013) Gemmell *et al.*	49	17	0.333333	0.019608

Appendix 3.1.2 Mathematical transformation

The *t*-statistic of the estimated regression coefficient is the same as the *t*-statistic of the corresponding partial correlation coefficient (t^{PCC}) as shown below:

$$t^{\mathrm{Reg}} = t^{PCC} \quad \text{where} \quad t^{\mathrm{Reg}} = \frac{\beta}{SE^{\mathrm{Reg}}} \quad \text{and} \quad t^{PCC} = \frac{PCC}{SE^{PCC}}$$

Therefore, $\dfrac{\beta}{SE^{\mathrm{Reg}}} = \dfrac{PCC}{SE^{PCC}}$

Appendix 3.2 Descriptive Statistics

Appendix 3.2.1 Number of Estimates by Study

```
. tab namestudy
```

namestudy	Freq.	Percent	Cum.
(1998) Davoodi and Zou	30	3.00	3.00
(1998) Woller and Philips	12	1.20	4.20
(1998) Zhang and Zou	50	5.00	9.19
(1999) Yilmaz	3	0.30	9.49
(2000) Ebel and Yilmaz	3	0.30	9.79
(2000) Lin and Liu	12	1.20	10.99
(2001) Im and Lee	12	1.20	12.19
(2002) Akai and Sakata	20	2.00	14.19
(2003) Naumets	6	0.60	14.79
(2003) Thiessen	37	3.70	18.48
(2004) Eller	39	3.90	22.38
(2004) Feld et al.	8	0.80	23.18
(2004) Ismail et al.	3	0.30	23.48
(2004) Meloche et al.	8	0.80	24.28
(2005) Desai et al.	12	1.20	25.47
(2005) Feltensten and Iwata	14	1.40	26.87
(2005) Gil-Serrate and Lopez-Lobarda	3	0.30	27.17
(2005) Huan and Cheng	4	0.40	27.57
(2005) Iimi	2	0.20	27.77
(2005) Jin and Zou	25	2.50	30.27
(2005) Thiessen	5	0.50	30.77
(2005) Wilgender	30	3.00	33.77
(2006) Ismal and Hamzah	20	2.00	35.76
(2006) Kim	6	0.60	36.36
(2006) Malik et al.	4	0.40	36.76
(2006) Martinez-Vazquez and McNab	12	1.20	37.96
(2007) Akai et al.	32	3.20	41.16
(2007) Ding	8	0.80	41.96
(2007) Khamaladze	3	0.30	42.26
(2007) Rodrigues-Pose et al.	86	8.59	50.85
(2007) Thornton	5	0.50	51.35
(2008) Qiao et al.	8	0.80	52.15
(2008) Tosun and Yilmaz	8	0.80	52.95
(2009) Baskaran and Feld	48	4.80	57.74
(2009) Bodman et al.	26	2.60	60.34
(2009) Cantanerero and Gonzales	16	1.60	61.94
(2009) Feld et al.	68	6.79	68.73
(2009) Rodriguez-Pose and Kroijer	27	2.70	71.43
(2009) Sagbas et al.	18	1.80	73.23
(2010) Rehman Khatak, et al.	4	0.40	73.63
(2010) Rodriguez-Pose and Ezcurra	90	8.99	82.62
(2010) Samimi et al.	12	1.20	83.82
(2011) Bodman and Ford	26	2.60	86.41
(2011) Buser	30	3.00	89.41
(2011) Devkota	2	0.20	89.61
(2011) Faridi	4	0.40	90.01
(2012) Philip and Isah	12	1.20	91.21
(2012) Stoilova and Patonov	36	3.60	94.81
(2013) Gemmell et al.	52	5.19	100.00
Total	1,001	100.00	

Appendix 3.2.2 Correlation Matrix

a) No categorization into K/Z moderator variables

```
. corr published finsupport puby timeseries cross panel ols paneltech dynamic iv othertech longrun mixed developed develo
> ping transition unitary mixed_const national regional imf othersources single multi fdexp fdrev fdexprev threefd otherf
> d numberfd growth level othery published nexplanatory midpoint span control samplesize
(obs=988)
```

	publis~d	finsup~t	puby	timese~s	cross	panel	ols	panelt~h	dynamic	iv	othert~h
published	1.0000										
finsupport	0.2403	1.0000									
puby	-0.0209	0.2239	1.0000								
timeseries	0.0257	-0.0808	0.0481	1.0000							
cross	0.1672	-0.0958	0.0385	-0.0672	1.0000						
panel	-0.1250	0.1327	-0.0551	-0.6090	-0.7224	1.0000					
ols	-0.2334	-0.1964	-0.0060	-0.0964	0.4344	-0.2899	1.0000				
paneltech	0.1331	0.3332	0.0173	-0.2425	-0.2876	0.3922	-0.5896	1.0000			
dynamic	0.2468	-0.1182	-0.0850	-0.0830	-0.0984	0.1363	-0.2018	-0.3549	1.0000		
iv	-0.1977	-0.0951	0.0621	-0.0667	-0.0792	0.1096	-0.1623	-0.2855	-0.0977	1.0000	
othertech	0.0228	-0.0800	0.0043	0.9296	-0.0666	-0.5628	-0.1365	-0.2400	-0.0821	-0.0661	1.0000
longrun	0.2972	0.4169	0.2574	-0.1412	0.1183	0.0127	-0.0884	0.1384	0.1302	-0.1891	-0.1395
mixed	0.0632	0.0390	-0.2260	-0.0359	-0.0426	0.0590	0.0867	-0.0576	-0.0526	-0.0159	0.0566
developed	-0.0163	0.1774	0.3387	-0.0758	0.1950	-0.0785	-0.0246	0.0147	-0.1076	0.1853	-0.0699
developing	-0.0578	-0.0730	-0.0945	0.2843	-0.0969	-0.1187	0.0448	-0.0128	-0.1195	-0.0962	0.2293
transition	0.0404	-0.1672	-0.2422	-0.1173	-0.1392	0.1625	-0.0379	0.0140	0.2390	-0.1381	-0.1161
unitary	-0.0286	-0.2001	-0.1931	-0.1404	0.0279	0.0465	-0.0000	0.0471	0.1666	-0.1654	-0.1287
mixed_const	0.3441	0.4228	0.0654	-0.1911	0.1063	0.0569	-0.0628	0.2612	-0.0394	-0.2170	-0.1891
national	0.2579	0.3232	0.2272	0.0649	0.0289	-0.0497	-0.0469	0.1511	-0.0267	-0.2865	0.0974
regional	-0.2785	-0.3141	-0.2151	-0.1844	-0.0209	0.1225	0.0634	-0.1225	0.0367	0.2950	-0.2182
imf	-0.0206	-0.1044	-0.2110	-0.1378	-0.0475	0.1369	0.1225	0.1529	-0.2018	-0.1533	-0.1051
othersources	0.0206	0.1044	0.2110	0.1378	0.0475	-0.1369	-0.1225	-0.1529	0.2018	0.1533	0.1051
single	-0.2719	-0.3469	-0.2011	0.2328	-0.0489	-0.1316	0.0058	-0.2232	0.0020	0.2664	0.2033
multi	0.2719	0.3469	0.2011	-0.2328	0.0489	0.1316	-0.0058	0.2232	-0.0020	-0.2664	-0.2033
fdexp	-0.0563	0.3663	-0.1002	-0.0765	-0.0971	0.1302	0.2334	0.0189	-0.1614	-0.1771	-0.0453
fdrev	0.1469	-0.0513	0.0552	-0.0337	0.1789	-0.1226	-0.0443	0.1800	-0.1468	-0.1151	-0.0317
fdexprev	-0.0170	-0.1469	0.3103	0.1433	-0.0905	-0.0190	0.0246	-0.1745	0.2689	-0.1214	0.1217
threefd	-0.0891	-0.0900	0.1173	-0.0632	-0.0750	0.1038	-0.1536	0.0646	-0.0925	0.3026	-0.0625
otherfd	-0.0129	-0.1832	-0.2815	0.0326	0.0604	-0.0745	-0.1506	-0.0849	0.1469	0.2398	0.0137
numberfd	0.0136	-0.1513	-0.2572	-0.0645	-0.1558	0.1677	0.0027	-0.3411	0.5862	0.0254	-0.0717
growth	0.0217	0.1238	-0.1954	-0.2760	0.0549	0.1355	0.1531	0.1073	0.1271	-0.4300	-0.2238
level	-0.0508	-0.1164	0.2159	0.2989	-0.0717	-0.1382	-0.1529	-0.0590	-0.1195	0.3099	0.2441

othery	0.0486	-0.0407	-0.0401	-0.0285	0.0316	-0.0036	-0.0299	-0.1221	-0.0418	0.3617	-0.0283
published	1.0000	0.2403	-0.0209	0.0257	0.1672	-0.1250	-0.2334	0.1331	0.2468	-0.1977	0.0228
nexplanatory	0.1874	0.0694	-0.0842	-0.0020	-0.0581	0.0435	-0.2186	0.1712	0.0545	-0.0269	-0.0117
midpoint	-0.1514	0.2426	0.4169	-0.2595	-0.0101	0.1616	0.1304	0.0848	-0.1092	0.0045	-0.2823
span	-0.3205	0.1979	0.6018	0.0129	-0.2801	0.1952	-0.0135	0.0501	-0.1247	0.0720	-0.0185
control	0.3060	0.1809	-0.1464	0.0752	0.0914	-0.1332	-0.2640	0.1570	0.0260	0.0493	0.0445
samplesize	0.0086	0.3434	0.1406	-0.2352	-0.2790	0.3564	-0.0817	0.2493	0.0401	-0.1913	-0.2057

	longrun	mixed	develo~d	develo~g	transi~n	unitary	mixed_~t	national	regional	imf	others~s
longrun	1.0000										
mixed	0.0462	1.0000									
developed	0.3724	-0.2185	1.0000								
developing	-0.1602	-0.0518	-0.4967	1.0000							
transition	-0.3324	-0.0744	-0.7135	-0.1690	1.0000						
unitary	-0.3979	-0.0733	-0.6959	0.0389	0.8179	1.0000					
mixed_const	0.6528	0.1459	0.3280	-0.0793	-0.3797	-0.4733	1.0000				
national	0.5377	0.1437	0.0661	-0.0299	-0.1083	-0.2579	0.7644	1.0000			
regional	-0.5195	-0.1397	-0.0858	0.0397	0.1225	0.2752	-0.7429	-0.9719	1.0000		
imf	0.1079	0.2607	-0.1844	0.0220	0.1034	-0.0000	0.4058	0.5514	-0.5360	1.0000	
othersources	-0.1079	-0.2607	0.1844	-0.0220	-0.1034	0.0000	-0.4058	-0.5514	0.5360	-1.0000	1.0000
single	-0.5762	-0.1543	-0.1080	0.1441	0.0733	0.2159	-0.8205	-0.9316	0.9054	-0.5919	0.5919
multi	0.5762	0.1543	0.1080	-0.1441	-0.0733	-0.2159	0.8205	0.9316	-0.9054	0.5919	-0.5919
fdexp	0.1271	0.1808	0.0676	0.1080	-0.2306	-0.2195	0.1487	0.0142	0.0063	0.0020	-0.0020
fdrev	0.0568	-0.0437	0.1306	-0.0137	-0.1272	-0.0864	0.1496	0.0848	-0.0704	-0.0960	0.0960
fdexprev	0.0432	-0.0653	-0.1344	0.0143	0.1717	0.1696	-0.0916	0.1068	-0.1726	0.0694	-0.0694
threefd	-0.1790	-0.0400	-0.1049	-0.0910	0.2091	0.1514	-0.2129	-0.0579	0.0655	0.1006	-0.1006
otherfd	-0.1292	-0.0815	-0.0259	-0.0669	0.1126	0.0965	-0.1059	-0.1547	0.1704	-0.0278	0.0278
numberfd	-0.2070	-0.1127	-0.1928	-0.1025	0.3486	0.2240	-0.2743	-0.2953	0.2881	-0.1509	0.1509
growth	0.0290	0.0550	-0.0837	-0.1310	0.1797	0.1720	0.0994	0.0555	-0.0660	-0.0064	0.0064
level	-0.0037	-0.0518	0.0605	0.1510	-0.1690	-0.1722	-0.0590	-0.0035	0.0132	0.0448	-0.0448
othery	-0.0809	-0.0181	0.0828	-0.0411	-0.0591	-0.0316	-0.0962	-0.1259	0.1295	-0.0694	0.0694
published	0.2972	0.0632	-0.0163	-0.0578	0.0404	-0.0286	0.3441	0.2579	-0.2785	-0.0206	0.0206
nexplanatory	-0.0578	-0.0527	-0.1377	0.1458	0.0691	0.2219	-0.1594	-0.2468	0.2272	-0.1991	0.1991
midpoint	-0.1967	-0.1790	-0.2024	0.0162	0.2927	0.3976	-0.3146	-0.1366	0.2132	-0.2146	0.2146
span	0.1147	-0.1135	0.1552	0.0672	-0.1928	-0.1509	-0.0960	0.0421	-0.0076	-0.1943	0.1943
control	0.0433	-0.0661	-0.0044	-0.0756	0.0883	0.1083	-0.0397	-0.1537	0.1297	-0.2735	0.2735
samplesize	0.0191	0.0567	0.1107	0.0108	-0.1600	-0.1247	0.1943	0.0776	-0.0497	-0.1004	0.1004

	single	multi	fdexp	fdrev	fdexprev	threefd	otherfd	numberfd	growth	level	othery
single	1.0000										
multi	-1.0000	1.0000									
fdexp	-0.0224	0.0224	1.0000								
fdrev	-0.0812	0.0812	-0.3693	1.0000							

```
    fdexprev |  -0.1151   0.1151  -0.3115  -0.2222   1.0000
     threefd |   0.0390  -0.0390  -0.1909  -0.1362  -0.1149   1.0000
     otherfd |   0.1793  -0.1793  -0.3885  -0.2771  -0.2338  -0.1433   1.0000
    numberfd |   0.2598  -0.2598  -0.0950  -0.2809   0.0829   0.1644   0.2113   1.0000
      growth |  -0.1680   0.1680   0.1497   0.0556   0.0717  -0.1061  -0.2243   0.0276   1.0000
       level |   0.1243  -0.1243  -0.1285  -0.0380  -0.0400   0.1218   0.1462  -0.0392  -0.9199   1.0000
      othery |   0.1172  -0.1172  -0.0863  -0.0615  -0.0519  -0.0318   0.2221   0.0231  -0.3287  -0.0411   1.0000
   published |  -0.2719   0.2719  -0.0563   0.1469  -0.0170  -0.0891  -0.0129   0.0136   0.0217  -0.0508   0.0486
nexplanatory |   0.2258  -0.2258  -0.1327  -0.0762   0.1109   0.1105   0.0617   0.2025   0.1330  -0.1296  -0.0343
    midpoint |   0.0967  -0.0967   0.0897  -0.0465   0.0615   0.0886  -0.1650   0.0114   0.0306  -0.0861   0.1207
        span |  -0.0085   0.0085   0.1527  -0.0295   0.0226   0.1685  -0.2662  -0.0876  -0.1080   0.1613  -0.1457
     control |   0.1564  -0.1564  -0.1706   0.0128  -0.0926   0.2258   0.1259   0.1275   0.1228  -0.1358  -0.0021
  samplesize |  -0.1476   0.1476   0.3354  -0.0685  -0.0447  -0.1152  -0.2041  -0.0542   0.2974  -0.2597  -0.1184

             | publis~d nexpla~y midpoint     span  control sampl~ze
-------------+------------------------------------------------------
   published |   1.0000
nexplanatory |   0.1874   1.0000
    midpoint |  -0.1514   0.1104   1.0000
        span |  -0.3205  -0.0030   0.4207   1.0000
     control |   0.3060   0.5723  -0.0423  -0.1070   1.0000
  samplesize |   0.0086  -0.0409   0.1037   0.1695  -0.0657   1.0000
```

b) Categorization into K/Z moderator variables

```
. corr published finsupport puby_se timeseries_se cross_se panel_se ols_se paneltech_se dynamic_se iv_se othertech_se lon
> grun_se mixed_se developed_se developing_se transition_se unitary_se mixedconst_se national_se regional_se imf_se other
> sources_se single_se multi_se fdexp_se fdrev_se fdexprev_se threefd_se otherfd_se numberfd_se growth_se level_se othery
> _se nexplanatory_se midpoint_se span_se samplesize_se
(obs=1000)

             | publis~d finsup~t  puby_se timese~e cross_se panel_se   ols_se panelt~e dynami~e    iv_se othert~e
-------------+---------------------------------------------------------------------------------------------------
   published |   1.0000
  finsupport |   0.2365   1.0000
     puby_se |  -0.3572   0.0049   1.0000
timeseries~e |   0.0060  -0.0770  -0.1508   1.0000
    cross_se |   0.1377  -0.0888  -0.1610  -0.0602   1.0000
    panel_se |  -0.3991  -0.0493   0.9390  -0.2166  -0.2500   1.0000
      ols_se |  -0.4428  -0.1288   0.8617  -0.0782  -0.0176   0.8807   1.0000
paneltech_se |   0.0743   0.2693  -0.0850  -0.1978  -0.2283   0.0199  -0.3309   1.0000
  dynamic_se |   0.2260  -0.1085   0.1218  -0.0736  -0.0849   0.0354  -0.1231  -0.2789   1.0000
```

iv_se	-0.1013	-0.0838	-0.0867	-0.0568	-0.0655	-0.0673	-0.0950	-0.2153	-0.0801	1.0000	
othertech_se	0.0123	-0.0717	-0.1506	0.7528	-0.0561	-0.1767	-0.0813	-0.1842	-0.0685	-0.0529	1.0000
longrun_se	0.2579	0.4388	0.0819	-0.1247	-0.0837	-0.0579	-0.1985	0.0235	0.5212	-0.1426	-0.1164
mixed_se	-0.0118	0.0425	-0.0377	-0.0274	-0.0317	0.0684	-0.0272	0.2089	-0.0387	-0.0253	0.1136
developed_se	-0.3110	0.0038	0.8343	-0.1222	-0.0948	0.8150	0.7467	-0.0523	0.0456	-0.0102	-0.1157
developing~e	-0.2065	-0.0575	0.2790	0.0016	-0.0611	0.3180	0.3300	-0.0290	-0.0747	-0.0577	-0.0179
transition~e	0.0831	-0.1551	-0.1787	-0.1051	-0.1213	-0.0922	-0.1088	0.0467	0.0737	-0.1144	-0.0979
unitary_se	-0.0562	-0.1726	-0.1022	-0.1170	0.0062	-0.0386	-0.1315	0.2724	0.0098	-0.1273	-0.0767
mixedconst~e	0.1976	0.3539	0.0484	-0.1521	-0.1162	0.0380	-0.2068	0.4164	0.2499	-0.1638	-0.1416
national_se	0.1658	0.3026	0.0338	-0.0991	-0.1585	-0.0129	-0.2377	0.3473	0.2964	-0.2040	-0.0424
regional_se	-0.4340	-0.1864	0.8265	-0.1172	-0.0848	0.8889	0.9058	-0.1593	-0.1055	0.0163	-0.1176
imf_se	-0.1302	-0.0698	-0.1530	-0.1136	-0.0930	-0.0161	-0.1302	0.3749	-0.1602	-0.1214	-0.0378
otherso~s_se	-0.3301	-0.0365	0.9273	-0.1096	-0.1271	0.9225	0.8826	-0.1468	0.0769	-0.0318	-0.1134
single_se	-0.4370	-0.1916	0.8223	-0.0653	-0.0885	0.8817	0.9059	-0.1711	-0.1101	0.0133	-0.0718
multi_se	0.1715	0.3064	0.0474	-0.1824	-0.1515	0.0066	-0.2275	0.3615	0.2999	-0.1968	-0.1166
fdexp_se	-0.3944	0.0442	0.8419	-0.0978	-0.1036	0.9004	0.9159	-0.1165	-0.1311	-0.1051	-0.0689
fdrev_se	0.1327	-0.0228	-0.0008	-0.0729	0.0022	-0.0316	-0.1143	0.2519	-0.0547	-0.0472	-0.0691
fdexprev_se	0.0311	-0.1308	0.1345	-0.0008	-0.0858	-0.0054	-0.0949	-0.1475	0.5739	-0.0964	-0.0171
threefd_se	-0.0228	-0.0857	-0.0749	-0.0581	-0.0670	-0.0905	-0.0971	0.0327	-0.0819	0.1184	-0.0541
otherfd_se	-0.0285	-0.1492	-0.1432	-0.0449	-0.0477	-0.0299	-0.1572	0.2076	0.0359	0.2022	-0.0584
numberfd_se	-0.3593	-0.1248	0.8758	-0.1202	-0.1465	0.9215	0.9242	-0.2545	0.1055	-0.0817	-0.1115
growth_se	-0.3884	-0.0429	0.9225	-0.1713	-0.1613	0.9716	0.8945	-0.0107	0.0412	-0.1850	-0.1363
level_se	-0.0457	-0.0943	-0.0410	0.0802	-0.0499	-0.0566	-0.1020	0.0206	-0.0901	0.4477	0.0253
othery_se	0.0449	-0.0401	-0.0667	-0.0272	0.0760	-0.0647	-0.0368	-0.1031	-0.0383	0.2744	-0.0253
nexplanato~e	-0.1582	-0.0344	0.6350	-0.1512	-0.1811	0.6768	0.5722	0.1198	-0.0314	-0.0759	-0.1372
midpoint_se	-0.4073	-0.0655	0.9459	-0.1621	-0.1727	0.9925	0.9063	-0.0168	0.0216	-0.0807	-0.1375
span_se	-0.1307	0.1949	0.3396	-0.1064	-0.0280	0.3200	0.3148	0.0892	-0.1596	-0.0952	-0.0994
samplesize~e	-0.3498	0.0128	0.9338	-0.1571	-0.1813	0.9714	0.8469	0.0677	0.0324	-0.0854	-0.1237

	longru~e	mixed_se	dev~d_se	dev~g_se	transi~e	unitar~e	mixedc~e	nation~e	region~e	imf_se	oth~s_se
longrun_se	1.0000										
mixed_se	-0.0160	1.0000									
developed_se	0.0669	-0.0864	1.0000								
developing~e	-0.1207	-0.0279	-0.1668	1.0000							
transition~e	-0.2640	-0.0553	-0.3310	-0.1067	1.0000						
unitary_se	-0.2938	-0.0481	-0.2392	0.0007	0.7131	1.0000					
mixedconst~e	0.5708	0.2877	0.0857	-0.0651	-0.3021	-0.3410	1.0000				
national_se	0.5642	0.2928	0.0057	-0.0971	-0.1552	-0.2444	0.9004	1.0000			
regional_se	-0.3084	-0.0665	0.7285	0.3296	-0.0238	0.0727	-0.3682	-0.4577	1.0000		
imf_se	-0.0145	0.4357	-0.1250	-0.0019	0.0432	-0.0383	0.4722	0.5758	-0.2751	1.0000	
otherso~s_se	-0.0678	-0.0929	0.8040	0.3001	-0.1107	-0.0213	-0.1522	-0.2382	0.9333	-0.3844	1.0000
single_se	-0.3169	-0.0683	0.7260	0.3307	-0.0297	0.0667	-0.3786	-0.4650	0.9984	-0.2828	0.9321
multi_se	0.5693	0.2922	0.0170	-0.0963	-0.1442	-0.2314	0.9048	0.9939	-0.4416	0.5800	-0.2256
fdexp_se	-0.1091	0.0944	0.7485	0.3419	-0.1831	-0.1749	-0.0754	-0.1462	0.8745	-0.0545	0.8636

fdrev_se	-0.0143	-0.0110	0.0251	-0.0384	-0.1234	-0.0382	0.2302	0.1713	-0.1018	-0.0681	-0.0077
fdexprev_se	0.3786	-0.0466	-0.0252	-0.0505	0.1520	0.1106	0.1690	0.3076	-0.1468	0.0117	-0.0183
threefd_se	-0.1459	-0.0306	-0.1430	-0.0590	0.2604	0.1669	-0.1693	-0.0089	-0.0884	0.1281	-0.1421
otherfd_se	-0.1525	-0.0532	-0.0349	-0.0789	0.1734	0.3274	-0.0299	-0.0914	0.0095	0.0810	-0.0609
numberfd_se	-0.1245	-0.0365	0.7607	0.3064	-0.0277	-0.0717	-0.1496	-0.1865	0.9063	-0.1431	0.9101
growth_se	-0.0690	0.0704	0.7927	0.3229	-0.0713	-0.0362	0.0333	-0.0113	0.8751	-0.0315	0.9155
level_se	-0.0219	-0.0336	0.0112	-0.0471	-0.1287	0.0039	-0.0514	-0.0822	-0.0162	0.0322	-0.0658
othery_se	-0.0683	-0.0143	-0.0276	-0.0276	-0.0548	-0.0356	-0.0793	-0.0985	-0.0129	-0.0592	-0.0369
nexplanato~e	-0.1432	-0.0097	0.5576	0.2256	-0.0604	0.0342	-0.1023	-0.1709	0.6722	-0.1470	0.6740
midpoint_se	-0.0793	0.0648	0.8229	0.3241	-0.1032	-0.0373	0.0138	-0.0396	0.9060	-0.0362	0.9365
span_se	-0.0511	-0.0572	0.3459	-0.0452	0.0161	0.1443	-0.1441	-0.1218	0.3427	-0.1243	0.3448
samplesize~e	-0.0212	0.0746	0.8148	0.3147	-0.1352	-0.0562	0.0940	0.0362	0.8548	-0.0338	0.9160

	single~e	multi_se	fdexp_se	fdrev_se	fdexpr~e	threef~e	otherf~e	number~e	growth~e	level_se	othery~e
single_se	1.0000										
multi_se	-0.4540	1.0000									
fdexp_se	0.8739	-0.1366	1.0000								
fdrev_se	-0.1062	0.1747	-0.2119	1.0000							
fdexprev_se	-0.1479	0.3100	-0.1865	-0.1711	1.0000						
threefd_se	-0.0920	-0.0036	-0.1222	-0.1121	-0.0986	1.0000					
otherfd_se	0.0065	-0.0871	-0.2128	-0.1952	-0.1718	-0.1126	1.0000				
numberfd_se	0.9045	-0.1731	0.8834	-0.1509	-0.0061	-0.0510	-0.0473	1.0000			
growth_se	0.8706	0.0046	0.9048	-0.0231	0.0041	-0.1052	-0.0939	0.9171	1.0000		
level_se	-0.0140	-0.0891	-0.1086	-0.0390	-0.0453	0.0258	0.2577	-0.0909	-0.2468	1.0000	
othery_se	-0.0145	-0.0951	-0.0572	-0.0525	-0.0462	-0.0303	0.1176	-0.0421	-0.1103	-0.0333	1.0000
nexplanato~e	0.6673	-0.1545	0.5992	0.0451	-0.0250	-0.0575	-0.0290	0.6343	0.6709	-0.0911	-0.0675
midpoint_se	0.9018	-0.0243	0.9145	-0.0346	-0.0155	-0.1047	-0.0359	0.9309	0.9791	-0.0593	-0.0622
span_se	0.3387	-0.1113	0.3485	-0.0162	-0.0773	0.0454	-0.1369	0.2812	0.3382	-0.1332	0.0301
samplesize~e	0.8507	0.0499	0.8839	0.0022	-0.0111	-0.1098	-0.0351	0.8765	0.9641	-0.0788	-0.0819

	nexpla~e	midpoi~e	span_se	sampl~se
nexplanato~e	1.0000			
midpoint_se	0.6739	1.0000		
span_se	0.3364	0.3275	1.0000	
samplesize~e	0.6772	0.9786	0.3250	1.0000

Appendix 3.2.3 Moderator Variables Descriptive Statistics

a) Full Sample

```
. sum finsupport timeseries cross panel ols paneltech dynamic iv othertech longrun
mixed developed developing transition
> unitary mixed_const national regional imf othersources single multi fdexp fdrev
fdexprev threefd otherfd numberfd growt
> h level othery pubyear published nexplanatory midpoint span control samplesize
```

Variable	Obs	Mean	Std. Dev.	Min	Max
finsupport	1001	.1018981	.3026655	0	1
timeseries	1001	.0539461	.2260241	0	1
cross	1001	.0729271	.2601467	0	1
panel	1001	.8681319	.3385165	0	1
ols	1001	.2477522	.431923	0	1
paneltech	1001	.5144855	.50004	0	1
dynamic	1001	.1068931	.3091317	0	1
iv	1001	.0719281	.2584979	0	1
othertech	1001	.0529471	.2240397	0	1
longrun	1001	.3086913	.4621844	0	1
mixed	1001	.021978	.146685	0	1
developed	1001	.6813187	.4661981	0	1
developing	1001	.1038961	.3052782	0	1
transition	1001	.1928072	.3947002	0	1
unitary	1001	.2547453	.4359357	0	1
mixed_const	1001	.3866134	.4872172	0	1
national	1001	.5184815	.4999081	0	1
regional	1001	.4675325	.4991942	0	1
imf	1001	.2477522	.431923	0	1
othersources	1001	.7522478	.431923	0	1
single	1001	.5174825	.4999441	0	1
multi	1001	.4825175	.4999441	0	1
fdexp	1001	.3426573	.4748353	0	1
fdrev	1001	.2117882	.4087798	0	1
fdexprev	1001	.1558442	.3628888	0	1
threefd	1001	.0649351	.2465344	0	1
otherfd	1001	.2237762	.4169822	0	1
numberfd	1001	2.356643	1.813747	1	9
growth	1001	.8841159	.3202459	0	1
level	1001	.1038961	.3052782	0	1
othery	1001	.013986	.1174913	0	1
pubyear	1001	2006.809	4.097872	1998	2013
published	1001	.6693307	.4706893	0	1
nexplanatory	1000	8.69	7.123106	2	65
midpoint	1001	1991.377	6.441342	1974	2005
span	1001	.5894106	.4921867	0	1
control	988	.5799595	.493815	0	1
samplesize	1001	.4995005	.5002497	0	1

b) Output-Growth Studies

```
. sum finsupport timeseries cross panel ols paneltech dynamic iv othertech longrun
mixed developed developing transition
> unitary mixed_const national regional imf othersources single multi fdexp fdrev
fdexprev threefd otherfd numberfd pubye
> ar published nexplanatory midpoint span control samplesize if growth==1
```

Variable	Obs	Mean	Std. Dev.	Min	Max
finsupport	885	.1152542	.3195091	0	1
timeseries	885	.0316384	.1751345	0	1
cross	885	.0779661	.2682698	0	1

```
       panel |        885    .8847458    .3195091          0          1
         ols |        885    .2711864    .4448235          0          1
-------------+---------------------------------------------------------
   paneltech |        885    .5344633    .4990929          0          1
     dynamic |        885     .120904       .3262          0          1
          iv |        885    .0316384    .1751345          0          1
   othertech |        885    .0350282    .1839552          0          1
     longrun |        885    .3129944    .4639743          0          1
-------------+---------------------------------------------------------
       mixed |        885    .0248588    .1557826          0          1
   developed |        885    .6677966    .4712698          0          1
  developing |        885    .0892655    .2852879          0          1
  transition |        885    .2180791    .4131749          0          1
     unitary |        885    .2813559     .449915          0          1
-------------+---------------------------------------------------------
 mixed_const |        885    .4033898    .4908551          0          1
    national |        885    .5276836    .4995153          0          1
    regional |        885    .4564972    .4983856          0          1
         imf |        885    .2463277    .4311153          0          1
othersources |        885    .7536723    .4311153          0          1
-------------+---------------------------------------------------------
      single |        885    .4881356    .5001419          0          1
       multi |        885    .5118644    .5001419          0          1
       fdexp |        885    .3683616    .4826329          0          1
       fdrev |        885     .220339    .4147096          0          1
    fdexprev |        885    .1649718    .3713649          0          1
-------------+---------------------------------------------------------
     threefd |        885    .0553672     .228825          0          1
     otherfd |        885    .1898305    .3923887          0          1
    numberfd |        885    2.374011    1.891635          1          9
     pubyear |        885     2006.52    4.182882       1998       2013
   published |        885    .6734463    .4692176          0          1
-------------+---------------------------------------------------------
nexplanatory |        884    8.973982    7.498464          2         65
    midpoint |        885    1991.452     6.63041       1974       2005
        span |        885    .5694915    .4954274          0          1
     control |        872    .6020642     .489753          0          1
  samplesize |        885    .5536723     .497392          0          1
```

c) Output-Level Studies

```
. sum finsupport timeseries cross panel ols paneltech dynamic iv othertech longrun
mixed developed developing transition unitary mixed_const national regional imf
othersources single multi fdexp fdrev fdexprev threefd otherfd numberfd pubyear
published nexplanatory midpoint span control samplesize if level==1

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
  finsupport |        104           0           0          0          0
  timeseries |        104         .25    .4351096          0          1
       cross |        104    .0192308    .1380002          0          1
       panel |        104    .7307692    .4457081          0          1
         ols |        104    .0576923    .2342898          0          1
-------------+---------------------------------------------------------
   paneltech |        104    .4230769    .4964399          0          1
     dynamic |        104           0           0          0          0
          iv |        104    .3076923    .4637735          0          1
   othertech |        104    .2115385     .410377          0          1
     longrun |        104    .3076923    .4637735          0          1
-------------+---------------------------------------------------------
       mixed |        104           0           0          0          0
   developed |        104    .7596154    .4293864          0          1
  developing |        104    .2403846    .4293864          0          1
  transition |        104           0           0          0          0
     unitary |        104    .0384615     .193239          0          1
-------------+---------------------------------------------------------
 mixed_const |        104    .3076923    .4637735          0          1
    national |        104    .5192308    .5020496          0          1
    regional |        104    .4807692    .5020496          0          1
         imf |        104    .3076923    .4637735          0          1
othersources |        104    .6923077    .4637735          0          1
-------------+---------------------------------------------------------
      single |        104    .6923077    .4637735          0          1
       multi |        104    .3076923    .4637735          0          1
```

Variable	Obs	Mean	Std. Dev.	Min	Max
fdexp	104	.1634615	.371577	0	1
fdrev	104	.1634615	.371577	0	1
fdexprev	104	.1153846	.3210327	0	1
threefd	104	.1538462	.3625484	0	1
otherfd	104	.4038462	.4930435	0	1
numberfd	104	2.153846	1.049912	1	4
pubyear	104	2009.404	2.257756	2004	2012
published	104	.5961538	.4930435	0	1
nexplanatory	104	6.471154	1.843154	3	12
midpoint	104	1989.726	4.237993	1980	2002
span	104	.8269231	.3801458	0	1
control	104	.3846154	.4888602	0	1
samplesize	104	.1153846	.3210327	0	1

Appendix 3.2.4 Study Descriptive Statistics

a) For the full sample:

```
. sum study_1 study_2 study_3 study_4 study_5 study_6 study_7 study_8 study_9 study_10
study_11 study_12 study_13 study_14 study_15 study_16 study_17 study_18 study_19
study_20 study_21 study_22 study_23 study_24 study_25 study_26 study_27 study_28
study_29 study_30 study_31 study_32 study_33 study_34 study_35 study_36 study_37
study_38 study_39 study_40 study_41 study_42 study_43 study_44 study_45 study_46
study_47 study_48 study_49
```

Variable	Obs	Mean	Std. Dev.	Min	Max
study_1	1001	.02997	.1705899	0	1
study_2	1001	.011988	.1088859	0	1
study_3	1001	.04995	.2179507	0	1
study_4	1001	.002997	.0546901	0	1
study_5	1001	.011988	.1088859	0	1
study_6	1001	.002997	.0546901	0	1
study_7	1001	.011988	.1088859	0	1
study_8	1001	.01998	.1400014	0	1
study_9	1001	.005994	.0772272	0	1
study_10	1001	.036963	.1887654	0	1
study_11	1001	.038961	.1935989	0	1
study_12	1001	.007992	.0890846	0	1
study_13	1001	.002997	.0546901	0	1
study_14	1001	.007992	.0890846	0	1
study_15	1001	.011988	.1088859	0	1
study_16	1001	.013986	.1174913	0	1
study_17	1001	.002997	.0546901	0	1
study_18	1001	.003996	.0631191	0	1
study_19	1001	.001998	.0446767	0	1
study_20	1001	.024975	.1561269	0	1
study_21	1001	.004995	.0705339	0	1
study_22	1001	.02997	.1705899	0	1
study_23	1001	.01998	.1400014	0	1
study_24	1001	.005994	.0772272	0	1
study_25	1001	.003996	.0631191	0	1
study_26	1001	.011988	.1088859	0	1
study_27	1001	.031968	.1760029	0	1
study_28	1001	.007992	.0890846	0	1
study_29	1001	.002997	.0546901	0	1
study_30	1001	.0859141	.2803772	0	1
study_31	1001	.004995	.0705339	0	1
study_32	1001	.007992	.0890846	0	1
study_33	1001	.007992	.0890846	0	1
study_34	1001	.047952	.2137716	0	1
study_35	1001	.025974	.1591373	0	1
study_36	1001	.015984	.1254761	0	1
study_37	1001	.0679321	.2517551	0	1
study_38	1001	.026973	.1620856	0	1

```
    study_39 |       1001      .017982     .1329523           0           1
    study_40 |       1001      .003996     .0631191           0           1
-------------+---------------------------------------------------------
    study_41 |       1001      .011988     .1088859           0           1
    study_42 |       1001     .0899101     .2861959           0           1
    study_43 |       1001      .025974     .1591373           0           1
    study_44 |       1001       .02997     .1705899           0           1
    study_45 |       1001      .001998     .0446767           0           1
-------------+---------------------------------------------------------
    study_46 |       1001      .003996     .0631191           0           1
    study_47 |       1001      .011988     .1088859           0           1
    study_48 |       1001      .035964     .1862936           0           1
    study_49 |       1001     .0519481     .2220331           0           1
```

```
    b)  For the output-growth literature
    c)  For the output-level literature
```

Appendix 3.3 Diagnostics

Appendix 3.3.1 The letter-value approach

```
. lv t

 #   1000                  t-stat
             ---------------------------------
M     500.5 |              -.0808377           |     spread  pseudosigma
F     250.5 | -1.846154   -.0818534   1.682447 |   3.528601    2.616773
E     125.5 |    -3.015     -.1095      2.796 |      5.811    2.527087
D      63   |    -4.625     -.3275       3.97 |      8.595    2.803443
C      32   | -6.090571   -.4806354    5.1293 |   11.21987    3.020979
B      16.5 |    -7.782   -.5995001     6.583 |     14.365    3.355683
A       8.5 |   -9.4215    -1.04275     7.336 |    16.7575    3.488961
Z       4.5 |       -15     -3.5595     7.881 |     22.881      4.3362
Y       2.5 |       -20   -5.548679  8.902643 |   28.90264    5.065441
X       1.5 |       -20    -5.41538   9.16924 |   29.16924    4.790863
        1   |       -20   -5.388453  9.223094 |   29.22309    4.570633
            |                                  |
            |                                  |    # below     # above
inner fence | -7.139055              6.975348 |         21          13
outer fence | -12.43196              12.26825 |          4           0
```

Appendix 3.3.2 The Extremes Approach

```
. extremes t

  +------------+
  | obs:     t |
  |------------|
  | 443.   -20 |
  | 444.   -20 |
  | 445.   -20 |
  | 446.   -20 |
  | 435.   -10 |
  +------------+

  +----------------+
  | 938.     7.754 |
  | 934.     8.008 |
  | 348.    8.6899 |
  | 108.   9.11539 |
  | 268.   9.22309 |
  +----------------+

note: 2 values of -10
```

Appendix 3.3.3 Testing for heterogeneity

a) Cochran Q

```
reg t invSE  [aweight=weights], noc
(sum of wgt is   4.8967e+01)

      Source |       SS       df       MS              Number of obs =    1000
-------------+------------------------------           F(  1,   999) =    0.46
       Model |  3.80323859     1  3.80323859           Prob > F      =  0.4980
    Residual |  8268.09128   999  8.27636765           R-squared     =  0.0005
-------------+------------------------------           Adj R-squared = -0.0005
       Total |  8271.89452  1000  8.27189452           Root MSE      =  2.8769

------------------------------------------------------------------------------
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       invSE |  -.0034951   .0051559    -0.68   0.498    -.0136126    .0066225
------------------------------------------------------------------------------
```

b) I2

I^2 using the sum of squared errors = 8268

I^2 = (8268-999/8268)*100 = 87%

Appendix 3.3.4 Double Clustering

```
. reg t invSE if t>-12, vce(cluster idstudy)



Linear regression                                      Number of obs =     997
                                                       F(  1,    48) =    2.37
                                                       Prob > F      =  0.1303
                                                       R-squared     =  0.0020
                                                       Root MSE      =   2.827
                               (Std. Err. adjusted for 49 clusters in idstudy)
------------------------------------------------------------------------------
             |               Robust
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       invSE |  -.0074297   .0048264    -1.54   0.130    -.0171337    .0022744
       _cons |   .0073965   .2363576     0.03   0.975    -.4678322    .4826253
------------------------------------------------------------------------------

. cluster2 t invSE if t>-12, fcluster(idspec) tcluster(idstudy)

Linear regression with 2D clustered SEs                Number of obs =     997
                                                       F(  1,   618) =    1.32
                                                       Prob > F      =  0.2509
Number of clusters (idspec) =   619                    R-squared     =  0.0020
Number of clusters (idstudy) =    49                   Root MSE      =  2.8270
------------------------------------------------------------------------------
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       invSE |  -.0074297   .0048264    -1.54   0.124    -.0169077    .0020484
       _cons |   .0073965   .2363576     0.03   0.975    -.4567648    .4715579
------------------------------------------------------------------------------

     SE clustered by idspec and idstudy (multiple obs per idspec-idstudy)
```

Appendix 3.4 FAT-PET

Appendix 3.4.1 Full Sample

```
*WLS
. regress t invSE if t>-7.138112 & t<=6.973776  [aweight=weights], vce(cluster
idstudy)
(sum of wgt is   4.7462e+01)

Linear regression                                      Number of obs =     966
                                                       F(  1,     48) =    2.10
                                                       Prob > F      =  0.1538
                                                       R-squared     =  0.0078
                                                       Root MSE      =  2.3936

                               (Std. Err. adjusted for 49 clusters in idstudy)
------------------------------------------------------------------------------
             |               Robust
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       invSE |  -.0188568   .0130132    -1.45   0.154    -.0450215    .0073079
       _cons |   .5650906   .2554129     2.21   0.032     .0515485    1.078633
------------------------------------------------------------------------------


.
. vif

    Variable |       VIF       1/VIF
-------------+----------------------
       invSE |      1.00    1.000000
-------------+----------------------
    Mean VIF |      1.00

.
. estat ovtest

Ramsey RESET test using powers of the fitted values of t
       Ho:  model has no omitted variables
                 F(3, 961) =      1.46
                  Prob > F =      0.2253

. outreg2 using 21oct3.doc
21oct3.doc
dir : seeout


. *FE

. regress t invSE invSE_study1 invSE_study2 invSE_study3 invSE_study4 invSE_study5
invSE_study6 invSE_study8 invSE_study9 invSE_study10 invSE_study11 invSE_study12
invSE_study13 invSE_study14 invSE_study15 invSE_study16 invSE_study17 invSE_study18
invSE_study19 invSE_study20 invSE_study21 invSE_study22 invSE_study24 invSE_study25
invSE_study26 invSE_study27 invSE_study28 invSE_study29 invSE_study30 invSE_study31
invSE_study33 invSE_study34 invSE_study35 invSE_study36 invSE_study37 invSE_study38
invSE_study39 invSE_study41 invSE_study40 invSE_study42 invSE_study43 invSE_study44
invSE_study45 invSE_study46 invSE_study47 invSE_study48 invSE_study49 if t>-7.138112
& t<=6.973776 [aweight=weights], vce(cluster idstudy)
(sum of wgt is   4.7462e+01)

Linear regression                                      Number of obs =     966
                                                       F(  1,     48) =       .
                                                       Prob > F      =       .
                                                       R-squared     =  0.3275
                                                       Root MSE      =  2.0193

                                (Std. Err. adjusted for 49 clusters in idstudy)
-------------------------------------------------------------------------------
              |               Robust
            t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
--------------+----------------------------------------------------------------
        invSE |  -.0245453   .0197184    -1.24   0.219    -.0641918    .0151013
 invSE_study1 |  -.1052024   .0367456    -2.86   0.006    -.1790843   -.0313204
 invSE_study2 |    .010171    .022593     0.45   0.655    -.0352553    .0555973
 invSE_study3 |  -.0572324   .0254088    -2.25   0.029    -.1083202   -.0061447
 invSE_study4 |   .1054477   .0212782     4.96   0.000     .0626651    .1482303
```

```
 invSE_study5 |   .1297655   .0153937     8.43   0.000     .0988145    .1607166
 invSE_study6 |   .5037588   .0559614     9.00   0.000     .3912409    .6162767
 invSE_study8 |   .1986192    .038312     5.18   0.000     .1215878    .2756506
 invSE_study9 |  -.1378001   .0393194    -3.50   0.001    -.2168571   -.0587431
invSE_study10 |   .1446016   .0213554     6.77   0.000     .1016637    .1875395
invSE_study11 |   .0165904   .0168684     0.98   0.330    -.0173258    .0505065
invSE_study12 |   .0041635   .0154483     0.27   0.789    -.0268975    .0352245
invSE_study13 |   .0950123   .0411849     2.31   0.025     .0122044    .1778202
invSE_study14 |   .2085884    .067507     3.09   0.003     .0728565    .3443204
invSE_study15 |   .0693868   .0379388     1.83   0.074    -.0068943    .1456679
invSE_study16 |   .3800798    .076422     4.97   0.000      .226423    .5337366
invSE_study17 |   .1097999   .0218142     5.03   0.000     .0659394    .1536603
invSE_study18 |  -.0048628   .0182995    -0.27   0.792    -.0416563    .0319307
invSE_study19 |   .3606559   .0510485     7.06   0.000     .2580159    .4632958
invSE_study20 |   .0104686   .0192538     0.54   0.589    -.0282437    .0491809
invSE_study21 |   .1381792   .0810418     1.71   0.095    -.0247662    .3011246
invSE_study22 |   .0226468   .0505773     0.45   0.656    -.0790457    .1243393
invSE_study24 |   .0622358   .0146254     4.26   0.000     .0328295     .091642
invSE_study25 |   .2172321   .0650139     3.34   0.002     .0865129    .3479514
invSE_study26 |  -.0428336   .0184303    -2.32   0.024    -.0798903   -.0057769
invSE_study27 |   .0364419    .018562     1.96   0.055    -.0008796    .0737634
invSE_study28 |   .2572111   .0213521    12.05   0.000     .2142798    .3001425
invSE_study29 |  -.1115502   .0949549    -1.17   0.246    -.3024697    .0793693
invSE_study30 |   .0243994   .0162975     1.50   0.141     -.008369    .0571678
invSE_study31 |  -.0046482   .0941252    -0.05   0.961    -.1938997    .1846033
invSE_study33 |  -.0358538   .0146026    -2.46   0.018    -.0652142   -.0064933
invSE_study34 |    -.01703   .0160703    -1.06   0.295    -.0493416    .0152816
invSE_study35 |   .0021997   .0338613     0.06   0.948    -.0658831    .0702825
invSE_study36 |   .1425462   .0180763     7.89   0.000     .1062012    .1788911
invSE_study37 |   .0071175   .0411707     0.17   0.863    -.0756616    .0898967
invSE_study38 |  -.1116156   .0242182    -4.61   0.000    -.1603094   -.0629217
invSE_study39 |  -.0894144   .0405153    -2.21   0.032    -.1708759    -.007953
invSE_study41 |   .0517144   .0253424     2.04   0.047     .0007601    .1026687
invSE_study40 |  -.0461101    .068257    -0.68   0.503    -.1833499    .0911297
invSE_study42 |   -.135711   .0213871    -6.35   0.000    -.1787127   -.0927094
invSE_study43 |  -.0337597   .0228236    -1.48   0.146    -.0796497    .0121302
invSE_study44 |   .1685694   .0297707     5.66   0.000     .1087113    .2284275
invSE_study45 |   .6109236   .0912972     6.69   0.000     .4273583    .7944889
invSE_study46 |   .6400767   .0450291    14.21   0.000     .5495396    .7306139
invSE_study47 |  -.1245509   .1001082    -1.24   0.219     -.325832    .0767301
invSE_study48 |   .0509604   .0280795     1.81   0.076    -.0054972    .1074179
invSE_study49 |   .0075573   .0151149     0.50   0.619    -.0228332    .0379478
        _cons |     .01405   .4148945     0.03   0.973    -.8201513    .8482514
------------------------------------------------------------------------------

.
. outreg2 using 21oct3.doc
21oct3.doc
dir : seeout

.
. vif

    Variable |       VIF       1/VIF
-------------+----------------------
       invSE |      6.72    0.148737
invSE_stu~30 |      4.46    0.224026
invSE_stu~33 |      1.51    0.661265
invSE_stu~24 |      1.47    0.679629
invSE_stu~49 |      1.28    0.783126
invSE_stu~47 |      1.27    0.786442
invSE_stu~31 |      1.27    0.787041
invSE_study5 |      1.27    0.790230
invSE_stu~45 |      1.26    0.790819
invSE_stu~29 |      1.26    0.790906
invSE_stu~12 |      1.26    0.791515
invSE_stu~21 |      1.26    0.794781
invSE_stu~40 |      1.25    0.802707
invSE_stu~14 |      1.24    0.803282
invSE_stu~25 |      1.24    0.805180
invSE_stu~16 |      1.23    0.813147
invSE_stu~19 |      1.22    0.818204
invSE_stu~22 |      1.21    0.826296
invSE_stu~13 |      1.20    0.830025
invSE_stu~46 |      1.20    0.830047
invSE_stu~37 |      1.20    0.830416
invSE_stu~39 |      1.20    0.830776
```

```
invSE_study9 |      1.20    0.832379
invSE_stu~15 |      1.20    0.834238
invSE_stu~11 |      1.19    0.838121
invSE_study8 |      1.19    0.838674
invSE_stu~36 |      1.19    0.839158
invSE_stu~18 |      1.19    0.840530
invSE_stu~27 |      1.19    0.842379
invSE_study1 |      1.19    0.843663
invSE_stu~26 |      1.18    0.845204
invSE_stu~44 |      1.18    0.845885
invSE_stu~34 |      1.18    0.847519
invSE_stu~35 |      1.18    0.848508
invSE_stu~42 |      1.18    0.850638
invSE_stu~17 |      1.18    0.850767
invSE_stu~28 |      1.17    0.851101
invSE_stu~20 |      1.17    0.851756
invSE_stu~38 |      1.17    0.853118
invSE_study4 |      1.17    0.853292
invSE_study3 |      1.16    0.862211
invSE_study2 |      1.16    0.864532
invSE_study6 |      1.15    0.866275
invSE_stu~41 |      1.15    0.871800
invSE_stu~10 |      1.14    0.875436
invSE_stu~43 |      1.10    0.906014
invSE_stu~48 |      1.08    0.925218
-------------+----------------------
    Mean VIF |      1.40

.
. estat ovtest

Ramsey RESET test using powers of the fitted values of t
       Ho:  model has no omitted variables
                 F(3, 915) =      6.54
                  Prob > F =      0.0002
```

Appendix 3.4.2 By Type of Study

A. Output-Growth Studies

```
*WLS, output-growth studies
. regress t invSE if t>-7.138112 & t<=6.973776  & growth==1 [aweight=weights],
vce(cluster idstudy)
(sum of wgt is   3.8212e+01)

Linear regression                                      Number of obs =     850
                                                       F(  1,    40) =    0.61
                                                       Prob > F      =  0.4400
                                                       R-squared     =  0.0016
                                                       Root MSE      =  2.3595

                               (Std. Err. adjusted for 41 clusters in idstudy)
------------------------------------------------------------------------------
             |               Robust
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       invSE |  -.0081382   .0104339    -0.78   0.440    -.0292259    .0129495
       _cons |   .3414777   .2460163     1.39   0.173    -.1557398    .8386951
------------------------------------------------------------------------------

.
. outreg2 using 21oct3.doc
21oct3.doc
dir : seeout

.
. vif

    Variable |       VIF       1/VIF
-------------+----------------------
       invSE |      1.00    1.000000
-------------+----------------------
    Mean VIF |      1.00
```

```
.
. estat ovtest

Ramsey RESET test using powers of the fitted values of t
       Ho:  model has no omitted variables
                 F(3, 845) =      0.44
                  Prob > F =      0.7228


*FE, output-growth studies

. regress t invSE invSE_study1 invSE_study2 invSE_study3 invSE_study4 invSE_study5
invSE_study6 invSE_study8 invSE_study9 invSE_study10 invSE_study11 invSE_study13
invSE_study14 invSE_study16 invSE_study17 invSE_study18 invSE_study19 invSE_study20
invSE_study21 invSE_study22 invSE_study24 invSE_study26 invSE_study27 invSE_study28
invSE_study29 invSE_study30 invSE_study31 invSE_study33 invSE_study34 invSE_study35
invSE_study36 invSE_study37 invSE_study38 invSE_study39 invSE_study41 invSE_study42
invSE_study43 invSE_study48 invSE_study49 if t>-7.138112 & t<=6.973776 & growth==1
[aweight=weights], vce(cluster idstudy)
(sum of wgt is   3.8212e+01)

Linear regression                                      Number of obs =     850
                                                       F(  1,    40) =       .
                                                       Prob > F      =       .
                                                       R-squared     =  0.2798
                                                       Root MSE      =  2.0505

                                (Std. Err. adjusted for 41 clusters in idstudy)
-------------------------------------------------------------------------------
              |               Robust
            t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
--------------+----------------------------------------------------------------
        invSE |    -.03478   .0185071    -1.88   0.068    -.0721842    .0026243
 invSE_study1 |  -.1259902   .0373532    -3.37   0.002    -.2014839   -.0504965
 invSE_study2 |   .0002061   .0219174     0.01   0.993    -.0440906    .0445029
 invSE_study3 |  -.0695276   .0250557    -2.77   0.008    -.1201671   -.0188881
 invSE_study4 |   .0966375   .0204307     4.73   0.000     .0553456    .1379294
 invSE_study5 |   .1278098   .0134592     9.50   0.000     .1006078    .1550118
 invSE_study6 |   .4696146   .0577343     8.13   0.000     .3529293      .5863
 invSE_study8 |   .1767132   .0390286     4.53   0.000     .0978334     .255593
 invSE_study9 |  -.1604212   .0401043    -4.00   0.000     -.241475   -.0793674
invSE_study10 |    .135722   .0205185     6.61   0.000     .0942526    .1771913
invSE_study11 |     .01236   .0152793     0.81   0.423    -.0185207    .0432407
invSE_study13 |   .0710745   .0420926     1.69   0.099    -.0139978    .1561469
invSE_study14 |    .166622     .06988     2.38   0.022     .0253893    .3078547
invSE_study16 |   .3321206   .0792342     4.19   0.000     .1719824    .4922589
invSE_study17 |   .1005123   .0210388     4.78   0.000     .0579913    .1430333
invSE_study18 |  -.0107691   .0169877    -0.63   0.530    -.0451025    .0235644
invSE_study19 |   .3298723   .0525499     6.28   0.000      .223665    .4360796
invSE_study20 |   .0035718   .0181046     0.20   0.845     -.033019    .0401626
invSE_study21 |   .0871255   .0840758     1.04   0.306     -.082798    .2570491
invSE_study22 |  -.0078131    .052052    -0.15   0.881     -.113014    .0973879
invSE_study24 |   .0649139   .0124409     5.22   0.000     .0397699     .090058
invSE_study26 |  -.0488803   .0171418    -2.85   0.007    -.0835253   -.0142354
invSE_study27 |   .0302554   .0172966     1.75   0.088    -.0047023    .0652131
invSE_study28 |   .2483344   .0205148    12.11   0.000     .2068725    .2897963
invSE_study29 |  -.1718916   .0986406    -1.74   0.089    -.3712516    .0274685
invSE_study30 |   .0307328   .0144868     2.12   0.040     .0014539    .0600117
invSE_study31 |  -.0644368   .0977727    -0.66   0.514    -.2620428    .1331691
invSE_study33 |   .0125698   .0127214     0.99   0.329     -.013141    .0382806
invSE_study34 |  -.0201462   .0143038    -1.41   0.167    -.0490553    .0087628
invSE_study35 |  -.0165049   .0342573    -0.48   0.633    -.0857415    .0527316
invSE_study36 |   .1368833   .0167243     8.18   0.000     .1030824    .1706843
invSE_study37 |  -.0007903    .042229    -0.02   0.985    -.0861382    .0845576
invSE_study38 |  -.1229445   .0237352    -5.18   0.000    -.1709152   -.0749738
invSE_study39 |  -.1128806   .0413794    -2.73   0.009    -.1965115   -.0292498
invSE_study41 |   .0394725   .0249824     1.58   0.122    -.0110187    .0899637
invSE_study42 |  -.1446191   .0205545    -7.04   0.000    -.1861612   -.1030769
invSE_study43 |  -.0439219   .0221766    -1.98   0.055    -.0887424    .0008987
invSE_study48 |   .0365709   .0279908     1.31   0.199    -.0200007    .0931425
invSE_study49 |   .0061966   .0131051     0.47   0.639    -.0202899     .032683
        _cons |   .2872016   .4323113     0.66   0.510    -.5865321    1.160935
-------------------------------------------------------------------------------

.
. outreg2 using 21oct3.doc
21oct3.doc
```

```
dir : seeout
. vif

    Variable |       VIF       1/VIF  
-------------+----------------------
       invSE |      6.42    0.155733
invSE_stu~30 |      4.60    0.217187
invSE_stu~24 |      1.47    0.679406
invSE_stu~31 |      1.31    0.762126
invSE_stu~29 |      1.31    0.766264
invSE_stu~21 |      1.30    0.770835
invSE_stu~14 |      1.28    0.780606
invSE_stu~49 |      1.27    0.786472
invSE_stu~16 |      1.26    0.790835
invSE_stu~33 |      1.26    0.793131
invSE_study5 |      1.26    0.793275
invSE_stu~19 |      1.25    0.798079
invSE_stu~22 |      1.24    0.806860
invSE_stu~13 |      1.23    0.812417
invSE_stu~39 |      1.23    0.813373
invSE_study9 |      1.23    0.815377
invSE_study8 |      1.22    0.822384
invSE_study1 |      1.21    0.828162
invSE_stu~35 |      1.20    0.834266
invSE_stu~36 |      1.19    0.837632
invSE_stu~11 |      1.19    0.838471
invSE_stu~18 |      1.19    0.838664
invSE_stu~27 |      1.19    0.840124
invSE_stu~26 |      1.19    0.843158
invSE_stu~17 |      1.18    0.844425
invSE_stu~38 |      1.18    0.844524
invSE_stu~42 |      1.18    0.844770
invSE_stu~28 |      1.18    0.845285
invSE_study4 |      1.18    0.847616
invSE_stu~20 |      1.18    0.848587
invSE_stu~34 |      1.18    0.848903
invSE_study6 |      1.18    0.849852
invSE_study3 |      1.17    0.853092
invSE_study2 |      1.17    0.857830
invSE_stu~41 |      1.16    0.863204
invSE_stu~10 |      1.15    0.870282
invSE_stu~37 |      1.12    0.895242
invSE_stu~43 |      1.11    0.900796
invSE_stu~48 |      1.09    0.918683
-------------+----------------------
    Mean VIF |      1.43

.
. estat ovtest

Ramsey RESET test using powers of the fitted values of t
       Ho:  model has no omitted variables
                 F(3, 807) =      4.33
                  Prob > F =      0.0049
```

B. Output-Level Studies

```
. regress t invSE if t>-7.138112 & t<=6.973776  & level==1 [aweight=weights],
vce(cluster idstudy)
(sum of wgt is   8.0323e+00)

Linear regression                                      Number of obs =     104
                                                       F(  1,      9) =    7.25
                                                       Prob > F      =  0.0247
                                                       R-squared     =  0.1050
                                                       Root MSE      =  2.3953

                               (Std. Err. adjusted for 10 clusters in idstudy)
------------------------------------------------------------------------------
             |               Robust
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       invSE |  -.0995338     .036959    -2.69   0.025    -.1831409   -.0159267
       _cons |   1.728061    .7799853     2.22   0.054    -.0363885     3.49251
```

```
------------------------------------------------------------------------------

.
end of do-file

. do "C:\Users\PERDOR~1\AppData\Local\Temp\STD01000000.tmp"

. estat ovtest

Ramsey RESET test using powers of the fitted values of t
       Ho:  model has no omitted variables
                  F(3, 99) =      5.49
                  Prob > F =      0.0016

. vif

    Variable |       VIF       1/VIF
-------------+----------------------
       invSE |      1.00    1.000000
-------------+----------------------
    Mean VIF |      1.00


. regress t invSE invSE_study11 study_33 invSE_study37  invSE_study40  invSE_study45
invSE_study46  study_47 if t>-7.138112 & t<=6.973776 & level==1 [
> aweight=weights], vce(cluster idstudy)
(sum of wgt is   8.0323e+00)

Linear regression                                      Number of obs =     104
                                                       F(  1,     9) =       .
                                                       Prob > F      =       .
                                                       R-squared     =  0.5201
                                                       Root MSE      =  1.8174

                                (Std. Err. adjusted for 10 clusters in idstudy)
------------------------------------------------------------------------------
             |               Robust
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       invSE |  -.0854166   .0254267    -3.36   0.008    -.1429358   -.0278974
invSE_study11 |  -.0534097   .0145376    -3.67   0.005     -.086296   -.0205234
    study_33 |  -1.549798   .3400024    -4.56   0.001    -2.318937   -.7806589
invSE_study37 |  -.1480999   .0475131    -3.12   0.012     -.255582   -.0406179
invSE_study40 |  -.2949418   .0833107    -3.54   0.006    -.4834037   -.1064799
invSE_study45 |    .271415   .1133645     2.39   0.040     .0149668    .5278632
invSE_study46 |   .4843564   .0528075     9.17   0.000     .3648977    .6038152
    study_47 |  -1.791869   .4616823    -3.88   0.004    -2.836267   -.7474705
       _cons |   1.619086    .537267     3.01   0.015      .403704    2.834469
------------------------------------------------------------------------------

.
end of do-file

. do "C:\Users\PERDOR~1\AppData\Local\Temp\STD01000000.tmp"

. estat ovtest

Ramsey RESET test using powers of the fitted values of t
       Ho:  model has no omitted variables
                  F(3, 92) =      6.25
                  Prob > F =      0.0007

. vif

    Variable |       VIF       1/VIF
-------------+----------------------
       invSE |      1.80    0.554392
    study_47 |      1.39    0.718007
invSE_stu~45 |      1.37    0.730174
    study_33 |      1.34    0.747266
invSE_stu~40 |      1.32    0.758098
invSE_stu~46 |      1.23    0.812068
invSE_stu~37 |      1.12    0.890982
invSE_stu~11 |      1.01    0.987202
-------------+----------------------
    Mean VIF |      1.32
```

Appendix 3.4.3 Robustness Check

A. Full Sample

```
. rreg t invSE

   Huber iteration 1:  maximum difference in weights = .80333214
   Huber iteration 2:  maximum difference in weights = .19541016
   Huber iteration 3:  maximum difference in weights = .0379409
Biweight iteration 4:  maximum difference in weights = .22027368
Biweight iteration 5:  maximum difference in weights = .02829757
Biweight iteration 6:  maximum difference in weights = .00793258

Robust regression                                      Number of obs =     1001
                                                       F(  1,    998) =     0.23
                                                       Prob > F      =   0.6348

------------------------------------------------------------------------------
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       invSE |   -.002358   .0049623    -0.48   0.635    -.0120957    .0073798
       _cons |   -.041733   .1231459    -0.34   0.735    -.2833876    .1999216
------------------------------------------------------------------------------
```

B. Output-Growth Studies

```
. rreg t invSE if growth ==1

   Huber iteration 1:  maximum difference in weights = .79909233
   Huber iteration 2:  maximum difference in weights = .19432345
   Huber iteration 3:  maximum difference in weights = .0311748
Biweight iteration 4:  maximum difference in weights = .21456302
Biweight iteration 5:  maximum difference in weights = .0358598
Biweight iteration 6:  maximum difference in weights = .00591671

Robust regression                                      Number of obs =      884
                                                       F(  1,    882) =     0.00
                                                       Prob > F      =   0.9560

------------------------------------------------------------------------------
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       invSE |  -.0002869   .0051934    -0.06   0.956    -.0104798     .009906
       _cons |  -.1346171   .1354307    -0.99   0.320    -.4004211    .1311869
------------------------------------------------------------------------------
```

C. Output-Level Studies

```
. rreg t invSE if level ==1

   Huber iteration 1:  maximum difference in weights = .51953603
   Huber iteration 2:  maximum difference in weights = .08708258
   Huber iteration 3:  maximum difference in weights = .02007069
Biweight iteration 4:  maximum difference in weights = .15509184
Biweight iteration 5:  maximum difference in weights = .01126612
Biweight iteration 6:  maximum difference in weights = .0044583

Robust regression                                      Number of obs =      104
                                                       F(  1,    102) =     2.48
                                                       Prob > F      =   0.1181

------------------------------------------------------------------------------
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       invSE |  -.0539534   .0342299    -1.58   0.118    -.1218483    .0139415
       _cons |   .7614895   .4036946     1.89   0.062    -.0392368    1.562216
------------------------------------------------------------------------------
```

Appendix 3.5 Multivariate MRA

Appendix 3.5.1 Full Sample

a) WLS

```
***************************Full Sample****************************************

.
. *1* wls(positive publication bias and negative genuine effect)

.
. reg t invSE published puby_se finsupport cross_se timeseries_se ols_se dynamic_se
iv_se othertech_se longrun_se mixed_se developing_se transition_se endog_se
nonlinear_se national_se imf_se unitary_se  fdrev_se fdexprev_se  threefd_se
otherfd_se level_se othery_se  span_se nexplanatory_se if t>-7.138112 & t<=6.973776
[aweight=weights], vce(cluster idstudy)
(sum of wgt is   4.7462e+01)

Linear regression                                      Number of obs =     966
                                                       F( 27,    48) =   10.21
                                                       Prob > F      =  0.0000
                                                       R-squared     =  0.1485
                                                       Root MSE      =  2.2478

                                 (Std. Err. adjusted for 49 clusters in idstudy)
--------------------------------------------------------------------------------
               |               Robust
             t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
---------------+----------------------------------------------------------------
         invSE |  -.0328132   .0500937    -0.66   0.516    -.1335332    .0679069
     published |   .7266646   .3716102     1.96   0.056    -.0205079    1.473837
       puby_se |    .005907   .0050357     1.17   0.247    -.0042178    .0160319
    finsupport |  -2.446936   .6034069    -4.06   0.000    -3.660167   -1.233705
      cross_se |  -.1182092   .0810379    -1.46   0.151    -.2811469    .0447285
 timeseries_se |   .2320874   .1720986     1.35   0.184    -.1139399    .5781148
        ols_se |  -.0264415   .0310018    -0.85   0.398    -.0887748    .0358919
    dynamic_se |    .000616   .0685177     0.01   0.993    -.1371481    .1383802
         iv_se |  -.0012782     .04872    -0.03   0.979    -.0992364    .0966799
  othertech_se |  -.0293212   .0941917    -0.31   0.757    -.2187063     .160064
    longrun_se |  -.0191876   .0348289    -0.55   0.584    -.0892159    .0508406
      mixed_se |   .0259188   .0237328     1.09   0.280    -.0217993    .0736368
 developing_se |   .0212738   .0109748     1.94   0.058    -.0007926    .0433402
 transition_se |   .0342558   .0510641     0.67   0.506    -.0684155    .1369272
      endog_se |   .0173012   .0295165     0.59   0.561    -.0420458    .0766482
  nonlinear_se |   .0107708   .0325986     0.33   0.743    -.0547732    .0763147
   national_se |  -.0873612   .0421644    -2.07   0.044    -.1721384    -.002584
        imf_se |   .0677723   .0449375     1.51   0.138    -.0225806    .1581252
    unitary_se |  -.0248098   .0417621    -0.59   0.555    -.1087781    .0591585
      fdrev_se |  -.0306688   .0237581    -1.29   0.203    -.0784377    .0171001
   fdexprev_se |  -.0363951   .0419444    -0.87   0.390      -.12073    .0479398
    threefd_se |  -.2185626   .0696024    -3.14   0.003    -.3585076   -.0786176
    otherfd_se |   .0044974   .0364677     0.12   0.902    -.0688258    .0778206
      level_se |  -.0623799   .0256125    -2.44   0.019    -.1138772   -.0108825
     othery_se |  -.1165163   .0389982    -2.99   0.004    -.1949274   -.0381052
       span_se |   .0217177   .0158459     1.37   0.177    -.0101427    .0535781
nexplanatory_se |  -.0018906   .0008981    -2.11   0.041    -.0036963   -.0000849
         _cons |   .2459775   .4285345     0.57   0.569    -.6156488    1.107604
--------------------------------------------------------------------------------

.
. outreg2 using finalchapter4.doc
finalchapter4.doc
dir : seeout

.
. lincom _cons + 0.6693307*published + 0.1018981*finsupport

 ( 1)  .6693307*published + .1018981*finsupport + _cons = 0

------------------------------------------------------------------------------
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   .4830183   .3546012     1.36   0.180    -.2299552    1.195992
```

```
------------------------------------------------------------------------------

.
. lincom invSE + 9.809191*puby_se + 0.0539461*timeseries_se + 0.0729271*cross_se
+0.2477522*ols_se + 0.3091317*dynamic_se>  + 0.0529471*othertech_se +
0.3086913*longrun_se + 0.021978*mixed_se + 0.1038961*developing_se +
0.1928072*transition_s> e + 0.2997003*endog_se + 0.2117882*nonlinear_se +
0.5184815*national_se + 0.2317682*imf_se +0.3586414*unitary_se + 0.2117882*fdrev_se +
0.1558442*fdexprev + 0.0649351*threefd + 0.2237762*otherfd_se + 0.1038961*level_se +
0.013986*othery_se + 0.36*span_se +8.69*nexplanatory_se

 ( 1)  invSE + 9.809191*puby_se + .0729271*cross_se + .0539461*timeseries_se +
.2477522*ols_se + .3091317*dynamic_se +        .0529471*othertech_se +
.3086913*longrun_se + .021978*mixed_se + .1038961*developing_se +
.1928072*transition_se +       .2997003*endog_se + .2117882*nonlinear_se +
.5184815*national_se + .2317682*imf_se + .3586414*unitary_se +
.2117882*fdrev_se + .1558442*fdexprev_se + .0649351*threefd_se + .2237762*otherfd_se
+ .1038961*level_se +       .013986*othery_se + .36*span_se + 8.69*nexplanatory_se =
0

------------------------------------------------------------------------------
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |  -.0485157   .0267608    -1.81   0.076     -.102322    .0052906
------------------------------------------------------------------------------

.
. vif

    Variable |       VIF       1/VIF  
-------------+----------------------
       invSE |     18.09    0.055276
     puby_se |     15.68    0.063791
      imf_se |      6.93    0.144233
 national_se |      6.18    0.161925
  unitary_se |      5.72    0.174755
      ols_se |      5.13    0.194935
transition~e |      3.93    0.254735
    endog_se |      3.91    0.255570
       iv_se |      3.40    0.294093
  otherfd_se |      2.62    0.381061
  dynamic_se |      2.52    0.397498
 fdexprev_se |      2.43    0.410969
nexplanato~e |      2.34    0.428111
    level_se |      2.32    0.430440
  longrun_se |      2.13    0.469140
     span_se |      2.13    0.470066
timeseries~e |      2.06    0.484303
    mixed_se |      2.05    0.487176
othertech_se |      1.77    0.563406
  finsupport |      1.69    0.590191
  threefd_se |      1.67    0.600312
nonlinear_se |      1.61    0.620472
    fdrev_se |      1.50    0.664491
    cross_se |      1.48    0.676583
developing~e |      1.44    0.696839
   published |      1.36    0.735096
   othery_se |      1.27    0.786687
-------------+----------------------
    Mean VIF |      3.83

.
. estat ovtest

Ramsey RESET test using powers of the fitted values of t
       Ho:  model has no omitted variables
                 F(3, 935) =     16.74
                  Prob > F =      0.0000
.


.
```

b) FE

```
.
. *2* fe
```

```
.
. reg t invSE published puby_se finsupport  developing_se national_se imf_se
threefd_se level_se othery_se   invSE_study3
>  invSE_study5 invSE_study6 invSE_study8 invSE_study9  invSE_study11  invSE_study14
invSE_study15 invSE_study16 invSE_st
> udy17  invSE_study19 invSE_study22 invSE_study24 invSE_study25 invSE_study27
invSE_study32 invSE_study33 invSE_study35
>  invSE_study37 invSE_study39 invSE_study40 invSE_study41 invSE_study43
invSE_study45 invSE_study46 invSE_study47 if t>-
> 7.138112 & t<=6.973776  [aweight=weights], vce(cluster idstudy)
(sum of wgt is   4.7462e+01)

Linear regression                                      Number of obs =     966
                                                       F(  9,    48) =       .
                                                       Prob > F      =       .
                                                       R-squared     =  0.2906
                                                       Root MSE      =  2.0617

                                (Std. Err. adjusted for 49 clusters in idstudy)
------------------------------------------------------------------------------
             |               Robust
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       invSE |  -.0961189   .0238847    -4.02   0.000    -.1441424   -.0480954
   published |   1.211209   .3484219     3.48   0.001     .5106599    1.911758
     puby_se |   .0107809   .0024119     4.47   0.000     .0059315    .0156303
  finsupport |  -2.194593   .2536155    -8.65   0.000    -2.704521   -1.684665
developing_se |   .0140633   .0091306     1.54   0.130    -.0042949    .0324215
 national_se |  -.1267055    .021155    -5.99   0.000    -.1692405   -.0841704
      imf_se |    .143452   .0202597     7.08   0.000     .1027171    .1841868
  threefd_se |  -.2282868    .039408    -5.79   0.000     -.307522   -.1490517
    level_se |  -.0462935   .0171308    -2.70   0.009    -.0807373   -.0118497
   othery_se |  -.1827798   .0231529    -7.89   0.000    -.2293319   -.1362278
 invSE_study3 |   -.071097   .0372926    -1.91   0.063    -.1460788    .0038848
 invSE_study5 |   .1286011   .0247348     5.20   0.000     .0788685    .1783337
 invSE_study6 |    .522637   .0504206    10.37   0.000     .4212596    .6240143
 invSE_study8 |   .1097836   .0422036     2.60   0.012     .0249276    .1946397
 invSE_study9 |  -.0940969   .0270399    -3.48   0.001    -.1484643   -.0397295
invSE_study11 |   .0140208   .0111237     1.26   0.214    -.0083449    .0363865
invSE_study14 |   .3898926   .0468835     8.32   0.000     .2956271    .4841582
invSE_study15 |   .1318688   .0367162     3.59   0.001      .058046    .2056915
invSE_study16 |   .1725691   .0695648     2.48   0.017     .0326997    .3124385
invSE_study17 |    .117001   .0154656     7.57   0.000     .0859053    .1480968
invSE_study19 |   .1933135   .0408255     4.74   0.000     .1112283    .2753988
invSE_study22 |   .1006232   .0331986     3.03   0.004     .0338729    .1673734
invSE_study24 |   .0452485   .0094915     4.77   0.000     .0261644    .0643325
invSE_study25 |   .1833087   .0394908     4.64   0.000     .1039071    .2627104
invSE_study27 |  -.0542084   .0220793    -2.46   0.018    -.0986018    -.009815
invSE_study32 |  -.0786206   .0204369    -3.85   0.000    -.1197118   -.0375294
invSE_study33 |  -.0463675   .0115488    -4.01   0.000    -.0695878   -.0231472
invSE_study35 |  -.1514937   .0351205    -4.31   0.000    -.2221083   -.0808791
invSE_study37 |   .0597954   .0310299     1.93   0.060    -.0025944    .1221852
invSE_study39 |  -.2588862   .0403078    -6.42   0.000    -.3399305    -.177842
invSE_study40 |  -.1160304   .0384719    -3.02   0.004    -.1933834   -.0386775
invSE_study41 |  -.1054078   .0272989    -3.86   0.000    -.1602959   -.0505197
invSE_study43 |  -.0540022   .0104506    -5.17   0.000    -.0750147   -.0329898
invSE_study45 |   .7668493   .0698362    10.98   0.000     .6264342    .9072643
invSE_study46 |   .4708035   .0332819    14.15   0.000     .4038858    .5377212
invSE_study47 |  -.3009923   .0604905    -4.98   0.000    -.4226166   -.1793681
       _cons |  -.2920164   .2581995    -1.13   0.264    -.8111613    .2271286
------------------------------------------------------------------------------

. outreg2 using finalchapter4.doc
finalchapter4.doc
dir : seeout

.
. lincom _cons + 0.6693307*published + 0.1018981*finsupport

 ( 1)  .6693307*published + .1018981*finsupport + _cons = 0

------------------------------------------------------------------------------
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   .2950581   .2429937     1.21   0.231    -.1935134    .7836297
------------------------------------------------------------------------------
```

```
.
. lincom invSE + 9.809191*puby_se +0.1038961*developing_se + 0.5184815*national_se +
0.2317682*imf_se + 0.0649351*threefd
>  + 0.1038961*level_se + 0.013986*othery_se + 0.04995*invSE_study3
+0.011988*invSE_study5 + 0.002997*invSE_study6 +0.01998* invSE_study8 +
0.005994*invSE_study9 + 0.007992*invSE_study11 + 0.007992*invSE_study14 +
0.011988*invSE_study15 + 0 .013986*invSE_study16 + 0.002997*invSE_study17 +
0.001998*invSE_study19 + 0.02997*invSE_study22 + 0.005994*invSE_study24 +
0.003996*invSE_study25 + 0.031968*invSE_study27 + 0.007992*invSE_study32 +
0.007992*invSE_study33 + 0.025974*invSE_study35 + 0.0679321*invSE_study37 +
0.017982*invSE_study39 + 0.003996*invSE_study40 + 0.011988*invSE_study41
+0.025974*invSE_study43 + 0.001998*invSE_study45 + 0.003996*invSE_study46 +
0.011988*invSE_study47

 ( 1)  invSE + 9.809191*puby_se + .1038961*developing_se + .5184815*national_se +
.2317682*imf_se + .0649351*threefd_se +       .1038961*level_se + .013986*othery_se +
.04995*invSE_study3 + .011988*invSE_study5 + .002997*invSE_study6 +
.01998*invSE_study8 + .005994*invSE_study9 + .007992*invSE_study11 +
.007992*invSE_study14 + .011988*invSE_study15       + .013986*invSE_study16 +
.002997*invSE_study17 + .001998*invSE_study19 + .02997*invSE_study22 +
.005994*invSE_study24 + .003996*invSE_study25 + .031968*invSE_study27 +
.007992*invSE_study32 +       .007992*invSE_study33 + .025974*invSE_study35 +
.0679321*invSE_study37 + .017982*invSE_study39 +       .003996*invSE_study40 +
.011988*invSE_study41 + .025974*invSE_study43 + .001998*invSE_study45 +
.003996*invSE_study46 + .011988*invSE_study47 = 0

------------------------------------------------------------------------------
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |  -.0409624   .0183937    -2.23   0.031    -.0779455   -.0039794
------------------------------------------------------------------------------

.
. vif

    Variable |       VIF       1/VIF
-------------+----------------------
     puby_se |     17.56    0.056949
       invSE |     17.54    0.057017
      imf_se |      7.69    0.129978
 national_se |      4.91    0.203529
   othery_se |      4.63    0.216122
invSE_stu~15 |      4.61    0.216937
   published |      3.07    0.325968
invSE_study5 |      1.75    0.571692
    level_se |      1.52    0.658504
invSE_stu~33 |      1.52    0.659130
developing~e |      1.37    0.731086
invSE_study3 |      1.35    0.741144
invSE_stu~45 |      1.32    0.755819
invSE_stu~14 |      1.31    0.762185
invSE_stu~11 |      1.31    0.763247
invSE_stu~37 |      1.30    0.771236
invSE_study9 |      1.26    0.794858
  threefd_se |      1.25    0.799072
invSE_stu~22 |      1.25    0.801139
invSE_stu~17 |      1.22    0.817760
  finsupport |      1.21    0.827434
invSE_stu~41 |      1.20    0.831237
invSE_stu~24 |      1.19    0.840364
invSE_stu~46 |      1.19    0.840671
invSE_stu~32 |      1.13    0.882564
invSE_stu~25 |      1.13    0.884245
invSE_study6 |      1.13    0.887777
invSE_study8 |      1.13    0.888683
invSE_stu~27 |      1.11    0.901440
invSE_stu~40 |      1.11    0.903258
invSE_stu~43 |      1.10    0.906366
invSE_stu~39 |      1.10    0.909515
invSE_stu~47 |      1.10    0.911386
invSE_stu~35 |      1.10    0.912221
invSE_stu~16 |      1.09    0.921044
invSE_stu~19 |      1.08    0.926321
-------------+----------------------
    Mean VIF |      2.66
. estat ovtest
```

```
Ramsey RESET test using powers of the fitted values of t
       Ho:  model has no omitted variables
                 F(3, 926) =      9.49
                  Prob > F =      0.0000

.
.
```

c) Robust Regression

```
. *3* robust regression
.

.
. rreg t invSE published puby_se finsupport cross_se timeseries_se ols_se dynamic_se
iv_se othertech_se longrun_se mixed_
> se developing_se transition_se endog_se nonlinear_se national_se imf_se unitary_se
fdrev_se fdexprev_se  threefd_se ot
> herfd_se level_se othery_se  span_se nexplanatory_se

   Huber iteration 1:  maximum difference in weights = .79780456
   Huber iteration 2:  maximum difference in weights = .40190513
   Huber iteration 3:  maximum difference in weights = .15121793
   Huber iteration 4:  maximum difference in weights = .02704883
Biweight iteration 5:  maximum difference in weights = .28722488
Biweight iteration 6:  maximum difference in weights = .12459166
Biweight iteration 7:  maximum difference in weights = .04463399
Biweight iteration 8:  maximum difference in weights = .06053218
Biweight iteration 9:  maximum difference in weights = .07969939
Biweight iteration 10:  maximum difference in weights = .08538206
Biweight iteration 11:  maximum difference in weights = .08572206
Biweight iteration 12:  maximum difference in weights = .07112616
Biweight iteration 13:  maximum difference in weights = .0388112
Biweight iteration 14:  maximum difference in weights = .02355848
Biweight iteration 15:  maximum difference in weights = .01219367
Biweight iteration 16:  maximum difference in weights = .00794214

Robust regression                                      Number of obs =    1001
                                                       F( 27,    972) =   11.29
                                                       Prob > F      =  0.0000
```

t	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
invSE	.1600016	.0268362	5.96	0.000	.107338	.2126652
published	1.157554	.2194184	5.28	0.000	.7269658	1.588143
puby_se	-.0040113	.0025274	-1.59	0.113	-.0089711	.0009485
finsupport	-1.194885	.4542045	-2.63	0.009	-2.086219	-.3035503
cross_se	-.030698	.0590518	-0.52	0.603	-.1465817	.0851856
timeseries_se	.1375594	.1042383	1.32	0.187	-.0669986	.3421174
ols_se	-.0988456	.0181829	-5.44	0.000	-.1345278	-.0631633
dynamic_se	.0336894	.0272808	1.23	0.217	-.0198468	.0872255
iv_se	.0322582	.043738	0.74	0.461	-.0535736	.1180901
othertech_se	-.0342489	.0903404	-0.38	0.705	-.2115336	.1430358
longrun_se	.0093112	.0212445	0.44	0.661	-.0323791	.0510014
mixed_se	.0148483	.0297432	0.50	0.618	-.04352	.0732165
developing_se	.020186	.0094356	2.14	0.033	.0016695	.0387026
transition_se	-.0567702	.0290658	-1.95	0.051	-.1138091	.0002686
endog_se	-.0819105	.0221183	-3.70	0.000	-.1253155	-.0385055
nonlinear_se	.0951449	.0176361	5.39	0.000	.0605357	.1297541
national_se	-.1227907	.0243632	-5.04	0.000	-.1706011	-.0749802
imf_se	-.031428	.0265097	-1.19	0.236	-.0834508	.0205947
unitary_se	-.0956827	.0247904	-3.86	0.000	-.1443317	-.0470338
fdrev_se	-.0073263	.0175475	-0.42	0.676	-.0417616	.0271091
fdexprev_se	.0160784	.0243219	0.66	0.509	-.0316511	.0638078
threefd_se	.0352744	.039666	0.89	0.374	-.0425664	.1131151
otherfd_se	.0331761	.0195392	1.70	0.090	-.0051677	.0715199
level_se	-.041237	.0274835	-1.50	0.134	-.0951709	.0126968
othery_se	-.0989288	.0820167	-1.21	0.228	-.2598789	.0620214
span_se	.006643	.0082108	0.81	0.419	-.00947	.022756
nexplanatory_se	-.0024837	.0008708	-2.85	0.004	-.0041926	-.0007748
_cons	-.7656064	.2642305	-2.90	0.004	-1.284134	-.2470785

```
.
. outreg2 using finalchapter4.doc
finalchapter4.doc
```

```
dir : seeout
```

Appendix 3.4.2 Output-Growth Studies

a) WLS

```
. ***************************Output-Growth**************************************

.
. *4* wls(positive publication bias and negative genuine effect)WLS

.
. regress t invSE published puby_se finsupport cross_se timeseries_se ols_se
dynamic_se iv_se othertech_se longrun_se mix
> ed_se developing_se transition_se endog_se nonlinear_se national_se imf_se
unitary_se  fdrev_se fdexprev_se  threefd_se
>  otherfd_se  span_se nexplanatory_se if t>-7.138112 & t<=6.973776 & growth==1
[aweight=weights], vce(cluster idstudy)
(sum of wgt is   3.8212e+01)

Linear regression                                      Number of obs =     850
                                                       F( 24,     40) =       .
                                                       Prob > F      =       .
                                                       R-squared     =  0.1411
                                                       Root MSE      =  2.2202

                                  (Std. Err. adjusted for 41 clusters in idstudy)
------------------------------------------------------------------------------
                |               Robust
              t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
----------------+-------------------------------------------------------------
          invSE |  -.0025661   .0521971    -0.05   0.961    -.1080605    .1029282
      published |   .8363283   .4004686     2.09   0.043     .0269511    1.645706
        puby_se |   .0033791   .0056839     0.59   0.556    -.0081085    .0148666
     finsupport |  -2.372474   .6675263    -3.55   0.001    -3.721595   -1.023353
       cross_se |  -.1375144   .0861728    -1.60   0.118    -.3116761    .0366472
  timeseries_se |  -.0261869   .1261417    -0.21   0.837    -.2811289    .2287551
         ols_se |  -.0305917   .0302515    -1.01   0.318    -.0917323     .030549
     dynamic_se |  -.0158739    .070476    -0.23   0.823    -.1583113    .1265635
          iv_se |   .0296372   .0462723     0.64   0.526    -.0638826     .123157
   othertech_se |   .0617069   .0424168     1.45   0.154    -.0240207    .1474345
     longrun_se |  -.0379974   .0325331    -1.17   0.250    -.1037493    .0277545
       mixed_se |   .0055246   .0200951     0.27   0.785    -.0350891    .0461382
  developing_se |   .0153244   .0113398     1.35   0.184    -.0075941    .0382429
  transition_se |   .0256068   .0470471     0.54   0.589     -.069479    .1206926
       endog_se |   .0224657   .0295789     0.76   0.452    -.0373155    .0822468
   nonlinear_se |   .0009448   .0313149     0.03   0.976     -.062345    .0642347
    national_se |     -.0583   .0416558    -1.40   0.169    -.1424894    .0258895
         imf_se |   .0204849   .0466995     0.44   0.663    -.0738983    .1148682
     unitary_se |  -.0296699   .0414918    -0.72   0.479     -.113528    .0541882
       fdrev_se |  -.0398056   .0237904    -1.67   0.102    -.0878877    .0082766
    fdexprev_se |  -.0258377   .0437471    -0.59   0.558    -.1142539    .0625785
     threefd_se |   -.196738   .0774685    -2.54   0.015    -.3533078   -.0401682
     otherfd_se |   .0170756   .0392706     0.43   0.666    -.0622932    .0964445
        span_se |    .018343   .0151504     1.21   0.233    -.0122771     .048963
nexplanatory_se |  -.0018345    .000907    -2.02   0.050    -.0036677   -1.30e-06
          _cons |   .1924818   .4323765     0.45   0.659    -.6813838    1.066347
------------------------------------------------------------------------------

.
. outreg2 using finalchapter4.doc
finalchapter4.doc
dir : seeout

.
. lincom _cons + 0.6693307*published + 0.1018981*finsupport

 ( 1)  .6693307*published + .1018981*finsupport + _cons = 0

------------------------------------------------------------------------------
          t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
------------+-----------------------------------------------------------------
        (1) |   .5105114   .3453869     1.48   0.147    -.1875415    1.208564
------------------------------------------------------------------------------
```

```
.
. lincom invSE + 9.5*puby_se + 0.0539461*timeseries_se + 0.0729271*cross_se
+0.2477522*ols_se + 0.3091317*dynamic_se + 0.
> 0719281* iv_se + 0.0529471*othertech_se + 0.3086913*longrun_se + 0.021978*mixed_se
+ 0.1038961*developing_se + 0.192807
> 2*transition_se + 0.2997003*endog_se + 0.2117882*nonlinear_se +
0.5184815*national_se + 0.2317682*imf_se +0.3586414*uni
> tary_se + 0.2117882*fdrev_se + 0.1558442*fdexprev + 0.0649351*threefd +
0.2237762*otherfd_se + 0.36*span_se +8.69*nexpl
> anatory_se

 ( 1)  invSE + 9.5*puby_se + .0729271*cross_se + .0539461*timeseries_se +
.2477522*ols_se + .3091317*dynamic_se +
       .0719281*iv_se + .0529471*othertech_se + .3086913*longrun_se +
.021978*mixed_se + .1038961*developing_se +
       .1928072*transition_se + .2997003*endog_se + .2117882*nonlinear_se +
.5184815*national_se + .2317682*imf_se +
       .3586414*unitary_se + .2117882*fdrev_se + .1558442*fdexprev_se +
.0649351*threefd_se + .2237762*otherfd_se +
       .36*span_se + 8.69*nexplanatory_se = 0

------------------------------------------------------------------------------
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   -.054009   .0277763    -1.94   0.059    -.1101469    .0021289
------------------------------------------------------------------------------

.
. vif

    Variable |       VIF       1/VIF  
-------------+----------------------
       invSE |     19.71    0.050746
     puby_se |     18.63    0.053676
      imf_se |      7.65    0.130786
 national_se |      6.29    0.159019
  unitary_se |      5.27    0.189721
      ols_se |      5.18    0.192974
transition~e |      4.04    0.247453
    endog_se |      3.32    0.301034
 fdexprev_se |      2.76    0.362557
  dynamic_se |      2.54    0.393504
nexplanato~e |      2.26    0.442442
  longrun_se |      2.18    0.458972
  otherfd_se |      2.18    0.459424
    mixed_se |      2.13    0.470557
     span_se |      2.08    0.480527
  threefd_se |      1.81    0.552087
  finsupport |      1.77    0.565907
othertech_se |      1.70    0.589702
nonlinear_se |      1.54    0.647763
   published |      1.53    0.652957
    cross_se |      1.52    0.660052
    fdrev_se |      1.47    0.680299
developing~e |      1.44    0.694943
timeseries~e |      1.35    0.739631
       iv_se |      1.20    0.831038
-------------+----------------------
    Mean VIF |      4.06

.
. estat ovtest

Ramsey RESET test using powers of the fitted values of t
       Ho:  model has no omitted variables
                 F(3, 821) =      1.32
                  Prob > F =      0.2682

.
```

b) FE

```
. *5* fe no publication bias, but negative genuine effect)

. regress t invSE published puby_se finsupport  developing_se national_se imf_se
threefd_se nexplanatory_se invSE_study3
```

```
> invSE_study5 invSE_study6 invSE_study8  invSE_study14 invSE_study16 invSE_study17
invSE_study19  invSE_study22 invSE_s
> tudy24 invSE_study27  invSE_study32 invSE_study33  invSE_study35  invSE_study37
invSE_study39 invSE_study41 invSE_study
> 43  if t>-7.138112 & t<=6.973776 & growth==1 [aweight=weights], vce(cluster
idstudy)
(sum of wgt is   3.8212e+01)

Linear regression                                      Number of obs =     850
                                                       F(  9,    40) =       .
                                                       Prob > F      =       .
                                                       R-squared     =  0.2243
                                                       Root MSE      =  2.1124

                                  (Std. Err. adjusted for 41 clusters in idstudy)
------------------------------------------------------------------------------
                |               Robust
              t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
----------------+-------------------------------------------------------------
          invSE |  -.0984488   .0299307    -3.29   0.002     -.158941   -.0379566
      published |   1.329566   .3782338     3.52   0.001     .5651273    2.094005
        puby_se |   .0109954   .0028874     3.81   0.000     .0051596    .0168311
     finsupport |  -2.230695   .2775939    -8.04   0.000    -2.791733   -1.669657
   developing_se |   .0145166   .0103455     1.40   0.168    -.0063924    .0354257
     national_se |  -.1257923   .0233879    -5.38   0.000     -.173061   -.0785236
         imf_se |   .1478198   .0250997     5.89   0.000     .0970914    .1985481
     threefd_se |   -.235956    .040686    -5.80   0.000    -.3181854   -.1537265
nexplanatory_se |   .0002964   .0009423     0.31   0.755    -.0016081    .0022009
    invSE_study3 |  -.0677841   .0392073    -1.73   0.092    -.1470251    .0114568
    invSE_study5 |   .1300984   .0268529     4.84   0.000     .0758266    .1843702
    invSE_study6 |   .5306005   .0544309     9.75   0.000     .4205916    .6406094
    invSE_study8 |   .1143823   .0437964     2.61   0.013     .0258666    .2028981
   invSE_study14 |   .4200998   .0534697     7.86   0.000     .3120335    .5281662
   invSE_study16 |   .1801288   .0711444     2.53   0.015     .0363407     .323917
   invSE_study17 |   .1265341   .0166322     7.61   0.000     .0929192     .160149
   invSE_study19 |   .1922836   .0420963     4.57   0.000     .1072038    .2773635
   invSE_study22 |   .1218554   .0373967     3.26   0.002     .0462739    .1974369
   invSE_study24 |   .0478766   .0092268     5.19   0.000     .0292285    .0665246
   invSE_study27 |   -.059602   .0218327    -2.73   0.009    -.1037275   -.0154765
   invSE_study32 |  -.0796335   .0197921    -4.02   0.000    -.1196348   -.0396322
   invSE_study33 |  -.0282435    .010956    -2.58   0.014    -.0503864   -.0061005
   invSE_study35 |    -.14891   .0374195    -3.98   0.000    -.2245377   -.0732824
   invSE_study37 |   .0731881    .032951     2.22   0.032     .0065916    .1397847
   invSE_study39 |  -.2544051   .0447283    -5.69   0.000    -.3448043   -.1640059
   invSE_study41 |  -.1131896   .0308322    -3.67   0.001    -.1755037   -.0508754
   invSE_study43 |  -.0538129   .0113018    -4.76   0.000    -.0766547   -.0309711
          _cons |  -.4582781   .2823581    -1.62   0.112    -1.028945    .1123889
------------------------------------------------------------------------------

.
. outreg2 using finalchapter4.doc
finalchapter4.doc
dir : seeout

.
. lincom invSE + 9.5*puby_se + 0.1038961*developing_se + 0.5184815*national_se +
0.2317682*imf_se + 0.0649351*threefd + 8
> .69*nexplanatory_se +  0.04995*invSE_study3 +0.011988*invSE_study5 +
0.002997*invSE_study6 +0.01998* invSE_study8 +  0.
> 007992*invSE_study14  + 0.013986*invSE_study16 + 0.002997*invSE_study17 +
0.001998*invSE_study19  + 0.02997*invSE_study
> 22 + 0.005994*invSE_study24  + 0.031968*invSE_study27 + 0.007992*invSE_study32 +
0.007992*invSE_study33 + 0.025974*invS
> E_study35 + 0.0679321*invSE_study37 + 0.017982*invSE_study39 +
0.011988*invSE_study41 +0.025974* invSE_study43

 ( 1)  invSE + 9.5*puby_se + .1038961*developing_se + .5184815*national_se +
.2317682*imf_se + .0649351*threefd_se +
       8.69*nexplanatory_se + .04995*invSE_study3 + .011988*invSE_study5 +
.002997*invSE_study6 + .01998*invSE_study8 +
       .007992*invSE_study14 + .013986*invSE_study16 + .002997*invSE_study17 +
.001998*invSE_study19 +
       .02997*invSE_study22 + .005994*invSE_study24 + .031968*invSE_study27 +
.007992*invSE_study32 +
       .007992*invSE_study33 + .025974*invSE_study35 + .0679321*invSE_study37 +
.017982*invSE_study39 +
       .011988*invSE_study41 + .025974*invSE_study43 = 0
```

```
------------------------------------------------------------------------------
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |  -.0325562   .0170171    -1.91   0.063    -.0669491    .0018367
------------------------------------------------------------------------------

.
. lincom _cons + 0.6693307*published + 0.1018981*finsupport

 ( 1)  .6693307*published + .1018981*finsupport + _cons = 0

------------------------------------------------------------------------------
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   .2043379   .2550227     0.80   0.428    -.3110822    .7197579
------------------------------------------------------------------------------

.
. vif

    Variable |       VIF       1/VIF
-------------+----------------------
      imf_se |      5.44    0.183890
 national_se |      4.52    0.221264
nexplanato~e |      3.66    0.272900
        puby |      3.19    0.313223
       invSE |      2.81    0.355446
   published |      2.17    0.461204
invSE_stu~41 |      1.92    0.520405
invSE_stu~27 |      1.88    0.533145
invSE_study3 |      1.34    0.745284
  threefd_se |      1.32    0.758508
invSE_study5 |      1.32    0.759861
developing~e |      1.29    0.773204
invSE_stu~14 |      1.28    0.778279
  finsupport |      1.25    0.798457
invSE_stu~32 |      1.21    0.823468
invSE_study6 |      1.21    0.824584
invSE_stu~22 |      1.20    0.835481
invSE_stu~39 |      1.19    0.838762
invSE_stu~24 |      1.18    0.850452
invSE_stu~35 |      1.17    0.853326
invSE_stu~17 |      1.17    0.853795
invSE_study8 |      1.13    0.884300
invSE_stu~43 |      1.12    0.890002
invSE_stu~37 |      1.12    0.894933
invSE_stu~19 |      1.09    0.919114
invSE_stu~16 |      1.08    0.923704
invSE_stu~33 |      1.08    0.923833
-------------+----------------------
    Mean VIF |      1.79

.
. estat ovtest

Ramsey RESET test using powers of the fitted values of t
       Ho:  model has no omitted variables
                  F(3, 819) =      2.95
                   Prob > F =      0.0319
```

c) Robust Regression

```
*6* robust regression

. rreg t invSE published puby_se finsupport cross_se timeseries_se ols_se dynamic_se
iv_se othertech_se longrun_se mixed_
> se developing_se transition_se endog_se nonlinear_se national_se imf_se unitary_se
fdrev_se fdexprev_se  threefd_se ot
> herfd_se  span_se nexplanatory_se if growth==1

   Huber iteration 1:  maximum difference in weights = .79798412
   Huber iteration 2:  maximum difference in weights = .40912522
   Huber iteration 3:  maximum difference in weights = .14675949
   Huber iteration 4:  maximum difference in weights = .03139976
```

```
Biweight iteration 5:  maximum difference in weights = .2865797
Biweight iteration 6:  maximum difference in weights = .11333882
Biweight iteration 7:  maximum difference in weights = .14292975
Biweight iteration 8:  maximum difference in weights = .14197625
Biweight iteration 9:  maximum difference in weights = .09456283
Biweight iteration 10:  maximum difference in weights = .0575733
Biweight iteration 11:  maximum difference in weights = .01996627
Biweight iteration 12:  maximum difference in weights = .00973629

Robust regression                                      Number of obs =     884
                                                       F( 25,    858) =   12.95
                                                       Prob > F      =  0.0000

------------------------------------------------------------------------------
             t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
---------------+--------------------------------------------------------------
          invSE |   .2220329   .0289861     7.66   0.000     .1651409     .278925
      published |   1.138017   .2585733     4.40   0.000      .630507    1.645528
        puby_se |  -.0104856   .0028129    -3.73   0.000    -.0160066   -.0049646
     finsupport |  -1.215587   .4633233    -2.62   0.009    -2.124967   -.3062073
       cross_se |  -.0249562   .0641528    -0.39   0.697    -.1508709    .1009585
  timeseries_se |  -.0161344   .1362198    -0.12   0.906    -.2834974    .2512286
         ols_se |  -.0920612    .018379    -5.01   0.000    -.1281342   -.0559881
     dynamic_se |    .014132   .0275193     0.51   0.608     -.039881    .0681449
          iv_se |    .075544    .060714     1.24   0.214    -.0436215    .1947094
   othertech_se |   .1036318   .1032638     1.00   0.316    -.0990475    .3063111
     longrun_se |  -.0061126   .0224174    -0.27   0.785    -.0501119    .0378868
       mixed_se |  -.0001092   .0301026    -0.00   0.997    -.0591924    .0589741
  developing_se |    .017776   .0094668     1.88   0.061    -.0008048    .0363569
  transition_se |  -.1025303   .0297432    -3.45   0.001    -.1609082   -.0441523
       endog_se |  -.0483438    .022601    -2.14   0.033    -.0927036    -.003984
   nonlinear_se |     .08331   .0180235     4.62   0.000     .0479347    .1186854
    national_se |  -.0902983    .025456    -3.55   0.000    -.1402615    -.040335
         imf_se |  -.0852339   .0288599    -2.95   0.003    -.1418783   -.0285896
     unitary_se |  -.0660982     .02599    -2.54   0.011    -.1171095   -.0150868
       fdrev_se |  -.0067153   .0180152    -0.37   0.709    -.0420744    .0286438
    fdexprev_se |   .0406065   .0260106     1.56   0.119    -.0104454    .0916585
     threefd_se |   .1010407   .0442283     2.28   0.023     .0142324     .187849
     otherfd_se |   .0471562   .0207718     2.27   0.023     .0063868    .0879256
        span_se |   .0054367   .0082559     0.66   0.510    -.0107675    .0216409
nexplanatory_se |  -.0024776     .00088    -2.82   0.005    -.0042047   -.0007505
          _cons |  -.9932289   .3049085    -3.26   0.001    -1.591683    -.394775
------------------------------------------------------------------------------
.
.
```

Appendix 3.4.3 Output-Level Studies

a) WLS

```
. *7* wls (positive publication bias and negative genuine effect)

.
. regress t invSE published puby_se cross_se ols_se imf_se fdrev_se threefd_se if t>-
7.138112 & t<=6.973776 & level==1  [
> aweight=weights], vce(cluster idstudy)
(sum of wgt is   8.0323e+00)

Linear regression                                      Number of obs =     104
                                                       F(  5,     9) =       .
                                                       Prob > F      =       .
                                                       R-squared     =  0.4829
                                                       Root MSE      =  1.8865

                              (Std. Err. adjusted for 10 clusters in idstudy)
------------------------------------------------------------------------------
             |               Robust
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       invSE |   .0423357   .0814332     0.52   0.616    -.1418789    .2265504
   published |   -1.51973   .7814223    -1.94   0.084     -3.28743    .2479704
     puby_se |  -.0169139   .0090915    -1.86   0.096    -.0374803    .0036524
    cross_se |  -.8551241   .1155273    -7.40   0.000    -1.116465   -.5937832
```

```
     ols_se |   .7018152   .0712906     9.84   0.000     .5405446    .8630858
     imf_se |   .2011442   .0915031     2.20   0.056    -.0058502    .4081386
   fdrev_se |   .0642051   .0238585     2.69   0.025     .0102334    .1181769
 threefd_se |  -.2698023   .0796119    -3.39   0.008     -.449897   -.0897077
      _cons |   2.335406   .7772339     3.00   0.015     .5771802    4.093631
------------------------------------------------------------------------------

.
. outreg2 using finalchapter4.doc
finalchapter4.doc
dir : seeout

.
. lincom invSE+ 12.40*puby_se + 0.0192308*cross_se +0.0576923*ols_se +
0.3076923*imf_se + 0.1538462*threefd_se + 0.16*fdr
> ev_se

 ( 1)  invSE + 12.4*puby_se + .0192308*cross_se + .0576923*ols_se + .3076923*imf_se +
.16*fdrev_se + .1538462*threefd_se
       = 0

------------------------------------------------------------------------------
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |  -.1126969   .0371514    -3.03   0.014    -.1967392   -.0286546
------------------------------------------------------------------------------

.
. lincom _cons+ 0.59*published

 ( 1)  .59*published + _cons = 0

------------------------------------------------------------------------------
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   1.438765   .4469919     3.22   0.011      .427599    2.449931
------------------------------------------------------------------------------

.
. vif

    Variable |       VIF       1/VIF
-------------+----------------------
     puby_se |     11.25    0.088901
       invSE |     10.50    0.095280
      ols_se |      1.72    0.580334
    cross_se |      1.66    0.602616
      imf_se |      1.62    0.617662
   published |      1.57    0.636775
    fdrev_se |      1.18    0.850476
  threefd_se |      1.06    0.942631
-------------+----------------------
    Mean VIF |      3.82

.
. estat ovtest

Ramsey RESET test using powers of the fitted values of t
       Ho:  model has no omitted variables
                  F(3, 92) =      5.06
                  Prob > F =      0.0027

.
```

b) FE

```
. *8* fe

.
. regress t invSE published puby_se cross_se ols_se imf_se fdrev_se threefd_se
invSE_study37 invSE_study25 invSE_study11
>  if t>-7.138112 & t<=6.973776 & level==1  [aweight=weights], vce(cluster idstudy)
(sum of wgt is   8.0323e+00)

Linear regression                                      Number of obs =     104
```

```
                                                  F(  4,     9) =         .
                                                  Prob > F      =         .
                                                  R-squared     =  0.5564
                                                  Root MSE      =  1.7757

                                (Std. Err. adjusted for 10 clusters in idstudy)
------------------------------------------------------------------------------
              |               Robust
            t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        invSE |    .150392   .0186267     8.07   0.000     .1082554    .1925285
    published |   -2.78266   .1756249   -15.84   0.000    -3.179951   -2.385369
      puby_se |  -.0285834   .0024505   -11.66   0.000    -.0341267     -.02304
     cross_se |  -1.048477   .0264073   -39.70   0.000    -1.108215   -.9887397
       ols_se |   .8158441   .0269629    30.26   0.000     .7548498    .8768383
       imf_se |   .3376589   .0207196    16.30   0.000     .2907879    .3845298
     fdrev_se |   .0533821   .0161578     3.30   0.009     .0168305    .0899336
   threefd_se |  -.1456766   .0014947   -97.46   0.000    -.1490579   -.1422954
invSE_study37 |  -.2024735   .0104218   -19.43   0.000    -.2260492   -.1788978
invSE_study25 |   .2317545   .0348418     6.65   0.000     .1529368    .3105722
invSE_study11 |  -.5032132   .0259116   -19.42   0.000    -.5618294    -.444597
        _cons |   3.163249   .1374177    23.02   0.000     2.852388    3.474109
------------------------------------------------------------------------------

.
. outreg2 using finalchapter4.doc
finalchapter4.doc
dir : seeout

.
. lincom _cons+ 0.59*published

 ( 1)  .59*published + _cons = 0

------------------------------------------------------------------------------
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   1.521479   .1798436     8.46   0.000     1.114644    1.928314
------------------------------------------------------------------------------

.
. lincom invSE+ 12.40*puby + 0.0192308*cross_se +0.0576923*ols_se + 0.3076923*imf_se
+ 0.1538462*threefd_se + 0.16*fdrev_
> se

 ( 1)  invSE + 12.4*puby_se + .0192308*cross_se + .0576923*ols_se + .3076923*imf_se +
.16*fdrev_se + .1538462*threefd_se
       = 0

------------------------------------------------------------------------------
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |  -.0871125   .0161936    -5.38   0.000     -.123745   -.0504799
------------------------------------------------------------------------------

.
. vif

    Variable |       VIF       1/VIF
-------------+----------------------
     puby_se |     14.42    0.069370
       invSE |     13.35    0.074896
      imf_se |      2.37    0.422334
   published |      2.29    0.436465
      ols_se |      1.96    0.509045
    cross_se |      1.84    0.543918
invSE_stu~37 |      1.57    0.635437
invSE_stu~11 |      1.52    0.659728
  threefd_se |      1.25    0.798479
    fdrev_se |      1.23    0.812421
invSE_stu~25 |      1.22    0.819514
-------------+----------------------
    Mean VIF |      3.91

.
. estat ovtest
```

```
Ramsey RESET test using powers of the fitted values of t
       Ho:  model has no omitted variables
                  F(3, 89) =      6.82
                  Prob > F =      0.0003

..
.
```

c) Robust Regression

```
. *9* robust regression

. *9* robust regression

.
. rreg t invSE published puby_se cross_se ols_se imf_se fdrev_se threefd_se if
level==1

   Huber iteration 1:  maximum difference in weights = .54261755
   Huber iteration 2:  maximum difference in weights = .13062857
   Huber iteration 3:  maximum difference in weights = .08182024
   Huber iteration 4:  maximum difference in weights = .01327128
Biweight iteration 5:  maximum difference in weights = .19821641
Biweight iteration 6:  maximum difference in weights = .12235448
Biweight iteration 7:  maximum difference in weights = .13001313
Biweight iteration 8:  maximum difference in weights = .19051172
Biweight iteration 9:  maximum difference in weights = .25486839
Biweight iteration 10:  maximum difference in weights = .29183429
Biweight iteration 11:  maximum difference in weights = .11200858
Biweight iteration 12:  maximum difference in weights = .04741704
Biweight iteration 13:  maximum difference in weights = .02100303
Biweight iteration 14:  maximum difference in weights = .01454624
Biweight iteration 15:  maximum difference in weights = .01725982
Biweight iteration 16:  maximum difference in weights = .01684336
Biweight iteration 17:  maximum difference in weights = .01575978
Biweight iteration 18:  maximum difference in weights = .0141942
Biweight iteration 19:  maximum difference in weights = .01238638
Biweight iteration 20:  maximum difference in weights = .0106166
Biweight iteration 21:  maximum difference in weights = .00898429

Robust regression                                      Number of obs =     104
                                                       F(  8,     95) =   33.07
                                                       Prob > F      =  0.0000

------------------------------------------------------------------------------
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       invSE |   .3005103   .0497132     6.04   0.000     .2018171    .3992035
   published |  -1.073239   .3732701    -2.88   0.005    -1.814274   -.3322045
     puby_se |   -.039665   .0056086    -7.07   0.000    -.0507996   -.0285304
    cross_se |   -.912587   .1609562    -5.67   0.000    -1.232125   -.5930486
      ols_se |   .8470116    .103139     8.21   0.000     .6422547    1.051768
      imf_se |   .4526883   .0330878    13.68   0.000     .3870008    .5183759
    fdrev_se |   .0127642   .0384396     0.33   0.741    -.0635481    .0890765
  threefd_se |  -.1600736    .061424    -2.61   0.011    -.2820156   -.0381316
       _cons |   1.540679   .4208621     3.66   0.000     .7051622    2.376196
------------------------------------------------------------------------------
```

Appendix 3.4.4 Publication Year as K-moderator Variable

Table A4.1 Multivariate MRA Results (replication of Table 4.7)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	WLS	FE	Robust Reg	WLS	FE	Robust Reg	WLS	FE	Robust Reg
VARIABLES	Full Sample	Full Sample	Full Sample	Output-Growth	Output-Growth	Output-Growth	Output-Level	Output-Level	Output-Level
invSE	0.0175	0.00889	0.125***	0.0259	0.00748	0.137***	-0.149***	-0.181***	-0.109***
	(0.0325)	(0.00921)	(0.0192)	(0.0304)	(0.0113)	(0.0194)	(0.0241)	(0.0247)	(0.0297)
published	0.768**	1.504***	1.151***	0.870**	1.548***	1.120***	-1.662*	-2.783***	-0.128
	(0.378)	(0.344)	(0.222)	(0.416)	(0.361)	(0.266)	(0.826)	(0.427)	(0.391)
puby	0.0488	0.159***	-0.0170	0.0354	0.172***	-0.0759**	-0.262**	-0.432***	-0.396***
	(0.0632)	(0.0405)	(0.0283)	(0.0690)	(0.0476)	(0.0327)	(0.0954)	(0.116)	(0.0870)
finsupport	-2.341***	-2.282***	-1.078**	-2.336***	-2.356***	-1.143**			
	(0.609)	(0.202)	(0.455)	(0.661)	(0.238)	(0.467)			
developing_se	0.0165	0.0172*	0.0217**	0.0134	0.0160*	0.0202**			
	(0.0102)	(0.00860)	(0.00944)	(0.0105)	(0.00934)	(0.00953)			
national_se	-0.0817*	-0.123***	-0.132***	-0.0561	-0.125***	-0.107***			
	(0.0434)	(0.0216)	(0.0237)	(0.0441)	(0.0240)	(0.0249)			
imf_se	0.0511	0.117***	-0.0158	0.0131	0.127***	-0.0573**	0.196**	0.296***	0.340***
	(0.0429)	(0.0191)	(0.0249)	(0.0463)	(0.0235)	(0.0272)	(0.0749)	(0.0454)	(0.0335)
threefd_se	-0.195***	-0.229***	0.0175	-0.187***	-0.243***	0.0622	-0.306**	-0.151***	-0.145**
	(0.0639)	(0.0410)	(0.0382)	(0.0686)	(0.0446)	(0.0427)	(0.101)	(0.00417)	(0.0652)
level_se	-0.0584**	-0.0601***	-0.0462*						
	(0.0274)	(0.0142)	(0.0275)						
othery_se	-0.110***	-0.200***	-0.104						
	(0.0401)	(0.0232)	(0.0820)						
cross_se	-0.141*		-0.0229	-0.155*		0.00290	-0.923***	-1.124***	-0.821***
	(0.0812)		(0.0593)	(0.0906)		(0.0660)	(0.123)	(0.0902)	(0.172)
timeseries_se	0.208		0.141	-0.0326		-0.0257			
	(0.174)		(0.105)	(0.124)		(0.137)			
ols_se	-0.0173		-0.106***	-0.0253		-0.113***	0.721***	0.792***	0.754***
	(0.0296)		(0.0172)	(0.0274)		(0.0174)	(0.0516)	(0.0585)	(0.109)
dynamic_se	0.00686		0.0370	-0.0117		0.00629			
	(0.0717)		(0.0282)	(0.0708)		(0.0289)			

iv_se	-0.00996		0.0428	0.0308		0.0794			
	(0.0482)		(0.0436)	(0.0477)		(0.0613)			
othertech_se	-0.0330		-0.0338	0.0623		0.108			
	(0.0996)		(0.0908)	(0.0456)		(0.104)			
longrun_se	-0.0179		0.00743	-0.0374		-0.00866			
	(0.0353)		(0.0213)	(0.0335)		(0.0227)			
mixed_se	0.0185		0.0236	0.00107		0.0196			
	(0.0253)		(0.0294)	(0.0207)		(0.0299)			
transition_se	0.0172		-0.0414	0.0177		-0.0748**			
	(0.0463)		(0.0285)	(0.0408)		(0.0294)			
endog_se	0.0178		-0.0942***	0.0228		-0.0650***			
	(0.0295)		(0.0221)	(0.0294)		(0.0226)			
nonlinear_se	0.0137		0.0917***	0.00186		0.0784***			
	(0.0325)		(0.0176)	(0.0312)		(0.0181)			
unitary_se	-0.0190		-0.107***	-0.0271		-0.0836***			
	(0.0395)		(0.0247)	(0.0399)		(0.0262)			
fdrev_se	-0.0275		-0.00928	-0.0380		-0.0167	0.0779***	0.0646***	0.0289
	(0.0243)		(0.0175)	(0.0238)		(0.0181)	(0.0218)	(0.0174)	(0.0407)
fdexprev_se	-0.0239		0.0106	-0.0206		0.0217			
	(0.0418)		(0.0234)	(0.0419)		(0.0251)			
otherfd_se	0.00374		0.0363*	0.0168		0.0531**			
	(0.0360)		(0.0196)	(0.0390)		(0.0209)			
span_se	0.0211		0.00710	0.0183		0.00549			
	(0.0159)		(0.00823)	(0.0153)		(0.00833)			
nexplanatory_se	-0.00203**		-0.00233***	-0.00194*	0.000261	-0.00231***			
	(0.000995)		(0.000872)	(0.00102)	(0.000870)	(0.000887)			
Constant	-0.164	-1.913***	-0.582	-0.104	-2.073***	-0.264	5.665**	8.876***	5.688***
	(0.756)	(0.446)	(0.380)	(0.800)	(0.460)	(0.432)	(1.743)	(1.743)	(1.278)
Observations	966	966	1,001	850	850	884	104	104	104
R-squared	0.146	0.295	0.234	0.141	0.233	0.264	0.495	0.554	0.645

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

a) Full Sample

```
. *1* wls(positive publication bias and negative genuine effect)

.
. reg t invSE published puby finsupport cross_se timeseries_se ols_se dynamic_se
iv_se othertech_se longrun_se mixed_se developing_se transition_s
> e endog_se nonlinear_se national_se imf_se unitary_se  fdrev_se fdexprev_se
threefd_se otherfd_se level_se othery_se  span_se nexplanatory_se i
> f t>-7.138112 & t<=6.973776  [aweight=weights], vce(cluster idstudy)
(sum of wgt is   4.7462e+01)

Linear regression                                      Number of obs =     966
                                                       F( 27,     48) =    6.01
                                                       Prob > F      =  0.0000
                                                       R-squared     =  0.1462
                                                       Root MSE      =  2.2509

                                  (Std. Err. adjusted for 49 clusters in idstudy)
---------------------------------------------------------------------------------
                |               Robust
              t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
----------------+----------------------------------------------------------------
          invSE |   .0175346   .0325333     0.54   0.592     -.047878    .0829471
      published |    .768377   .3781344     2.03   0.048     .0080868    1.528667
           puby |   .0487723   .0631937     0.77   0.444     -.078287    .1758317
     finsupport |  -2.341096   .6085776    -3.85   0.000    -3.564723   -1.117468
       cross_se |  -.1410493   .0812152    -1.74   0.089    -.3043433    .0222447
  timeseries_se |   .2080419   .1740757     1.20   0.238    -.1419608    .5580447
         ols_se |  -.0172679   .0296124    -0.58   0.563    -.0768076    .0422717
     dynamic_se |   .0068561   .0716852     0.10   0.924    -.1372766    .1509888
          iv_se |  -.0099638   .0481668    -0.21   0.837    -.1068095     .086882
   othertech_se |  -.0330269   .0996061    -0.33   0.742    -.2332983    .1672446
     longrun_se |  -.0178759   .0352724    -0.51   0.615    -.0887958     .053044
       mixed_se |   .0184551   .0253419     0.73   0.470    -.0324981    .0694083
  developing_se |   .0165086   .0102406     1.61   0.114    -.0040816    .0370988
  transition_se |   .0172288   .0463172     0.37   0.712    -.0758981    .1103556
       endog_se |   .0178362   .0294618     0.61   0.548    -.0414008    .0770731
   nonlinear_se |   .0136611    .032472     0.42   0.676    -.0516283    .0789505
    national_se |  -.0816724   .0434216    -1.88   0.066    -.1689773    .0056326
         imf_se |   .0511384   .0428986     1.19   0.239     -.035115    .1373918
     unitary_se |  -.0190302   .0394725    -0.48   0.632    -.0983949    .0603345
       fdrev_se |  -.0275272   .0242563    -1.13   0.262    -.0762978    .0212434
    fdexprev_se |  -.0238963   .0418133    -0.57   0.570    -.1079675     .060175
     threefd_se |  -.1946073   .0638644    -3.05   0.004    -.3230152   -.0661994
     otherfd_se |   .0037428   .0360203     0.10   0.918    -.0686808    .0761664
       level_se |     -.0584   .0273885    -2.13   0.038    -.1134684   -.0033317
      othery_se |  -.1102281   .0401326    -2.75   0.008      -.19092   -.0295361
        span_se |   .0211465   .0159382     1.33   0.191    -.0108993    .0531924
nexplanatory_se |  -.0020325   .0009948    -2.04   0.047    -.0040327   -.0000323
          _cons |  -.1635665   .7563375    -0.22   0.830    -1.684285    1.357152
---------------------------------------------------------------------------------

.
. lincom _cons + 0.6693307*published + 9.809191*puby + 0.1018981*finsupport

 ( 1)  .6693307*published + 9.809191*puby + .1018981*finsupport + _cons = 0

------------------------------------------------------------------------------
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   .5905958   .3473705     1.70   0.096    -.1078394    1.289031
------------------------------------------------------------------------------

.
. lincom invSE + 0.0539461*timeseries_se + 0.0729271*cross_se +0.2477522*ols_se +
0.3091317*dynamic_se + 0.0529471*othertech_se + 0.3086913*longru
> n_se + 0.021978*mixed_se + 0.1038961*developing_se + 0.1928072*transition_se +
0.2997003*endog_se + 0.2117882*nonlinear_se + 0.5184815*national_
> se + 0.2317682*imf_se +0.3586414*unitary_se + 0.2117882*fdrev_se +
0.1558442*fdexprev + 0.0649351*threefd + 0.2237762*otherfd_se + 0.1038961*lev
> el_se + 0.013986*othery_se + 0.36*span_se +8.69*nexplanatory_se

 ( 1)  invSE + .0729271*cross_se + .0539461*timeseries_se + .2477522*ols_se +
.3091317*dynamic_se + .0529471*othertech_se + .3086913*longrun_se +
```

```
       .021978*mixed_se + .1038961*developing_se + .1928072*transition_se +
.2997003*endog_se + .2117882*nonlinear_se + .5184815*national_se +
       .2317682*imf_se + .3586414*unitary_se + .2117882*fdrev_se +
.1558442*fdexprev_se + .0649351*threefd_se + .2237762*otherfd_se +
       .1038961*level_se + .013986*othery_se + .36*span_se + 8.69*nexplanatory_se = 0

------------------------------------------------------------------------------
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |  -.0536034   .0271288    -1.98   0.054    -.1081494    .0009426
------------------------------------------------------------------------------

.
. vif

    Variable |       VIF       1/VIF
-------------+----------------------
       invSE |      7.43    0.134552
 national_se |      6.04    0.165502
      imf_se |      5.97    0.167631
  unitary_se |      5.66    0.176825
      ols_se |      4.83    0.207020
    endog_se |      3.92    0.254950
transition~e |      3.36    0.297942
       iv_se |      3.33    0.300696
  otherfd_se |      2.63    0.380908
  dynamic_se |      2.55    0.391769
nexplanato~e |      2.32    0.430936
    level_se |      2.30    0.434750
 fdexprev_se |      2.20    0.454637
timeseries~e |      2.19    0.457069
  longrun_se |      2.13    0.469133
     span_se |      2.13    0.470018
    mixed_se |      2.04    0.490994
        puby |      2.02    0.496065
othertech_se |      1.79    0.559404
  finsupport |      1.67    0.599931
nonlinear_se |      1.60    0.625619
  threefd_se |      1.50    0.665327
    fdrev_se |      1.50    0.667294
    cross_se |      1.49    0.672033
developing~e |      1.40    0.714895
   published |      1.38    0.726569
   othery_se |      1.27    0.789807
-------------+----------------------
    Mean VIF |      2.84

.
. estat ovtest

Ramsey RESET test using powers of the fitted values of t
       Ho:  model has no omitted variables
                 F(3, 935) =     14.85
                  Prob > F =      0.0000


. *2* fe(positive publication bias and negative genuine effect)
.
. reg t invSE published puby finsupport  developing_se national_se imf_se threefd_se
level_se othery_se   invSE_study3 invSE_study5 invSE_study6 i
> nvSE_study8 invSE_study9  invSE_study11  invSE_study14 invSE_study15 invSE_study16
invSE_study17  invSE_study19 invSE_study22 invSE_study24 invS
> E_study25 invSE_study27 invSE_study32 invSE_study33 invSE_study35  invSE_study37
invSE_study39 invSE_study40 invSE_study41 invSE_study43 invSE_s
> tudy45 invSE_study46 invSE_study47 if t>-7.138112 & t<=6.973776  [aweight=weights],
vce(cluster idstudy)
(sum of wgt is   4.7462e+01)

Linear regression                                      Number of obs =     966
                                                       F(  9,    48) =       .
                                                       Prob > F      =       .
                                                       R-squared     =  0.2950
                                                       Root MSE      =  2.0552

                                (Std. Err. adjusted for 49 clusters in idstudy)
------------------------------------------------------------------------------
             |               Robust
```

```
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       invSE |    .008895   .0092098     0.97   0.339    -.0096226    .0274126
   published |   1.504021   .3441259     4.37   0.000       .81211    2.195933
        puby |    .158878   .0404841     3.92   0.000     .0774793    .2402768
  finsupport |  -2.282373   .2023281   -11.28   0.000    -2.689181   -1.875565
developing_se |    .017177   .0086029     2.00   0.052    -.0001203    .0344742
 national_se |  -.1227869   .0216028    -5.68   0.000    -.1662222   -.0793517
      imf_se |   .1171473   .0191437     6.12   0.000     .0786564    .1556383
  threefd_se |  -.2289421   .0410139    -5.58   0.000    -.3114059   -.1464782
    level_se |  -.0601233   .0142345    -4.22   0.000    -.0887437   -.0315029
   othery_se |  -.2002561   .0231694    -8.64   0.000    -.2468414   -.1536708
 invSE_study3 |  -.0689092   .0322263    -2.14   0.038    -.1337044    -.004114
 invSE_study5 |   .0939199   .0172069     5.46   0.000     .0593232    .1285167
 invSE_study6 |   .5843489   .0530465    11.02   0.000     .4776917    .6910061
 invSE_study8 |    .121448   .0370374     3.28   0.002     .0469794    .1959166
 invSE_study9 |  -.0541449   .0293172    -1.85   0.071    -.1130911    .0048013
invSE_study11 |   .0343461   .0149543     2.30   0.026     .0042784    .0644138
invSE_study14 |   .4536131   .0539576     8.41   0.000     .3451241     .562102
invSE_study15 |    .137213   .0340258     4.03   0.000     .0687996    .2056265
invSE_study16 |   .1659153   .0645405     2.57   0.013      .036148    .2956826
invSE_study17 |   .1232253   .0145779     8.45   0.000     .0939144    .1525362
invSE_study19 |   .2054707   .0397454     5.17   0.000     .1255574    .2853841
invSE_study22 |   .1324955   .0345703     3.83   0.000     .0629872    .2020037
invSE_study24 |   .0425408   .0074797     5.69   0.000     .0275019    .0575797
invSE_study25 |   .1632517   .0331773     4.92   0.000     .0965443    .2299591
invSE_study27 |   -.067098   .0217895    -3.08   0.003    -.1109089   -.0232872
invSE_study32 |  -.0875915   .0208888    -4.19   0.000    -.1295912   -.0455918
invSE_study33 |  -.0289278   .0070902    -4.08   0.000    -.0431835    -.014672
invSE_study35 |  -.1884432   .0397876    -4.74   0.000    -.2684416   -.1084448
invSE_study37 |   .0554983   .0313371     1.77   0.083    -.0075092    .1185058
invSE_study39 |  -.3059228   .0458885    -6.67   0.000    -.3981878   -.2136578
invSE_study40 |  -.1957359   .0419951    -4.66   0.000    -.2801727    -.111299
invSE_study41 |  -.1340728   .0336232    -3.99   0.000    -.2016766   -.0664689
invSE_study43 |  -.0789393   .0136416    -5.79   0.000    -.1063675   -.0515111
invSE_study45 |   .6689962   .0767097     8.72   0.000      .514761    .8232314
invSE_study46 |    .406472   .0474694     8.56   0.000     .3110283    .5019157
invSE_study47 |  -.5234131   .0920359    -5.69   0.000    -.7084638   -.3383625
       _cons |  -1.912709   .4462053    -4.29   0.000    -2.809865   -1.015553
------------------------------------------------------------------------------

.
. lincom _cons + 0.6693307*published + 9.809191*puby + 0.1018981*finsupport

 ( 1)  .6693307*published + 9.809191*puby + .1018981*finsupport + _cons = 0

------------------------------------------------------------------------------
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   .4198745   .2379578     1.76   0.084    -.0585716    .8983207
------------------------------------------------------------------------------


.
. lincom invSE + 0.1038961*developing_se + 0.5184815*national_se + 0.2317682*imf_se +
0.0649351*threefd + 0.1038961*level_se + 0.013986*othery_se
> + 0.04995*invSE_study3 +0.011988*invSE_study5 + 0.002997*invSE_study6 +0.01998*
invSE_study8 + 0.005994*invSE_study9 + 0.007992*invSE_study11 +
> 0.007992*invSE_study14 + 0.011988*invSE_study15 + 0.013986*invSE_study16 +
0.002997*invSE_study17 + 0.001998*invSE_study19 + 0.02997*invSE_study
> 22 + 0.005994*invSE_study24 + 0.003996*invSE_study25 + 0.031968*invSE_study27 +
0.007992*invSE_study32 + 0.007992*invSE_study33 + 0.025974*invSE
> _study35 + 0.0679321*invSE_study37 + 0.017982*invSE_study39 +
0.003996*invSE_study40 + 0.011988*invSE_study41 +0.025974* invSE_study43 + 0.00199
> 8*invSE_study45 + 0.003996*invSE_study46 + 0.011988*invSE_study47

 ( 1)  invSE + .1038961*developing_se + .5184815*national_se + .2317682*imf_se +
.0649351*threefd_se + .1038961*level_se + .013986*othery_se +
       .04995*invSE_study3 + .011988*invSE_study5 + .002997*invSE_study6 +
.01998*invSE_study8 + .005994*invSE_study9 + .007992*invSE_study11 +
       .007992*invSE_study14 + .011988*invSE_study15 + .013986*invSE_study16 +
.002997*invSE_study17 + .001998*invSE_study19 +
       .02997*invSE_study22 + .005994*invSE_study24 + .003996*invSE_study25 +
.031968*invSE_study27 + .007992*invSE_study32 +
       .007992*invSE_study33 + .025974*invSE_study35 + .0679321*invSE_study37 +
.017982*invSE_study39 + .003996*invSE_study40 +
       .011988*invSE_study41 + .025974*invSE_study43 + .001998*invSE_study45 +
.003996*invSE_study46 + .011988*invSE_study47 = 0
```

```
------------------------------------------------------------------------------
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |  -.0521408   .0181986    -2.87   0.006    -.0887315   -.0155502
------------------------------------------------------------------------------

.
. vif

    Variable |       VIF       1/VIF
-------------+----------------------
      imf_se |      5.05    0.197958
   othery_se |      4.63    0.215781
invSE_stu~15 |      4.61    0.216858
 national_se |      4.50    0.221981
   published |      3.16    0.316202
        puby |      3.14    0.318651
       invSE |      1.83    0.545369
    level_se |      1.53    0.654574
invSE_stu~33 |      1.46    0.683934
developing~e |      1.38    0.724349
invSE_stu~45 |      1.37    0.731133
invSE_stu~14 |      1.36    0.733766
invSE_study9 |      1.31    0.765988
invSE_study3 |      1.30    0.768389
invSE_stu~37 |      1.30    0.770759
invSE_stu~46 |      1.29    0.774425
invSE_study5 |      1.28    0.783160
invSE_stu~11 |      1.28    0.783936
invSE_stu~22 |      1.27    0.789708
invSE_stu~41 |      1.26    0.791521
invSE_stu~47 |      1.25    0.801292
invSE_stu~17 |      1.23    0.814041
  threefd_se |      1.22    0.819093
  finsupport |      1.22    0.819183
invSE_study6 |      1.19    0.840397
invSE_stu~24 |      1.18    0.845403
invSE_stu~39 |      1.15    0.868729
invSE_stu~32 |      1.15    0.869986
invSE_stu~35 |      1.14    0.876226
invSE_stu~40 |      1.13    0.881752
invSE_study8 |      1.13    0.882830
invSE_stu~25 |      1.12    0.889591
invSE_stu~27 |      1.12    0.892368
invSE_stu~43 |      1.12    0.894138
invSE_stu~16 |      1.08    0.921686
invSE_stu~19 |      1.07    0.932476
-------------+----------------------
    Mean VIF |      1.75

.
. estat ovtest

Ramsey RESET test using powers of the fitted values of t
       Ho:  model has no omitted variables
                 F(3, 926) =      9.65
                  Prob > F =      0.0000



. *3* robust regression (no pub bias and no genuine effect, but the signs are ok)
.
. rreg t invSE published puby finsupport cross_se timeseries_se ols_se dynamic_se
iv_se othertech_se longrun_se mixed_se developing_se transition_
> se endog_se nonlinear_se national_se imf_se unitary_se  fdrev_se fdexprev_se
threefd_se otherfd_se level_se othery_se  span_se nexplanatory_se

   Huber iteration 1:  maximum difference in weights = .79764759
   Huber iteration 2:  maximum difference in weights = .38971082
   Huber iteration 3:  maximum difference in weights = .15521599
   Huber iteration 4:  maximum difference in weights = .02815885
Biweight iteration 5:  maximum difference in weights = .29078739
Biweight iteration 6:  maximum difference in weights = .12233304
Biweight iteration 7:  maximum difference in weights = .03110156
Biweight iteration 8:  maximum difference in weights = .03395306
Biweight iteration 9:  maximum difference in weights = .04112835
```

```
Biweight iteration 10:  maximum difference in weights = .05917474
Biweight iteration 11:  maximum difference in weights = .07317765
Biweight iteration 12:  maximum difference in weights = .06785949
Biweight iteration 13:  maximum difference in weights = .07566487
Biweight iteration 14:  maximum difference in weights = .05966172
Biweight iteration 15:  maximum difference in weights = .04612769
Biweight iteration 16:  maximum difference in weights = .02676069
Biweight iteration 17:  maximum difference in weights = .02009113
Biweight iteration 18:  maximum difference in weights = .01677228
Biweight iteration 19:  maximum difference in weights = .01446974
Biweight iteration 20:  maximum difference in weights = .00760331

Robust regression                                      Number of obs =     1000
                                                       F( 27,    972) =   11.01
                                                       Prob > F      =  0.0000
```

t	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
invSE	.1254338	.0191551	6.55	0.000	.0878437	.163024
published	1.15101	.2219734	5.19	0.000	.7154075	1.586612
puby	-.0170097	.0282931	-0.60	0.548	-.0725322	.0385128
finsupport	-1.078389	.4552421	-2.37	0.018	-1.97176	-.1850187
cross_se	-.0228743	.0593397	-0.39	0.700	-.1393229	.0935742
timeseries_se	.1413764	.1047471	1.35	0.177	-.06418	.3469329
ols_se	-.1059098	.0171652	-6.17	0.000	-.139595	-.0722247
dynamic_se	.0370268	.0282012	1.31	0.190	-.0183155	.092369
iv_se	.0428115	.0435875	0.98	0.326	-.042725	.1283479
othertech_se	-.0338493	.0907768	-0.37	0.709	-.2119904	.1442917
longrun_se	.007432	.021251	0.35	0.727	-.0342712	.0491352
mixed_se	.0235731	.0293883	0.80	0.423	-.0340987	.0812449
developing_se	.0216783	.009437	2.30	0.022	.0031591	.0401976
transition_se	-.0413689	.0284597	-1.45	0.146	-.0972183	.0144806
endog_se	-.0942249	.0220549	-4.27	0.000	-.1375056	-.0509442
nonlinear_se	.0916582	.0175865	5.21	0.000	.0571463	.12617
national_se	-.1319645	.0237081	-5.57	0.000	-.1784893	-.0854396
imf_se	-.0158166	.0249242	-0.63	0.526	-.064728	.0330949
unitary_se	-.1072216	.0246748	-4.35	0.000	-.1556436	-.0587996
fdrev_se	-.00928	.0175013	-0.53	0.596	-.0436246	.0250646
fdexprev_se	.0105569	.0233798	0.45	0.652	-.0353238	.0564376
threefd_se	.0174564	.0382349	0.46	0.648	-.057576	.0924888
otherfd_se	.0363279	.0195891	1.85	0.064	-.0021138	.0747697
level_se	-.0461756	.0275387	-1.68	0.094	-.1002178	.0078666
othery_se	-.1038064	.0820258	-1.27	0.206	-.2647746	.0571617
span_se	.0070996	.0082287	0.86	0.388	-.0090484	.0232477
nexplanatory_se	-.0023278	.0008723	-2.67	0.008	-.0040396	-.0006161
_cons	-.582126	.3798243	-1.53	0.126	-1.327496	.1632441

b) Output-Growth Studies

```
. *4* wls(positive publication bias and negative genuine effect)WLS
.
. regress t invSE published puby finsupport cross_se timeseries_se ols_se dynamic_se
iv_se othertech_se longrun_se mixed_se developing_se transiti
> on_se endog_se nonlinear_se national_se imf_se unitary_se  fdrev_se fdexprev_se
threefd_se otherfd_se  span_se nexplanatory_se if t>-7.138112 &
>  t<=6.973776 & growth==1  [aweight=weights], vce(cluster idstudy)
(sum of wgt is   3.8212e+01)

Linear regression                                      Number of obs =      850
                                                       F( 24,     40) =       .
                                                       Prob > F      =       .
                                                       R-squared     =  0.1407
                                                       Root MSE      =  2.2207

                                  (Std. Err. adjusted for 41 clusters in idstudy)
```

t	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
invSE	.0259016	.0303632	0.85	0.399	-.0354646	.0872679
published	.8697743	.416433	2.09	0.043	.0281318	1.711417
puby	.0353588	.0689742	0.51	0.611	-.1040432	.1747608
finsupport	-2.335932	.6614398	-3.53	0.001	-3.672752	-.9991124
cross_se	-.1545457	.0906021	-1.71	0.096	-.3376595	.028568

```
  timeseries_se |  -.0326329   .1235622    -0.26   0.793    -.2823614    .2170957
         ols_se |  -.0252567   .0274117    -0.92   0.362    -.0806578    .0301444
     dynamic_se |  -.0116674   .0708219    -0.16   0.870    -.1548038     .131469
          iv_se |    .030767   .0477157     0.64   0.523    -.0656701    .1272041
   othertech_se |   .0623226   .0455975     1.37   0.179    -.0298334    .1544786
     longrun_se |  -.0373577   .0334858    -1.12   0.271    -.1050349    .0303196
       mixed_se |   .0010741   .0206542     0.05   0.959    -.0406697    .0428178
  developing_se |   .0133603   .0104555     1.28   0.209    -.0077712    .0344918
  transition_se |   .0176776   .0408183     0.43   0.667    -.0648193    .1001745
       endog_se |   .0228006    .029373     0.78   0.442    -.0365644    .0821656
   nonlinear_se |   .0018583   .0311901     0.06   0.953    -.0611792    .0648958
    national_se |  -.0560872   .0440659    -1.27   0.210    -.1451477    .0329733
         imf_se |   .0131088   .0462963     0.28   0.779    -.0804596    .1066771
     unitary_se |  -.0271373   .0398704    -0.68   0.500    -.1077184    .0534438
       fdrev_se |  -.0380083   .0237748    -1.60   0.118    -.0860589    .0100423
    fdexprev_se |  -.0206264   .0419179    -0.49   0.625    -.1053456    .0640929
     threefd_se |  -.1870561   .0685651    -2.73   0.009    -.3256314   -.0484809
     otherfd_se |   .0168043   .0390463     0.43   0.669    -.0621112    .0957197
        span_se |   .0183188   .0153134     1.20   0.239    -.0126308    .0492684
nexplanatory_se |  -.0019379   .0010239    -1.89   0.066    -.0040073    .0001315
          _cons |  -.1040688   .8000374    -0.13   0.897    -1.721005    1.512867
------------------------------------------------------------------------------

.
. lincom _cons + 0.6693307*published + 9.809191*puby + 0.1018981*finsupport

 ( 1)  .6693307*published + 9.809191*puby + .1018981*finsupport + _cons = 0

------------------------------------------------------------------------------
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   .5869124   .3374574     1.74   0.090    -.0951144    1.268939
------------------------------------------------------------------------------

.
. lincom invSE + 0.0539461*timeseries_se + 0.0729271*cross_se +0.2477522*ols_se +
0.3091317*dynamic_se + 0.0719281* iv_se + 0.0529471*othertech_se
>  + 0.3086913*longrun_se + 0.021978*mixed_se + 0.1038961*developing_se +
0.1928072*transition_se + 0.2997003*endog_se + 0.2117882*nonlinear_se +
> 0.5184815*national_se + 0.2317682*imf_se +0.3586414*unitary_se + 0.2117882*fdrev_se
+ 0.1558442*fdexprev + 0.0649351*threefd + 0.2237762*otherfd
> _se + 0.36*span_se +8.69*nexplanatory_se

 ( 1)  invSE + .0729271*cross_se + .0539461*timeseries_se + .2477522*ols_se +
.3091317*dynamic_se + .0719281*iv_se + .0529471*othertech_se +
       .3086913*longrun_se + .021978*mixed_se + .1038961*developing_se +
.1928072*transition_se + .2997003*endog_se + .2117882*nonlinear_se +
       .5184815*national_se + .2317682*imf_se + .3586414*unitary_se +
.2117882*fdrev_se + .1558442*fdexprev_se + .0649351*threefd_se +
       .2237762*otherfd_se + .36*span_se + 8.69*nexplanatory_se = 0

------------------------------------------------------------------------------
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |  -.0566362   .0285752    -1.98   0.054    -.1143889    .0011166
------------------------------------------------------------------------------

.
. vif

    Variable |       VIF       1/VIF  
-------------+----------------------
       invSE |      6.82    0.146651
      imf_se |      6.50    0.153809
 national_se |      6.14    0.162889
  unitary_se |      5.26    0.190079
      ols_se |      4.90    0.204007
transition~e |      3.51    0.285130
    endog_se |      3.32    0.300952
  dynamic_se |      2.60    0.385322
 fdexprev_se |      2.48    0.402467
        puby |      2.38    0.420597
nexplanato~e |      2.24    0.446043
  longrun_se |      2.19    0.455634
  otherfd_se |      2.18    0.459741
    mixed_se |      2.09    0.477346
     span_se |      2.08    0.480509
```

```
  finsupport |      1.74    0.574578
othertech_se |      1.72    0.582533
  threefd_se |      1.64    0.611092
    cross_se |      1.60    0.625392
   published |      1.57    0.637400
nonlinear_se |      1.53    0.653084
    fdrev_se |      1.46    0.685416
developing~e |      1.40    0.712150
timeseries~e |      1.35    0.741602
       iv_se |      1.20    0.831829
-------------+----------------------
    Mean VIF |      2.80

.
. estat ovtest

Ramsey RESET test using powers of the fitted values of t
       Ho:  model has no omitted variables
                  F(3, 821) =      1.55
                   Prob > F =      0.1994

.
.
. *5* fe no publication bias, but negative genuine effect)

. regress t invSE published puby finsupport  developing_se national_se imf_se
threefd_se nexplanatory_se invSE_study3 invSE_study5 invSE_study6 in
> vSE_study8  invSE_study14 invSE_study16 invSE_study17  invSE_study19  invSE_study22
invSE_study24 invSE_study27  invSE_study32 invSE_study33  in
> vSE_study35  invSE_study37 invSE_study39 invSE_study41 invSE_study43  if t>-
7.138112 & t<=6.973776 & growth==1 [aweight=weights], vce(cluster id
> study)
(sum of wgt is   3.8212e+01)

Linear regression                                     Number of obs =     850
                                                      F(  9,    40) =       .
                                                      Prob > F      =       .
                                                      R-squared     =  0.2330
                                                      Root MSE      =  2.1006

                                  (Std. Err. adjusted for 41 clusters in idstudy)
---------------------------------------------------------------------------------
                |               Robust
              t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
----------------+----------------------------------------------------------------
          invSE |   .0074762   .0112657     0.66   0.511    -.0152926     .030245
      published |   1.547745   .3613932     4.28   0.000     .8173423    2.278148
           puby |   .1718867   .0475911     3.61   0.001     .0757015    .2680718
     finsupport |  -2.355573   .2378944    -9.90   0.000    -2.836376   -1.874771
  developing_se |   .0159855   .0093425     1.71   0.095    -.0028963    .0348673
    national_se |  -.1252276   .0240228    -5.21   0.000    -.1737794   -.0766758
         imf_se |   .1268117   .0234924     5.40   0.000     .0793317    .1742916
     threefd_se |  -.2426985   .0445923    -5.44   0.000    -.3328229   -.1525741
nexplanatory_se |   .0002605   .0008704     0.30   0.766    -.0014985    .0020196
   invSE_study3 |  -.0614015   .0330557    -1.86   0.071    -.1282094    .0054065
   invSE_study5 |   .0967364   .0175053     5.53   0.000     .0613568     .132116
   invSE_study6 |   .6002221   .0548704    10.94   0.000     .4893249    .7111192
   invSE_study8 |   .1268657    .037302     3.40   0.002     .0514755    .2022559
  invSE_study14 |   .4693258   .0528744     8.88   0.000     .3624627     .576189
  invSE_study16 |    .167048   .0670466     2.49   0.017     .0315418    .3025541
  invSE_study17 |   .1260292   .0139652     9.02   0.000     .0978044    .1542539
  invSE_study19 |   .1983578   .0421552     4.71   0.000      .113159    .2835567
  invSE_study22 |   .1397872   .0338466     4.13   0.000     .0713807    .2081937
  invSE_study24 |     .04306   .0071504     6.02   0.000     .0286085    .0575115
  invSE_study27 |  -.0739505     .02247    -3.29   0.002    -.1193641    -.028537
  invSE_study32 |  -.0907448   .0211517    -4.29   0.000     -.133494   -.0479957
  invSE_study33 |  -.0197696   .0081426    -2.43   0.020    -.0362264   -.0033127
  invSE_study35 |  -.1932303   .0449407    -4.30   0.000    -.2840589   -.1024017
  invSE_study37 |   .0446904   .0336616     1.33   0.192    -.0233421     .112723
  invSE_study39 |  -.3104721   .0535583    -5.80   0.000    -.4187175   -.2022268
  invSE_study41 |   -.145322   .0359191    -4.05   0.000    -.2179172   -.0727269
  invSE_study43 |  -.0815879   .0158435    -5.15   0.000    -.1136088    -.049567
          _cons |   -2.07261   .4602953    -4.50   0.000    -3.002901   -1.142318
---------------------------------------------------------------------------------

. lincom invSE + 0.1038961*developing_se + 0.5184815*national_se + 0.2317682*imf_se +
0.0649351*threefd + 8.69*nexplanatory_se +  0.04995*invSE_st
```

```
> udy3 +0.011988*invSE_study5 + 0.002997*invSE_study6 +0.01998* invSE_study8 +
0.007992*invSE_study14  + 0.013986*invSE_study16 + 0.002997*invSE_
> study17 + 0.001998*invSE_study19  + 0.02997*invSE_study22 + 0.005994*invSE_study24
+ 0.031968*invSE_study27 + 0.007992*invSE_study32 + 0.007992
> *invSE_study33 + 0.025974*invSE_study35 + 0.0679321*invSE_study37 +
0.017982*invSE_study39 + 0.011988*invSE_study41 +0.025974* invSE_study43

 ( 1)  invSE + .1038961*developing_se + .5184815*national_se + .2317682*imf_se +
.0649351*threefd_se + 8.69*nexplanatory_se + .04995*invSE_study3
       + .011988*invSE_study5 + .002997*invSE_study6 + .01998*invSE_study8 +
.007992*invSE_study14 + .013986*invSE_study16 + .002997*invSE_study17
       + .001998*invSE_study19 + .02997*invSE_study22 + .005994*invSE_study24 +
.031968*invSE_study27 + .007992*invSE_study32 +
       .007992*invSE_study33 + .025974*invSE_study35 + .0679321*invSE_study37 +
.017982*invSE_study39 + .011988*invSE_study41 +
       .025974*invSE_study43 = 0

------------------------------------------------------------------------------
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |  -.0408354   .0173497    -2.35   0.024    -.0759006   -.0057703
------------------------------------------------------------------------------

. lincom _cons + 0.6693307*published + 9.809191*puby + 0.1018981*finsupport

 ( 1)  .6693307*published + 9.809191*puby + .1018981*finsupport + _cons = 0

------------------------------------------------------------------------------
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   .4093841   .2622058     1.56   0.126    -.1205535    .9393218
------------------------------------------------------------------------------

. vif

    Variable |       VIF       1/VIF  
-------------+----------------------
      imf_se |      5.44    0.183890
 national_se |      4.52    0.221264
nexplanato~e |      3.66    0.272900
        puby |      3.19    0.313223
       invSE |      2.81    0.355446
   published |      2.17    0.461204
invSE_stu~41 |      1.92    0.520405
invSE_stu~27 |      1.88    0.533145
invSE_study3 |      1.34    0.745284
  threefd_se |      1.32    0.758508
invSE_study5 |      1.32    0.759861
developing~e |      1.29    0.773204
invSE_stu~14 |      1.28    0.778279
  finsupport |      1.25    0.798457
invSE_stu~32 |      1.21    0.823468
invSE_study6 |      1.21    0.824584
invSE_stu~22 |      1.20    0.835481
invSE_stu~39 |      1.19    0.838762
invSE_stu~24 |      1.18    0.850452
invSE_stu~35 |      1.17    0.853326
invSE_stu~17 |      1.17    0.853795
invSE_study8 |      1.13    0.884300
invSE_stu~43 |      1.12    0.890002
invSE_stu~37 |      1.12    0.894933
invSE_stu~19 |      1.09    0.919114
invSE_stu~16 |      1.08    0.923704
invSE_stu~33 |      1.08    0.923833
-------------+----------------------
    Mean VIF |      1.79

. estat ovtest

Ramsey RESET test using powers of the fitted values of t
       Ho:  model has no omitted variables
                 F(3, 819) =      2.38
                  Prob > F =      0.0687
```

```
. *6* robust regression
.
. rreg t invSE published puby finsupport cross_se timeseries_se ols_se dynamic_se
iv_se othertech_se longrun_se mixed_se developing_se transition_
> se endog_se nonlinear_se national_se imf_se unitary_se  fdrev_se fdexprev_se
threefd_se otherfd_se  span_se nexplanatory_se if growth==1

   Huber iteration 1:  maximum difference in weights = .79685157
   Huber iteration 2:  maximum difference in weights = .41103096
   Huber iteration 3:  maximum difference in weights = .14960152
   Huber iteration 4:  maximum difference in weights = .02969872
Biweight iteration 5:  maximum difference in weights = .28839198
Biweight iteration 6:  maximum difference in weights = .12067707
Biweight iteration 7:  maximum difference in weights = .09596647
Biweight iteration 8:  maximum difference in weights = .11170723
Biweight iteration 9:  maximum difference in weights = .1178338
Biweight iteration 10:  maximum difference in weights = .08596264
Biweight iteration 11:  maximum difference in weights = .04746533
Biweight iteration 12:  maximum difference in weights = .02308486
Biweight iteration 13:  maximum difference in weights = .01042802
Biweight iteration 14:  maximum difference in weights = .00556722

Robust regression                                      Number of obs =     884
                                                       F( 25,    858) =   12.34
                                                       Prob > F      =  0.0000

------------------------------------------------------------------------------
              t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
----------------+-------------------------------------------------------------
          invSE |   .1368691   .0193745     7.06   0.000      .098842    .1748961
      published |   1.120154   .2658687     4.21   0.000     .5983249    1.641983
           puby |  -.0759114   .0327069    -2.32   0.021    -.1401063   -.0117165
     finsupport |  -1.142552   .4672681    -2.45   0.015    -2.059674   -.2254293
       cross_se |   .0029025   .0659763     0.04   0.965    -.1265914    .1323963
  timeseries_se |  -.0257056   .1373643    -0.19   0.852     -.295315    .2439039
         ols_se |  -.1126984   .0174219    -6.47   0.000     -.146893   -.0785038
     dynamic_se |    .006294   .0289286     0.22   0.828     -.050485     .063073
          iv_se |   .0794489    .061255     1.30   0.195    -.0407783    .1996761
   othertech_se |   .1077055   .1042677     1.03   0.302    -.0969442    .3123551
     longrun_se |  -.0086643   .0226808    -0.38   0.703    -.0531807     .035852
       mixed_se |   .0196312   .0299113     0.66   0.512    -.0390766    .0783391
  developing_se |   .0201747   .0095338     2.12   0.035     .0014625    .0388869
  transition_se |  -.0747963   .0294361    -2.54   0.011    -.1325715   -.0170211
       endog_se |  -.0649648   .0226488    -2.87   0.004    -.1094183   -.0205113
   nonlinear_se |   .0783544   .0181132     4.33   0.000     .0428031    .1139057
    national_se |  -.1069998   .0248704    -4.30   0.000    -.1558138   -.0581858
         imf_se |  -.0572509   .0271809    -2.11   0.035    -.1105998    -.003902
     unitary_se |  -.0836494   .0261792    -3.20   0.001    -.1350322   -.0322667
       fdrev_se |  -.0167295    .018068    -0.93   0.355    -.0521921    .0187332
    fdexprev_se |   .0216634   .0250704     0.86   0.388     -.027543    .0708698
     threefd_se |   .0621523   .0427164     1.46   0.146    -.0216884    .1459931
     otherfd_se |    .053104   .0209417     2.54   0.011     .0120012    .0942069
        span_se |    .005494   .0083268     0.66   0.510    -.0108494    .0218373
nexplanatory_se |  -.0023102    .000887    -2.60   0.009    -.0040512   -.0005692
          _cons |  -.2637092   .4323989    -0.61   0.542    -1.112393    .5849743
------------------------------------------------------------------------------

.
.
```

c) Output-Level Studies

```
. *7* wls (positive publication bias and negative genuine effect)
.
. regress t invSE published puby cross_se ols_se imf_se fdrev_se threefd_se if t>-
7.138112 & t<=6.973776 & level==1  [aweight=weights], vce(cluste
> r idstudy)
(sum of wgt is   8.0323e+00)

Linear regression                                      Number of obs =     104
                                                       F(  5,      9) =       .
                                                       Prob > F      =       .
                                                       R-squared     =  0.4954
                                                       Root MSE      =  1.8636
```

```
                              (Std. Err. adjusted for 10 clusters in idstudy)
------------------------------------------------------------------------------
             |               Robust
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       invSE |  -.1490909   .0241204    -6.18   0.000    -.2036549   -.0945268
   published |  -1.661726   .8264092    -2.01   0.075    -3.531193    .2077418
        puby |  -.2619807   .0954305    -2.75   0.023    -.4778595   -.0461019
    cross_se |  -.9230726   .1229672    -7.51   0.000    -1.201244   -.6449015
      ols_se |   .7212837   .0516362    13.97   0.000     .6044745     .838093
      imf_se |    .196344   .0749284     2.62   0.028     .0268442    .3658438
    fdrev_se |    .077855   .0218159     3.57   0.006      .028504     .127206
  threefd_se |  -.3060625   .1007255    -3.04   0.014    -.5339193   -.0782057
       _cons |   5.664663   1.743325     3.25   0.010     1.720987    9.608339
------------------------------------------------------------------------------

.
. lincom invSE+ 0.0192308*cross_se +0.0576923*ols_se + 0.3076923*imf_se +
0.1538462*threefd_se + 0.16*fdrev_se

 ( 1)  invSE + .0192308*cross_se + .0576923*ols_se + .3076923*imf_se + .16*fdrev_se +
.1538462*threefd_se = 0

------------------------------------------------------------------------------
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   -.099446   .0358638    -2.77   0.022    -.1805755   -.0183165
------------------------------------------------------------------------------

.
. lincom _cons+ 0.59*published + 12.40*puby

 ( 1)  .59*published + 12.4*puby + _cons = 0

------------------------------------------------------------------------------
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   1.435684   .4424252     3.25   0.010     .4348489     2.43652
------------------------------------------------------------------------------

.
. vif

    Variable |       VIF       1/VIF  
-------------+----------------------
        puby |      2.14    0.466686
    cross_se |      1.78    0.562002
       invSE |      1.74    0.575200
      ols_se |      1.73    0.578970
   published |      1.60    0.623675
      imf_se |      1.40    0.713210
    fdrev_se |      1.15    0.869118
  threefd_se |      1.07    0.935131
-------------+----------------------
    Mean VIF |      1.58

.
. estat ovtest

Ramsey RESET test using powers of the fitted values of t
       Ho:  model has no omitted variables
                  F(3, 92) =      4.67
                  Prob > F =      0.0044

.
.

. *8* fe (positive publication bias and negative genuine effect)

. . regress t invSE published puby cross_se ols_se imf_se fdrev_se threefd_se
invSE_study37 invSE_study25 invSE_study11 if t>-7.138112 & t<=6.97377
> 6 & level==1  [aweight=weights], vce(cluster idstudy)
(sum of wgt is   8.0323e+00)

Linear regression                                      Number of obs =     104
                                                       F(  4,     9) =       .
                                                       Prob > F      =       .
```

```
                                                    R-squared     =  0.5537
                                                    Root MSE      =   1.781

                                  (Std. Err. adjusted for 10 clusters in idstudy)
-------------------------------------------------------------------------------
              |               Robust
            t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
--------------+----------------------------------------------------------------
        invSE |  -.1810614    .024659    -7.34   0.000     -.236844   -.1252789
    published |  -2.782627   .4273606    -6.51   0.000    -3.749384   -1.815871
         puby |  -.4319652   .1162998    -3.71   0.005    -.6950536   -.1688768
     cross_se |  -1.123572   .0901621   -12.46   0.000    -1.327533    -.919611
       ols_se |   .7923133   .0584585    13.55   0.000     .6600709    .9245557
       imf_se |   .2962143   .0453565     6.53   0.000     .1936107    .3988179
     fdrev_se |   .0646047   .0173711     3.72   0.005     .0253085    .1039009
   threefd_se |  -.1514314   .0041706   -36.31   0.000    -.1608659   -.1419969
invSE_study37 |  -.2787741   .0295038    -9.45   0.000    -.3455164   -.2120317
invSE_study25 |  -.0315733   .0778825    -0.41   0.695    -.2077557    .1446091
invSE_study11 |  -.4634708    .071659    -6.47   0.000    -.6255748   -.3013669
        _cons |   8.875903   1.742624     5.09   0.001     4.933815    12.81799
-------------------------------------------------------------------------------

.
. vif

    Variable |       VIF       1/VIF
-------------+----------------------
        puby |      4.24    0.236082
       invSE |      2.73    0.366150
   published |      2.32    0.431126
    cross_se |      2.09    0.478283
invSE_stu~25 |      1.99    0.502302
      imf_se |      1.93    0.518217
      ols_se |      1.84    0.542140
invSE_stu~37 |      1.71    0.586318
invSE_stu~11 |      1.43    0.696959
  threefd_se |      1.25    0.798178
    fdrev_se |      1.20    0.832702
-------------+----------------------
    Mean VIF |      2.07

.
. lincom _cons+ 0.59*published + 12.40*puby

 ( 1)  .59*published + 12.4*puby + _cons = 0

------------------------------------------------------------------------------
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |   1.877785   .2850117     6.59   0.000     1.233044    2.522526
------------------------------------------------------------------------------


.
. lincom invSE+ 0.0192308*cross_se +0.0576923*ols_se + 0.3076923*imf_se +
0.1538462*threefd_se + 0.16*fdrev_se

 ( 1)  invSE + .0192308*cross_se + .0576923*ols_se + .3076923*imf_se + .16*fdrev_se +
.1538462*threefd_se = 0

------------------------------------------------------------------------------
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         (1) |  -.0787757    .022651    -3.48   0.007    -.1300159   -.0275356
------------------------------------------------------------------------------


.
. outreg2 usign 26oct.doc
  outreg2 usign 26oct.doc using `"26oct1.doc"'
26oct1.doc
dir : seeout

.
.
. *9* robust regression

.
. rreg t invSE published puby cross_se ols_se imf_se fdrev_se threefd_se if level==1
```

```
   Huber iteration 1:  maximum difference in weights = .54024661
   Huber iteration 2:  maximum difference in weights = .1158604
   Huber iteration 3:  maximum difference in weights = .03276009
Biweight iteration 4:  maximum difference in weights = .2563729
Biweight iteration 5:  maximum difference in weights = .14343965
Biweight iteration 6:  maximum difference in weights = .15198207
Biweight iteration 7:  maximum difference in weights = .13513249
Biweight iteration 8:  maximum difference in weights = .13345701
Biweight iteration 9:  maximum difference in weights = .1335
Biweight iteration 10:  maximum difference in weights = .12164479
Biweight iteration 11:  maximum difference in weights = .09720437
Biweight iteration 12:  maximum difference in weights = .06047851
Biweight iteration 13:  maximum difference in weights = .01737281
Biweight iteration 14:  maximum difference in weights = .02116871
Biweight iteration 15:  maximum difference in weights = .01348459
Biweight iteration 16:  maximum difference in weights = .0045696

Robust regression                                      Number of obs =     104
                                                       F(  8,    95) =   21.59
                                                       Prob > F      =  0.0000

------------------------------------------------------------------------------
           t |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       invSE |  -.1089921   .0296935    -3.67   0.000    -.1679411   -.0500431
   published |   -.128219   .3910847    -0.33   0.744    -.9046203    .6481822
        puby |  -.3959746   .0870092    -4.55   0.000    -.5687097   -.2232394
    cross_se |  -.8214281   .1715207    -4.79   0.000     -1.16194   -.4809164
      ols_se |   .7540629   .1090885     6.91   0.000     .5374949    .9706308
      imf_se |   .3398445   .0335149    10.14   0.000      .273309      .40638
    fdrev_se |   .0289499   .0407366     0.71   0.479    -.0519225    .1098223
  threefd_se |  -.1446085    .065173    -2.22   0.029    -.2739933   -.0152236
       _cons |   5.688484   1.277903     4.45   0.000     3.151526    8.225442
------------------------------------------------------------------------------
```

Appendix Chapter 4

FISCAL DECENTRALISATION AND ECONOMIC PERFORMANCE IN TRANSITION ECONOMIES - AN EMPIRICAL INVESTIGATION

Box 1

The IMF Governmental Finance Statistics database organises government into institutional units according to the level of government in charged for. A general government consists of three layers of government: central, state and local government. Institutional units controlled by a single central authority across the country lie under the central government. On the other side, distinct institutional units from central government controlled by regional or provincial authorities across a sub-section territory of a country are part of state government. A smaller geographical area than the one of state government where separate institutional units inherit fiscal, legislative and executive authority involves local government.

Appendix 4.1 Correlation Matrix

```
. corr popgrowth educ2 educ3 dschooling laggdp gfcf_gdp trade govcons schooling_wb schooling_undp dschooling eu tindex rule_estimates
rule_rank europe fdexp fdrev fdtax fiscalperform1 fiscalperform2 imbalance1 imbalance2 fdtax_l (obs=268)
```

	popgro~h	educ2	educ3	dschoo~g	laggdp	gfcf_gdp	trade	govcons	school~b	school~p	dschoo~g	eu	tindex
popgrowth	1.0000												
educ2	-0.1163	1.0000											
educ3	-0.1548	0.6970	1.0000										
dschooling	-0.0126	0.1614	0.1898	1.0000									
laggdp	0.1239	0.5539	0.4875	0.1044	1.0000								
gfcf_gdp	0.1295	-0.1798	-0.1906	0.1315	0.0436	1.0000							
trade	0.0495	0.1569	0.2393	0.0361	0.3334	-0.0394	1.0000						
govcons	-0.1899	0.1190	0.1291	-0.1540	0.2033	-0.2095	0.3218	1.0000					
schooling_wb	0.2656	0.1230	0.2062	0.0706	-0.2134	-0.0057	0.1684	-0.3250	1.0000				
schooling_~p	0.1181	0.6030	0.5271	0.2017	0.6621	0.1009	0.3364	0.2012	0.2142	1.0000			
dschooling	-0.0126	0.1614	0.1898	1.0000	0.1044	0.1315	0.0361	-0.1540	0.0706	0.2017	1.0000		
eu	-0.1120	0.4477	0.6206	0.0963	0.6952	-0.0445	0.5234	0.1781	-0.0441	0.5427	0.0963	1.0000	
tindex	-0.1173	0.3733	0.3505	0.1483	0.7129	0.1770	0.3997	0.3533	-0.3974	0.5511	0.1483	0.6918	1.0000
rule_estim~s	-0.1799	0.4434	0.3405	0.0327	0.7872	0.0473	0.3103	0.4577	-0.4323	0.5390	0.0327	0.5878	0.7868
rule_rank	-0.1928	0.4250	0.3244	0.0388	0.7768	0.0552	0.2988	0.4576	-0.4368	0.5152	0.0388	0.5799	0.7790
europe	-0.3118	0.2022	0.1715	0.0225	0.6298	0.0522	0.0885	0.3462	-0.7112	0.1388	0.0225	0.4471	0.6654
fdexp	0.1230	0.3390	0.2089	-0.0409	0.0983	-0.2992	-0.0526	0.0666	0.3246	0.2349	-0.0409	0.0431	-0.1008
fdrev	0.1334	0.2871	0.1731	-0.0354	0.0733	-0.3693	-0.0473	0.0873	0.3107	0.1975	-0.0354	0.0219	-0.1376
fdtax	0.0628	-0.0106	-0.0282	-0.1708	-0.1575	-0.1998	-0.1570	0.0070	0.2448	-0.0397	-0.1708	-0.1292	-0.3568
fiscalperf~1	0.1941	-0.2396	-0.3059	-0.0625	-0.3549	-0.0447	-0.3301	-0.2663	0.1563	-0.2388	-0.0625	-0.3488	-0.5070
fiscalperf~2	0.2046	-0.2487	-0.2843	-0.0378	-0.4360	0.0303	-0.3185	-0.3474	0.3406	-0.2720	-0.0378	-0.4113	-0.6248
imbalance1	-0.1200	0.2202	0.2572	0.1332	0.2159	0.0928	0.2713	0.0501	0.0853	0.2314	0.1332	0.2375	0.3584
imbalance2	0.0362	0.1814	0.1795	0.1519	0.1091	0.0911	0.1845	-0.1158	0.2519	0.1831	0.1519	0.1028	0.1624
fdtax_l	0.1203	-0.2560	-0.2671	-0.0875	-0.3941	0.0432	-0.3247	-0.2487	0.1906	-0.2860	-0.0875	-0.3622	-0.5403

	rule_e~s	rule_r~k	europe	fdexp	fdrev	fdtax	fiscal~1	fiscal~2	imbala~1	imbala~2	fdtax_l
rule_estim~s	1.0000										
rule_rank	0.9943	1.0000									
europe	0.7478	0.7522	1.0000								
fdexp	-0.0577	-0.0994	-0.2461	1.0000							
fdrev	-0.0666	-0.1031	-0.2813	0.9436	1.0000						
fdtax	-0.2416	-0.2647	-0.3917	0.5771	0.6342	1.0000					
fiscalperf~1	-0.4285	-0.4221	-0.4592	0.0399	0.0804	0.6255	1.0000				
fiscalperf~2	-0.5765	-0.5775	-0.6156	0.1561	0.1929	0.7040	0.9013	1.0000			
imbalance1	0.2385	0.2437	0.1986	-0.0903	-0.1050	-0.6774	-0.8884	-0.7445	1.0000		
imbalance2	0.0472	0.0584	-0.0131	-0.0553	-0.0368	-0.5807	-0.7125	-0.5389	0.9310	1.0000	
fdtax_l	-0.4808	-0.4846	-0.4906	0.1166	0.1372	0.7395	0.8855	0.9614	-0.8314	-0.6964	1.0000

Appendix 4.2 Diagnostics

Appendix 4.2.1 Summary Statistics

```
. xtsum growth  fdexp fdrev fdtax fiscalperform1 fiscalperform2 imbalance1 imbalance2
fdtax_l popgrowth educ2 educ3  schooling_wb schooling_undp dschooling laggdp lag2gdp
lngdpini gfcf_gdp trade govcons tindex rule_estimates rule_rank europe eu

Variable         |      Mean   Std. Dev.       Min        Max |    Observations
-----------------+--------------------------------------------+----------------
growth   overall |  3.939919   4.547403  -15.73542   13.74634 |     N =     364
         between |             1.531516   1.615957   6.853537 |     n =      21
         within  |             4.306808  -16.80605   13.07969 | T-bar = 17.3333
                 |                                            |
fdexp    overall |  23.77712   9.338959       5.12      55.63 |     N =     358
         between |             9.153969   7.565833   45.76941 |     n =      21
         within  |             3.818539   9.117649   37.59765 | T-bar = 17.0476
                 |                                            |
fdrev    overall |  25.53412     9.9686        5.2      59.23 |     N =     359
         between |             9.739891   7.816667   47.44471 |     n =      21
         within  |             4.081196   13.86942   40.80362 | T-bar = 17.0952
                 |                                            |
fdtax    overall |  16.85992   12.93801        1.4      76.95 |     N =     358
         between |             11.21796     1.9795   41.63353 |     n =      21
         within  |             6.313699  -.8816625   67.00141 | T-bar = 17.0476
                 |                                            |
fiscal~1 overall |  55.38652   24.59587       9.63     118.67 |     N =     359
         between |             22.36057     13.611   107.9991 |     n =      21
         within  |             12.88486   18.37152    108.487 | T-bar = 17.0952
                 |                                            |
fiscal~2 overall |  39.65933   23.86436       3.03      98.31 |     N =     359
         between |             20.19813      4.241   71.41412 |     n =      21
         within  |             12.86277   .5676651   91.21683 | T-bar = 17.0952
                 |                                            |
imbala~1 overall |  48.75487   21.26715       4.65      90.33 |     N =     359
         between |             17.67082   10.50091    86.2145 |     n =      21
         within  |             12.73806  -1.885626   80.63432 | T-bar = 17.0952
                 |                                            |
imbala~2 overall |  51.51436   23.58207       5.62     120.47 |     N =     358
         between |             17.29849   12.88545    85.2585 |     n =      21
         within  |             16.80705   1.723858   115.6794 | T-bar = 17.0476
                 |                                            |
fdtax_l  overall |  36.79425   20.95755       3.18      83.83 |     N =     358
         between |             16.70101      4.376   70.28941 |     n =      21
         within  |             12.49957   3.278135   86.29225 | T-bar = 17.0476
                 |                                            |
popgro~h overall | -.3375207   .6854643      -2.26       2.64 |     N =     363
         between |             .6007097     -1.142      1.432 |     n =      21
         within  |             .4059679  -2.692784   1.677216 | T-bar = 17.2857
                 |                                            |
educ2    overall |  94.34234   8.378795         68   119.4924 |     N =     357
         between |               6.2246   81.02554    101.771 |     n =      21
         within  |             5.914394   80.20353   114.4996 | T-bar =      17
                 |                                            |
educ3    overall |  52.22902   16.90763   16.43171   90.43713 |     N =     353
         between |             11.06993   35.82792   71.08829 |     n =      21
         within  |             12.75114   14.52438   79.56836 | T-bar = 16.8095
                 |                                            |
school~b overall |  4.218182   1.111248         .5        6.9 |     N =     297
         between |             1.044635      2.895   6.368421 |     n =      17
         within  |               .48396   1.578182   5.278182 | T-bar = 17.4706
                 |                                            |
school~p overall |  10.98033   1.021451        8.6       13.1 |     N =     361
         between |             .8052952   9.114286      12.62 |     n =      21
         within  |             .6488077   8.945332   13.02151 | T-bar = 17.1905
                 |                                            |
dschoo~g overall |  .0094708    .447113         -4          1 |     N =     359
         between |             .0565546  -.1090909   .1307692 |     n =      21
         within  |             .4442649  -3.950529   .9544707 | T-bar = 17.0952
                 |                                            |
laggdp   overall |  14471.28   7498.841   2268.499   31137.78 |     N =     364
         between |             6777.672   2789.771   25406.43 |     n =      21
         within  |             3547.256   5520.984   23215.06 | T-bar = 17.3333
                 |                                            |
lag2gdp  overall |  14270.56   7406.592   2268.499   31137.78 |     N =     343
```

```
         between |             6722.239    2746.23   25245.72 |     n =      21
         within  |             3446.855   5670.012   22370.88 | T-bar = 16.3333
                 |                                            |
lngdpini overall |   9.01878   .6023695   7.790522   9.856976 |     N =     364
         between |             .6246839   7.790522   9.856976 |     n =      21
         within  |                    0    9.01878    9.01878 | T-bar = 17.3333
                 |                                            |
gfcf_gdp overall |  24.47802   5.399173   5.385321   40.47286 |     N =     364
         between |             3.633381   19.85558   32.71138 |     n =      21
         within  |             4.223384   9.252266   38.17171 | T-bar = 17.3333
                 |                                            |
trade    overall |   105.556   30.13797   45.47565   184.5514 |     N =     364
         between |             25.23123   69.34934   144.7662 |     n =      21
         within  |             17.12333    50.6348   155.0891 | T-bar = 17.3333
                 |                                            |
govcons  overall |   17.8376   3.605838   8.538813   27.09808 |     N =     364
         between |             3.135079   10.87151   22.09974 |     n =      21
         within  |             2.096092   8.985127   28.09751 | T-bar = 17.3333
                 |                                            |
                 |                                            |
tindex   overall |  74.68816   14.81082   16.81818        100 |     N =     344
         between |             14.01776   27.72727    91.1244 |     n =      21
         within  |             4.923805   47.96301   83.98109 |     T =  16.381
                 |                                            |
rule_e~s overall |  .0276648   .7111169      -1.46       1.36 |     N =     364
         between |             .6968778     -1.221     .99675 |     n =      21
         within  |             .2083533  -.8433878   .9166122 | T-bar = 17.3333
                 |                                            |
rule_r~k overall |  52.08778   21.96454       6.16       86.6 |     N =     364
         between |             21.45243     10.181   81.44425 |     n =      21
         within  |              7.09947   23.80015   82.48015 | T-bar = 17.3333
                 |                                            |
europe   overall |  .6840659   .4655267          0          1 |     N =     364
         between |             .4830459          0          1 |     n =      21
         within  |                    0   .6840659   .6840659 | T-bar = 17.3333
                 |                                            |
eu       overall |  .3214286   .4676677          0          1 |     N =     364
         between |              .288737          0         .6 |     n =      21
         within  |             .3737237  -.2785714   1.121429 | T-bar = 17.3333
```

Appendix 4.2.2 VIF command

```
. reg growth fdexp fdtax_l popgrowth dschooling laggdp gfcf_gdp trade tindex year1
year2 year3 year4 year5 year6 year7 year8 year9 yea
> r10 year11 year12 year13 year14 year15 year16 year17 year18 if growth<=21.20154 &
growth>=-12.55204

      Source |       SS       df       MS              Number of obs =     328
-------------+------------------------------           F( 26,   301) =   16.35
       Model |  3107.94205    26  119.536233           Prob > F      =  0.0000
    Residual |  2200.93038   301  7.31206108           R-squared     =  0.5854
-------------+------------------------------           Adj R-squared =  0.5496
       Total |  5308.87243   327  16.2350839           Root MSE      =  2.7041

------------------------------------------------------------------------------
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       fdexp |   .0690888   .0189805     3.64   0.000     .0317375    .1064402
     fdtax_l |  -.0124964   .0095545    -1.31   0.192    -.0312985    .0063058
   popgrowth |  -1.021732   .2348323    -4.35   0.000    -1.483853   -.5596109
  dschooling |   1.491129   .4514797     3.30   0.001     .6026723    2.379585
      laggdp |  -.0001366   .0000286    -4.78   0.000    -.0001928   -.0000804
    gfcf_gdp |   .1577501   .0319733     4.93   0.000     .0948306    .2206697
       trade |   .0015034   .0055959     0.27   0.788    -.0095086    .0125154
      tindex |  -.0033484   .0156646    -0.21   0.831    -.0341745    .0274776
       year1 |   1.472597   1.307964     1.13   0.261    -1.101315    4.046509
       year2 |   .8195724   .9922106     0.83   0.409    -1.132976     2.77212
       year3 |  -1.228833   .9949355    -1.24   0.218    -3.186743     .729077
       year4 |   -2.75268   .9714833    -2.83   0.005     -4.66444   -.8409214
       year5 |   1.030182   .9679615     1.06   0.288    -.8746471    2.935011
       year6 |   1.355603    .946637     1.43   0.153    -.5072621    3.218467
       year7 |   1.419781   .9570908     1.48   0.139    -.4636556    3.303217
       year8 |   2.582987   .9151989     2.82   0.005      .781988    4.383985
       year9 |   2.854985   .9102835     3.14   0.002     1.063659     4.64631
      year10 |   2.986381    .901463     3.31   0.001     1.212413    4.760349
```

```
      year11 |   3.137535   .8957269     3.50   0.001     1.374855    4.900215
      year12 |   3.160169   .8950898     3.53   0.000     1.398742    4.921595
      year13 |   .0129177   .8893653     0.01   0.988    -1.737243    1.763079
      year14 |  -6.428777   .9324745    -6.89   0.000    -8.263772   -4.593783
      year15 |  -.8386976   .8620914    -0.97   0.331    -2.535187    .8577918
      year16 |   .8376386   .8698838     0.96   0.336    -.8741852    2.549462
      year17 |   -1.69897   .8581205    -1.98   0.049    -3.387645    -.010295
      year18 |  -.1708662   .8900214    -0.19   0.848    -1.922318    1.580586
       _cons |    .438677   1.802041     0.24   0.808    -3.107517    3.984871
------------------------------------------------------------------------------

. vif

    Variable |       VIF       1/VIF
-------------+----------------------
      tindex |      2.49    0.401866
       year1 |      2.49    0.402041
      year12 |      2.15    0.464326
      year13 |      2.13    0.470322
      year11 |      2.06    0.485268
      year15 |      2.00    0.500552
      year10 |      1.99    0.502696
  dschooling |      1.98    0.503836
      year17 |      1.98    0.505195
      laggdp |      1.97    0.508416
       year8 |      1.95    0.513155
      year16 |      1.94    0.514530
       year9 |      1.93    0.518712
       year6 |      1.87    0.536133
      year18 |      1.84    0.542598
      year14 |      1.81    0.552542
       year7 |      1.79    0.557663
     fdtax_l |      1.74    0.574077
       year4 |      1.73    0.578077
       year5 |      1.72    0.582291
       year3 |      1.69    0.591657
       year2 |      1.68    0.594911
       fdexp |      1.44    0.694131
    gfcf_gdp |      1.32    0.756251
       trade |      1.23    0.815945
   popgrowth |      1.15    0.873213
-------------+----------------------
    Mean VIF |      1.85

. reg growth fdexp fdtax_l imbalance2 popgrowth dschooling laggdp gfcf_gdp trade tindex
year1 year2 year3 year4 year5 year6 year7 year
> 8  year9  year10  year11  year12  year13  year14  year15  year16  year17  year18  if
growth<=21.20154 & growth>=-12.55204

      Source |       SS       df       MS              Number of obs =     328
-------------+------------------------------           F( 27,   300) =   16.06
       Model |  3138.07041    27  116.22483           Prob > F      =  0.0000
    Residual |  2170.80202   300  7.23600673           R-squared     =  0.5911
-------------+------------------------------           Adj R-squared =  0.5543
       Total |  5308.87243   327  16.2350839           Root MSE      =    2.69

------------------------------------------------------------------------------
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       fdexp |   .0615038    .019244     3.20   0.002     .0236335    .0993741
     fdtax_l |   .0124135   .0154715     0.80   0.423    -.0180329      .04286
  imbalance2 |   .0242439   .0118813     2.04   0.042     .0008626    .0476251
   popgrowth |  -1.077826   .2352197    -4.58   0.000    -1.540716   -.6149364
  dschooling |   1.464095    .449321     3.26   0.001     .5798751    2.348315
      laggdp |  -.0001152   .0000303    -3.80   0.000    -.0001748   -.0000555
    gfcf_gdp |    .145944   .0323286     4.51   0.000     .0823245    .2095635
       trade |   .0027956   .0056026     0.50   0.618    -.0082298     .013821
      tindex |  -.0015168   .0156088    -0.10   0.923    -.0322334    .0291998
       year1 |   1.867132   1.315432     1.42   0.157    -.7215105    4.455774
       year2 |    1.19222    1.00379     1.19   0.236    -.7831406    3.167581
       year3 |  -.9316103   1.000409    -0.93   0.352    -2.900318    1.037097
       year4 |  -2.329673    .988402    -2.36   0.019    -4.274753    -.384594
       year5 |    1.41619   .9813208     1.44   0.150    -.5149539    3.347334
       year6 |   1.675181   .9546359     1.75   0.080    -.2034502    3.553811
       year7 |   1.707697    .962499     1.77   0.077    -.1864072    3.601802
       year8 |   2.783081   .9156927     3.04   0.003     .9810862    4.585075
       year9 |   3.028212   .9095078     3.33   0.001     1.238389    4.818035
```

```
     year10 |   3.138493   .8998557     3.49   0.001     1.367665    4.909322
     year11 |   3.310551   .8950815     3.70   0.000     1.549117    5.071984
     year12 |   3.296119   .8929118     3.69   0.000     1.538956    5.053283
     year13 |   .0574347   .8849969     0.06   0.948    -1.684153    1.799023
     year14 |   -6.30579   .9295685    -6.78   0.000    -8.135091    -4.47649
     year15 |  -.8376508   .8575964    -0.98   0.329    -2.525317    .8500158
     year16 |   .8378454    .865348     0.97   0.334    -.8650756    2.540766
     year17 |  -1.717432    .853694    -2.01   0.045    -3.397419   -.0374452
     year18 |   -.156706   .8854079    -0.18   0.860    -1.899103    1.585691
      _cons |  -2.015214   2.158655    -0.93   0.351    -6.263239     2.23281
------------------------------------------------------------------------------

. vif

    Variable |       VIF       1/VIF  
-------------+----------------------
    fdtax_l |      4.62    0.216663
  imbalance2 |      3.43    0.291510
       year1 |      2.54    0.393355
      tindex |      2.50    0.400537
      laggdp |      2.24    0.447290
      year12 |      2.17    0.461741
      year13 |      2.13    0.470037
      year11 |      2.08    0.480913
      year10 |      2.00    0.499246
      year15 |      2.00    0.500552
  dschooling |      1.99    0.503398
      year17 |      1.98    0.505139
       year8 |      1.97    0.507270
       year9 |      1.94    0.514193
      year16 |      1.94    0.514530
       year6 |      1.92    0.521702
      year18 |      1.84    0.542565
       year7 |      1.83    0.545678
      year14 |      1.82    0.550219
       year4 |      1.81    0.552647
       year5 |      1.78    0.560652
       year2 |      1.74    0.575219
       year3 |      1.73    0.579114
       fdexp |      1.50    0.668232
    gfcf_gdp |      1.37    0.732028
       trade |      1.24    0.805519
   popgrowth |      1.16    0.861286
-------------+----------------------
    Mean VIF |      2.05
```

Appendix 4.2.3 RESET test

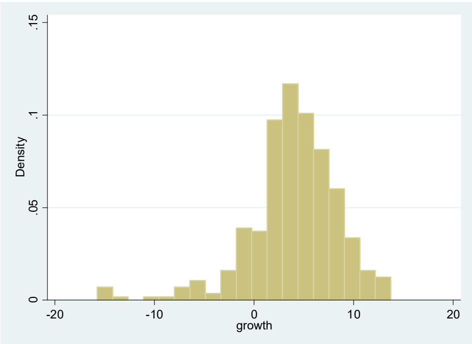
```
. xtreg growth fdexp fdtax_l popgrowth dschooling laggdp gfcf_gdp trade tindex year1
year2 year3 year4 year5 year6 year7 year8 year9 y
> ear10 year11 year12 year13 year14 year15 year16 year17 year18 if growth<=21.20154 &
growth>=-12.55204

Random-effects GLS regression                   Number of obs      =       328
Group variable: id_country                      Number of groups   =        21

R-sq:  within  = 0.5837                         Obs per group: min =         6
       between = 0.6225                                        avg =      15.6
       overall = 0.5854                                        max =        19

                                                Wald chi2(26)      =    425.04
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
      growth |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       fdexp |   .0690888   .0189805     3.64   0.000     .0318877      .10629
     fdtax_l |  -.0124964   .0095545    -1.31   0.191    -.0312229    .0062302
   popgrowth |  -1.021732   .2348323    -4.35   0.000    -1.481995   -.5614691
  dschooling |   1.491129   .4514797     3.30   0.001     .6062446    2.376013
      laggdp |  -.0001366   .0000286    -4.78   0.000    -.0001926   -.0000806
    gfcf_gdp |   .1577501   .0319733     4.93   0.000     .0950836    .2204167
       trade |   .0015034   .0055959     0.27   0.788    -.0094643    .0124711
      tindex |  -.0033484   .0156646    -0.21   0.831    -.0340506    .0273537
       year1 |   1.472597   1.307964     1.13   0.260    -1.090965     4.03616
```

```
       year2 |   .8195724   .9922106     0.83   0.409    -1.125125    2.764269
       year3 |  -1.228833   .9949355    -1.24   0.217    -3.178871    .7212045
       year4 |   -2.75268   .9714833    -2.83   0.005    -4.656753   -.8486083
       year5 |   1.030182   .9679615     1.06   0.287    -.8669881    2.927351
       year6 |   1.355603    .946637     1.43   0.152    -.4997718    3.210977
       year7 |   1.419781   .9570908     1.48   0.138    -.4560825    3.295644
       year8 |   2.582987   .9151989     2.82   0.005     .7892296    4.376743
       year9 |   2.854985   .9102835     3.14   0.002     1.070862    4.639108
      year10 |   2.986381    .901463     3.31   0.001     1.219546    4.753216
      year11 |   3.137535   .8957269     3.50   0.000     1.381943    4.893127
      year12 |   3.160169   .8950898     3.53   0.000     1.405825    4.914512
      year13 |   .0129177   .8893653     0.01   0.988    -1.730206    1.756042
      year14 |  -6.428777   .9324745    -6.89   0.000    -8.256394   -4.601161
      year15 |  -.8386976   .8620914    -0.97   0.331    -2.528366    .8509705
      year16 |   .8376386   .8698838     0.96   0.336    -.8673022    2.542579
      year17 |   -1.69897   .8581205    -1.98   0.048    -3.380855   -.0170849
      year18 |  -.1708662   .8900214    -0.19   0.848    -1.915276    1.573544
       _cons |    .438677   1.802041     0.24   0.808    -3.093258    3.970612
-------------+----------------------------------------------------------------
     sigma_u |          0
     sigma_e |  2.3609404
         rho |          0   (fraction of variance due to u_i)
------------------------------------------------------------------------------

.
. predict yhat
(option xb assumed; fitted values)
(31 missing values generated)

.
. gen yhat2 = yhat* yhat
(31 missing values generated)

.
. gen yhat3 = yhat* yhat * yhat
(31 missing values generated)

.
. xtreg growth fdexp fdtax_l popgrowth dschooling laggdp gfcf_gdp trade tindex yhat2
yhat3 year1 year2 year3 year4 year5 year6 year7 y
> ear8 year9 year10 year11 year12 year13 year14 year15 year16 year17 year18 if
growth<=21.20154 & growth>=-12.55204

Random-effects GLS regression                   Number of obs      =       328
Group variable: id_country                      Number of groups   =        21

R-sq:  within  = 0.5832                         Obs per group: min =         6
       between = 0.6264                                        avg =      15.6
       overall = 0.5857                                        max =        19

                                                Wald chi2(28)      =    422.71
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
      growth |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       fdexp |   .0651882   .0215731     3.02   0.003     .0229057    .1074707
     fdtax_l |  -.0122243   .0096266    -1.27   0.204    -.0310922    .0066435
   popgrowth |  -.9646443   .3004806    -3.21   0.001    -1.553575   -.3757131
  dschooling |   1.393244   .5243079     2.66   0.008     .3656198    2.420869
      laggdp |  -.0001304   .0000332    -3.93   0.000    -.0001955   -.0000653
    gfcf_gdp |    .148826   .0416956     3.57   0.000     .0671043    .2305478
       trade |   .0013326   .0056358     0.24   0.813    -.0097134    .0123786
      tindex |  -.0029989   .0157978    -0.19   0.849    -.0339619    .0279642
       yhat2 |   .0126846   .0309751     0.41   0.682    -.0480255    .0733947
       yhat3 |  -.0006551   .0029387    -0.22   0.824    -.0064149    .0051046
       year1 |   1.347264   1.351944     1.00   0.319    -1.302497    3.997025
       year2 |   .7509243   1.008899     0.74   0.457    -1.226482    2.728331
       year3 |  -1.164279   1.022348    -1.14   0.255    -3.168044    .8394865
       year4 |  -2.630745   1.017321    -2.59   0.010    -4.624657   -.6368324
       year5 |   .9475951   .9901532     0.96   0.339    -.9930694     2.88826
       year6 |    1.24009   .9836689     1.26   0.207    -.6878652    3.168046
       year7 |   1.301229   .9957507     1.31   0.191    -.6504067    3.252864
       year8 |    2.37031   1.046587     2.26   0.024     .3190377    4.421583
       year9 |    2.62516   1.065918     2.46   0.014     .5359986    4.714322
      year10 |   2.748679   1.075468     2.56   0.011     .6407996    4.856557
      year11 |   2.887843   1.099044     2.63   0.009     .7337575    5.041929
```

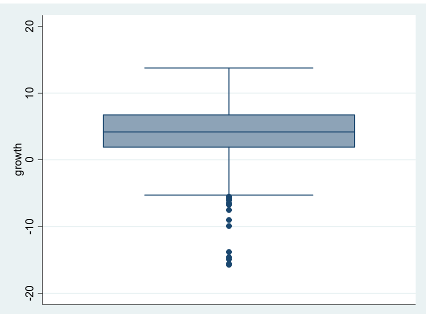
```
      year12 |   2.910728   1.106841     2.63   0.009     .7413592    5.080097
      year13 |   -.001509   .9007689    -0.00   0.999    -1.766984    1.763966
      year14 |  -6.513839   1.016139    -6.41   0.000    -8.505435   -4.522242
      year15 |  -.7972825   .8727843    -0.91   0.361    -2.507908    .9133433
      year16 |     .77861   .8835241     0.88   0.378    -.9530654    2.510285
      year17 |  -1.628128   .8760761    -1.86   0.063    -3.345205    .0889498
      year18 |  -.1598754   .8932269    -0.18   0.858    -1.910568    1.590817
       _cons |   .5132421   1.846617     0.28   0.781    -3.106061    4.132545
-------------+----------------------------------------------------------------
     sigma_u |          0
     sigma_e |  2.3679194
         rho |          0   (fraction of variance due to u_i)
------------------------------------------------------------------------------

.
. test yhat2=yhat3=0

 ( 1)  yhat2 - yhat3 = 0
 ( 2)  yhat2 = 0

           chi2(  2) =    0.20
         Prob > chi2 =    0.9031
```

Appendix 4.2.4 Normality Assumption

a. Histogram



b. Box Plot



c. Detection of Outliers

```
. lv growth


 #     364                GDPgrowth
          ---------------------------------
M     182.5 |            4.169904            |     spread   pseudosigma
F      91.5 |   1.913781     4.32475     6.73572 |   4.821939     3.578326
E      46   | -.3364187    4.026436     8.38929 |   8.725709     3.798132
D      23.5 | -2.541421    3.779639     10.1007 |   12.64212     4.144019
C      12   | -6.061302    2.820477    11.70226 |   17.76356     4.796103
```

```
 B      6.5 | -9.471185   1.546197   12.56358 |  22.03476    5.192389
 A      3.5 | -14.75126  -.6768351   13.39759 |  28.14885     5.91736
 Z      2   | -15.57294  -.9512763   13.67039 |  29.24333    5.609843
 Y      1.5 | -15.65418  -.9729087   13.70836 |  29.36254    5.385004
        1   | -15.73542  -.9945412   13.74634 |  29.48175    5.095184
            |                                 |
            |                                 |   # below     # above
inner fence | -5.319127              13.96863 |        15           0
outer fence | -12.55204              21.20154 |         5           0

. lv fdexp

 #    358                Fdexp
            ---------------------------------
 M    179.5 |               24.2              |    spread  pseudosigma
 F     90   |     17.87     22.695      27.52 |      9.65    7.161324
 E     45.5 |     12.96     22.345      31.73 |     18.77      8.1945
 D     23   |      9.37     24.375      39.38 |     30.01    9.820003
 C     12   |      8.25      27.24      46.23 |     37.98     10.2957
 B      6.5 |      6.64     29.385      52.13 |     45.49    10.75346
 A      3.5 |     6.195    30.3975       54.6 |    48.405    10.20183
 Z      2   |      5.18     30.315      55.45 |     50.27    9.664562
 Y      1.5 |      5.15     30.345      55.54 |     50.39    9.260008
        1   |      5.12     30.375      55.63 |     50.51    8.745164
            |                                 |
            |                                 |   # below     # above
inner fence |  3.395001                41.995 |         0          16
outer fence |    -11.08                 56.47 |         0           0

. lv fdrev

 #    359                Fdrev
            ---------------------------------
 M    180   |              25.59              |    spread  pseudosigma
 F     90.5 |     19.38    24.2475     29.115 |     9.735    7.247904
 E     45.5 |     13.97     24.265      34.56 |     20.59    8.975775
 D     23   |      9.99     25.925      41.86 |     31.87    10.41896
 C     12   |      7.82      29.15      50.48 |     42.66    11.55656
 B      6.5 |       6.9    30.9875     55.075 |    48.175    11.38212
 A      3.5 |      6.24       31.4      56.56 |     50.32    10.60083
 Z      2   |      5.67      31.83      57.99 |     52.32    10.05498
 Y      1.5 |     5.435    32.0225      58.61 |    53.175    9.768492
        1   |       5.2     32.215      59.23 |     54.03    9.351769
            |                                 |
            |                                 |   # below     # above
inner fence |  4.777501               43.7175 |         0          18
outer fence | -9.824999                 58.32 |         0           1

. lv fdtax

 #    358                Fdtax
            ---------------------------------
 M    179.5 |             14.415              |    spread  pseudosigma
 F     90   |      5.37      15.04      24.71 |     19.34    14.35233
 E     45.5 |      2.92     18.895      34.87 |     31.95    13.94855
 D     23   |      2.28     21.215      40.15 |     37.87    12.39199
 C     12   |      1.93     23.585      45.24 |     43.31    11.74057
 B      6.5 |      1.76    24.9575     48.155 |    46.395     10.9674
 A      3.5 |       1.6     25.555      49.51 |     47.91     10.0975
 Z      2   |      1.53     26.115       50.7 |     49.17    9.453083
 Y      1.5 |     1.465     32.645     63.825 |     62.36     11.4597
        1   |       1.4     39.175      76.95 |     75.55    13.08052
            |                                 |
            |                                 |   # below     # above
inner fence |    -23.64                 53.72 |         0           1
outer fence |    -52.65                 82.73 |         0           0

. lv fdtax_l

 #    358               fdtax_l
            ---------------------------------
 M    179.5 |              37.62              |    spread  pseudosigma
 F     90   |     18.95       35.6      52.25 |      33.3    24.71213
 E     45.5 |      9.15      34.12      59.09 |     49.94    21.80252
 D     23   |      5.02      38.16       71.3 |     66.28    21.68843
 C     12   |      4.43     41.405      78.38 |     73.95    20.04653
 B      6.5 |     3.835    42.4875      81.14 |    77.305    18.27426
```

```
 A      3.5 |      3.55       43.42       83.29 |     79.74    16.80598
 Z      2   |      3.46       43.64       83.82 |     80.36    15.44946
 Y      1.5 |      3.32     43.5725      83.825 |    80.505    14.79414
        1   |      3.18      43.505       83.83 |     80.65    13.96352
            |                                   |
            |                                   |   # below     # above
inner fence |       -31                   102.2 |         0           0
outer fence |    -80.95                  152.15 |         0           0

. lv fiscalperform1

 #    359                Coverage1
               ---------------------------------
 M    180   |                 56.04             |    spread  pseudosigma
 F     90.5 |    40.285      55.225      70.165 |     29.88    22.24626
 E     45.5 |    22.915     53.9525       84.99 |    62.075    27.06028
 D     23   |     14.88       56.62       98.36 |     83.48    27.29133
 C     12   |     13.16      59.085      105.01 |     91.85    24.88209
 B      6.5 |     11.37       59.01      106.65 |     95.28    22.51143
 A      3.5 |    10.695     61.1575      111.62 |   100.925     21.2617
 Z      2   |     10.57       62.84      115.11 |    104.54    20.09075
 Y      1.5 |      10.1      63.495      116.89 |    106.79    19.61781
        1   |      9.63       64.15      118.67 |    109.04    18.87316
            |                                   |
            |                                   |   # below     # above
inner fence | -4.535002                 114.985 |         0           2
outer fence |   -49.355                 159.805 |         0           0

. lv fiscalperform2

 #    359                Coverage2
               ---------------------------------
 M    180   |                  37.9             |    spread  pseudosigma
 F     90.5 |     21.48     38.5125      55.545 |    34.065    25.36208
 E     45.5 |      8.69     38.4175      68.145 |    59.455    25.91815
 D     23   |      4.95      41.635       78.32 |     73.37    23.98617
 C     12   |      4.23       46.48       88.73 |      84.5    22.89098
 B      6.5 |      3.72     48.2725      92.825 |    89.105    21.05248
 A      3.5 |       3.5     50.4175      97.335 |    93.835    19.76807
 Z      2   |      3.38      50.605       97.83 |     94.45    18.15163
 Y      1.5 |     3.205     50.6375       98.07 |    94.865    17.42714
        1   |      3.03       50.67       98.31 |     95.28    16.49152
            |                                   |
            |                                   |   # below     # above
inner fence |  -29.6175                106.6425 |         0           0
outer fence |   -80.715                  157.74 |         0           0

. lv imbalance1

 #    359                Imbalance
               ---------------------------------
 M    180   |                 47.88             |    spread  pseudosigma
 F     90.5 |    33.475     48.6625       63.85 |    30.375     22.6148
 E     45.5 |    23.175      50.345      77.515 |     54.34    23.68837
 D     23   |     14.56      49.475       84.39 |     69.83    22.82887
 C     12   |      12.4       49.34       86.28 |     73.88    20.01403
 B      6.5 |     10.36       49.37       88.38 |     78.02    18.43347
 A      3.5 |     7.565     48.2525       88.94 |    81.375    17.14314
 Z      2   |      5.67       47.41       89.15 |     83.48    16.04339
 Y      1.5 |      5.16       47.45       89.74 |     84.58    15.53773
        1   |      4.65       47.49       90.33 |     85.68     14.8299
            |                                   |
            |                                   |   # below     # above
inner fence |  -12.0875                109.4125 |         0           0
outer fence | -57.65001                 154.975 |         0           0

. lv imbalance2

 #    358                Imbalance2
               ---------------------------------
 M    179.5 |                48.825             |    spread  pseudosigma
 F     90   |     33.68      51.715       69.75 |     36.07    26.76777
 E     45.5 |     23.92       52.38       80.84 |     56.92    24.84981
 D     23   |     16.54       52.47        88.4 |     71.86    23.51434
 C     12   |     13.75       55.63       97.51 |     83.76    22.70585
 B      6.5 |    11.455      55.735     100.015 |     88.56    20.93485
 A      3.5 |      8.02      58.145      108.27 |    100.25    21.12867
```

```
 Z       2   |       6.32      57.705      109.09 |     102.77     19.75785
 Y       1.5 |       5.97      60.375      114.78 |     108.81     19.99566
         1   |       5.62      63.045      120.47 |     114.85     19.88482
             |                                    |
             |                                    |    # below      # above
inner fence  |    -20.425                 123.855 |          0            0
outer fence  |     -74.53                  177.96 |          0            0
```

b. Ladder command

```
. ladder gfcf_gdp

Transformation         formula                  chi2(2)       P(chi2)
------------------------------------------------------------------
cubic                  gfcf_gdp^3                     .         0.000
square                 gfcf_gdp^2                 54.03         0.000
identity               gfcf_gdp                   14.92         0.001
square root            sqrt(gfcf_gdp)             10.15         0.006
log                    log(gfcf_gdp)              58.01         0.000
1/(square root)        1/sqrt(gfcf_gdp)               .         0.000
inverse                1/gfcf_gdp                     .         0.000
1/square               1/(gfcf_gdp^2)                 .         0.000
1/cubic                1/(gfcf_gdp^3)                 .         0.000


ladder educ2

Transformation         formula                  chi2(2)       P(chi2)
------------------------------------------------------------------
cubic                  educ2^3                     7.50         0.024
square                 educ2^2                     1.03         0.598
identity               educ2                       6.48         0.039
square root            sqrt(educ2)                12.44         0.002
log                    log(educ2)                 20.39         0.000
1/(square root)        1/sqrt(educ2)              30.14         0.000
inverse                1/educ2                    41.42         0.000
1/square               1/(educ2^2)                67.38         0.000
1/cubic                1/(educ2^3)                    .         0.000

. ladder educ3

Transformation         formula                  chi2(2)       P(chi2)
------------------------------------------------------------------
cubic                  educ3^3                    48.95         0.000
square                 educ3^2                    22.97         0.000
identity               educ3                      16.08         0.000
square root            sqrt(educ3)                 9.01         0.011
log                    log(educ3)                 16.23         0.000
1/(square root)        1/sqrt(educ3)              47.70         0.000
inverse                1/educ3                        .         0.000
1/square               1/(educ3^2)                    .         0.000
1/cubic                1/(educ3^3)                    .         0.000


. ladder schooling_undp

Transformation         formula                  chi2(2)       P(chi2)
------------------------------------------------------------------
cubic                  school~p^3                 12.66         0.002
square                 school~p^2                 12.46         0.002
identity               school~p                   12.10         0.002
square root            sqrt(school~p)             12.86         0.002
log                    log(school~p)              14.70         0.001
1/(square root)        1/sqrt(school~p)           17.72         0.000
inverse                1/school~p                 21.91         0.000
1/square               1/(school~p^2)             33.16         0.000
1/cubic                1/(school~p^3)             47.04         0.000
```

Appendix 4.2.5 Unit Root Test

```
 xtunitroot fisher popgrowth , pp lag(1) demean

Fisher-type unit-root test for popgrowth
Based on Phillips-Perron tests
----------------------------------------
Ho: All panels contain unit roots           Number of panels       =     21
Ha: At least one panel is stationary        Avg. number of periods =  17.29

AR parameter:    Panel-specific             Asymptotics: T -> Infinity
Panel means:     Included
Time trend:      Not included               Cross-sectional means removed
Newey-West lags: 1 lag
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(42)   P        63.8067       0.0166
 Inverse normal            Z        -1.9546       0.0253
 Inverse logit t(109)      L*       -2.0116       0.0234
 Modified inv. chi-squared Pm        2.3793       0.0087
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------

. . xtunitroot fisher gfcf_gdp , pp lag(1) demean

Fisher-type unit-root test for gfcf_gdp
Based on Phillips-Perron tests
---------------------------------------
Ho: All panels contain unit roots           Number of panels       =     21
Ha: At least one panel is stationary        Avg. number of periods =  17.33

AR parameter:    Panel-specific             Asymptotics: T -> Infinity
Panel means:     Included
Time trend:      Not included               Cross-sectional means removed
Newey-West lags: 1 lag
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(42)   P        64.5994       0.0141
 Inverse normal            Z        -2.1388       0.0162
 Inverse logit t(109)      L*       -2.3686       0.0098
 Modified inv. chi-squared Pm        2.4658       0.0068
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------

. . xtunitroot fisher trade , pp lag(1) demean

Fisher-type unit-root test for trade
Based on Phillips-Perron tests
------------------------------------
Ho: All panels contain unit roots           Number of panels       =     21
Ha: At least one panel is stationary        Avg. number of periods =  17.33

AR parameter:    Panel-specific             Asymptotics: T -> Infinity
Panel means:     Included
Time trend:      Not included               Cross-sectional means removed
Newey-West lags: 1 lag
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(42)   P        51.3006       0.1539
 Inverse normal            Z         0.6671       0.7476
 Inverse logit t(109)      L*        0.2865       0.6125
 Modified inv. chi-squared Pm        1.0148       0.1551
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------

. . xtunitroot fisher govcons , pp lag(1) demean
```

```
Fisher-type unit-root test for govcons
Based on Phillips-Perron tests
--------------------------------------
Ho: All panels contain unit roots           Number of panels       =     21
Ha: At least one panel is stationary        Avg. number of periods =  17.33

AR parameter:    Panel-specific             Asymptotics: T -> Infinity
Panel means:     Included
Time trend:      Not included               Cross-sectional means removed
Newey-West lags: 1 lag
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(42)   P       97.8745       0.0000
 Inverse normal            Z       -3.7096       0.0001
 Inverse logit t(109)      L*      -4.3705       0.0000
 Modified inv. chi-squared Pm       6.0964       0.0000
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------

. . xtunitroot fisher dschooling , pp lag(1) demean

Fisher-type unit-root test for dschooling
Based on Phillips-Perron tests
-----------------------------------------
Ho: All panels contain unit roots           Number of panels       =     21
Ha: At least one panel is stationary        Avg. number of periods =  17.10

AR parameter:    Panel-specific             Asymptotics: T -> Infinity
Panel means:     Included
Time trend:      Not included               Cross-sectional means removed
Newey-West lags: 1 lag
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(42)   P      874.7980       0.0000
 Inverse normal            Z      -25.4557       0.0000
 Inverse logit t(109)      L*     -52.8348       0.0000
 Modified inv. chi-squared Pm      90.8657       0.0000
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------

. . xtunitroot fisher educ2 , pp lag(1) demean

Fisher-type unit-root test for educ2
Based on Phillips-Perron tests
------------------------------------
Ho: All panels contain unit roots           Number of panels       =     21
Ha: At least one panel is stationary        Avg. number of periods =  17.00

AR parameter:    Panel-specific             Asymptotics: T -> Infinity
Panel means:     Included
Time trend:      Not included               Cross-sectional means removed
Newey-West lags: 1 lag
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(42)   P       40.3368       0.5441
 Inverse normal            Z        0.3929       0.6528
 Inverse logit t(109)      L*       0.3828       0.6487
 Modified inv. chi-squared Pm      -0.1815       0.5720
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------

. . xtunitroot fisher educ3 , pp lag(1) demean

Fisher-type unit-root test for educ3
Based on Phillips-Perron tests
------------------------------------
Ho: All panels contain unit roots           Number of panels       =     21
Ha: At least one panel is stationary        Avg. number of periods =  16.81
```

```
AR parameter:    Panel-specific            Asymptotics: T -> Infinity
Panel means:     Included
Time trend:      Not included              Cross-sectional means removed
Newey-West lags: 1 lag
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(42)   P        34.0335       0.8043
 Inverse normal            Z         1.8245       0.9660
 Inverse logit t(104)      L*        2.1962       0.9849
 Modified inv. chi-squared Pm       -0.8692       0.8076
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------

. . xtunitroot fisher tindex , pp lag(1) demean

Fisher-type unit-root test for tindex
Based on Phillips-Perron tests
-------------------------------------
Ho: All panels contain unit roots          Number of panels       =     21
Ha: At least one panel is stationary       Avg. number of periods =  16.38

AR parameter:    Panel-specific            Asymptotics: T -> Infinity
Panel means:     Included
Time trend:      Not included              Cross-sectional means removed
Newey-West lags: 1 lag
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(42)   P       127.1456       0.0000
 Inverse normal            Z        -2.5638       0.0052
 Inverse logit t(109)      L*       -5.1355       0.0000
 Modified inv. chi-squared Pm        9.2901       0.0000
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------

. . xtunitroot fisher rule_rank , pp lag(1) demean

Fisher-type unit-root test for rule_rank
Based on Phillips-Perron tests
----------------------------------------
Ho: All panels contain unit roots          Number of panels       =     21
Ha: At least one panel is stationary       Avg. number of periods =  17.33

AR parameter:    Panel-specific            Asymptotics: T -> Infinity
Panel means:     Included
Time trend:      Not included              Cross-sectional means removed
Newey-West lags: 1 lag
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(42)   P       104.6251       0.0000
 Inverse normal            Z        -3.9737       0.0000
 Inverse logit t(109)      L*       -4.7315       0.0000
 Modified inv. chi-squared Pm        6.8330       0.0000
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------

. . xtunitroot fisher fdexp, pp lag(1) demean

Fisher-type unit-root test for fdexp
Based on Phillips-Perron tests
------------------------------------
Ho: All panels contain unit roots          Number of panels       =     21
Ha: At least one panel is stationary       Avg. number of periods =  17.05

AR parameter:    Panel-specific            Asymptotics: T -> Infinity
Panel means:     Included
Time trend:      Not included              Cross-sectional means removed
Newey-West lags: 1 lag
```

```
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(42)   P        51.5278       0.1488
 Inverse normal            Z        -0.4281       0.3343
 Inverse logit t(109)      L*       -0.5558       0.2897
 Modified inv. chi-squared Pm        1.0396       0.1493
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------

. . xtunitroot fisher fdtax_l, pp lag(1) demean

Fisher-type unit-root test for fdtax_l
Based on Phillips-Perron tests
--------------------------------------
Ho: All panels contain unit roots           Number of panels       =     21
Ha: At least one panel is stationary        Avg. number of periods =  17.05

AR parameter:    Panel-specific             Asymptotics: T -> Infinity
Panel means:     Included
Time trend:      Not included               Cross-sectional means removed
Newey-West lags: 1 lag
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(42)   P        39.4703       0.5826
 Inverse normal            Z         0.9485       0.8286
 Inverse logit t(109)      L*        0.8586       0.8038
 Modified inv. chi-squared Pm       -0.2760       0.6087
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------

. . xtunitroot fisher imbalance1, pp lag(1) demean

Fisher-type unit-root test for imbalance1
Based on Phillips-Perron tests
-----------------------------------------
Ho: All panels contain unit roots           Number of panels       =     21
Ha: At least one panel is stationary        Avg. number of periods =  17.10

AR parameter:    Panel-specific             Asymptotics: T -> Infinity
Panel means:     Included
Time trend:      Not included               Cross-sectional means removed
Newey-West lags: 1 lag
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(42)   P        68.0940       0.0066
 Inverse normal            Z        -1.6284       0.0517
 Inverse logit t(109)      L*       -2.0300       0.0224
 Modified inv. chi-squared Pm        2.8471       0.0022
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------

. . xtunitroot fisher imbalance2, pp lag(1) demean

Fisher-type unit-root test for imbalance2
Based on Phillips-Perron tests
-----------------------------------------
Ho: All panels contain unit roots           Number of panels       =     21
Ha: At least one panel is stationary        Avg. number of periods =  17.05

AR parameter:    Panel-specific             Asymptotics: T -> Infinity
Panel means:     Included
Time trend:      Not included               Cross-sectional means removed
Newey-West lags: 1 lag
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(42)   P        52.6529       0.1255
 Inverse normal            Z        -0.6776       0.2490
```

```
 Inverse logit t(109)      L*       -0.8684       0.1935
 Modified inv. chi-squared Pm        1.1623       0.1226
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------

. . xtunitroot fisher fiscalperform1 , pp lag(1) demean

Fisher-type unit-root test for fiscalperform1
Based on Phillips-Perron tests
---------------------------------------------
Ho: All panels contain unit roots           Number of panels       =     21
Ha: At least one panel is stationary        Avg. number of periods =  17.10

AR parameter:    Panel-specific             Asymptotics: T -> Infinity
Panel means:     Included
Time trend:      Not included               Cross-sectional means removed
Newey-West lags: 1 lag
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(42)   P       122.3890       0.0000
 Inverse normal            Z        -3.4968       0.0002
 Inverse logit t(109)      L*       -5.6666       0.0000
 Modified inv. chi-squared Pm        8.7712       0.0000
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------

. . xtunitroot fisher fiscalperform2 , pp lag(1) demean

Fisher-type unit-root test for fiscalperform2
Based on Phillips-Perron tests
---------------------------------------------
Ho: All panels contain unit roots           Number of panels       =     21
Ha: At least one panel is stationary        Avg. number of periods =  17.10

AR parameter:    Panel-specific             Asymptotics: T -> Infinity
Panel means:     Included
Time trend:      Not included               Cross-sectional means removed
Newey-West lags: 1 lag
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(42)   P        52.5704       0.1271
 Inverse normal            Z        -0.3890       0.3486
 Inverse logit t(109)      L*       -0.4507       0.3265
 Modified inv. chi-squared Pm        1.1533       0.1244
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------
```

Appendix 4.2.6 Homoscedasticity

```
. qui xtreg growth popgrowth educ2 educ3 laggdp gfcf_gdp trade fdexp fdtax_l imbalance1
year1 year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12 year13
year14 year15 year16 year17 year18 year19 if growth<=21.20154 & growth>=-12.55204, fe


. xttest3

Modified Wald test for groupwise heteroskedasticity
in fixed effect regression model

H0: sigma(i)^2 = sigma^2 for all i

chi2 (21)  =      140.60
Prob>chi2 =      0.0000
```

Appendix 4.2.7 Serial Correlation

```
. xtserial growth popgrowth educ2 educ3 laggdp gfcf_gdp trade fdexp fdtax_l
imbalance1 year1 year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12
year13 year14 year15 year16 year17 year18 year19 if growth<=21.20154 & growth>=-
12.55204


Wooldridge test for autocorrelation in panel data
H0: no first order autocorrelation
    F(  1,       20) =      11.107
           Prob > F =      0.0033


. xi: xtserial growth laggdp popgrowth gfcf_gdp educ2 educ3 trade tindex fdexp
fdtax_l i.year
i.year            _Iyear_1996-2015    (naturally coded; _Iyear_1996 omitted)

Wooldridge test for autocorrelation in panel data
H0: no first order autocorrelation
    F(  1,       20) =      12.548
           Prob > F =      0.0020
```

Appendix 4.2.8 Cross Sectional Dependence

```
. xtreg growth popgrowth educ2 educ3 laggdp gfcf_gdp trade fdexp year1 year2 year3
year4 year5 year6 year7 year8 year9 year10 year11 year12 year13 year14 year15 year16
year17 year18 year19 if growth<=21.20154 & growth>=-12.55204, fe


Fixed-effects (within) regression               Number of obs      =       337
Group variable: id_country                      Number of groups   =        21

R-sq:  within  = 0.6100                         Obs per group: min =         6
       between = 0.1675                                        avg =      16.0
       overall = 0.3141                                        max =        20

                                                F(26,290)          =     17.44
corr(u_i, Xb)  = -0.7355                        Prob > F           =    0.0000

------------------------------------------------------------------------------
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |  -.8671415   .4074067    -2.13   0.034     -1.66899   -.0652926
       educ2 |   .0254119   .0334603     0.76   0.448    -.0404439    .0912677
       educ3 |  -.0204842    .019679    -1.04   0.299    -.0592161    .0182477
      laggdp |  -.0005851   .0001043    -5.61   0.000    -.0007903   -.0003798
    gfcf_gdp |   .1756166   .0394499     4.45   0.000     .0979722     .253261
       trade |   .0383917   .0116387     3.30   0.001     .0154847    .0612988
       fdexp |   .0542558   .0386722     1.40   0.162    -.0218581    .1303696
       year1 |  -4.406607   1.549694    -2.84   0.005     -7.45668   -1.356534
       year2 |  -2.455699   1.440511    -1.70   0.089    -5.290881     .379482
       year3 |  -4.049504   1.407715    -2.88   0.004    -6.820139    -1.27887
       year4 |  -5.893325   1.341051    -4.39   0.000    -8.532752   -3.253898
       year5 |  -2.383373   1.297284    -1.84   0.067    -4.936659    .1699139
       year6 |  -1.488155   1.255483    -1.19   0.237    -3.959168     .982858
       year7 |  -.8452197     1.2158    -0.70   0.487     -3.23813     1.54769
       year8 |   .2954668   1.134939     0.26   0.795    -1.938296     2.52923
       year9 |   1.018043   1.076497     0.95   0.345    -1.100695    3.136781
      year10 |   1.249464   1.014188     1.23   0.219    -.7466391    3.245567
      year11 |   1.960656   .9715642     2.02   0.045      .048445    3.872867
      year12 |   2.425953    .948511     2.56   0.011     .5591146    4.292791
      year13 |  -.2637225   .9336221    -0.28   0.778    -2.101257    1.573812
      year14 |  -5.653907    .942311    -6.00   0.000    -7.508543   -3.799271
      year15 |  -1.022935    .886892    -1.15   0.250    -2.768497    .7226258
      year16 |   .4082957   .8844156     0.46   0.645    -1.332392    2.148983
      year17 |  -1.975318   .8638957    -2.29   0.023    -3.675619   -.2750179
      year18 |  -.2746814   .8771302    -0.31   0.754     -2.00103    1.451667
      year19 |  -.1504953   .8642633    -0.17   0.862    -1.851519    1.550529
       _cons |   2.365106   4.020722     0.59   0.557     -5.54839     10.2786
-------------+----------------------------------------------------------------
     sigma_u |  3.6954931
     sigma_e |  2.3759065
```

```
         rho |  .70754076   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(20, 290) =     5.09             Prob > F = 0.0000

. . xtcsd, pesaran abs


Pesaran's test of cross sectional independence =    -3.026, Pr = 0.0025

Average absolute value of the off-diagonal elements =     0.320

. . xtreg growth popgrowth educ2 educ3 laggdp gfcf_gdp trade fdexp fdtax_l year1
year2 year3 year4 year5 year6 year7 year8 year9 year1
> 0 year11 year12 year13 year14 year15 year16 year17 year18 year19 if
growth<=21.20154 & growth>=-12.55204, fe

Fixed-effects (within) regression               Number of obs      =       336
Group variable: id_country                      Number of groups   =        21

R-sq:  within  = 0.6105                         Obs per group: min =         6
       between = 0.1743                                        avg =      16.0
       overall = 0.3261                                        max =        20

                                                F(27,288)          =     16.72
corr(u_i, Xb)  = -0.7176                        Prob > F           =    0.0000

------------------------------------------------------------------------------
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |  -.9007758   .4100249    -2.20   0.029    -1.707801   -.0937504
       educ2 |   .0206944   .0339367     0.61   0.542     -.046101    .0874898
       educ3 |  -.0186351   .0202006    -0.92   0.357    -.0583946    .0211244
      laggdp |  -.0005686   .0001063    -5.35   0.000    -.0007778   -.0003593
    gfcf_gdp |    .174195   .0400713     4.35   0.000     .0953252    .2530647
       trade |   .0391879   .0117995     3.32   0.001     .0159638     .062412
       fdexp |   .0520266   .0390561     1.33   0.184    -.0248451    .1288983
     fdtax_l |  -.0078317   .0126122    -0.62   0.535    -.0326554    .0169921
       year1 |  -4.241843   1.661058    -2.55   0.011    -7.511195   -.9724904
       year2 |  -2.137194   1.539017    -1.39   0.166    -5.166342    .8919532
       year3 |  -3.744626   1.497276    -2.50   0.013    -6.691618   -.7976337
       year4 |  -5.578021    1.44204    -3.87   0.000    -8.416296   -2.739746
       year5 |  -2.093894   1.383784    -1.51   0.131    -4.817505    .6297181
       year6 |  -1.209196   1.338505    -0.90   0.367    -3.843689    1.425297
       year7 |  -.6133478   1.275845    -0.48   0.631    -3.124511    1.897815
       year8 |   .5108584   1.187861     0.43   0.667    -1.827131    2.848848
       year9 |   1.194797   1.114634     1.07   0.285    -.9990637    3.388658
      year10 |   1.400286   1.041389     1.34   0.180    -.6494117    3.449985
      year11 |   2.067498   .9852303     2.10   0.037     .1283335    4.006663
      year12 |   2.518089   .9582219     2.63   0.009     .6320825    4.404095
      year13 |  -.2226372    .936725    -0.24   0.812    -2.066332    1.621058
      year14 |  -5.622314    .945946    -5.94   0.000    -7.484158   -3.760469
      year15 |  -.9819316   .8920633    -1.10   0.272    -2.737722    .7738586
      year16 |    .414835   .8863711     0.47   0.640    -1.329752    2.159422
      year17 |   -1.95834   .8662258    -2.26   0.025    -3.663276   -.2534037
      year18 |  -.2445975   .8802107    -0.28   0.781    -1.977059    1.487864
      year19 |  -.1320906   .8665776    -0.15   0.879    -1.837719    1.573538
       _cons |    2.61601   4.044329     0.65   0.518    -5.344182     10.5762
-------------+----------------------------------------------------------------
     sigma_u |  3.5340941
     sigma_e |   2.380562
         rho |  .68788304   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(20, 288) =     4.99             Prob > F = 0.0000

. . xtcsd, pesaran abs


Pesaran's test of cross sectional independence =    -3.019, Pr = 0.0025

Average absolute value of the off-diagonal elements =     0.318

. . xtreg growth popgrowth educ2 educ3 laggdp gfcf_gdp trade fdexp fdtax_l imbalance1
year1 year2 year3 year4 year5 year6 year7 year8
> year9 year10 year11 year12 year13 year14 year15 year16 year17 year18 year19 if
growth<=21.20154 & growth>=-12.55204, fe

Fixed-effects (within) regression               Number of obs      =       336
```

```
Group variable: id_country                      Number of groups   =        21

R-sq:  within  = 0.6107                         Obs per group: min =         6
       between = 0.1810                                        avg =      16.0
       overall = 0.3266                                        max =        20

                                                F(28,287)          =     16.08
corr(u_i, Xb)  = -0.7209                        Prob > F           =    0.0000

------------------------------------------------------------------------------
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |  -.8945561   .4109938    -2.18   0.030      -1.7035   -.0856118
       educ2 |   .0209496    .033995     0.62   0.538    -.0459615    .0878607
       educ3 |  -.0181232   .0202792    -0.89   0.372    -.0580381    .0217917
     laggdp  |  -.0005693   .0001065    -5.35   0.000    -.0007789   -.0003597
    gfcf_gdp |   .1733556   .0401971     4.31   0.000     .0942372    .2524741
       trade |   .0394565     .01184     3.33   0.001     .0161523    .0627608
       fdexp |   .0507196   .0392775     1.29   0.198    -.0265889    .1280281
    fdtax_1  |  -.0008065   .0229687    -0.04   0.972     -.046015     .044402
  imbalance1 |   .0086405   .0235949     0.37   0.714    -.0378005    .0550815
       year1 |  -4.216139    1.66504    -2.53   0.012    -7.493379   -.9389001
       year2 |  -2.129581   1.541476    -1.38   0.168    -5.163613    .9044511
       year3 |  -3.755276   1.499814    -2.50   0.013    -6.707307   -.8032455
       year4 |  -5.547204   1.446663    -3.83   0.000    -8.394618   -2.699789
       year5 |  -2.071338   1.387237    -1.49   0.136    -4.801786    .6591107
       year6 |  -1.209136   1.340522    -0.90   0.368    -3.847637    1.429365
       year7 |  -.6186417   1.277849    -0.48   0.629    -3.133786    1.896503
       year8 |   .4758994   1.193475     0.40   0.690    -1.873174    2.824973
       year9 |    1.16108   1.120104     1.04   0.301     -1.04358     3.36574
      year10 |   1.357509   1.049479     1.29   0.197    -.7081439    3.423161
      year11 |   2.028777   .9923638     2.04   0.042     .0755433    3.982012
      year12 |   2.469718    .968713     2.55   0.011     .5630351    4.376401
      year13 |  -.2857673    .953844    -0.30   0.765    -2.163184     1.59165
      year14 |  -5.684504   .9624721    -5.91   0.000    -7.578903   -3.790104
      year15 |  -1.055141   .9155011    -1.15   0.250    -2.857089    .7468071
      year16 |   .3574507   .9014312     0.40   0.692    -1.416804    2.131705
      year17 |  -2.018236   .8828145    -2.29   0.023    -3.755848   -.2806235
      year18 |  -.2853415   .8885303    -0.32   0.748    -2.034204    1.463521
      year19 |  -.1625388   .8718569    -0.19   0.852    -1.878583    1.553506
       _cons |   1.952713   4.436965     0.44   0.660    -6.780405    10.68583
-------------+----------------------------------------------------------------
     sigma_u |  3.5450471
     sigma_e |  2.3841487
         rho |   .6885649   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(20, 287) =     4.95             Prob > F = 0.0000

. . xtcsd, pesaran abs


Pesaran's test of cross sectional independence =    -2.997, Pr = 0.0027

Average absolute value of the off-diagonal elements =     0.318
```

A. Alternative measure of Education: dschooling

```
. . xtreg growth popgrowth dschooling laggdp gfcf_gdp trade fdexp year1 year2 year3
year4 year5 year6 year7 year8 year9 year10 year11
> year12 year13 year14 year15 year16 year17 year18 year19 if growth<=21.20154 &
growth>=-12.55204, fe

Fixed-effects (within) regression               Number of obs      =       348
Group variable: id_country                      Number of groups   =        21

R-sq:  within  = 0.6082                         Obs per group: min =         6
       between = 0.1885                                        avg =      16.6
       overall = 0.3433                                        max =        20

                                                F(25,302)          =     18.75
corr(u_i, Xb)  = -0.6799                        Prob > F           =    0.0000

------------------------------------------------------------------------------
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
```

```
-------------+----------------------------------------------------------------
   popgrowth |  -.4414347   .3562407    -1.24   0.216    -1.142463    .2595936
  dschooling |   1.132162   .3991598     2.84   0.005     .3466749    1.917648
     laggdp  |  -.0005195   .0001027    -5.06   0.000    -.0007217   -.0003173
    gfcf_gdp |   .2135623   .0391596     5.45   0.000      .136502    .2906225
       trade |   .0524965   .0114319     4.59   0.000     .0300003    .0749928
       fdexp |   .0570811   .0368522     1.55   0.122    -.0154385    .1296007
       year1 |  -.5379923   1.646722    -0.33   0.744    -3.778495     2.70251
       year2 |  -1.058696   1.365174    -0.78   0.439    -3.745154    1.627761
       year3 |  -2.812264   1.322276    -2.13   0.034    -5.414305   -.2102235
       year4 |  -4.096596   1.278126    -3.21   0.001    -6.611758   -1.581435
       year5 |  -.5542304   1.244274    -0.45   0.656    -3.002775    1.894314
       year6 |   .1895183   1.188056     0.16   0.873    -2.148398    2.527435
       year7 |   .7000142    1.15501     0.61   0.545    -1.572872      2.9729
       year8 |   1.720728   1.057083     1.63   0.105    -.3594536    3.800909
       year9 |   1.969869   .9974519     1.97   0.049      .007033    3.932705
      year10 |   2.123038   .9397325     2.26   0.025     .2737851    3.972291
      year11 |   2.526039   .8913611     2.83   0.005     .7719737    4.280104
      year12 |   2.809206   .8601829     3.27   0.001     1.116495    4.501917
      year13 |   .1410026   .8274014     0.17   0.865    -1.487199    1.769205
      year14 |  -5.206463   .8640105    -6.03   0.000    -6.906706    -3.50622
      year15 |  -.3830264   .8091788    -0.47   0.636    -1.975369    1.209316
      year16 |   .8181996   .8023736     1.02   0.309    -.7607516    2.397151
      year17 |  -1.590391    .782096    -2.03   0.043    -3.129439   -.0513435
      year18 |   .1907962   .8066042     0.24   0.813     -1.39648    1.778072
      year19 |   .3345662   .7915308     0.42   0.673    -1.223048     1.89218
       _cons |  -.5699817   2.531833    -0.23   0.822     -5.55225    4.412286
-------------+----------------------------------------------------------------
     sigma_u |  3.2959192
     sigma_e |  2.4331601
         rho |  .64725352   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(20, 302) =     5.40             Prob > F = 0.0000

. . xtcsd, pesaran abs


Pesaran's test of cross sectional independence =    -2.724, Pr = 0.0064

Average absolute value of the off-diagonal elements =     0.295

. . xtreg growth popgrowth dschooling laggdp gfcf_gdp trade fdexp fdtax_l year1 year2
year3 year4 year5 year6 year7 year8 year9 year10
>  year11 year12 year13 year14 year15 year16 year17 year18 year19 if growth<=21.20154
& growth>=-12.55204, fe

Fixed-effects (within) regression               Number of obs      =       347
Group variable: id_country                      Number of groups   =        21

R-sq:  within  = 0.6085                         Obs per group: min =         6
       between = 0.1940                                        avg =      16.5
       overall = 0.3536                                        max =        20

                                                F(26,300)          =     17.94
corr(u_i, Xb)  = -0.6626                        Prob > F           =    0.0000

------------------------------------------------------------------------------
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |  -.4629196   .3582684    -1.29   0.197    -1.167957    .2421178
  dschooling |   1.152137   .4215502     2.73   0.007     .3225667    1.981707
      laggdp |   -.000508   .0001041    -4.88   0.000    -.0007128   -.0003033
    gfcf_gdp |   .2169767   .0395841     5.48   0.000      .139079    .2948745
       trade |   .0537698   .0115653     4.65   0.000     .0310104    .0765292
       fdexp |   .0547122   .0370459     1.48   0.141    -.0181907     .127615
     fdtax_l |  -.0093133   .0126009    -0.74   0.460    -.0341106    .0154839
       year1 |  -.1363723   1.742378    -0.08   0.938    -3.565204    3.292459
       year2 |  -.7580559   1.422728    -0.53   0.595    -3.557847    2.041735
       year3 |  -2.525971   1.379078    -1.83   0.068    -5.239863    .1879214
       year4 |  -3.792885   1.341323    -2.83   0.005    -6.432478   -1.153293
       year5 |  -.2890297   1.296597    -0.22   0.824    -2.840607    2.262547
       year6 |   .4654083   1.244923     0.37   0.709    -1.984479    2.915296
       year7 |   .9163254   1.193393     0.77   0.443    -1.432156    3.264807
       year8 |   1.915116   1.092304     1.75   0.081    -.2344313    4.064664
       year9 |   2.139161    1.02658     2.08   0.038     .1189504    4.159371
      year10 |    2.26316   .9618894     2.35   0.019     .3702547    4.156065
      year11 |   2.619529   .9035796     2.90   0.004     .8413716    4.397686
```

```
      year12 |   2.883284   .8703834     3.31   0.001     1.170454    4.596115
      year13 |   .1699583   .8317671     0.20   0.838    -1.466879    1.806795
      year14 |  -5.169596   .8681698    -5.95   0.000     -6.87807   -3.461122
      year15 |  -.3311099   .8140354    -0.41   0.684    -1.933053    1.270833
      year16 |   .8276693   .8043738     1.03   0.304    -.7552603    2.410599
      year17 |  -1.569268   .7844045    -2.00   0.046      -3.1129   -.0256356
      year18 |   .2116958   .8090125     0.26   0.794    -1.380362    1.803754
      year19 |   .3446176   .7933767     0.43   0.664    -1.216671    1.905906
       _cons |  -.6950123   2.541777    -0.27   0.785    -5.696983    4.306958
-------------+----------------------------------------------------------------
     sigma_u |  3.1764134
     sigma_e |  2.4384868
         rho |  .62919152   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(20, 300) =     5.37             Prob > F = 0.0000

. . xtcsd, pesaran abs


Pesaran's test of cross sectional independence =    -2.711, Pr = 0.0067

Average absolute value of the off-diagonal elements =     0.295

. . xtreg growth popgrowth dschooling laggdp gfcf_gdp trade fdexp fdtax_l imbalance1
year1 year2 year3 year4 year5 year6 year7 year8 y
> ear9 year10 year11 year12 year13 year14 year15 year16 year17 year18 year19 if
growth<=21.20154 & growth>=-12.55204, fe

Fixed-effects (within) regression               Number of obs      =       347
Group variable: id_country                      Number of groups   =        21

R-sq:  within  = 0.6086                         Obs per group: min =         6
       between = 0.1975                                        avg =      16.5
       overall = 0.3536                                        max =        20

                                                F(27,299)          =     17.22
corr(u_i, Xb)  = -0.6651                        Prob > F           =    0.0000

------------------------------------------------------------------------------
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |   -.461971   .3588655    -1.29   0.199    -1.168193     .244251
  dschooling |   1.149599   .4223836     2.72   0.007     .3183779    1.980821
      laggdp |  -.0005083   .0001042    -4.88   0.000    -.0007134   -.0003032
    gfcf_gdp |   .2163773   .0397435     5.44   0.000     .1381648    .2945897
       trade |   .0538678   .0115925     4.65   0.000     .0310544    .0766811
       fdexp |    .053958   .0372677     1.45   0.149    -.0193822    .1272982
     fdtax_l |  -.0051596   .0229459    -0.22   0.822    -.0503155    .0399964
  imbalance1 |   .0051165   .0236047     0.22   0.829     -.041336    .0515689
       year1 |  -.1261351   1.745791    -0.07   0.942     -3.56173     3.30946
       year2 |  -.7519336   1.425273    -0.53   0.598    -3.556771    2.052904
       year3 |  -2.530527   1.381434    -1.83   0.068    -5.249091     .188038
       year4 |  -3.771039   1.347233    -2.80   0.005      -6.4223   -1.119779
       year5 |  -.2705995   1.301442    -0.21   0.835    -2.831745    2.290546
       year6 |   .4704246    1.24712     0.38   0.706    -1.983819    2.924668
       year7 |   .9192164   1.195367     0.77   0.443    -1.433182    3.271615
       year8 |   1.904712   1.095095     1.74   0.083    -.2503581    4.059783
       year9 |    2.12763    1.02959     2.07   0.040     .1014688    4.153791
      year10 |   2.247384   .9661661     2.33   0.021     .3460369    4.148731
      year11 |   2.606179   .9071115     2.87   0.004      .821047     4.39131
      year12 |   2.864662   .8759923     3.27   0.001     1.140771    4.588554
      year13 |   .1450001   .8410109     0.17   0.863     -1.51005     1.80005
      year14 |  -5.195139    .877501    -5.92   0.000       -6.922   -3.468279
      year15 |  -.3631062   .8285862    -0.44   0.662    -1.993706    1.267493
      year16 |   .8059779   .8118458     0.99   0.322    -.7916775    2.403633
      year17 |  -1.592082   .7926726    -2.01   0.045    -3.152006   -.0321583
      year18 |   .2011192   .8117684     0.25   0.804    -1.396384    1.798622
      year19 |   .3396746    .794967     0.43   0.669    -1.224764    1.904114
       _cons |  -1.060777   3.054289    -0.35   0.729    -7.071402    4.949848
-------------+----------------------------------------------------------------
     sigma_u |   3.184399
     sigma_e |  2.4423693
         rho |  .62962071   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(20, 299) =     5.33             Prob > F = 0.0000

. . xtcsd, pesaran abs
```

```
Pesaran's test of cross sectional independence =    -2.700, Pr = 0.0069

Average absolute value of the off-diagonal elements =     0.294
```

Appendix 4.2.9 Modified Hausman test

```
. qui xtreg growth fdexp fdtax_l popgrowth dschooling laggdp gfcf_gdp trade tindex
year1 year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12 year13
year14 year15 year16 year17 year18 if growth<=21.20154 & growth>=-12.55204, fe


. est store feli

. qui xtreg growth fdexp fdtax_l popgrowth dschooling laggdp gfcf_gdp trade tindex
year1 year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12 year13
year14 year15 year16 year17 year18 if growth<=21.20154 & growth>=-12.55204, re

. est store reli

. hausman feli reli, sigmamore

Note: the rank of the differenced variance matrix (19) does not equal the number of
coefficients being tested (26); be sure this is what you expect, or there may be
problems computing the test.  Examine the output of your estimators for anything
unexpected and possibly consider scaling your variables so that the coefficients are
on a similar scale.

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |      feli         reli         Difference          S.E.
-------------+----------------------------------------------------------------
       fdexp |    .0630018     .0690888       -.0060871        .0383868
     fdtax_l |   -.0176564    -.0124964       -.0051601         .011142
   popgrowth |   -.3483808    -1.021732         .673351        .3645085
  dschooling |    1.024126     1.491129       -.4670022        .1411752
      laggdp |   -.0005921    -.0001366       -.0004555        .0001198
    gfcf_gdp |    .2092223     .1577501        .0514722        .0326543
       trade |    .0489335     .0015034        .0474301        .0125859
      tindex |   -.0415161    -.0033484       -.0381676        .0577388
       year1 |   -2.171347     1.472597       -3.643945          1.7797
       year2 |    -2.30937     .8195724       -3.128943        1.442017
       year3 |   -3.999291    -1.228833       -2.770458        1.371364
       year4 |   -5.291211     -2.75268        -2.53853        1.313651
       year5 |   -1.669739     1.030182        -2.69992        1.203158
       year6 |   -.7856582     1.355603       -2.141261        1.125712
       year7 |   -.2468366     1.419781       -1.666618        1.017722
       year8 |    .8341795     2.582987       -1.748807        .8744882
       year9 |    1.189308     2.854985       -1.665677        .7442008
      year10 |    1.477834     2.986381       -1.508547         .606336
      year11 |    1.949491     3.137535       -1.188044        .4811338
      year12 |    2.346729     3.160169       -.8134393        .4004334
      year13 |    -.233056     .0129177       -.2459737        .2661853
      year14 |    -5.61075    -6.428777        .8180278        .2633348
      year15 |   -.8180228    -.8386976        .0206748        .2428751
      year16 |    .4132497     .8376386       -.4243889        .1484674
      year17 |   -1.915881     -1.69897       -.2169105        .0962459
      year18 |   -.1221111    -.1708662         .048755        .0606531
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                 chi2(19) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       86.70
                Prob>chi2 =      0.0000
                (V_b-V_B is not positive definite)
```

Appendix 4.3 Model Estimation

Appendix 4.3.1 Using fdexp and fdtax_l

A. FE with Driscoll Kraay

```
. xtscc growth fdexp fdtax_l popgrowth dschooling laggdp gfcf_gdp trade tindex year1
year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12 year13 year14
year15 year16 year17 year18 if growth<=21.20154 & growth>=-12.55204, fe

Regression with Driscoll-Kraay standard errors   Number of obs     =       328
Method: Fixed-effects regression                 Number of groups  =        21
Group variable (i): id_country                   F( 26,     18)    = 886947.22
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.6267

------------------------------------------------------------------------------
             |             Drisc/Kraay
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       fdexp |   .0630018   .0356049     1.77   0.094    -.0118014     .137805
     fdtax_l |  -.0176564   .0095206    -1.85   0.080    -.0376585    .0023456
   popgrowth |  -.3483808   .3516658    -0.99   0.335    -1.087203    .3904415
  dschooling |   1.024126   .3505032     2.92   0.009     .2877466    1.760506
      laggdp |  -.0005921   .0001962    -3.02   0.007    -.0010042     -.00018
    gfcf_gdp |   .2092223   .0308515     6.78   0.000     .1444057     .274039
       trade |   .0489335   .0125931     3.89   0.001     .0224763    .0753906
      tindex |  -.0415161   .0526642    -0.79   0.441    -.1521594    .0691273
       year1 |  -2.171347   2.409234    -0.90   0.379    -7.232961    2.890266
       year2 |   -2.30937    1.90147    -1.21   0.240    -6.304211     1.68547
       year3 |  -3.999291   1.810679    -2.21   0.040    -7.803387   -.1951954
       year4 |  -5.291211   1.742231    -3.04   0.007    -8.951503   -1.630918
       year5 |  -1.669739   1.648934    -1.01   0.325    -5.134021    1.794544
       year6 |  -.7856582   1.516416    -0.52   0.611     -3.97153    2.400214
       year7 |  -.2468366   1.344155    -0.18   0.856    -3.070801    2.577128
       year8 |   .8341795   1.239263     0.67   0.509    -1.769415    3.437774
       year9 |   1.189308   1.058016     1.12   0.276    -1.033502    3.412117
      year10 |   1.477834   .8821567     1.68   0.111    -.3755084    3.331177
      year11 |   1.949491   .7246475     2.69   0.015     .4270633    3.471919
      year12 |   2.346729   .5692231     4.12   0.001     1.150836    3.542623
      year13 |   -.233056   .3455049    -0.67   0.509    -.9589348    .4928228
      year14 |   -5.61075   .3538228   -15.86   0.000    -6.354104   -4.867395
      year15 |  -.8180228   .3239406    -2.53   0.021    -1.498597   -.1374487
      year16 |   .4132497   .2596533     1.59   0.129    -.1322616     .958761
      year17 |  -1.915881   .1713533   -11.18   0.000    -2.275881   -1.555881
      year18 |  -.1221111   .0931082    -1.31   0.206    -.3177242     .073502
       _cons |   5.304454   5.758621     0.92   0.369    -6.793961    17.40287
------------------------------------------------------------------------------


. outreg2 using 05sept2.doc
05sept2.doc
dir : seeout
```

B. FEVD

```
. xtfevd growth fdexp fdtax_l popgrowth dschooling lngdpini gfcf_gdp trade tindex year1
year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12 year13 year14
year15 year16 year17 year18 if growth<=21.20154 & growth>=-12.55204, invariant
(lngdpini fdexp fdtax_l tindex)

panel fixed effects regression with vector decomposition

degrees of freedom fevd      =       281          number of obs        =       328
mean squared error           = 5.290641           F( 28, 281)          = 13.77096
root mean squared error      = 2.300139           Prob > F             = 1.59e-36
Residual Sum of Squares      =  1735.33           R-squared            = .6731264
Total Sum of Squares         = 5308.872           adj. R-squared       = .6196168
Estimation Sum of Squares    = 3573.542

------------------------------------------------------------------------------
             |                fevd
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
```

```
-------------+----------------------------------------------------------------
   popgrowth |  -.8589234   .5167255    -1.66   0.098    -1.876068    .1582209
  dschooling |   1.419608   .4722639     3.01   0.003     .4899834    2.349232
    gfcf_gdp |   .2044222   .0539372     3.79   0.000       .09825    .3105944
       trade |   .0397358   .0205909     1.93   0.055    -.0007962    .0802679
       year1 |   3.985347    1.66513     2.39   0.017     .7076359    7.263058
       year2 |   2.996182   1.169012     2.56   0.011     .6950494    5.297315
       year3 |   .9290639   1.179529     0.79   0.432     -1.39277    3.250898
       year4 |  -.5469213   1.170183    -0.47   0.641    -2.850359    1.756517
       year5 |   2.974979   1.074077     2.77   0.006     .8607216    5.089236
       year6 |   3.457671   1.065755     3.24   0.001     1.359793    5.555549
       year7 |   3.529826    1.06405     3.32   0.001     1.435305    5.624347
       year8 |   4.178283   1.009918     4.14   0.000     2.190319    6.166248
       year9 |   4.090332   .9664772     4.23   0.000     2.187877    5.992786
      year10 |   3.862525   .9279168     4.16   0.000     2.035974    5.689075
      year11 |   3.734838   .9170588     4.07   0.000      1.92966    5.540015
      year12 |   3.490863   .8905476     3.92   0.000     1.737872    5.243854
      year13 |     .19441   .8924932     0.22   0.828    -1.562411    1.951231
      year14 |  -5.381051   1.039477    -5.18   0.000    -7.427202     -3.3349
      year15 |  -.0884098   .8900596    -0.10   0.921    -1.840441    1.663621
      year16 |   .9670699   .8603194     1.12   0.262     -.726419    2.660559
      year17 |  -1.618451   .8411604    -1.92   0.055    -3.274226    .0373248
      year18 |   .0455777   .8701383     0.05   0.958    -1.667239    1.758395
    lngdpini |  -1.392949   .6589747    -2.11   0.035    -2.690102   -.0957951
       fdexp |   .0245001   .0367029     0.67   0.505    -.0477474    .0967476
    fdtax_l |   -.007523    .018464    -0.41   0.684    -.0438683    .0288223
      tindex |  -.0266465   .0320243    -0.83   0.406    -.0896844    .0363915
         eta |          1          .        .       .            .           .
       _cons |   7.499719   6.169603     1.22   0.225    -4.644787    19.64422
------------------------------------------------------------------------------
```

C. IV

```
. xtivreg2 growth popgrowth fdexp tindex dschooling laggdp (gfcf_gdp trade  fdtax_l =
l.gfcf_gdp l.trade l2.fdtax_l l4.fdtax_l) year1 year2 year3 year4 year5 year6 year7
year8 year9 year10 year11 year12 year13 year14 year15 year16 year17 year18 if
growth<=21.20154
>  & growth>=-12.55204,  fe  endog(fdtax_l gfcf_gdp trade) small
Warning - collinearities detected
Vars dropped:       year1 year2 year3 year4

FIXED EFFECTS ESTIMATION
------------------------
Number of groups =        21                   Obs per group: min =         2
                                                              avg =      11.8
                                                              max =        15
Warning - collinearities detected
Vars dropped:  year1 year2 year3 year4

IV (2SLS) estimation
--------------------

Estimates efficient for homoskedasticity only
Statistics consistent for homoskedasticity only

                                                      Number of obs =      247
                                                      F( 22,    204) =    15.78
                                                      Prob > F      =   0.0000
Total (centered) SS     =  2943.914767                Centered R2   =   0.6233
Total (uncentered) SS   =  2943.914767                Uncentered R2 =   0.6233
Residual SS             =  1108.854713                Root MSE      =    2.331

------------------------------------------------------------------------------
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    gfcf_gdp |    .031164   .0757912     0.41   0.681    -.1182706    .1805987
       trade |   .0439079   .0208109     2.11   0.036     .0028759      .08494
    fdtax_l |  -.0375302    .031639    -1.19   0.237    -.0999115    .0248511
   popgrowth |  -.8020887   .5235897    -1.53   0.127     -1.83443    .2302526
       fdexp |   .0249935   .0484724     0.52   0.607    -.0705776    .1205645
      tindex |   .0762657   .0862254     0.88   0.377    -.0937414    .2462729
  dschooling |   1.402443   1.072779     1.31   0.193    -.7127131      3.5176
```

```
      laggdp |   -.000418   .0001332    -3.14   0.002    -.0006807   -.0001553
       year1 |          0  (omitted)
       year2 |          0  (omitted)
       year3 |          0  (omitted)
       year4 |          0  (omitted)
       year5 |   .9899527   1.741849     0.57   0.570    -2.444384    4.424289
       year6 |   1.301598   1.693033     0.77   0.443     -2.03649    4.639685
       year7 |   1.601284   1.561142     1.03   0.306    -1.476759    4.679327
       year8 |   2.726718   1.424164     1.91   0.057    -.0812512    5.534687
       year9 |   3.268158   1.280816     2.55   0.011     .7428227    5.793494
      year10 |   3.010773   1.153399     2.61   0.010     .7366623    5.284884
      year11 |   3.929392   1.110016     3.54   0.000     1.740817    6.117967
      year12 |   4.396587   1.097177     4.01   0.000     2.233327    6.559847
      year13 |   .8601276   .9617462     0.89   0.372     -1.03611    2.756365
      year14 |  -5.351213   .9448649    -5.66   0.000    -7.214166    -3.48826
      year15 |  -.4296635   .8211869    -0.52   0.601    -2.048766    1.189439
      year16 |   .7181164   .7792075     0.92   0.358    -.8182166    2.254449
      year17 |  -1.573333   .7526282    -2.09   0.038    -3.057261   -.0894058
      year18 |     -.0818   .7724969    -0.11   0.916    -1.604902    1.441302
------------------------------------------------------------------------------
Underidentification test (Anderson canon. corr. LM statistic):          67.396
                                                   Chi-sq(2) P-val =    0.0000
------------------------------------------------------------------------------
Weak identification test (Cragg-Donald Wald F statistic):               21.565
Stock-Yogo weak ID test critical values:                       <not available>
------------------------------------------------------------------------------
Sargan statistic (overidentification test of all instruments):           0.057
                                                   Chi-sq(1) P-val =    0.8107
-endog- option:
Endogeneity test of endogenous regressors:                              20.824
                                                   Chi-sq(3) P-val =    0.0001
Regressors tested:    fdtax_l gfcf_gdp trade
------------------------------------------------------------------------------
Instrumented:         gfcf_gdp trade fdtax_l
Included instruments: popgrowth fdexp tindex dschooling laggdp year5 year6
                      year7 year8 year9 year10 year11 year12 year13 year14
                      year15 year16 year17 year18
Excluded instruments: L.gfcf_gdp L.trade L2.fdtax_l L4.fdtax_l
Dropped collinear:    year1 year2 year3 year4
------------------------------------------------------------------------------
```

Appendix 4.3.2 Using fdexp, fdtax_l and imbalance2

A. FE with Driscoll Kraay SEs

```
 . xtscc growth fdexp fdtax_l imbalance2 popgrowth dschooling laggdp gfcf_gdp trade
tindex year1 year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12
year13 year14 year15 year16 year17 year18 if growth<=21.20154 & growth>=-12.55204, fe

Regression with Driscoll-Kraay standard errors   Number of obs     =       328
Method: Fixed-effects regression                 Number of groups  =        21
Group variable (i): id_country                   F( 27,     18)    = 275173.74
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.6274

------------------------------------------------------------------------------
             |             Drisc/Kraay
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       fdexp |   .0659427   .0354054     1.86   0.079    -.0084412    .1403266
     fdtax_l |  -.0042499   .0284997    -0.15   0.883    -.0641256    .0556259
  imbalance2 |    .0124955   .0244299     0.51   0.615    -.0388299    .0638208
   popgrowth |  -.3791887   .3565506    -1.06   0.302    -1.128274    .3698964
  dschooling |     1.0214   .3483119     2.93   0.009      .289624    1.753176
      laggdp |  -.0005907   .0001955    -3.02   0.007    -.0010015   -.0001799
    gfcf_gdp |   .2093069   .0311018     6.73   0.000     .1439645    .2746493
       trade |   .0495282    .012047     4.11   0.001     .0242183    .0748381
      tindex |  -.0330343   .0507487    -0.65   0.523    -.1396534    .0735849
       year1 |  -1.969776   2.510813    -0.78   0.443    -7.244797    3.305245
       year2 |  -2.133861   2.010089    -1.06   0.302    -6.356902     2.08918
       year3 |  -3.871841   1.883164    -2.06   0.055    -7.828223    .0845403
       year4 |  -5.096532   1.858016    -2.74   0.013    -9.000078   -1.192986
       year5 |  -1.507055   1.755269    -0.86   0.402    -5.194738    2.180628
       year6 |  -.6718706   1.588501    -0.42   0.677    -4.009187    2.665446
```

```
       year7 |  -.1546289   1.404307    -0.11   0.914    -3.104968     2.79571
       year8 |     .90268   1.279779     0.71   0.490    -1.786036    3.591396
       year9 |   1.251257     1.0957     1.14   0.268    -1.050723    3.553236
      year10 |   1.510054   .9008924     1.68   0.111    -.3826507    3.402759
      year11 |   1.981423    .741213     2.67   0.016     .4241923    3.538654
      year12 |   2.353728   .5738838     4.10   0.001     1.148043    3.559413
      year13 |  -.2655687   .3556909    -0.75   0.465    -1.012848    .4817101
      year14 |  -5.597396   .3543896   -15.79   0.000    -6.341941   -4.852851
      year15 |  -.8571017   .3215177    -2.67   0.016    -1.532585   -.1816181
      year16 |   .3763869    .237532     1.58   0.130    -.1226494    .8754232
      year17 |  -1.954038   .1552219   -12.59   0.000    -2.280147   -1.627928
      year18 |  -.1314212   .0890979    -1.48   0.157    -.3186089    .0557664
       _cons |   3.321357   6.716641     0.49   0.627    -10.78978     17.4325
------------------------------------------------------------------------------
```

B. FEVD

```
. xtfevd growth fdexp fdtax_l imbalance2 popgrowth dschooling lngdpini gfcf_gdp trade
tindex year1 year2 year3 year4 year5 year6 year7year8 year9 year10 year11 year12
year13 year14 year15 year16 year17 year18 if growth<=21.20154 & growth>=-12.55204,
invariant (lngdpini fdexp fdtax_l tindex)

panel fixed effects regression with vector decomposition

degrees of freedom fevd     =       280          number of obs        =      328
mean squared error          = 5.279537           F( 29, 280)          = 13.37714
root mean squared error     = 2.297724           Prob > F             = 2.44e-36
Residual Sum of Squares     = 1731.688           R-squared            = .6738124
Total Sum of Squares        = 5308.872           adj. R-squared       = .6190595
Estimation Sum of Squares   = 3577.184

------------------------------------------------------------------------------
             |                fevd
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  imbalance2 |   .0143607   .0399167     0.36   0.719    -.0642142    .0929355
   popgrowth |  -.8928975   .5287633    -1.69   0.092    -1.933753    .1479584
  dschooling |   1.415365   .4687859     3.02   0.003     .4925727    2.338157
    gfcf_gdp |   .2045328   .0538278     3.80   0.000     .0985744    .3104913
       trade |   .0404452   .0204587     1.98   0.049     .0001727    .0807176
       year1 |   4.199734   1.693539     2.48   0.014     .8660491     7.53342
       year2 |   3.183005   1.193432     2.67   0.008     .8337664    5.532243
       year3 |   1.061712   1.180935     0.90   0.369    -1.262926     3.38635
       year4 |  -.3364933    1.21993    -0.28   0.783    -2.737892    2.064905
       year5 |   3.148916   1.117396     2.82   0.005     .9493529    5.348479
       year6 |   3.576539   1.077786     3.32   0.001     1.454947    5.698131
       year7 |   3.625202   1.082607     3.35   0.001      1.49412    5.756284
       year8 |   4.247627    1.01048     4.20   0.000     2.258525    6.236728
       year9 |   4.153389   .9645836     4.31   0.000     2.254633    6.052145
      year10 |   3.892864   .9257475     4.21   0.000     2.070555    5.715172
      year11 |   3.766527   .9133892     4.12   0.000     1.968546    5.564509
      year12 |   3.495697   .8909009     3.92   0.000     1.741983    5.249411
      year13 |    .155845   .9038574     0.17   0.863    -1.623373    1.935063
      year14 |  -5.366349   1.043545    -5.14   0.000    -7.420539   -3.312159
      year15 |  -.1353688   .8940076    -0.15   0.880    -1.895198    1.624461
      year16 |   .9231509   .8617515     1.07   0.285    -.7731831    2.619485
      year17 |  -1.663138    .846269    -1.97   0.050    -3.328995    .0027196
      year18 |   .0344075   .8698202     0.04   0.968     -1.67781    1.746625
    lngdpini |  -1.236349   .8738286    -1.41   0.158    -2.956456    .4837589
       fdexp |   .0212954   .0368757     0.58   0.564    -.0512933    .0938841
     fdtax_l |   .0072596   .0495535     0.15   0.884    -.0902851    .1048043
      tindex |  -.0243286   .0326107    -0.75   0.456    -.0885218    .0398647
         eta |          1          .        .       .            .           .
       _cons |   4.568719   11.45677     0.40   0.690    -17.98362    27.12106
------------------------------------------------------------------------------
```

C. IV

```
. xtivreg2 growth fdexp popgrowth laggdp dschooling tindex ( gfcf_gdp trade   fdtax_l
imbalance2 = l3.imbalance2  l3.gfcf_gdp l.gfcf_gdp l.trade l2.trade l2.fdtax_l)  year4
year5 year6 year7 year8 year9 year10 year11 year12 year13 year14 year15 year16 year17
year18  if growth<=21.20154 & growth>=-12.55204,   fe   endog(fdtax_l gfcf_gdp trade)
small
```

```
FIXED EFFECTS ESTIMATION
------------------------
Number of groups =        21                    Obs per group: min =         3
                                                               avg =      12.7
                                                               max =        16

IV (2SLS) estimation
--------------------

Estimates efficient for homoskedasticity only
Statistics consistent for homoskedasticity only

                                                      Number of obs =      267
                                                      F( 24,    222) =    11.26
                                                      Prob > F      =   0.0000
Total (centered) SS     =  3338.198869                Centered R2   =   0.4683
Total (uncentered) SS   =  3338.198869                Uncentered R2 =   0.4683
Residual SS             =  1774.800307                Root MSE      =    2.827

------------------------------------------------------------------------------
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    gfcf_gdp |    .056603   .0937367     0.60   0.547    -.1281246    .2413306
       trade |   .0504642   .0247329     2.04   0.042     .0017229    .0992054
     fdtax_l |   .1957239   .1281591     1.53   0.128    -.0568402    .4482879
  imbalance2 |    .211798     .10626     1.99   0.047     .0023906    .4212054
       fdexp |   .1114789    .065057     1.71   0.088    -.0167294    .2396871
   popgrowth |  -.9849171    .591807    -1.66   0.097    -2.151196    .1813614
     laggdp |  -.0003638   .0001541    -2.36   0.019    -.0006674   -.0000601
  dschooling |   1.502875   1.240575     1.21   0.227    -.9419354    3.947685
      tindex |   .2518131   .1070248     2.35   0.020     .0408985    .4627277
       year4 |   1.156932   2.523022     0.46   0.647    -3.815206    6.129069
       year5 |    4.15608   2.397973     1.73   0.084    -.5696234    8.881784
       year6 |   3.680723   2.126319     1.73   0.085    -.5096292    7.871074
       year7 |   3.560216   1.917926     1.86   0.065    -.2194547    7.339886
       year8 |   3.876032   1.671079     2.32   0.021     .5828242    7.169241
       year9 |   4.382012   1.495526     2.93   0.004     1.434767    7.329257
      year10 |   4.044191    1.40029     2.89   0.004      1.28463    6.803752
      year11 |   4.726616   1.293645     3.65   0.000      2.17722    7.276013
      year12 |   4.579853   1.309748     3.50   0.001     1.998722    7.160983
      year13 |   .3565979   1.214338     0.29   0.769    -2.036507    2.749703
      year14 |  -4.990009   1.091981    -4.57   0.000    -7.141984   -2.838033
      year15 |  -1.111517   1.004925    -1.11   0.270     -3.09193    .8688963
      year16 |   .0858253   .9761461     0.09   0.930    -1.837873    2.009524
      year17 |  -2.273266    .972757    -2.34   0.020    -4.190286    -.356247
      year18 |  -.1907848   .9391243    -0.20   0.839    -2.041524    1.659954
------------------------------------------------------------------------------
Underidentification test (Anderson canon. corr. LM statistic):          15.620
                                                   Chi-sq(3) P-val =    0.0014
------------------------------------------------------------------------------
Weak identification test (Cragg-Donald Wald F statistic):                2.486
Stock-Yogo weak ID test critical values:                       <not available>
------------------------------------------------------------------------------
Sargan statistic (overidentification test of all instruments):           1.006
                                                   Chi-sq(2) P-val =    0.6047
-endog- option:
Endogeneity test of endogenous regressors:                              13.223
                                                   Chi-sq(3) P-val =    0.0042
Regressors tested:    fdtax_l gfcf_gdp trade
------------------------------------------------------------------------------
Instrumented:         gfcf_gdp trade fdtax_l imbalance2
Included instruments: fdexp popgrowth laggdp dschooling tindex year4 year5
                      year6 year7 year8 year9 year10 year11 year12 year13 year14
                      year15 year16 year17 year18
Excluded instruments: L3.imbalance2 L3.gfcf_gdp L.gfcf_gdp L.trade L2.trade
                      L2.fdtax_l
------------------------------------------------------------------------------
```

Appendix 4.3.3 Stages of transition as a moderator

A. FE cluster robust SEs

```
xtreg growth laggdp popgrowth dschooling gfcf_gdp c.fdexp c.fdtax_l trade
c.tindex#c.fdexp c.tindex#c.fdtax_l c.imbalance2 c.tindex#c.imbalance2 year1 year2
year3 year4 year5 year6 year7 year8 year9 year10 year11 year12 year13 year14 year15
year16 year17 year18, fe vce(robust)
note: imbalance2 omitted because of collinearity

Fixed-effects (within) regression               Number of obs      =       333
Group variable: id_country                      Number of groups   =        21

R-sq:  within  = 0.6756                         Obs per group: min =         6
       between = 0.1826                                        avg =      15.9
       overall = 0.3241                                        max =        19

                                                F(20,20)           =         .
corr(u_i, Xb)  = -0.7773                        Prob > F           =         .

                                     (Std. Err. adjusted for 21 clusters in
id_country)
-------------------------------------------------------------------------------------
--
                      |               Robust
               growth |     Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
----------------------+--------------------------------------------------------------
--
               laggdp |-.0007692   .0001499    -5.13   0.000    -.0010819   -.0004566
            popgrowth |-.1494441   .5490437    -0.27   0.788    -1.294729     .995841
           dschooling | 1.085799   .3903247     2.78   0.012     .2715959    1.900002
             gfcf_gdp | .2010536    .074579     2.70   0.014     .0454845    .3566227
                fdexp |-.2206368   .1017931    -2.17   0.042    -.4329735      -.0083
              fdtax_l | .2501647   .1481342     1.69   0.107    -.0588378    .5591671
                trade | .0652097   .0217466     3.00   0.007      .019847    .1105724
     c.tindex#c.fdexp | .0048061   .0012403     3.87   0.001     .0022189    .0073933
   c.tindex#c.fdtax_l |-.0035469   .0021034    -1.69   0.107    -.0079345    .0008406
               tindex | .1356539   .1786949     0.76   0.457    -.2370972     .508405
           imbalance2 | .2513122   .1497575     1.68   0.109    -.0610766     .563701
c.tindex#c.imbalance2 |-.0032369   .0020306    -1.59   0.127    -.0074728    .0009989
                year1 |-2.867191   2.475784    -1.16   0.260    -8.031587    2.297205
                year2 |-2.910092   2.295825    -1.27   0.220    -7.699098    1.878910
                year3 |-4.466895   2.501974    -1.79   0.089    -9.685922    .7521319
                year4 |-5.622791   2.175105    -2.59   0.018    -10.15998   -1.085601
                year5 |-2.125269   1.700472    -1.25   0.226    -5.672391    1.421852
                year6 |-1.313641   1.704962    -0.77   0.450    -4.870129    2.242848
                year7 |-.6768696   1.472212    -0.46   0.651    -3.747851    2.394110
                 year8| .241794    1.572272     0.15   0.879    -3.037908    3.521496
                year9 | .6058746   1.361446     0.45   0.661    -2.234052    3.445801
               year10 | 1.000579   1.157564     0.86   0.398    -1.414057    3.415216
               year11 | 1.537518   1.092117     1.41   0.175    -.7405992    3.815634
               year12 | 2.108362   1.229509     1.71   0.102    -.4563497    4.673073
               year13 |-.4002549    1.07256    -0.37   0.713    -2.637575    1.837065
               year14 |-8.390345   1.225105    -6.85   0.000    -10.94587   -5.834821
               year15 | -1.03721   .8205573    -1.26   0.221    -2.748862    .6744431
               year16 | .0635448   .6163427     0.10   0.919    -1.222124    1.349213
               year17 |-2.100546   .6411073    -3.28   0.004    -3.437872   -.7632192
               year18 |-.2116126   .5877515    -0.36   0.723    -1.437641    1.014416
                _cons |-8.897512    15.9502    -0.56   0.583    -42.16904    24.37402
----------------------+--------------------------------------------------------------
              sigma_u |   4.7836312
              sigma_e |    2.703656
                  rho |   .75789805   (fraction of variance due to u_i)
-------------------------------------------------------------------------------------
--

. margins, dydx (fdexp fdtax_l imbalance2) at (tindex=(10 (10) 100))

Average marginal effects                          Number of obs    =        333
Model VCE     : Robust
Expression    : Linear prediction, predict()
dy/dx w.r.t. : fdexp fdtax_l imbalance2

1._at         : tindex          =          10
2._at         : tindex          =          20
3._at         : tindex          =          30
```

```
4._at        : tindex         =          40
5._at        : tindex         =          50
6._at        : tindex         =          60
7._at        : tindex         =          70
8._at        : tindex         =          80
9._at        : tindex         =          90
10._at       : tindex         =         100
```

	dy/dx	Delta-method Std. Err.	z	P>|z|	[95% Conf.	Interval]
fdexp						
_at						
1	-.1725758	.0909621	-1.90	0.058	-.3508583	.0057067
2	-.1245148	.0805857	-1.55	0.122	-.2824598	.0334303
3	-.0764538	.0708637	-1.08	0.281	-.215344	.0624365
4	-.0283928	.0621043	-0.46	0.648	-.1501149	.0933294
5	.0196682	.0547713	0.36	0.720	-.0876815	.127018
6	.0677293	.0495027	1.37	0.171	-.0292943	.1647528
7	.1157903	.046998	2.46	0.014	.0236759	.2079046
8	.1638513	.0476946	3.44	0.001	.0703716	.257331
9	.2119123	.0514627	4.12	0.000	.1110473	.3127773
10	.2599733	.0577037	4.51	0.000	.1468762	.3730704
fdtax_l						
_at						
1	.2146953	.1273757	1.69	0.092	-.0349565	.4643471
2	.179226	.1067251	1.68	0.093	-.0299513	.3884033
3	.1437567	.0862598	1.67	0.096	-.0253095	.3128228
4	.1082873	.0661522	1.64	0.102	-.0213687	.2379433
5	.072818	.0468649	1.55	0.120	-.0190355	.1646715
6	.0373487	.0300226	1.24	0.213	-.0214946	.096192
7	.0018793	.022164	0.08	0.932	-.0415613	.0453199
8	-.03359	.03108	-1.08	0.280	-.0945057	.0273256
9	-.0690593	.0482238	-1.43	0.152	-.1635762	.0254575
10	-.1045287	.0676013	-1.55	0.122	-.2370248	.0279675
imbalance2						
_at						
1	.2189427	.1296049	1.69	0.091	-.0350782	.4729637
2	.1865733	.1095092	1.70	0.088	-.0280608	.4012073
3	.1542038	.0895086	1.72	0.085	-.0212298	.3296374
4	.1218343	.0696851	1.75	0.080	-.0147461	.2584147
5	.0894648	.050249	1.78	0.075	-.0090214	.1879511
6	.0570954	.0319157	1.79	0.074	-.0054583	.119649
7	.0247259	.0183568	1.35	0.178	-.0112527	.0607045
8	-.0076436	.0219097	-0.35	0.727	-.0505858	.0352987
9	-.040013	.0380501	-1.05	0.293	-.1145898	.0345637
10	-.0723825	.0569235	-1.27	0.204	-.1839506	.0391855

B. FE with Driscoll Kraay

```
. *greater than the mean tindex = 74
. xtscc growth fdexp fdtax_l imbalance2 popgrowth dschooling laggdp gfcf_gdp trade
tindex year1 year2 year3 year4 year5 year6 year7 ye
> ar8 year9 year10 year11 year12 year13 year14 year15 year16 year17 year18 if
growth<=21.20154 & growth>=-12.55204 & tindex>=74, fe

Regression with Driscoll-Kraay standard errors   Number of obs     =       200
Method: Fixed-effects regression                 Number of groups  =        14
Group variable (i): id_country                   F( 27,     18)    = 714929.37
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.7233

------------------------------------------------------------------------------
             |             Drisc/Kraay
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       fdexp |   .1248107   .0670248     1.86   0.079    -.0160031    .2656246
     fdtax_l |  -.0015842   .0394163    -0.04   0.968    -.0843947    .0812263
  imbalance2 |   -.003964   .0310957    -0.13   0.900    -.0692936    .0613656
   popgrowth |   -.917845   .3096534    -2.96   0.008    -1.568403   -.2672873
  dschooling |   .5139345   .3780738     1.36   0.191    -.2803691    1.308238
      laggdp |  -.0005689    .000275    -2.07   0.053    -.0011467    8.98e-06
    gfcf_gdp |   .2637609   .0728798     3.62   0.002     .1106462    .4168757
       trade |   .0696362   .0171828     4.05   0.001     .0335364    .1057359
      tindex |   .0808655   .0894851     0.90   0.378    -.1071356    .2688667
       year1 |  -.2111199   2.039026    -0.10   0.919    -4.494954    4.072714
       year2 |  -.0791682   2.185455    -0.04   0.972    -4.670639    4.512302
       year3 |  -1.744283   2.052691    -0.85   0.407    -6.056826     2.56826
       year4 |  -2.168406   1.825751    -1.19   0.250    -6.004168    1.667355
       year5 |  -.0754991   1.770415    -0.04   0.966    -3.795004    3.644005
       year6 |  -.1873153   1.520494    -0.12   0.903    -3.381754    3.007124
       year7 |   .8525953   1.365876     0.62   0.540    -2.017004    3.722195
       year8 |   1.756863    1.19253     1.47   0.158     -.748549    4.262276
       year9 |   1.542665   1.084897     1.42   0.172    -.7366188     3.82195
      year10 |   2.004469   .9729731     2.06   0.054    -.0396722    4.048609
      year11 |   2.609889   .8997125     2.90   0.010      .719663    4.500115
      year12 |    3.06217   .6770493     4.52   0.000     1.639742    4.484598
      year13 |  -1.093969   .4799391    -2.28   0.035    -2.102284   -.0856548
      year14 |  -5.678103   .2689792   -21.11   0.000    -6.243207   -5.112998
      year15 |  -1.225921   .3240065    -3.78   0.001    -1.906633   -.5452086
      year16 |  -.0461165   .3565492    -0.13   0.899    -.7951985    .7029655
      year17 |  -1.535119   .1545824    -9.93   0.000    -1.859885   -1.210354
      year18 |  -1.309977    .111306   -11.77   0.000    -1.543822   -1.076132
       _cons |  -9.476086   4.211515    -2.25   0.037    -18.32415   -.6280217
------------------------------------------------------------------------------
```

```
. *lower than the mean tindex = 74
. xtscc growth fdexp fdtax_l imbalance2 popgrowth dschooling laggdp gfcf_gdp trade
tindex year1 year2 year3 year4 year5 year6 year7 ye
> ar8 year9 year10 year11 year12 year13 year14 year15 year16 year17 year18 if
growth<=21.20154 & growth>=-12.55204 & tindex<=74, fe

Regression with Driscoll-Kraay standard errors   Number of obs     =       128
Method: Fixed-effects regression                 Number of groups  =        15
Group variable (i): id_country                   F( 27,     18)    =   2497.82
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.6462

------------------------------------------------------------------------------
             |             Drisc/Kraay
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       fdexp |   .0259734   .0562988     0.46   0.650    -.0923061    .1442528
     fdtax_l |  -.0111872   .0580578    -0.19   0.849    -.1331622    .1107877
  imbalance2 |   .0095063   .0503937     0.19   0.852     -.096367    .1153795
   popgrowth |  -.5537335   .5745711    -0.96   0.348    -1.760863    .6533956
  dschooling |   .5475631   .5530992     0.99   0.335    -.6144552    1.709581
      laggdp |  -.0006429   .0002942    -2.19   0.042    -.0012609   -.0000249
    gfcf_gdp |   .1717247   .0676571     2.54   0.021     .0295825    .3138669
       trade |    .004939   .0258075     0.19   0.850    -.0492805    .0591584
      tindex |  -.2244058   .0458432    -4.90   0.000    -.3207187   -.1280929
```

```
       year1 |  -6.308997   3.432474    -1.84   0.083    -13.52036     .902364
       year2 |  -4.742287   2.165843    -2.19   0.042    -9.292554     -.19202
       year3 |  -6.633026   1.969263    -3.37   0.003    -10.77029   -2.495758
       year4 |  -8.154913    1.94232    -4.20   0.001    -12.23558    -4.07425
       year5 |  -1.845213   1.833562    -1.01   0.328    -5.697384    2.006959
       year6 |   .5179548   1.676976     0.31   0.761    -3.005241    4.041151
       year7 |   .1362782   1.411815     0.10   0.924    -2.829836    3.102392
       year8 |    1.79027   1.330199     1.35   0.195    -1.004376    4.584915
       year9 |   2.497634   1.140203     2.19   0.042     .1021561    4.893113
      year10 |   1.457316   1.047802     1.39   0.181    -.7440357    3.658667
      year11 |   1.301663   .7931889     1.64   0.118     -.364765    2.968091
      year12 |   1.764093   .7019763     2.51   0.022     .2892956    3.238891
      year13 |   2.192723   .5665796     3.87   0.001     1.002383    3.383062
      year14 |   -4.71932   .4965287    -9.50   0.000    -5.762488   -3.676152
      year15 |   .7189382   .4692604     1.53   0.143    -.2669414    1.704818
      year16 |   1.828506   .4687872     3.90   0.001     .8436204    2.813391
      year17 |  -2.109531   .3283675    -6.42   0.000    -2.799406   -1.419656
      year18 |   2.865199   .2233986    12.83   0.000     2.395856    3.334542
       _cons |   19.71245   6.806559     2.90   0.010     5.412397     34.0125
------------------------------------------------------------------------------
```

C. *Calculations of Marginal Effects (By hand)*

```
. xtscc growth fdexp fdtax_l imbalance2 popgrowth dschooling laggdp gfcf_gdp trade
tindex interaction_exp interaction_tax interaction_
> imb year1 year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12
year13 year14 year15 year16 year17 year18 if growth<=
> 21.20154 & growth>=-12.55204, fe

Regression with Driscoll-Kraay standard errors   Number of obs     =       328
Method: Fixed-effects regression                 Number of groups  =        21
Group variable (i): id_country                   F( 30,     18)    =  29343.26
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.6348

--------------------------------------------------------------------------------
                |             Drisc/Kraay
         growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
----------------+---------------------------------------------------------------
          fdexp |  -.1523874   .0831224    -1.83   0.083     -.327021    .0222463
        fdtax_l |   .2142518   .1321701     1.62   0.122    -.0634273     .491931
     imbalance2 |    .210142   .1357444     1.55   0.139    -.0750463    .4953303
      popgrowth |  -.5175082   .3361188    -1.54   0.141    -1.223668    .1886511
     dschooling |   .9912013   .3120882     3.18   0.005     .3355284    1.646874
         laggdp |  -.0006626     .00021    -3.16   0.005    -.0011038   -.0002214
       gfcf_gdp |   .1946843   .0416682     4.67   0.000     .1071425     .282226
          trade |   .0533012   .0159541     3.34   0.004      .019783    .0868194
         tindex |   .1073104   .1466287     0.73   0.474    -.2007451    .4153658
interaction_exp |   .0036629   .0014084     2.60   0.018      .000704    .0066218
interaction_tax |  -.0029143   .0018748    -1.55   0.137    -.0068532    .0010245
interaction_imb |  -.0026168   .0019178    -1.36   0.189     -.006646    .0014123
          year1 |  -2.580521   2.297297    -1.12   0.276    -7.406962    2.245919
          year2 |  -2.515846   1.942345    -1.30   0.212    -6.596562     1.56487
          year3 |  -4.159962   1.854808    -2.24   0.038    -8.056768   -.2631559
          year4 |  -5.351894   1.850987    -2.89   0.010    -9.240673   -1.463115
          year5 |  -1.764049   1.754046    -1.01   0.328    -5.449163    1.921065
          year6 |   -1.04251   1.617688    -0.64   0.527    -4.441146    2.356126
          year7 |  -.4784925   1.430787    -0.33   0.742    -3.484464    2.527479
          year8 |   .4810452   1.332009     0.36   0.722    -2.317403    3.279493
          year9 |   .8486963   1.124548     0.75   0.460     -1.51389    3.211283
         year10 |   1.211401   .9200071     1.32   0.204    -.7214625    3.144264
         year11 |   1.727596   .7575705     2.28   0.035     .1359996    3.319193
         year12 |   2.228169   .5765073     3.86   0.001     1.016972    3.439366
         year13 |  -.3703775   .3880301    -0.95   0.352    -1.185599    .4448435
         year14 |  -5.680404   .4000611   -14.20   0.000    -6.520901   -4.839907
         year15 |  -1.036329   .3264014    -3.18   0.005    -1.722073    -.350585
         year16 |   .1732837   .2679505     0.65   0.526    -.3896594    .7362269
         year17 |  -2.029217   .1534819   -13.22   0.000    -2.351671   -1.706764
         year18 |  -.1303741   .0874141    -1.49   0.153    -.3140243    .0532761
          _cons |  -7.481331   8.868047    -0.84   0.410    -26.11241    11.14975
--------------------------------------------------------------------------------

. xtivreg2 growth fdexp interaction_exp popgrowth laggdp dschooling tindex (gfcf_gdp
trade interaction_tax interaction_imb fdtax_l imb
```

```
> alance2 = l4.imbalance2 l.imbalance2 l.interaction_imb interaction_imb
l4.interaction_imb  l3.gfcf_gdp l.gfcf_gdp l.trade l2.trade l
> 3.trade l4.trade l.fdtax_l l2.fdtax_l l2.interaction_tax)  year4 year5 year6 year7
year8 year9 year10 year11 year12 year13 year14 ye
> ar15 year16 year17 year18 if growth<=21.20154,  fe  endog(fdtax_l gfcf_gdp trade
imbalance2 interaction_tax interaction_imb ) small
Warning - duplicate variables detected
Duplicates:         interaction_imb
Warning - collinearities detected
Vars dropped:       year4

FIXED EFFECTS ESTIMATION
------------------------
Number of groups =       21                 Obs per group: min =         2
                                                           avg =      11.9
                                                           max =        15

Warning - duplicate variables detected
Duplicates:    interaction_imb
Warning - collinearities detected
Vars dropped:  year4

IV (2SLS) estimation
--------------------

Estimates efficient for homoskedasticity only
Statistics consistent for homoskedasticity only

                                                      Number of obs =      250
                                                      F( 26,   203) =    14.99
                                                      Prob > F      =   0.0000
Total (centered) SS     =  4931.120337                Centered R2   =   0.6327
Total (uncentered) SS   =  4931.120337                Uncentered R2 =   0.6327
Residual SS             =  1811.309591                Root MSE      =    2.987

------------------------------------------------------------------------------
         growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
----------------+-------------------------------------------------------------
       gfcf_gdp |    .098978   .1111205     0.89   0.374    -.1201204    .3180764
          trade |   .1081297   .0322206     3.36   0.001     .0445997    .1716597
interaction_tax |  -.0028581   .0118272    -0.24   0.809     -.026178    .0204617
interaction_imb |  -.0032064    .010442    -0.31   0.759     -.023795    .0173823
        fdtax_l |   .4028552   .9338166     0.43   0.667    -1.438369    2.244079
     imbalance2 |   .4265033   .8008137     0.53   0.595    -1.152476    2.005483
          fdexp |  -.4733834   .2680836    -1.77   0.079    -1.001969    .0552021
interaction_exp |   .0096813   .0040882     2.37   0.019     .0016205    .0177421
      popgrowth |   .0111047   .7337766     0.02   0.988    -1.435696    1.457906
         laggdp |  -.0006408   .0001866    -3.43   0.001    -.0010087   -.0002728
     dschooling |   1.451487   1.442668     1.01   0.316    -1.393048    4.296022
         tindex |   .0276875   .9211328     0.03   0.976    -1.788527    1.843902
          year4 |          0  (omitted)
          year5 |   2.122494   2.681152     0.79   0.429    -3.163984    7.408971
          year6 |   1.877178   2.328879     0.81   0.421    -2.714717    6.469073
          year7 |   2.554463   2.226548     1.15   0.253    -1.835664    6.944591
          year8 |   2.463095   1.853389     1.33   0.185    -1.191266    6.117457
          year9 |   2.867931   1.676397     1.71   0.089    -.4374529    6.173314
         year10 |   2.922904   1.531748     1.91   0.058    -.0972722     5.94308
         year11 |   3.296299   1.418142     2.32   0.021     .5001221    6.092477
         year12 |   3.876668   1.378238     2.81   0.005      1.15917    6.594165
         year13 |   .3544622   1.307317     0.27   0.787    -2.223198    2.932123
         year14 |  -7.412885   1.237947    -5.99   0.000    -9.853769   -4.972001
         year15 |  -.5515119   1.061721    -0.52   0.604    -2.644927    1.541903
         year16 |    .283594   1.036611     0.27   0.785    -1.760312      2.3275
         year17 |  -1.985501   .9810997    -2.02   0.044    -3.919953    -.051048
         year18 |  -.0301208   1.019142    -0.03   0.976    -2.039582     1.97934
------------------------------------------------------------------------------
Underidentification test (Anderson canon. corr. LM statistic):           17.417
                                                   Chi-sq(8) P-val =    0.0261
------------------------------------------------------------------------------
Weak identification test (Cragg-Donald Wald F statistic):                 1.241
Stock-Yogo weak ID test critical values:                        <not available>
------------------------------------------------------------------------------
Sargan statistic (overidentification test of all instruments):            5.947
                                                   Chi-sq(7) P-val =    0.5459
-endog- option:
Endogeneity test of endogenous regressors:                               30.516
                                                   Chi-sq(6) P-val =    0.0000
Regressors tested:    fdtax_l gfcf_gdp trade imbalance2 interaction_tax
```

```
                      interaction_imb
------------------------------------------------------------------------------
Instrumented:         gfcf_gdp trade interaction_tax interaction_imb fdtax_l
                      imbalance2
Included instruments: fdexp interaction_exp popgrowth laggdp dschooling tindex
                      year5 year6 year7 year8 year9 year10 year11 year12 year13
                      year14 year15 year16 year17 year18
Excluded instruments: L4.imbalance2 L.imbalance2 L.interaction_imb
                      L4.interaction_imb L3.gfcf_gdp L.gfcf_gdp L.trade L2.trade
                      L3.trade L4.trade L.fdtax_l L2.fdtax_l L2.interaction_tax
Duplicates:           interaction_imb
Dropped collinear:    year4
------------------------------------------------------------------------------
```

FE with D-K SEs

fdexp coefficent	Interaction coefficent	tindex	Marginal Effect
-0.152	0.0036	10	-0.116
-0.152	0.0036	20	-0.08
-0.152	0.0036	30	-0.044
-0.152	0.0036	40	-0.008
-0.152	0.0036	50	0.028
-0.152	0.0036	60	0.064
-0.152	0.0036	70	0.1
-0.152	0.0036	80	0.136
-0.152	0.0036	90	0.172
-0.152	0.0036	100	0.208

fdtax_l coefficent	Interaction coefficent	tindex	Marginal Effect
0.214	-0.003	10	0.184
0.214	-0.003	20	0.154
0.214	-0.003	30	0.124
0.214	-0.003	40	0.094
0.214	-0.003	50	0.064
0.214	-0.003	60	0.034
0.214	-0.003	70	0.004
0.214	-0.003	80	-0.026
0.214	-0.003	90	-0.056
0.214	-0.003	100	-0.086

imbalance2 coefficent	Interaction coefficent	tindex	Marginal Effect
0.21	-0.0026	10	0.184
0.21	-0.0026	20	0.158
0.21	-0.0026	30	0.132
0.21	-0.0026	40	0.106
0.21	-0.0026	50	0.08
0.21	-0.0026	60	0.054
0.21	-0.0026	70	0.028
0.21	-0.0026	80	0.002
0.21	-0.0026	90	-0.024
0.21	-0.0026	100	-0.05

IV approach

fdexp coefficent	Interaction coefficent	tindex	Marginal Effect
-0.47	0.0096	10	-0.374
-0.47	0.0096	20	-0.278
-0.47	0.0096	30	-0.182
-0.47	0.0096	40	-0.086
-0.47	0.0096	50	0.01
-0.47	0.0096	60	0.106
-0.47	0.0096	70	0.202
-0.47	0.0096	80	0.298
-0.47	0.0096	90	0.394
-0.47	0.0096	100	0.49

fdtax_l coefficent	Interaction coefficent	tindex	Marginal Effect
0.402	-0.0028	10	0.374
0.402	-0.0028	20	0.346
0.402	-0.0028	30	0.318
0.402	-0.0028	40	0.29
0.402	-0.0028	50	0.262
0.402	-0.0028	60	0.234
0.402	-0.0028	70	0.206
0.402	-0.0028	80	0.178
0.402	-0.0028	90	0.15
0.402	-0.0028	100	0.122

imbalance2 coefficent	Interaction coefficent	tindex	Marginal Effect
0.42	-0.0032	10	0.388
0.42	-0.0032	20	0.356
0.42	-0.0032	30	0.324
0.42	-0.0032	40	0.292
0.42	-0.0032	50	0.26
0.42	-0.0032	60	0.228
0.42	-0.0032	70	0.196
0.42	-0.0032	80	0.164
0.42	-0.0032	90	0.132
0.42	-0.0032	100	0.1

D. FEVD

```
. *greater than the mean tindex >= 74
. xtfevd growth fdexp fdtax_l imbalance2 popgrowth dschooling lngdpini gfcf_gdp trade
tindex year1 year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12
year13 year14 year15 year16 year17 year18 if growth<=21.20154 & growth>=-12.55204 &
tindex>=74, invariant (lngdpini fdexp fdtax_l tindex)
```

panel fixed effects regression with vector decomposition

degrees of freedom fevd	= 159	number of obs	= 200
mean squared error	= 3.523556	F(29, 159)	= 14.29874
root mean squared error	= 1.877114	Prob > F	= 3.79e-30
Residual Sum of Squares	= 704.7113	R-squared	= .7691173
Total Sum of Squares	= 3052.248	adj. R-squared	= .7110336
Estimation Sum of Squares	= 2347.537		

growth	Coef.	fevd Std. Err.	t	P>|t|	[95% Conf.	Interval]
imbalance2	-.0026385	.0404129	-0.07	0.948	-.0824538	.0771769
popgrowth	-1.127424	.4982025	-2.26	0.025	-2.111372	-.1434763
dschooling	.7431662	.9744131	0.76	0.447	-1.181296	2.667628
gfcf_gdp	.2218638	.0973832	2.28	0.024	.0295324	.4141952
trade	.0710516	.0181803	3.91	0.000	.0351455	.1069576
year1	6.124503	2.275967	2.69	0.008	1.629476	10.61953
year2	5.670285	1.77359	3.20	0.002	2.167452	9.173118
year3	3.674622	1.732998	2.12	0.036	.2519575	7.097287
year4	3.069301	1.53268	2.00	0.047	.0422639	6.096338
year5	4.979225	1.473473	3.38	0.001	2.069122	7.889328
year6	4.356617	1.369055	3.18	0.002	1.652738	7.060495
year7	5.023567	1.36814	3.67	0.000	2.321496	7.725639
year8	5.580171	1.288911	4.33	0.000	3.034577	8.125766
year9	4.865771	1.225528	3.97	0.000	2.445359	7.286183
year10	4.688013	1.108722	4.23	0.000	2.498292	6.877735
year11	4.748152	1.116975	4.25	0.000	2.542131	6.954172
year12	4.500977	1.210331	3.72	0.000	2.110578	6.891377
year13	-.4623091	1.202235	-0.38	0.701	-2.836718	1.9121
year14	-5.219891	1.082717	-4.82	0.000	-7.358253	-3.08153
year15	-.2570286	.9369556	-0.27	0.784	-2.107512	1.593455
year16	.7183902	.8817753	0.81	0.416	-1.023113	2.459893
year17	-1.160929	.8241164	-1.41	0.161	-2.788555	.4666982
year18	-1.16961	.8314553	-1.41	0.161	-2.811731	.4725108
lngdpini	-5.050043	1.397076	-3.61	0.000	-7.809263	-2.290823
fdexp	.1371573	.0846863	1.62	0.107	-.0300978	.3044123
fdtax_l	.0119553	.0486817	0.25	0.806	-.0841908	.1081014
tindex	-.0887705	.0806755	-1.10	0.273	-.2481043	.0705633
eta	1	.	.	.	.	.
_cons	39.1363	14.75385	2.65	0.009	9.997497	68.27511

```
. *lower than the mean tindex <= 74
. xtfevd growth fdexp fdtax_l imbalance2 popgrowth dschooling lngdpini gfcf_gdp trade
tindex year3 year4 year5 year6 year7 year8 year9 year10 year11 year12 year13 year14
year15 year16 year17 year18 if growth<=21.20154 & growth>=-12.55204 & tindex<=74,
invariant (lngdpini fdexp fdtax_l tindex)
```

panel fixed effects regression with vector decomposition

degrees of freedom fevd	= 88	number of obs	= 128
mean squared error	= 5.306125	F(27, 88)	= 5.247519
root mean squared error	= 2.303503	Prob > F	= 3.12e-09
Residual Sum of Squares	= 679.184	R-squared	= .6952985
Total Sum of Squares	= 2229.014	adj. R-squared	= .5602603
Estimation Sum of Squares	= 1549.83		

growth	Coef.	fevd Std. Err.	t	P>|t|	[95% Conf.	Interval]
imbalance2	.0270138	.1134676	0.24	0.812	-.1984793	.2525068
popgrowth	-1.561195	1.334031	-1.17	0.245	-4.212301	1.089911
dschooling	1.065814	.492124	2.17	0.033	.0878207	2.043807
gfcf_gdp	.168395	.0981459	1.72	0.090	-.0266493	.3634393
trade	.0032068	.0434828	0.07	0.941	-.0832062	.0896198

```
       year3 |  -2.308322   1.585298    -1.46   0.149    -5.458768    .8421247
       year4 |  -3.831582   1.515512    -2.53   0.013    -6.843343   -.8198205
       year5 |   2.372075    1.63385     1.45   0.150    -.8748578    5.619008
       year6 |   3.983187   1.737034     2.29   0.024     .5311961    7.435177
       year7 |   3.079076   1.741949     1.77   0.081    -.3826813    6.540834
       year8 |   4.616593   1.616247     2.86   0.005     1.404642    7.828544
       year9 |   5.154875   1.587372     3.25   0.002     2.000307    8.309444
      year10 |   4.037999     1.6078     2.51   0.014     .8428356    7.233163
      year11 |   3.165813   1.615279     1.96   0.053    -.0442149     6.37584
      year12 |   3.172334   1.606617     1.97   0.051    -.0204809    6.365148
      year13 |   3.030458    1.59837     1.90   0.061    -.1459669    6.206882
      year14 |  -4.027393   1.659532    -2.43   0.017    -7.325365   -.7294213
      year15 |   1.356022   1.438115     0.94   0.348     -1.50193    4.213974
      year16 |   2.174423   1.422493     1.53   0.130    -.6524824    5.001329
      year17 |  -2.036734   1.407126    -1.45   0.151    -4.833101    .7596321
      year18 |   3.300958   1.628027     2.03   0.046     .0655969    6.536319
    lngdpini |   1.354002   1.741967     0.78   0.439    -2.107791    4.815796
       fdexp |   .0883482   .0849487     1.04   0.301    -.0804696     .257166
    fdtax_l  |   .0160614   .1270591     0.13   0.900    -.2364418    .2685646
      tindex |   .0236695   .0660215     0.36   0.721    -.1075343    .1548733
         eta |          1          .        .       .            .           .
       _cons |  -18.82705   25.70499    -0.73   0.466    -69.91032    32.25622
------------------------------------------------------------------------------
```

E. IV

```
. *greater than the mean tindex >= 74
. xtivreg2 growth fdexp popgrowth laggdp dschooling tindex (gfcf_gdp trade   fdtax_l
imbalance2 = l3.imbalance2 l2.imbalance2  l.gfcf_
> gdp l3.gfcf_gdp l2.trade l3.trade l2.fdtax_l l3.fdtax_l)  year4 year5 year6 year7
year8 year9 year10 year11 year12 year13 year14 yea
> r15 year16 year17 year18 if growth<=21.20154 & growth>=-12.55204 & tindex>=74,  fe
endog(fdtax_l gfcf_gdp trade imbalance2) small

FIXED EFFECTS ESTIMATION
------------------------
Number of groups =       14                    Obs per group: min =         6
                                                              avg =      12.8
                                                              max =        16

IV (2SLS) estimation
--------------------

Estimates efficient for homoskedasticity only
Statistics consistent for homoskedasticity only

                                                      Number of obs =      179
                                                      F( 24,    141) =     9.72
                                                      Prob > F      =   0.0000
Total (centered) SS     =  2143.590709                Centered R2   =   0.5748
Total (uncentered) SS   =  2143.590709                Uncentered R2 =   0.5748
Residual SS             =  911.4982538                Root MSE      =    2.543

------------------------------------------------------------------------------
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    gfcf_gdp |   .0533276   .1279872     0.42   0.678    -.1996943    .3063495
       trade |    .087678   .0550205     1.59   0.113    -.0210938    .1964499
    fdtax_l  |   .1499585   .0986257     1.52   0.131    -.0450177    .3449348
  imbalance2 |   .1661963   .0841976     1.97   0.050    -.0002565    .3326491
       fdexp |   .1650968   .1142981     1.44   0.151    -.0608627    .3910564
   popgrowth |  -1.253741   .7457556    -1.68   0.095    -2.728048    .2205669
      laggdp |  -.0004184   .0002124    -1.97   0.051    -.0008383    1.39e-06
  dschooling |    .620071   1.533133     0.40   0.686    -2.410828    3.650971
      tindex |   .1076649    .106453     1.01   0.314    -.1027854    .3181152
       year4 |   1.945482   3.495406     0.56   0.579    -4.964696    8.855661
       year5 |    3.88415   3.394325     1.14   0.254    -2.826198     10.5945
       year6 |   2.984779   3.104656     0.96   0.338    -3.152913    9.122471
       year7 |   3.569296   3.076846     1.16   0.248    -2.513417    9.652009
       year8 |   3.877285   2.879429     1.35   0.180    -1.815148    9.569719
       year9 |   3.474745   2.306719     1.51   0.134    -1.085482    8.034971
      year10 |   4.006669   1.976963     2.03   0.045     .0983498    7.914989
      year11 |   4.803401   1.682067     2.86   0.005     1.478069    8.128732
      year12 |   5.197734   1.647094     3.16   0.002     1.941541    8.453927
      year13 |   .1408647   1.478077     0.10   0.924    -2.781192    3.062921
      year14 |  -4.334697   1.714243    -2.53   0.013    -7.723637   -.9457567
      year15 |  -1.301369   1.290198    -1.01   0.315    -3.852002    1.249264
```

```
      year16 |   -.128897   1.069301    -0.12   0.904    -2.242832    1.985038
      year17 |  -1.753315   1.006577    -1.74   0.084    -3.743248    .2366181
      year18 |  -1.401569   .9985222    -1.40   0.163    -3.375579     .572441
------------------------------------------------------------------------------
Underidentification test (Anderson canon. corr. LM statistic):          18.427
                                                   Chi-sq(5) P-val =    0.0025
------------------------------------------------------------------------------
Weak identification test (Cragg-Donald Wald F statistic):                2.153
Stock-Yogo weak ID test critical values:                       <not available>
------------------------------------------------------------------------------
Sargan statistic (overidentification test of all instruments):           1.603
                                                   Chi-sq(4) P-val =    0.8082
-endog- option:
Endogeneity test of endogenous regressors:                              33.607
                                                   Chi-sq(4) P-val =    0.0000
Regressors tested:    fdtax_l gfcf_gdp trade imbalance2
------------------------------------------------------------------------------
Instrumented:         gfcf_gdp trade fdtax_l imbalance2
Included instruments: fdexp popgrowth laggdp dschooling tindex year4 year5
                      year6 year7 year8 year9 year10 year11 year12 year13 year14
                      year15 year16 year17 year18
Excluded instruments: L3.imbalance2 L2.imbalance2 L.gfcf_gdp L3.gfcf_gdp
                      L2.trade L3.trade L2.fdtax_l L3.fdtax_l
------------------------------------------------------------------------------

. *lower than the mean tindex <= 74
. xtivreg2 growth fdexp popgrowth laggdp dschooling tindex (gfcf_gdp trade   fdtax_l
imbalance2 = l2.imbalance2 l.gfcf_gdp l2.gfcf_gdp
>  l.trade l2.trade l.fdtax_l l2.fdtax_l) year1 year2 year3 year4 year5 year6 year7
year8 year9 year10 year11 year12 year13 year14 yea
> r15 year16 year17 year18 year19 year20 if growth<=21.20154 & growth>=-12.55204 &
tindex<74,  fe  endog(fdtax_l gfcf_gdp trade imbala
> nce2) small
Warning - singleton groups detected.  2 observation(s) not used.
Warning - collinearities detected
Vars dropped:       year1 year2 year19 year20

FIXED EFFECTS ESTIMATION
------------------------
Number of groups =       11                  Obs per group: min =         2
                                                            avg =       8.7
                                                            max =        17
Warning - collinearities detected
Vars dropped:  year1 year2 year19 year20

IV (2SLS) estimation
--------------------

Estimates efficient for homoskedasticity only
Statistics consistent for homoskedasticity only

                                                      Number of obs =       96
                                                      F( 25,    60) =     3.83
                                                      Prob > F      =   0.0000
Total (centered) SS     =  1306.369426                Centered R2   =   0.5796
Total (uncentered) SS   =  1306.369426                Uncentered R2 =   0.5796
Residual SS             =  549.2529518                Root MSE      =    3.026

------------------------------------------------------------------------------
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    gfcf_gdp |   .0396282   .2098627     0.19   0.851    -.3801596     .459416
       trade |  -.0068853   .0913759    -0.08   0.940    -.1896643    .1758936
     fdtax_l |  -.2632122   .2276431    -1.16   0.252    -.7185661    .1921418
  imbalance2 |  -.2408733   .1900163    -1.27   0.210    -.6209625    .1392158
       fdexp |  -.0435798   .1130646    -0.39   0.701    -.2697427    .1825831
   popgrowth |    .050563   1.806273     0.03   0.978     -3.56252    3.663646
      laggdp |   -.000524   .0003964    -1.32   0.191     -.001317     .000269
  dschooling |  -1.418772   3.060453    -0.46   0.645    -7.540589    4.703045
      tindex |  -.6732582   .5196938    -1.30   0.200    -1.712801    .3662842
       year1 |          0  (omitted)
       year2 |          0  (omitted)
       year3 |   -12.1543   7.211658    -1.69   0.097    -26.57976    2.271169
       year4 |  -17.05308    8.31543    -2.05   0.045    -33.68642   -.4197489
       year5 |  -8.785443    7.12267    -1.23   0.222     -23.0329    5.462019
       year6 |  -4.198583   6.128729    -0.69   0.496    -16.45787    8.060701
       year7 |  -3.981064   5.197288    -0.77   0.447    -14.37719     6.41506
```

```
       year8 |  -1.846707   4.788826    -0.39   0.701    -11.42579    7.732372
       year9 |   .1789849   4.886973     0.04   0.971    -9.596416    9.954386
      year10 |  -1.212423   3.830208    -0.32   0.753    -8.873979    6.449133
      year11 |   .5747463   3.323239     0.17   0.863    -6.072722    7.222215
      year12 |   1.254031   3.106159     0.40   0.688    -4.959213    7.467274
      year13 |   3.263471   2.280756     1.43   0.158    -1.298719    7.825662
      year14 |  -4.275222   2.253091    -1.90   0.063    -8.782075    .2316318
      year15 |   1.442484   2.040309     0.71   0.482    -2.638741    5.523709
      year16 |   2.486763   2.077101     1.20   0.236    -1.668057    6.641584
      year17 |  -1.300618   1.938825    -0.67   0.505    -5.178845    2.577609
      year18 |   2.218832   2.011493     1.10   0.274    -1.804753    6.242416
      year19 |          0  (omitted)
      year20 |          0  (omitted)
------------------------------------------------------------------------------
Underidentification test (Anderson canon. corr. LM statistic):          11.168
                                                   Chi-sq(4) P-val =    0.0247
------------------------------------------------------------------------------
Weak identification test (Cragg-Donald Wald F statistic):                1.232
Stock-Yogo weak ID test critical values:                       <not available>
------------------------------------------------------------------------------
Sargan statistic (overidentification test of all instruments):           2.613
                                                   Chi-sq(3) P-val =    0.4552
-endog- option:
Endogeneity test of endogenous regressors:                               9.920
                                                   Chi-sq(4) P-val =    0.0418
Regressors tested:    fdtax_l gfcf_gdp trade imbalance2
------------------------------------------------------------------------------
Instrumented:         gfcf_gdp trade fdtax_l imbalance2
Included instruments: fdexp popgrowth laggdp dschooling tindex year3 year4
                      year5 year6 year7 year8 year9 year10 year11 year12 year13
                      year14 year15 year16 year17 year18
Excluded instruments: L2.imbalance2 L.gfcf_gdp L2.gfcf_gdp L.trade L2.trade
                      L.fdtax_l L2.fdtax_l
Dropped collinear:    year1 year2 year19 year20
------------------------------------------------------------------------------
```

Appendix 4.3.4 Geographical location (Europe vs CIS) as a moderator

A. FE with Driscoll Kraay

```
.*europe =1 and FE with DK
. xtscc growth fdexp fdtax_l imbalance2 popgrowth dschooling laggdp gfcf_gdp trade
tindex year1 year2 year3 year4 year5 year6 year7 ye
> ar8  year9  year10  year11  year12  year13  year14  year15  year16  year17  year18  if
growth<=21.20154 & growth>=-12.55204 & europe==1, fe

Regression with Driscoll-Kraay standard errors   Number of obs     =       227
Method: Fixed-effects regression                 Number of groups  =        14
Group variable (i): id_country                   F( 27,     18)    = 169021.61
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.6876

------------------------------------------------------------------------------
             |             Drisc/Kraay
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       fdexp |   .1366509   .0526782     2.59   0.018      .025978    .2473237
     fdtax_l |   .0151543    .033271     0.46   0.654    -.0547455    .0850542
  imbalance2 |   .0230102   .0228556     1.01   0.327    -.0250077    .0710281
   popgrowth |  -.7904485   .4002789    -1.97   0.064    -1.631403    .0505062
  dschooling |   .0329299   .3835504     0.09   0.933    -.7728796    .8387394
      laggdp |   -.000661   .0002521    -2.62   0.017    -.0011906   -.0001314
    gfcf_gdp |   .2393758   .0293241     8.16   0.000     .1777682    .3009835
       trade |   .0697254   .0205649     3.39   0.003     .0265201    .1129307
      tindex |   .0334906   .0834585     0.40   0.693    -.1418492    .2088303
       year1 |  -1.925715   2.210603    -0.87   0.395    -6.570019    2.718589
       year2 |  -1.625314   1.906648    -0.85   0.405    -5.631033    2.380405
       year3 |  -2.272926   1.735546    -1.31   0.207    -5.919172    1.373321
       year4 |  -4.191769   1.706877    -2.46   0.024    -7.777784   -.6057541
       year5 |  -.8197401   1.641458    -0.50   0.624    -4.268315    2.628835
       year6 |  -1.043329   1.485575    -0.70   0.491    -4.164406    2.077748
       year7 |   .0057161   1.310003     0.00   0.997    -2.746498     2.75793
       year8 |   .7213022   1.181192     0.61   0.549    -1.760291    3.202895
       year9 |   .9500913   1.039811     0.91   0.373    -1.234471    3.134654
```

```
      year10 |   1.278924   .9043675     1.41   0.174    -.6210813     3.17893
      year11 |   1.752083   .7306028     2.40   0.028     .2171436    3.287023
      year12 |   2.135251   .5113268     4.18   0.001     1.060993    3.209509
      year13 |  -.4735788   .3060288    -1.55   0.139    -1.116521    .1693638
      year14 |   -5.34468   .4029414   -13.26   0.000    -6.191229   -4.498132
      year15 |  -1.188938   .3178719    -3.74   0.001    -1.856763   -.5211142
      year16 |  -.2617427    .312169    -0.84   0.413    -.9175853    .3940999
      year17 |  -2.216537   .1862715   -11.90   0.000    -2.607879   -1.825195
      year18 |   -1.16672   .0762272   -15.31   0.000    -1.326867   -1.006573
       _cons |  -4.906632   8.133233    -0.60   0.554    -21.99392    12.18066
------------------------------------------------------------------------------
```

```
. *europe =0 and FE with DK
. xtscc growth fdexp fdtax_l imbalance2 popgrowth dschooling laggdp gfcf_gdp trade
tindex year1 year2 year3 year4 year5 year6 year7 ye
> ar8 year9 year10 year11 year12 year13 year14 year15 year16 year17 year18 if
growth<=21.20154 & growth>=-12.55204 & europe==0, fe

Regression with Driscoll-Kraay standard errors   Number of obs     =       101
Method: Fixed-effects regression                 Number of groups  =         7
Group variable (i): id_country                   F( 27,     18)    =  54184.85
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.6388

------------------------------------------------------------------------------
             |             Drisc/Kraay
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       fdexp |  -.0065854   .0788334    -0.08   0.934    -.1722082    .1590374
     fdtax_l |  -.0159196   .0641624    -0.25   0.807    -.1507198    .1188806
  imbalance2 |    .003886    .042944     0.09   0.929     -.086336     .094108
   popgrowth |  -.3774396   .9050338    -0.42   0.682    -2.278845    1.523966
  dschooling |   1.550913   .8338509     1.86   0.079    -.2009424    3.302769
      laggdp |  -.0005304   .0002743    -1.93   0.069    -.0011066    .0000459
    gfcf_gdp |   .1620398   .0755136     2.15   0.046     .0033917    .3206879
       trade |    .003958   .0299672     0.13   0.896    -.0590009    .0669168
      tindex |  -.0975432   .1551021    -0.63   0.537    -.4234006    .2283142
       year1 |  -1.115468   4.428194    -0.25   0.804    -10.41876    8.187823
       year2 |   .0413972   2.327322     0.02   0.986    -4.848124    4.930919
       year3 |  -6.292844   2.327388    -2.70   0.015    -11.18251   -1.403182
       year4 |  -4.500097   2.603465    -1.73   0.101    -9.969774    .9695803
       year5 |   .1883509   2.547061     0.07   0.942    -5.162825    5.539527
       year6 |   2.137199   2.340074     0.91   0.373    -2.779114    7.053511
       year7 |   1.732855   1.964635     0.88   0.389    -2.394691      5.8604
       year8 |   3.643578   1.882962     1.94   0.069    -.3123793    7.599535
       year9 |   3.674664   1.565873     2.35   0.031      .384887    6.964441
      year10 |    3.02148   1.334434     2.26   0.036     .2179374    5.825023
      year11 |   3.157844   .9417633     3.35   0.004     1.179273    5.136415
      year12 |   3.499882    .893828     3.92   0.001     1.622019    5.377745
      year13 |   .9570887   .9841675     0.97   0.344    -1.110571    3.024748
      year14 |  -5.188099   .7160355    -7.25   0.000    -6.692433   -3.683764
      year15 |   .7763278    .615937     1.26   0.224    -.5177078    2.070363
      year16 |   2.269544   .4362481     5.20   0.000     1.353021    3.186067
      year17 |  -.8599084   .3460453    -2.48   0.023    -1.586923   -.1328942
      year18 |   2.702314   .2059234    13.12   0.000     2.269685    3.134943
       _cons |   11.03278   10.42716     1.06   0.304    -10.87387    32.93942
------------------------------------------------------------------------------
```

B. FEVD

```
. *europe =1 and FEVD
. xtfevd growth fdexp fdtax_l imbalance2 popgrowth dschooling lngdpini gfcf_gdp trade
tindex year1 year2 year3 year4 year5 year6 year7
>  year8 year9 year10 year11 year12 year13 year14 year15 year16 year17 year18 if
growth<=21.20154 & growth>=-12.55204 & europe==1, inv
> ariant (lngdpini fdexp fdtax_l tindex)

panel fixed effects regression with vector decomposition

degrees of freedom fevd     =       186          number of obs        =       227
mean squared error          = 3.981724           F( 29, 186)          = 12.33304
root mean squared error     = 1.995426           Prob > F             = 8.49e-29
Residual Sum of Squares     = 903.8512           R-squared            = .7091005
Total Sum of Squares        = 3107.091           adj. R-squared       = .6465415
Estimation Sum of Squares   =  2203.24
```

growth	fevd Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
imbalance2	.0272762	.1027324	0.27	0.791	-.1753942	.2299466
popgrowth	-1.206999	.696001	-1.73	0.085	-2.58007	.1660721
dschooling	.2614843	.7039178	0.37	0.711	-1.127205	1.650174
gfcf_gdp	.2238164	.0977917	2.29	0.023	.030893	.4167398
trade	.0658893	.0225384	2.92	0.004	.0214255	.1103531
year1	5.354932	1.758903	3.04	0.003	1.884967	8.824896
year2	5.054715	1.291903	3.91	0.000	2.50605	7.603381
year3	4.023733	1.441187	2.79	0.006	1.180558	6.866908
year4	1.926845	1.282072	1.50	0.135	-.6024276	4.456117
year5	5.003596	1.26205	3.96	0.000	2.513823	7.493369
year6	4.2674	1.133126	3.77	0.000	2.031969	6.502831
year7	4.770336	1.140035	4.18	0.000	2.521274	7.019398
year8	4.92549	1.15231	4.27	0.000	2.652213	7.198766
year9	4.627525	1.143701	4.05	0.000	2.371232	6.883818
year10	4.333782	1.074389	4.03	0.000	2.214228	6.453336
year11	4.128852	1.144634	3.61	0.000	1.870718	6.386986
year12	3.677091	1.240123	2.97	0.003	1.230576	6.123606
year13	.1490374	1.073629	0.14	0.890	-1.969018	2.267093
year14	-4.919639	1.134395	-4.34	0.000	-7.157574	-2.681704
year15	-.2317404	.9877327	-0.23	0.815	-2.18034	1.716859
year16	.4576004	.8944896	0.51	0.610	-1.307049	2.222249
year17	-1.848336	.8622542	-2.14	0.033	-3.549391	-.1472806
year18	-.9938454	.8734039	-1.14	0.257	-2.716897	.729206
lngdpini	-3.475161	2.033214	-1.71	0.089	-7.486287	.5359651
fdexp	.1706199	.0959659	1.78	0.077	-.0187017	.3599415
fdtax_l	.0268761	.1143594	0.24	0.814	-.1987321	.2524843
tindex	-.0978926	.0753979	-1.30	0.196	-.2466374	.0508523
eta	1	.	.	.	.	.
_cons	22.9937	24.73623	0.93	0.354	-25.80594	71.79334

```
. *europe =0 and FEVD
. xtfevd growth fdexp fdtax_l imbalance2 popgrowth dschooling lngdpini gfcf_gdp trade
tindex year1 year2 year3 year4 year5 year6 year7
>  year8 year9 year10 year11 year12 year13 year14 year15 year16 year17 year18 if
growth<=21.20154 & growth>=-12.55204 & europe==0, inv
> ariant (lngdpini fdexp fdtax_l tindex)
```

panel fixed effects regression with vector decomposition

degrees of freedom fevd	= 67	number of obs	= 101
mean squared error	= 6.216112	F(29, 67)	= 4.363526
root mean squared error	= 2.493213	Prob > F	= 4.96e-07
Residual Sum of Squares	= 627.8273	R-squared	= .6795694
Total Sum of Squares	= 1959.324	adj. R-squared	= .5217454
Estimation Sum of Squares	= 1331.497		

growth	fevd Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
imbalance2	.0088624	.0347666	0.25	0.800	-.0605319	.0782568
popgrowth	-1.237046	.7834189	-1.58	0.119	-2.800757	.3266646
dschooling	1.982649	1.026916	1.93	0.058	-.0670835	4.032382
gfcf_gdp	.1099303	.1256963	0.87	0.385	-.1409605	.3608211
trade	.010505	.0478704	0.22	0.827	-.0850446	.1060547
year1	2.724187	4.842295	0.56	0.576	-6.941074	12.38945
year2	3.051677	2.811413	1.09	0.282	-2.559926	8.663281
year3	-3.558979	2.604435	-1.37	0.176	-8.757453	1.639495
year4	-1.599201	2.481508	-0.64	0.521	-6.552311	3.353909
year5	2.465666	2.688473	0.92	0.362	-2.900549	7.831882
year6	4.05983	2.390669	1.70	0.094	-.7119647	8.831626
year7	3.352024	2.450501	1.37	0.176	-1.539196	8.243244
year8	5.03587	2.190192	2.30	0.025	.6642285	9.407511
year9	5.117134	2.057084	2.49	0.015	1.011176	9.223091
year10	4.20917	2.014052	2.09	0.040	.1891052	8.229236
year11	4.285563	1.806043	2.37	0.021	.680686	7.89044
year12	4.243396	1.83673	2.31	0.024	.5772678	7.909523
year13	1.354697	1.867898	0.73	0.471	-2.373644	5.083038
year14	-4.738409	1.894222	-2.50	0.015	-8.519293	-.9575256

```
      year15 |   1.000074   1.790249     0.56   0.578    -2.573279    4.573427
      year16 |   2.310046   1.769079     1.31   0.196    -1.221051    5.841143
      year17 |  -.9986678   1.752569    -0.57   0.571    -4.496811    2.499475
      year18 |   2.695466   1.866827     1.44   0.153    -1.030738    6.421669
    lngdpini |   2.764671   2.451853     1.13   0.264    -2.129248     7.65859
       fdexp |  -.0364001   .0849637    -0.43   0.670    -.2059884    .1331882
     fdtax_l |   .0198602   .0604733     0.33   0.744     -.100845    .1405655
      tindex |   .0285701   .0623174     0.46   0.648     -.095816    .1529562
         eta |          1          .        .       .            .           .
       _cons |  -25.77078   27.25609    -0.95   0.348    -80.17416    28.63259
------------------------------------------------------------------------------
```

C. IV

```
. *europe=1 and IV
. xtivreg2 growth popgrowth fdexp dschooling tindex laggdp (gfcf_gdp trade  fdtax_l
imbalance2 =  l2.imbalance2 l.gfcf_gdp  l3.gfcf_gd
> p  l.trade l2.trade l3.trade  l.fdtax_l)  year4 year5 year6 year7 year8 year9
year10 year11 year12 year13 year14 year15 year16 year1
> 7 year18 if growth<=21.20154 & growth>=-12.55204 & europe==1,  fe  endog(fdtax_l
gfcf_gdp trade imbalance2) small

FIXED EFFECTS ESTIMATION
------------------------
Number of groups =        14                    Obs per group: min =         3
                                                               avg =      13.4
                                                               max =        16

IV (2SLS) estimation
--------------------

Estimates efficient for homoskedasticity only
Statistics consistent for homoskedasticity only

                                                      Number of obs =      187
                                                      F( 24,    149) =    12.61
                                                      Prob > F      =   0.0000
Total (centered) SS     =  2169.099465                Centered R2   =   0.6596
Total (uncentered) SS   =  2169.099465                Uncentered R2 =   0.6596
Residual SS             =  738.3485516                Root MSE      =    2.226

------------------------------------------------------------------------------
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    gfcf_gdp |   .3148091   .2174907     1.45   0.150    -.1149553    .7445736
       trade |   .1024496   .0337291     3.04   0.003     .0358005    .1690987
     fdtax_l |   .2163598   .1893469     1.14   0.255    -.1577922    .5905118
  imbalance2 |   .2043468   .1674396     1.22   0.224    -.1265161    .5352096
   popgrowth |    -.98197   .6608738    -1.49   0.139    -2.287865    .3239254
       fdexp |   .1478968   .1026711     1.44   0.152    -.0549826    .3507763
  dschooling |   .7681003   1.340303     0.57   0.567    -1.880356    3.416556
      tindex |    .140512   .0910399     1.54   0.125    -.0393841    .3204081
      laggdp |  -.0005934   .0001726    -3.44   0.001    -.0009344   -.0002524
       year4 |  -.1593742   2.533955    -0.06   0.950    -5.166504    4.847755
       year5 |   3.086704   2.542861     1.21   0.227    -1.938022     8.11143
       year6 |   1.816685   2.122412     0.86   0.393    -2.377229    6.010599
       year7 |   2.523594   2.057164     1.23   0.222    -1.541389    6.588578
       year8 |    2.87855   1.805088     1.59   0.113    -.6883272    6.445428
       year9 |    2.61952   1.541212     1.70   0.091    -.4259352    5.664976
      year10 |   2.801963    1.38529     2.02   0.045     .0646124    5.539314
      year11 |   2.754781   1.491625     1.85   0.067    -.1926894    5.702251
      year12 |   2.561422   1.851529     1.38   0.169    -1.097224    6.220068
      year13 |  -.2263698   1.489138    -0.15   0.879    -3.168927    2.716187
      year14 |  -4.183229   1.180212    -3.54   0.001    -6.515343   -1.851115
      year15 |  -.1774143    1.20635    -0.15   0.883    -2.561178    2.206349
      year16 |  -.1227678   .9277988    -0.13   0.895     -1.95611    1.710575
      year17 |  -2.139797   .8740356    -2.45   0.016    -3.866903   -.4126915
      year18 |  -.9274684   .9122949    -1.02   0.311    -2.730175    .8752384
------------------------------------------------------------------------------
Underidentification test (Anderson canon. corr. LM statistic):           8.472
                                                   Chi-sq(4) P-val =    0.0757
------------------------------------------------------------------------------
Weak identification test (Cragg-Donald Wald F statistic):                1.074
Stock-Yogo weak ID test critical values:                       <not available>
```

```
------------------------------------------------------------------------------
Sargan statistic (overidentification test of all instruments):           3.101
                                                   Chi-sq(3) P-val =    0.3763
-endog- option:
Endogeneity test of endogenous regressors:                              21.421
                                                   Chi-sq(4) P-val =    0.0003
Regressors tested:    fdtax_l gfcf_gdp trade imbalance2
------------------------------------------------------------------------------
Instrumented:         gfcf_gdp trade fdtax_l imbalance2
Included instruments: popgrowth fdexp dschooling tindex laggdp year4 year5
                      year6 year7 year8 year9 year10 year11 year12 year13 year14
                      year15 year16 year17 year18
Excluded instruments: L2.imbalance2 L.gfcf_gdp L3.gfcf_gdp L.trade L2.trade
                      L3.trade L.fdtax_l
------------------------------------------------------------------------------


. *europe=0 and IV
. xtivreg2 growth popgrowth fdexp dschooling tindex laggdp (gfcf_gdp trade  fdtax_l
imbalance2 =  l2.imbalance2 l.gfcf_gdp  l2.gfcf_gd
> p  l.trade l2.trade  l.fdtax_l)  year4 year5 year6 year7 year8 year9 year10 year11
year12 year13 year14 year15 year16 year17 year18
> if growth<=21.20154 & growth>=-12.55204 & europe==0,  fe  endog(fdtax_l gfcf_gdp
trade imbalance2) small

FIXED EFFECTS ESTIMATION
------------------------
Number of groups =        7                    Obs per group: min =          7
                                                              avg =       12.3
                                                              max =         17

IV (2SLS) estimation
--------------------

Estimates efficient for homoskedasticity only
Statistics consistent for homoskedasticity only

                                                      Number of obs =       86
                                                      F( 24,    55) =     0.59
                                                      Prob > F      =   0.9186
Total (centered) SS     =  1336.769635                Centered R2   =  -1.4306
Total (uncentered) SS   =  1336.769635                Uncentered R2 =  -1.4306
Residual SS             =  3249.214875                Root MSE      =    7.686

------------------------------------------------------------------------------
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    gfcf_gdp |   .5211071   .9371096     0.56   0.580    -1.356902    2.399117
       trade |  -.0227329   .1771912    -0.13   0.898     -.377832    .3323663
    fdtax_l |  -1.032597   1.595204    -0.65   0.520    -4.229457    2.164263
  imbalance2 |  -.6186967    1.02238    -0.61   0.548    -2.667593    1.430199
   popgrowth |   4.541945   9.771811     0.46   0.644     -15.0412    24.12509
       fdexp |  -.0897086   .3220834    -0.28   0.782    -.7351781    .5557608
  dschooling |  -4.222776   7.909834    -0.53   0.596    -20.07444    11.62889
      tindex |  -.4694647   1.305334    -0.36   0.720    -3.085412    2.146483
      laggdp |  -.0008197   .0010508    -0.78   0.439    -.0029255    .0012861
       year4 |  -10.83126   15.67779    -0.69   0.493    -42.25026    20.58774
       year5 |   5.456223   7.940143     0.69   0.495    -10.45618    21.36863
       year6 |   8.284693   7.651902     1.08   0.284    -7.050061    23.61945
       year7 |   7.293549    7.31176     1.00   0.323    -7.359545    21.94664
       year8 |   11.14015    10.0676     1.11   0.273    -9.035764    31.31607
       year9 |   8.953832   6.045607     1.48   0.144    -3.161834     21.0695
      year10 |     10.668   8.917147     1.20   0.237    -7.202364    28.53836
      year11 |   4.119583   5.888256     0.70   0.487    -7.680746    15.91991
      year12 |    4.54296   5.710301     0.80   0.430     -6.90074    15.98666
      year13 |   6.531732   8.432075     0.77   0.442    -10.36652    23.42999
      year14 |  -4.345744   5.707818    -0.76   0.450    -15.78447    7.092979
      year15 |   6.607596   11.11418     0.59   0.555    -15.66572    28.88091
      year16 |   3.421689   4.986608     0.69   0.495    -6.571697    13.41507
      year17 |   .3529555   5.006509     0.07   0.944    -9.680312    10.38622
      year18 |   3.786316   5.046818     0.75   0.456    -6.327733    13.90036
------------------------------------------------------------------------------
Underidentification test (Anderson canon. corr. LM statistic):           0.652
                                                   Chi-sq(3) P-val =    0.8844
------------------------------------------------------------------------------
Weak identification test (Cragg-Donald Wald F statistic):                0.074
Stock-Yogo weak ID test critical values:                       <not available>
```

```
------------------------------------------------------------------------------
Sargan statistic (overidentification test of all instruments):           1.575
                                                   Chi-sq(2) P-val =    0.4550
-endog- option:
Endogeneity test of endogenous regressors:                              11.441
                                                   Chi-sq(4) P-val =    0.0220
Regressors tested:    fdtax_l gfcf_gdp trade imbalance2
------------------------------------------------------------------------------
Instrumented:         gfcf_gdp trade fdtax_l imbalance2
Included instruments: popgrowth fdexp dschooling tindex laggdp year4 year5
                      year6 year7 year8 year9 year10 year11 year12 year13 year14
                      year15 year16 year17 year18
Excluded instruments: L2.imbalance2 L.gfcf_gdp L2.gfcf_gdp L.trade L2.trade
                      L.fdtax_l
------------------------------------------------------------------------------
```

Appendix 4.4 Sensitivity Analysis

Appendix 4.4.1. Optimal Size

```
* 2 measures
. xtscc growth popgrowth dschooling laggdp gfcf_gdp trade tindex fdexp fdtax_l fdexp2
fdtax_l2 year1 year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12
year13 year14 year15 year16 year17 year18 if growth<=21.20154 & growth>=-12.55204, fe

Regression with Driscoll-Kraay standard errors   Number of obs     =       328
Method: Fixed-effects regression                 Number of groups  =        21
Group variable (i): id_country                   F( 28,     18)    = 320444.02
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.6300

------------------------------------------------------------------------------
             |             Drisc/Kraay
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |  -.3385293    .359089    -0.94   0.358    -1.092947    .4158888
  dschooling |   .9892502   .3343674     2.96   0.008     .2867703     1.69173
      laggdp |  -.0006353   .0002039    -3.12   0.006    -.0010637   -.0002069
    gfcf_gdp |   .2136546   .0314248     6.80   0.000     .1476336    .2796755
       trade |   .0530631   .0160122     3.31   0.004     .0194227    .0867036
      tindex |  -.0384293   .0517204    -0.74   0.467    -.1470898    .0702311
       fdexp |   .2171541   .1368018     1.59   0.130    -.0702558    .5045639
     fdtax_l |   .0282562   .0676274     0.42   0.681    -.1138237    .1703361
      fdexp2 |  -.0022744   .0019136    -1.19   0.250    -.0062946    .0017459
    fdtax_l2 |  -.0004852   .0007837    -0.62   0.544    -.0021318    .0011614
       year1 |  -2.534557    2.22947    -1.14   0.271      -7.2185    2.149386
       year2 |   -2.63578   1.810029    -1.46   0.163     -6.43851     1.16695
       year3 |  -4.246299    1.72649    -2.46   0.024     -7.87352   -.6190786
       year4 |  -5.461078   1.650107    -3.31   0.004    -8.927824   -1.994333
       year5 |  -1.771386   1.577008    -1.12   0.276    -5.084558    1.541786
       year6 |   -.955618   1.450953    -0.66   0.518    -4.003957    2.092721
       year7 |  -.4622652    1.29812    -0.36   0.726    -3.189515    2.264985
       year8 |   .6313606   1.196419     0.53   0.604    -1.882222    3.144943
       year9 |   .9319493   1.036973     0.90   0.381     -1.24665    3.110548
      year10 |   1.201698   .8797013     1.37   0.189    -.6464858    3.049882
      year11 |   1.658065   .7443144     2.23   0.039      .094319    3.221812
      year12 |   2.082613   .5969558     3.49   0.003     .8284555    3.336771
      year13 |  -.3955798   .3559563    -1.11   0.281    -1.143416    .3522566
      year14 |  -5.714475   .3490485   -16.37   0.000    -6.447798   -4.981151
      year15 |  -.9537424   .3318133    -2.87   0.010    -1.650856   -.2566286
      year16 |   .2349766   .3414008     0.69   0.500    -.4822798    .9522331
      year17 |  -2.056611      .2383    -8.63   0.000    -2.557261   -1.555961
      year18 |  -.1758904   .1473885    -1.19   0.248    -.4855423    .1337614
       _cons |   2.327756   6.803943     0.34   0.736     -11.9668    16.62231
------------------------------------------------------------------------------
```

```
*3 measures
xtscc growth popgrowth dschooling laggdp gfcf_gdp trade tindex fdexp fdtax_l fdexp2
fdtax_l2 imbalance2 year1 year2 year3 year4 year5 year6 year7 year8 year9 year10
year11 year12 year13 year14 year15 year16 year17 year18 if growth<=21.20154 &
growth>=-12.55204, fe

Regression with Driscoll-Kraay standard errors   Number of obs     =       328
```

```
Method: Fixed-effects regression                Number of groups  =        21
Group variable (i): id_country                  F( 29,     18)    = 445468.32
maximum lag: 2                                  Prob > F          =    0.0000
                                                within R-squared  =    0.6310

------------------------------------------------------------------------------
             |             Drisc/Kraay
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |  -.3760354   .3527651    -1.07   0.301    -1.117167    .3650965
  dschooling |   .9839703   .3293835     2.99   0.008     .2919613    1.675979
      laggdp |  -.0006359   .0002012    -3.16   0.005    -.0010587   -.0002131
    gfcf_gdp |   .2140009   .0319715     6.69   0.000     .1468312    .2811707
       trade |   .0540237   .0154168     3.50   0.003     .0216343    .0864131
      tindex |  -.0277836   .0488148    -0.57   0.576    -.1303397    .0747724
       fdexp |     .22929    .132865     1.73   0.102     -.049849    .5084289
    fdtax_l |   .0473223   .0616335     0.77   0.453    -.0821649    .1768096
      fdexp2 |     -.0024   .0018725    -1.28   0.216    -.0063339    .0015339
    fdtax_l2 |  -.0005116   .0007606    -0.67   0.510    -.0021094    .0010863
  imbalance2 |    .015441    .022817     0.68   0.507    -.0324957    .0633776
       year1 |  -2.305527   2.324929    -0.99   0.335    -7.190021    2.578966
       year2 |  -2.436916   1.899282    -1.28   0.216     -6.42716    1.553327
       year3 |  -4.102443    1.78333    -2.30   0.034     -7.84908   -.3558055
       year4 |   -5.22994   1.737955    -3.01   0.008    -8.881249   -1.578631
       year5 |  -1.575974   1.657404    -0.95   0.354     -5.05805    1.906102
       year6 |   -.824396   1.508695    -0.55   0.591    -3.994047    2.345255
       year7 |  -.3601808   1.349383    -0.27   0.793    -3.195129    2.474768
       year8 |   .7047939   1.226648     0.57   0.573    -1.872297    3.281885
       year9 |   .9943043   1.065407     0.93   0.363    -1.244033    3.232641
      year10 |   1.226277   .8907613     1.38   0.186    -.6451434    3.097697
      year11 |   1.681494   .7551485     2.23   0.039     .0949859    3.268002
      year12 |   2.076748   .5976408     3.47   0.003     .8211518    3.332345
      year13 |  -.4446826   .3609913    -1.23   0.234    -1.203097    .3137319
      year14 |  -5.703697   .3512826   -16.24   0.000    -6.441715    -4.96568
      year15 |  -1.009485   .3200358    -3.15   0.005    -1.681856   -.3371152
      year16 |   .1796509   .3081759     0.58   0.567    -.4678025    .8271044
      year17 |  -2.111473   .2093886   -10.08   0.000    -2.551382   -1.671564
      year18 |  -.1903294    .142524    -1.34   0.198    -.4897613    .1091025
       _cons |  -.2856857   6.787521    -0.04   0.967    -14.54574    13.97437
------------------------------------------------------------------------------
```

Appendix 4.4.2. Controlling for Government Size

```
. *2 measures (using FE with D-K SEs, FEVD and IV approach)

. xtscc growth fdexp fdtax_l popgrowth dschooling laggdp gfcf_gdp trade tindex
govcons year1 year2 year3 year4 year5 year6 year7 year8
>  year9 year10 year11 year12 year13 year14 year15 year16 year17 year18 if
growth<=21.20154 & growth>=-12.55204, fe

Regression with Driscoll-Kraay standard errors  Number of obs     =       328
Method: Fixed-effects regression                Number of groups  =        21
Group variable (i): id_country                  F( 27,     18)    = 409286.04
maximum lag: 2                                  Prob > F          =    0.0000
                                                within R-squared  =    0.6312

------------------------------------------------------------------------------
             |             Drisc/Kraay
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       fdexp |   .0677556   .0392565     1.73   0.101    -.0147192    .1502304
     fdtax_l |   -.021353   .0103164    -2.07   0.053    -.0430269    .0003209
   popgrowth |  -.3447516   .3920026    -0.88   0.391    -1.168318    .4788153
  dschooling |   .8196617    .368479     2.22   0.039     .0455159    1.593807
      laggdp |   -.000699   .0002493    -2.80   0.012    -.0012228   -.0001751
    gfcf_gdp |    .202559   .0336099     6.03   0.000     .1319471    .2731709
       trade |   .0471503   .0123056     3.83   0.001     .0212973    .0730034
      tindex |  -.0500964   .0458878    -1.09   0.289    -.1465031    .0463104
     govcons |  -.1459687   .0986865    -1.48   0.156    -.3533013    .0613639
       year1 |  -3.563006   2.911848    -1.22   0.237    -9.680572    2.554559
       year2 |   -3.38393   2.290198    -1.48   0.157    -8.195458    1.427598
       year3 |  -5.003335   2.164543    -2.31   0.033    -9.550871   -.4557996
       year4 |  -6.195375   2.058213    -3.01   0.008    -10.51952    -1.87123
```

```
      year5 |   -2.53914   1.971326    -1.29   0.214    -6.680742    1.602462
      year6 |  -1.607722   1.851881    -0.87   0.397     -5.49838    2.282936
      year7 |  -.9131643   1.593909    -0.57   0.574    -4.261843    2.435515
      year8 |   .2610291   1.471685     0.18   0.861    -2.830867    3.352925
      year9 |   .6291818   1.289788     0.49   0.632    -2.080563    3.338927
     year10 |   1.038973   1.071971     0.97   0.345    -1.213155    3.291102
     year11 |    1.60688   .8749318     1.84   0.083    -.2312834    3.445044
     year12 |   2.135629   .6623553     3.22   0.005     .7440723    3.527186
     year13 |  -.2374708   .3668808    -0.65   0.526    -1.008259    .5333172
     year14 |  -5.449309   .3421104   -15.93   0.000    -6.168057   -4.730562
     year15 |  -.8439406   .3397953    -2.48   0.023    -1.557824    -.130057
     year16 |   .3161806   .3052458     1.04   0.314    -.3251169    .9574782
     year17 |  -1.949865   .1884897   -10.34   0.000    -2.345867   -1.553862
     year18 |  -.1460331   .1001996    -1.46   0.162    -.3565447    .0644785
      _cons |   10.89142   6.710909     1.62   0.122    -3.207679    24.99052
------------------------------------------------------------------------------


.
. xtfevd growth fdexp fdtax_l popgrowth dschooling lngdpini gfcf_gdp trade tindex
govcons year1 year2 year3 year4 year5 year6 year7 ye
> ar8 year9 year10 year11 year12 year13 year14 year15 year16 year17 year18 if
growth<=21.20154 & growth>=-12.55204, invariant (lngdpin
> i fdexp fdtax_l tindex)

panel fixed effects regression with vector decomposition

degrees of freedom fevd    =       280          number of obs       =       328
mean squared error         = 5.273523           F( 29, 280)         = 12.92418
root mean squared error    = 2.296415           Prob > F            = 3.00e-35
Residual Sum of Squares    = 1729.716           R-squared           =  .674184
Total Sum of Squares       = 5308.872           adj. R-squared      = .6194935
Estimation Sum of Squares  = 3579.157

------------------------------------------------------------------------------
             |               fevd
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |   -.816404   .5377264    -1.52   0.130    -1.874904    .2420957
  dschooling |   1.483582   .4903163     3.03   0.003     .5184076    2.448756
    gfcf_gdp |   .2080406   .0563767     3.69   0.000     .0970647    .3190165
       trade |   .0413902   .0214449     1.93   0.055    -.0008236     .083604
     govcons |   .0701499   .1095342     0.64   0.522    -.1454653     .285765
       year1 |   4.120373   1.701807     2.42   0.016     .7704132    7.470333
       year2 |    3.05261   1.190638     2.56   0.011     .7088709    5.396348
       year3 |   .9843056   1.201915     0.82   0.414    -1.381632    3.350243
       year4 |  -.5237218   1.196564    -0.44   0.662    -2.879126    1.831682
       year5 |   2.990105   1.093747     2.73   0.007     .8370934    5.143116
       year6 |   3.484847     1.0814     3.22   0.001     1.356141    5.613553
       year7 |   3.522618   1.088883     3.24   0.001     1.379182    5.666054
       year8 |   4.163798   1.029111     4.05   0.000     2.138021    6.189575
       year9 |   4.108002   .9783745     4.20   0.000     2.182099    6.033905
      year10 |   3.866683   .9391427     4.12   0.000     2.018006    5.715359
      year11 |   3.744703   .9272456     4.04   0.000     1.919445     5.56996
      year12 |   3.493119   .8980891     3.89   0.000     1.725255    5.260982
      year13 |   .1594708   .9047289     0.18   0.860    -1.621463    1.940405
      year14 |  -5.478551   1.082185    -5.06   0.000    -7.608802   -3.348299
      year15 |  -.1392109    .908616    -0.15   0.878    -1.927797    1.649375
      year16 |   .9657039   .8686394     1.11   0.267    -.7441889    2.675597
      year17 |  -1.627906   .8485462    -1.92   0.056    -3.298246    .0424343
      year18 |   .0425358   .8809245     0.05   0.962     -1.69154    1.776611
    lngdpini |  -1.497382   .7050313    -2.12   0.035    -2.885217   -.1095471
       fdexp |   .0222416   .0381024     0.58   0.560    -.0527619     .097245
     fdtax_l |  -.0061928   .0198939    -0.31   0.756    -.0453534    .0329677
      tindex |  -.0271291   .0337867    -0.80   0.423    -.0936372    .0393791
         eta |          1          .        .       .            .           .
       _cons |   6.971205   6.736317     1.03   0.302     -6.28905    20.23146
------------------------------------------------------------------------------


.
. xtivreg2 growth popgrowth fdexp tindex dschooling laggdp (gfcf_gdp trade  fdtax_l
govcons =   l.govcons l2.gfcf_gdp l2.trade l.trade
>  l2.fdtax_l l4.fdtax_l) year1 year2 year3 year4 year5 year6 year7 year8 year9
year10 year11 year12 year13 year14 year15 year16 year1
> 7 year18 if growth<=21.20154 & growth>=-12.55204,  fe  endog(fdtax_l gfcf_gdp trade
govcons) small
```

```
Warning - collinearities detected
Vars dropped:       year1 year2 year3 year4

FIXED EFFECTS ESTIMATION
------------------------
Number of groups =       21                   Obs per group: min =         2
                                                             avg =      11.8
                                                             max =        15

Warning - collinearities detected
Vars dropped:  year1 year2 year3 year4

IV (2SLS) estimation
--------------------

Estimates efficient for homoskedasticity only
Statistics consistent for homoskedasticity only

                                                      Number of obs =      247
                                                      F( 23,   203) =    12.83
                                                      Prob > F      =   0.0000
Total (centered) SS     =  2943.914767                Centered R2   =   0.5536
Total (uncentered) SS   =  2943.914767                Uncentered R2 =   0.5536
Residual SS             =  1314.195244                Root MSE      =    2.544

------------------------------------------------------------------------------
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    gfcf_gdp |  -.2259262   .1427851    -1.58   0.115    -.5074582    .0556058
       trade |   .0192266   .0253053     0.76   0.448    -.0306684    .0691216
     fdtax_l |   -.047561   .0335484    -1.42   0.158     -.113709     .018587
     govcons |  -.3094773   .1874542    -1.65   0.100    -.6790843    .0601298
   popgrowth |  -1.096051   .5865223    -1.87   0.063    -2.252508    .0604059
       fdexp |   .0212944   .0526805     0.40   0.686    -.0825768    .1251656
      tindex |   .1420981   .1004539     1.41   0.159    -.0559687    .3401649
  dschooling |   1.391351   1.169865     1.19   0.236    -.9152932    3.697995
      laggdp |  -.0005966   .0001851    -3.22   0.001    -.0009615   -.0002317
       year1 |          0  (omitted)
       year2 |          0  (omitted)
       year3 |          0  (omitted)
       year4 |          0  (omitted)
       year5 |  -.1885807   2.110374    -0.09   0.929    -4.349645    3.972484
       year6 |   .2880896   2.003514     0.14   0.886    -3.662277    4.238456
       year7 |   .6100521   1.838566     0.33   0.740    -3.015083    4.235187
       year8 |   2.160508   1.638364     1.32   0.189    -1.069886    5.390901
       year9 |   2.948178   1.480134     1.99   0.048     .0297701    5.866586
      year10 |   3.235793   1.320078     2.45   0.015     .6329703    5.838616
      year11 |   4.944101   1.333672     3.71   0.000     2.314475    7.573728
      year12 |   5.988176   1.418411     4.22   0.000     3.191468    8.784883
      year13 |   2.537276   1.296682     1.96   0.052    -.0194166    5.093969
      year14 |  -4.594702   1.093014    -4.20   0.000    -6.749819   -2.439585
      year15 |  -.4756606   .8964855    -0.53   0.596    -2.243278    1.291957
      year16 |   .6926567   .8561895     0.81   0.419    -.9955082    2.380822
      year17 |  -1.356791   .8278578    -1.64   0.103    -2.989094    .2755119
      year18 |  -.0720083   .8433474    -0.09   0.932    -1.734852    1.590836
------------------------------------------------------------------------------
Underidentification test (Anderson canon. corr. LM statistic):          41.130
                                                   Chi-sq(3) P-val =    0.0000
------------------------------------------------------------------------------
Weak identification test (Cragg-Donald Wald F statistic):                7.453
Stock-Yogo weak ID test critical values:                       <not available>
------------------------------------------------------------------------------
Sargan statistic (overidentification test of all instruments):           1.192
                                                   Chi-sq(2) P-val =    0.5509
-endog- option:
Endogeneity test of endogenous regressors:                              27.152
                                                   Chi-sq(4) P-val =    0.0000
Regressors tested:    fdtax_l gfcf_gdp trade govcons
------------------------------------------------------------------------------
Instrumented:         gfcf_gdp trade fdtax_l govcons
Included instruments: popgrowth fdexp tindex dschooling laggdp year5 year6
                      year7 year8 year9 year10 year11 year12 year13 year14
                      year15 year16 year17 year18
Excluded instruments: L.govcons L2.gfcf_gdp L2.trade L.trade L2.fdtax_l
                      L4.fdtax_l
Dropped collinear:    year1 year2 year3 year4
------------------------------------------------------------------------------
```

```
.
. *3 measures (using FE with D-K SEs, FEVD and IV approach)

. xtscc growth fdexp fdtax_l imbalance2 popgrowth dschooling laggdp gfcf_gdp trade
tindex govcons year1 year3 year4 year5 year6 year7
> year8 year9 year10 year11 year12 year13 year14 year15 year16 year17 year18 if
growth<=21.20154 & growth>=-12.55204, fe

Regression with Driscoll-Kraay standard errors   Number of obs     =       328
Method: Fixed-effects regression                 Number of groups  =        21
Group variable (i): id_country                   F( 27,    18)     =  77470.77
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.6274

------------------------------------------------------------------------------
             |             Drisc/Kraay
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       fdexp |   .0608786   .0319926     1.90   0.073    -.0063353    .1280925
     fdtax_l |  -.0019968   .0280837    -0.07   0.944    -.0609985    .0570048
  imbalance2 |   .0209983   .0216429     0.97   0.345    -.0244717    .0664682
   popgrowth |   -.329053   .4112553    -0.80   0.434    -1.193068    .5349624
  dschooling |   1.024898   .2826804     3.63   0.002     .4310088    1.618788
      laggdp |  -.0005424   .0001328    -4.08   0.001    -.0008214   -.0002634
    gfcf_gdp |   .2024952   .0348484     5.81   0.000     .1292815     .275709
       trade |    .053561    .013004     4.12   0.001     .0262407    .0808814
      tindex |    .005974   .0422995     0.14   0.889    -.0828938    .0948419
     govcons |  -.1037448   .0760041    -1.36   0.189    -.2634236    .0559339
       year1 |   -.112405   .6784102    -0.17   0.870    -1.537692    1.312882
       year3 |  -2.324974   .3840336    -6.05   0.000    -3.131798   -1.518149
       year4 |  -3.513458   .3798056    -9.25   0.000      -4.3114   -2.715516
       year5 |  -.0733745   .3714398    -0.20   0.846    -.8537405    .7069916
       year6 |   .6563525   .3728619     1.76   0.095    -.1270013    1.439706
       year7 |   1.123599   .3149177     3.57   0.002     .4619811    1.785216
       year8 |   2.041699   .3105425     6.57   0.000     1.389273    2.694125
       year9 |   2.228753   .3055398     7.29   0.000     1.586837    2.870668
      year10 |   2.363113   .3465392     6.82   0.000     1.635061    3.091165
      year11 |   2.721888   .3920945     6.94   0.000     1.898128    3.545648
      year12 |    3.00796   .4871429     6.17   0.000     1.984511     4.03141
      year13 |   .2836616   .5639625     0.50   0.621    -.9011797    1.468503
      year14 |  -4.921105   .5543088    -8.88   0.000    -6.085664   -3.756545
      year15 |  -.2845718   .4694478    -0.61   0.552    -1.270845    .7017014
      year16 |    .770453   .4087024     1.89   0.076    -.0881988    1.629105
      year17 |  -1.593921   .4388807    -3.63   0.002    -2.515975   -.6718666
      year18 |   .2339381   .4498176     0.52   0.609    -.7110936     1.17897
       _cons |   .0489536   4.770484     0.01   0.992    -9.973461    10.07137
------------------------------------------------------------------------------


.
. xtfevd growth fdexp fdtax_l imbalance2 popgrowth dschooling lngdpini gfcf_gdp trade
tindex govcons year1 year2 year3 year4 year5 yea
> r6 year7 year8 year9 year10 year11 year12 year13 year14 year15 year16 year17 year18
if growth<=21.20154 & growth>=-12.55204, invaria
> nt (lngdpini fdexp fdtax_l tindex)

panel fixed effects regression with vector decomposition

degrees of freedom fevd    =       279          number of obs        =       328
mean squared error         = 5.265611           F( 30, 279)          = 12.60649
root mean squared error    = 2.294692           Prob > F             = 3.70e-35
Residual Sum of Squares    =  1727.12           R-squared            = .6746728
Total Sum of Squares       = 5308.872           adj. R-squared       = .6187026
Estimation Sum of Squares  = 3581.752

------------------------------------------------------------------------------
             |                fevd
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  imbalance2 |   .0122281    .043496     0.28   0.779    -.0733938    .0978501
   popgrowth |  -.8491661   .5504929    -1.54   0.124    -1.932813     .234481
  dschooling |   1.474202   .4877855     3.02   0.003     .5139947    2.434409
    gfcf_gdp |   .2078086   .0559866     3.71   0.000     .0975989    .3180183
       trade |   .0418451   .0212119     1.97   0.050     .0000894    .0836008
     govcons |   .0638261   .1150448     0.55   0.579      -.16264    .2902922
       year1 |   4.290753   1.722722     2.49   0.013     .8995687    7.681936
```

```
      year2 |   3.206603   1.219361     2.63   0.009     .8062865    5.606919
      year3 |   1.092276    1.20291     0.91   0.365    -1.275656    3.460208
      year4 |  -.3466332   1.257643    -0.28   0.783    -2.822307    2.129041
      year5 |   3.136849   1.148755     2.73   0.007     .8755206    5.398177
      year6 |   3.583614   1.095542     3.27   0.001     1.427035    5.740192
      year7 |   3.604481   1.117765     3.22   0.001     1.404156    5.804805
      year8 |    4.22415   1.031061     4.10   0.000     2.194504    6.253796
      year9 |   4.160102   .9764945     4.26   0.000      2.23787    6.082335
     year10 |   3.892142   .9362399     4.16   0.000     2.049151    5.735133
     year11 |   3.770797   .9235125     4.08   0.000      1.95286    5.588734
     year12 |   3.497031   .8977022     3.90   0.000     1.729902    5.264161
     year13 |   .1297822   .9135378     0.14   0.887     -1.66852    1.928084
     year14 |  -5.457243   1.092875    -4.99   0.000    -7.608571   -3.305914
     year15 |   -.174617   .9086359    -0.19   0.848     -1.96327    1.614036
     year16 |   .9284299   .8687221     1.07   0.286    -.7816523    2.638512
     year17 |  -1.665104   .8522054    -1.95   0.052    -3.342673    .0124647
     year18 |   .0332985   .8806447     0.04   0.970    -1.700253     1.76685
   lngdpini |  -1.354622   .9712799    -1.39   0.164     -3.26659    .5573452
      fdexp |   .0197164   .0382376     0.52   0.607    -.0555545    .0949873
    fdtax_l |   .0062747   .0527882     0.12   0.905    -.0976391    .1101884
     tindex |  -.0251119   .0342193    -0.73   0.464    -.0924726    .0422489
        eta |          1          .        .       .            .           .
      _cons |   4.523095   12.05369     0.38   0.708    -19.20463    28.25082
------------------------------------------------------------------------------

.
. xtivreg2 growth fdexp popgrowth laggdp dschooling tindex ( govcons gfcf_gdp trade
fdtax_l imbalance2 = l3.govcons l.govcons l3.imb
> alance2  l3.gfcf_gdp l.gfcf_gdp l.trade l2.trade l2.fdtax_l)  year4 year5 year6
year7 year8 year9 year10 year11 year12 year13 year14
>  year15 year16 year17 year18 if growth<=21.20154 & growth>=-12.55204,  fe
endog(fdtax_l gfcf_gdp trade imbalance2 govcons) small

FIXED EFFECTS ESTIMATION
------------------------
Number of groups =       21                  Obs per group: min =         3
                                                            avg =      12.7
                                                            max =        16

IV (2SLS) estimation
--------------------

Estimates efficient for homoskedasticity only
Statistics consistent for homoskedasticity only

                                                      Number of obs =      267
                                                      F( 25,   221) =    10.83
                                                      Prob > F      =   0.0000
Total (centered) SS     =  3338.198869                Centered R2   =   0.4717
Total (uncentered) SS   =  3338.198869                Uncentered R2 =   0.4717
Residual SS             =  1763.614578                Root MSE      =    2.825

------------------------------------------------------------------------------
      growth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     govcons |  -.2611274   .2003971    -1.30   0.194    -.6560613    .1338065
    gfcf_gdp |   .0246529   .0999124     0.25   0.805    -.1722501    .2215559
       trade |   .0458533   .0249453     1.84   0.067    -.0033078    .0950143
     fdtax_l |   .2138735   .1317806     1.62   0.106    -.0458339    .4735808
  imbalance2 |   .2239452   .1097946     2.04   0.043     .0075667    .4403237
       fdexp |   .1167088   .0660486     1.77   0.079    -.0134569    .2468746
   popgrowth |  -.9824768   .5914738    -1.66   0.098    -2.148127    .1831739
      laggdp |  -.0005579    .000203    -2.75   0.006     -.000958   -.0001578
  dschooling |   1.450775   1.238425     1.17   0.243    -.9898588    3.891409
      tindex |   .2222805   .1045731     2.13   0.035     .0161924    .4283686
       year4 |  -.8084574   2.586309    -0.31   0.755    -5.905443    4.288528
       year5 |   2.231503   2.477904     0.90   0.369    -2.651841    7.114847
       year6 |   1.908873   2.234324     0.85   0.394    -2.494435     6.31218
       year7 |   2.135156   2.006197     1.06   0.288     -1.81857    6.088881
       year8 |   2.601338   1.785935     1.46   0.147     -.918304    6.120981
       year9 |   3.239637   1.595816     2.03   0.044     .0946733    6.384601
      year10 |   3.170604   1.431523     2.21   0.028     .3494217    5.991786
      year11 |   4.117563   1.291367     3.19   0.002     1.572594    6.662532
      year12 |   4.212673   1.296968     3.25   0.001     1.656666    6.768681
      year13 |    .389196   1.214403     0.32   0.749    -2.004096    2.782488
      year14 |   -4.71836   1.121628    -4.21   0.000    -6.928816   -2.507903
```

```
      year15 |  -1.215812   1.013571    -1.20   0.232    -3.213313     .781689
      year16 |  -.0965963   .9971143    -0.10   0.923    -2.061665    1.868473
      year17 |   -2.33876    .977162    -2.39   0.018    -4.264508   -.4130117
      year18 |  -.2650862   .9401755    -0.28   0.778    -2.117943    1.587771
------------------------------------------------------------------------------
Underidentification test (Anderson canon. corr. LM statistic):          14.776
                                                   Chi-sq(4) P-val =    0.0052
------------------------------------------------------------------------------
Weak identification test (Cragg-Donald Wald F statistic):                1.741
Stock-Yogo weak ID test critical values:                       <not available>
------------------------------------------------------------------------------
Sargan statistic (overidentification test of all instruments):           1.410
                                                   Chi-sq(3) P-val =    0.7032
-endog- option:
Endogeneity test of endogenous regressors:                              38.209
                                                   Chi-sq(5) P-val =    0.0000
Regressors tested:    fdtax_l gfcf_gdp trade imbalance2 govcons
------------------------------------------------------------------------------
Instrumented:         govcons gfcf_gdp trade fdtax_l imbalance2
Included instruments: fdexp popgrowth laggdp dschooling tindex year4 year5
                      year6 year7 year8 year9 year10 year11 year12 year13 year14
                      year15 year16 year17 year18
Excluded instruments: L3.govcons L.govcons L3.imbalance2 L3.gfcf_gdp L.gfcf_gdp
                      L.trade L2.trade L2.fdtax_l
------------------------------------------------------------------------------
```

Appendix of Chapter 5

AN EMPIRICAL INVESTIGATION OF THE EFFECT OF FISCAL DECENTRALIZATION ON ECONOMIC GROWTH AT REGIONAL LEVEL FOR SELECTED ETEs

Appendix 5.1. Correlation Matrix

Appendix 5.1.1 Correlation Matrix – All the Independent Variables

```
. corr fdexp fdtax fdgrant lag1realgdp realgdpini popgrowth lngfcf_gdp educ2 educ3_n trade eu capital size size1 surf fdexp2 fdtax2
fdgrant2 expsize revsize grantsize
(obs=681)

             |  FDexp      FDtax    FDgran  GDPt-1    GDP0   Popgrowth    Inv      Educ2     Educ3_n  Trade    EU      Capital    Size
Size1     Surf   Exp2
-------------+------------------------------------------------------------------------------------------------------------------------
----------------------
       fdexp |   1.0000
       fdtax |   0.9789   1.0000
     fdgrant |   0.0303  -0.0247   1.0000
 lag1realgdp |   0.4515   0.4969  -0.4163   1.0000
  realgdpini |   0.5049   0.5430  -0.2878   0.9067   1.0000
   popgrowth |   0.1425   0.1889  -0.2358   0.1889   0.2095   1.0000
  lngfcf_gdp |   0.3278   0.3258   0.2592  -0.1555  -0.1231  -0.0703   1.0000
       educ2 |   0.0851   0.0876   0.2834  -0.0468  -0.0829  -0.1829   0.6207   1.0000
     educ3_n |   0.0782   0.0921  -0.2654   0.6068   0.4861  -0.0033  -0.0092   0.3166   1.0000
       trade |   0.3334   0.3543  -0.1511   0.4652   0.3861  -0.0439   0.3821   0.5122   0.2846   1.0000
          eu |   0.2901   0.3499  -0.4917   0.5978   0.4546   0.0894   0.0092   0.1549   0.4052   0.5550   1.0000
     capital |   0.2319   0.2481  -0.2620   0.4616   0.4084   0.1671  -0.0815  -0.0268   0.4433   0.0288  -0.0130   1.0000
        size |  -0.5645  -0.5207  -0.7146   0.0187  -0.0715   0.1259  -0.5763  -0.5010   0.0896  -0.3431   0.1214   0.0279   1.0000
       size1 |  -0.1241  -0.0780  -0.6421   0.4072   0.4537   0.2233  -0.6139  -0.6522   0.0724  -0.1488   0.3141   0.0190   0.7476
1.0000
        surf |  -0.4004  -0.3609  -0.5050   0.0658   0.0032   0.1440  -0.6026  -0.4864   0.1539  -0.5389   0.1635  -0.0288   0.8354
0.7005    1.0000
      fdexp2 |   0.9696   0.9494   0.0410   0.4540   0.5472   0.1860   0.2328  -0.0160   0.0214   0.2705   0.2222   0.2293  -0.5096  -
0.0150   -0.3412   1.0000
      fdtax2 |   0.9646   0.9648   0.0218   0.4785   0.5681   0.2075   0.2322  -0.0132   0.0255   0.2842   0.2531   0.2339  -0.4966
0.0041   -0.3279   0.9945
    fdgrant2 |  -0.1043  -0.1549   0.9571  -0.4572  -0.3540  -0.2387   0.1642   0.1968  -0.3051  -0.1963  -0.5365  -0.2150  -0.5990  -
0.5936   -0.4871  -0.0838
    expsize1 |   0.4817   0.5072  -0.3360   0.6020   0.7038   0.2118  -0.3464  -0.4871   0.0874   0.0761   0.4326   0.0749   0.2037
0.7510    0.2853   0.5632
    revsize1 |   0.4713   0.5041  -0.3471   0.6045   0.7010   0.2137  -0.3529  -0.4918   0.0894   0.0700   0.4320   0.0857   0.2157
0.7572    0.2927   0.5511
  grantsize1 |   0.1321   0.1574  -0.1826   0.3889   0.5526   0.2061  -0.4851  -0.5264  -0.0242  -0.1675   0.1647  -0.0776   0.3077
0.7854    0.5014   0.2797

             |    Tax2      Grant2 Expsize Taxsize Grantsize
-------------+---------------------------------------------
      fdtax2 |   1.0000
    fdgrant2 |  -0.1012   1.0000
```

expsize1	0.5785	-0.3488	1.0000		
revsize1	0.5698	-0.3563	0.9973	1.0000	
grantsize1	0.2933	-0.2610	0.7640	0.7603	1.0000

```
. pwcorr fdexp fdtax fdgrant lag1realgdp realgdpini popgrowth lngfcf_gdp educ2 educ3_n trade eu capital size size1 surf fdexp2 fdtax2
fdgrant2 expsize revsize grantsize
```

	fdexp	fdtax	fdgrant	lag1re~p	realgd~i	popgro~h	lngfcf~p
fdexp	1.0000						
fdtax	0.9795	1.0000					
fdgrant	0.0527	-0.0009	1.0000				
lag1realgdp	0.4417	0.4863	-0.4246	1.0000			
realgdpini	0.5124	0.5465	-0.2680	0.8886	1.0000		
popgrowth	0.1401	0.1854	-0.2367	0.1951	0.2068	1.0000	
lngfcf_gdp	0.3238	0.3233	0.2772	-0.1461	-0.0985	-0.0695	1.0000
educ2	0.0851	0.0898	0.2834	-0.0547	-0.1036	-0.1870	0.6147
educ3_n	0.0782	0.0941	-0.2654	0.5815	0.4393	-0.0072	-0.0072
trade	0.3409	0.3561	-0.1388	0.4540	0.4027	-0.0364	0.3436
eu	0.2745	0.3351	-0.5065	0.6041	0.4581	0.0986	0.0008
capital	0.2307	0.2483	-0.2507	0.4735	0.4041	0.1637	-0.0723
size	-0.5740	-0.5336	-0.7240	0.0184	-0.1298	0.1157	-0.5353
size1	-0.1257	-0.0858	-0.6548	0.4363	0.4617	0.2292	-0.5693
surf	-0.4069	-0.3655	-0.5238	0.0864	-0.0343	0.1400	-0.5652
fdexp2	0.9698	0.9502	0.0654	0.4389	0.5486	0.1821	0.2351
fdtax2	0.9649	0.9652	0.0467	0.4621	0.5675	0.2033	0.2345
fdgrant2	-0.0841	-0.1337	0.9576	-0.4646	-0.3383	-0.2413	0.1833
expsize1	0.4826	0.5063	-0.3412	0.6148	0.7044	0.2150	-0.3526
revsize1	0.4724	0.5023	-0.3519	0.6161	0.7007	0.2170	-0.3592
grantsize1	0.1443	0.1673	-0.1822	0.3952	0.5540	0.2083	-0.4817

	educ2	educ3_n	trade	eu	capital	size	size1
educ2	1.0000						
educ3_n	0.3240	1.0000					
trade	0.4946	0.2553	1.0000				
eu	0.1395	0.3556	0.6416	1.0000			
capital	-0.0172	0.4608	0.0282	-0.0120	1.0000		
size	-0.4738	0.0911	-0.3356	0.1333	0.0227	1.0000	
size1	-0.6573	0.0417	-0.0933	0.3634	0.0125	0.6934	1.0000
surf	-0.4708	0.1499	-0.5314	0.1928	-0.0289	0.8318	0.6652

fdexp2	-0.0160	0.0214	0.2800	0.2062	0.2286	-0.5243	-0.0265
fdtax2	-0.0132	0.0255	0.2920	0.2362	0.2335	-0.5113	-0.0085
fdgrant2	0.1968	-0.3051	-0.1861	-0.5506	-0.2058	-0.6081	-0.6098
expsize1	-0.4871	0.0874	0.1010	0.4455	0.0787	0.1898	0.7520
revsize1	-0.4916	0.0891	0.0930	0.4421	0.0897	0.2017	0.7564
grantsize1	-0.5264	-0.0242	-0.1356	0.1803	-0.0801	0.2789	0.7781

	surf	fdexp2	fdtax2	fdgrant2	expsize1	revsize1	grants~1
surf	1.0000						
fdexp2	-0.3560	1.0000					
fdtax2	-0.3428	0.9946	1.0000				
fdgrant2	-0.5024	-0.0619	-0.0790	1.0000			
expsize1	0.2783	0.5550	0.5693	-0.3585	1.0000		
revsize1	0.2862	0.5436	0.5614	-0.3656	0.9973	1.0000	
grantsize1	0.4720	0.2830	0.2955	-0.2644	0.7675	0.7636	1.0000

Appendix 5.1.2 Correlation between FD variables

```
corr fdexp fdgrant fdtax

             |    fdexp  fdgrant   fdtax
-------------+--------------------------
       fdexp |   1.0000
     fdgrant |   0.0527   1.0000
       fdtax |   0.9795  -0.0009   1.0000

qui reg realgrowth lag1realgdp popgrowth educ2 educ3_n lngfcf_gdp fdexp fdtax fdgrant
trade eu year2 year3 year4 year5 year6 year7 yea
> r8 year9 year10 year11 year12 year13 year14

. estat vif

    Variable |       VIF       1/VIF
-------------+----------------------
       fdtax |     39.58    0.025266
       fdexp |     36.73    0.027225
 lag1realgdp |      6.07    0.164688
      year11 |      5.13    0.195024
      year10 |      5.00    0.200055
      year12 |      4.96    0.201801
       year7 |      4.92    0.203174
       year8 |      4.88    0.204809
       year9 |      4.55    0.219948
          eu |      4.38    0.228454
       educ2 |      4.09    0.244305
       year4 |      4.04    0.247704
       year5 |      4.01    0.249437
       year6 |      3.93    0.254638
       trade |      3.69    0.271193
       year3 |      3.14    0.318016
      year13 |      3.11    0.321785
     educ3_n |      3.06    0.326312
  lngfcf_gdp |      2.60    0.385327
       year2 |      2.53    0.395389
     fdgrant |      2.29    0.437180
      year14 |      2.11    0.472932
   popgrowth |      1.26    0.794156
-------------+----------------------
    Mean VIF |      6.78
```

Appendix 5.1.3 Correlation between FD variables and their interaction with size

```
corr fdexp fdgrant grantsize1 expsize1 revsize1 fdtax

             |     fdexp   fdgrant grants~1 expsize1 revsize1   fdtax
-------------+----------------------------------------------------------
       fdexp |   1.0000
     fdgrant |   0.0527   1.0000
  grantsize  |   0.1443  -0.1822   1.0000
    expsize  |   0.4826  -0.3412   0.7675   1.0000
    revsize  |   0.4724  -0.3519   0.7636   0.9973   1.0000
       fdtax |   0.9795  -0.0009   0.1673   0.5063   0.5035   1.0000
```

Appendix 5.2 Descriptive Statistics

Appendix 5.2.1 Individual Country Descriptive Statistics

```
-------------------------------------------------------------------------------------
--------------------------------------------------------
-> country = Albania

   stats |    fdexp    fdtax    fdgrant   realgr~h   lag1re~p  realgd~i  popgro~h
lngfcf~p     educ2
   educ3_n    trade      eu     capital
---------+---------------------------------------------------------------------------
-------------------------------------------------------
    mean |  39.35214  35.65545  60.64786  6.907813  2010.214   1260.26 -1.198582
3.395231  47.77939   34.5575  78.51983         0  .0833333
variance |   329.115  340.8626   329.115  65.26814  627568.3    246335   27.4278
.2134439  178.1575  231.1244  90.35452         0  .0769231
     min |  4.922366  4.922366  18.33286   -39.103  679.3678  687.8272  -26.8453
.9368505     12.15     16.43  63.93424         0         0
     max |  81.66714  81.66714  95.07764  27.27601  4502.565  2711.739  15.42908
4.32923    103.44     62.55  90.76286         0         1
-------------------------------------------------------------------------------------
-------------------------------------------------------

   stats |      size     size1      surf    fdexp2    fdtax2    fdgrant  expsize1
revsize1  grants~1
---------+---------------------------------------------------------------------------
---------------
    mean |         0  .0069444     28748  1875.213  1713.866  4004.784         0
0         0
variance |         0  .0069444         0   2636210   2510067   4375352         0
0         0
     min |         0         0     28748  24.22969  24.22969  336.0937         0
0         0
     max |         0         1     28748  6669.522  6669.522  9039.757         0
0         0
-------------------------------------------------------------------------------------
---------------

-------------------------------------------------------------------------------------
---------------------------------------------------------
-> country = Czech Rep

   stats |    fdexp     fdtax    fdgrant  realgr~h  lag1re~p  realgd~i  popgro~h
lngfcf~p     educ2
   educ3_n     trade        eu   capital
---------+---------------------------------------------------------------------------
-------------------------------------------------------
    mean |  66.19634  65.84668  40.13339  2.208453   11394.7  10529.85  .2278225
3.255151  42.07214  51.14635  134.1353         1  .0714286
variance |  253.2818  258.0433  34.06834  50.53532  1.88e+07  1.45e+07  .2631987
.0198591  40.86339  1899.045  173.3825         0  .0668037
     min |  27.10056  25.97637  27.51727 -13.11161  7505.736  8430.477 -.4757891
2.820141      28.8       4.9  113.7411         1         0
     max |  90.41772  87.73891  51.61188  20.36015  29976.58  24029.87  2.375263
3.66625      66.5     222.7   158.727         1         1
-------------------------------------------------------------------------------------
-------------------------------------------------------

   stats |      size     size1      surf    fdexp2    fdtax2    fdgrant  expsize1
revsize1  grants~1
---------+---------------------------------------------------------------------------
---------------
    mean |         0         1     78870  4632.975  4608.667  1644.453  66.19634
65.84668  40.13339
variance |         0         0         0   3378771   3265901  214931.7  253.2818
258.0433  34.06834
     min |         0         1     78870  734.4405  703.9743  757.2004  27.10056
25.97637  27.51727
     max |         0         1     78870  8175.364  7933.152  2663.786  90.41772
87.73891  51.61188
-------------------------------------------------------------------------------------
---------------
```

```
------------------------------------------------------------------------------------
--------------------------------------------------------
-> country = Estonia

   stats |     fdexp     fdtax    fdgrant  realgr~h  lag1re~p  realgd~i  popgro~h
lngfcf~p     educ2
   educ3_n     trade        eu   capital
---------+--------------------------------------------------------------------------
------------------------------------------------------
    mean |  44.15157  44.53743  43.07976  8.077229  6765.563  4310.535 -1.108035
3.663858  95.29433     68.65  144.0701  .9166667  .0666667
variance |  54.76583  56.07403  79.79397  77.38451   8772379   2383971  .4866112
.0992028  347.2948  7.407901   308.626  .0768156  .0625698
     min |   29.2938  28.71533   17.0141 -15.82306  2485.352  2755.138    -2.425
2.715302     63.22      64.4  116.6497         0         0
     max |  66.36042  68.56834  66.76267  29.80765  20088.56  9459.616  .9974343
4.254229    162.07     73.11  170.4284         1         1
------------------------------------------------------------------------------------
------------------------------------------------------

   stats |      size     size1      surf    fdexp2    fdtax2    fdgran2  expsize1
revsize1  grants~1
---------+--------------------------------------------------------------------------
---------------
    mean |         0         0     45230  2003.823   2020.24  1935.217         0
0        0
variance |         0         0         0  462800.3  471633.5  523259.4         0
0        0
     min |         0         0     45230  858.1267  846.5408  289.4798         0
0        0
     max |         0         0     45230  4403.706  4550.224  4457.254         0
0        0
------------------------------------------------------------------------------------
---------------

------------------------------------------------------------------------------------
--------------------------------------------------------
-> country = Hungary

   stats |    fdexp     fdtax    fdgrant  realgr~h  lag1re~p  realgd~i  popgro~h
lngfcf~p     educ2
   educ3_n     trade        eu   capital
---------+--------------------------------------------------------------------------
------------------------------------------------------
    mean |  25.03838  25.63191  8.859151  5.701941  7190.891  4866.562 -.3665942
3.211485  46.32976  51.02143  145.1178  .7692308  .1428571
variance |  35.91507  51.00652  4.501282  68.69379   9770305   2682880  .2591754
.0266403  10.87175  446.0482  343.6389  .1794872  .1238095
     min |  15.85525  16.15864  3.975631 -19.99322   2914.39  3571.428 -1.335535
2.592237      39.5      19.2  116.8041         0         0
     max |  42.79121  47.75184      14.7  24.87003  16682.38  8516.483  1.132156
3.543625      52.3     105.8  168.2131         1         1
------------------------------------------------------------------------------------
------------------------------------------------------

   stats |      size     size1      surf     fdexp2    fdtax2  fdgrant  expsize1
revsize1  grants~1
---------+--------------------------------------------------------------------------
---------------
    mean |         1         1     93028  662.4082  683.7686  82.93224  25.03838
25.63191  8.859151
variance |         0         0         0  112820.6  140891.1  1427.488  35.91507
51.00652  4.501282
     min |         1         1     93028  251.3889  335.5226  15.80564  15.85525
16.15864  3.975631
     max |         1         1     93028  1831.088  1901.868    216.09  42.79121
47.75184      14.7
------------------------------------------------------------------------------------
---------------

------------------------------------------------------------------------------------
--------------------------------------------------------
-> country = Poland

   stats |    fdexp     fdtax    fdgrant  realgr~h  lag1re~p  realgd~i  popgro~h
lngfcf~p     educ2
   educ3_n     trade        eu   capital
```

```
---------+----------------------------------------------------------------------------------
-------------------------------------------------------
    mean |  27.65938  28.10996   23.6329  6.088062  6694.193  4098.547 -.0968429
2.979717  38.10625  60.50625  77.66429  .7857143     .0625
variance |  154.5129  154.4515  95.28051  84.35699   5599119  716647.7  .2198908
.0201126  7.074935   309.781  109.4121  .1691224  .0588565
     min |      5.72      5.84     10.71   -18.834   3178.93  3178.928   -5.7534
2.68444      33.6      30.2     58.08         0         0
     max |     68.64     64.63     48.31    21.234  16269.84   6721.16     .6934
3.378611      48.8       118     93.74         1         1
--------------------------------------------------------------------------------------------
-------------------------------------------------------

   stats |      size     size1      surf    fdexp2     fdtax2   fdgrant  expsize1
revsize1  grants~1
---------+----------------------------------------------------------------------------------
---------------
    mean |         1         1    312679  918.8641  930.1409  653.3692  27.65938
28.10996   23.6329
variance |         0         0         0  578949.7  576804.1  329180.2  154.5129
154.4515  95.28051
     min |         1         1    312679   32.7184   33.4048  114.7041      5.72
5.84     10.71
     max |         1         1    312679   4711.45  4077.902  2333.856     68.64
64.63     48.31
--------------------------------------------------------------------------------------------
---------------
```

Appendix 5.2.2 Detailed Descriptive Statistics

```
xtsum fdexp fdtax fdgrant realgrowth lag1realgdp realgdpini popgrowth lngfcf_gdp
educ2 educ3_n trade eu capital size size1 surf fdexp2 fdtax2 fdgrant2
>  expsize revsize grantsize

Variable         |      Mean   Std. Dev.       Min        Max |    Observations
-----------------+--------------------------------------------+----------------
  fdexp  overall |  39.41896   18.53587   4.922366   90.41772 |     N =     732
         between |             17.05992   14.33743   72.64894 |     n =      64
         within  |             9.420385  -2.237592   61.92396 | T-bar = 11.4375
                 |                                            |
  fdtax  overall |  38.92707   18.52447   4.922366   87.73891 |     N =     736
         between |              16.9299   12.00239   72.00077 |     n =      64
         within  |             9.678486  -3.232688   62.44801 | T-bar =    11.5
                 |                                            |
 fdgrant overall |  35.91906   19.22077   3.975631   95.07764 |     N =     732
         between |             17.80925   5.752301   85.66257 |     n =      64
         within  |             7.053193   16.91472   72.95858 | T-bar = 11.4375
                 |                                            |
realgr~h overall |  5.956884   8.643167    -39.103   29.80765 |     N =     779
         between |             2.274794   .9929062   10.08993 |     n =      64
         within  |             8.376556  -39.46042   27.86751 | T-bar = 12.1719
                 |                                            |
lag1re~p overall |  6747.625    4036.11   679.3678   29976.58 |     N =     779
         between |             3954.981   1371.709   26213.91 |     n =      64
         within  |             1518.756   469.1519   12349.03 | T-bar = 12.1719
                 |                                            |
realgd~i overall |  4868.402   3481.345   687.8272   24029.87 |     N =     779
         between |             3749.006   687.8272   24029.87 |     n =      64
         within  |                    0   4868.402   4868.402 | T-bar = 12.1719
                 |                                            |
popgro~h overall | -.5073167   2.369253   -26.8453   15.42908 |     N =     779
         between |             .9642852  -3.550927   2.327851 |     n =      64
         within  |             2.173322  -23.80169   13.54085 | T-bar = 12.1719
                 |                                            |
lngfcf~p overall |  3.297713   .3713231   .9368505    4.32923 |     N =     763
         between |             .3248788    2.60045   4.025808 |     n =      64
         within  |             .1765277   1.152132   4.216605 | T-bar = 11.9219
                 |                                            |
educ2    overall |  55.97906    25.7697      12.15     162.07 |     N =     714
         between |               23.601   30.19222   111.1575 |     n =      64
         within  |             9.387768   11.12997   106.8916 |     T = 11.1563
                 |                                            |
educ3_n  overall |  54.65664   25.47748        4.9      222.7 |     N =     726
         between |             25.50393   6.088889   189.9222 |     n =      64
         within  |             8.766747   26.53442   87.43442 |     T = 11.3438
                 |                                            |
trade    overall |  111.1951   34.50187      58.08   170.4284 |     N =     779
         between |             31.42097   77.66429   145.1178 |     n =      64
         within  |             13.77338   82.88135   137.5533 | T-bar = 12.1719
                 |                                            |
eu       overall |  .7073171   .4552864          0          1 |     N =     779
         between |              .355957          0          1 |     n =      64
         within  |             .2948097  -.2093496   .9380863 | T-bar = 12.1719
                 |                                            |
capital  overall |  .0783055   .2688244          0          1 |     N =     779
         between |             .2704897          0          1 |     n =      64
         within  |                    0   .0783055   .0783055 | T-bar = 12.1719
                 |                                            |
size     overall |  .4043646   .4910839          0          1 |     N =     779
         between |             .4836103          0          1 |     n =      64
         within  |                    0   .4043646   .4043646 | T-bar = 12.1719
                 |                                            |
size1    overall |  .5853659   .4929753          0          1 |     N =     779
         between |             .4963335          0          1 |     n =      64
         within  |             .0343254   .5020325   1.502033 | T-bar = 12.1719
                 |                                            |
surf     overall |    130717   117465.7      28748     312679 |     N =     779
         between |               113137      28748     312679 |     n =      64
         within  |                    0     130717     130717 | T-bar = 12.1719
                 |                                            |
  fdexp2 overall |  1896.964   1704.803   24.22969   8175.364 |     N =     732
         between |             1612.685   226.4088    5621.46 |     n =      64
         within  |             854.1651  -2744.279   4450.867 | T-bar = 11.4375
```

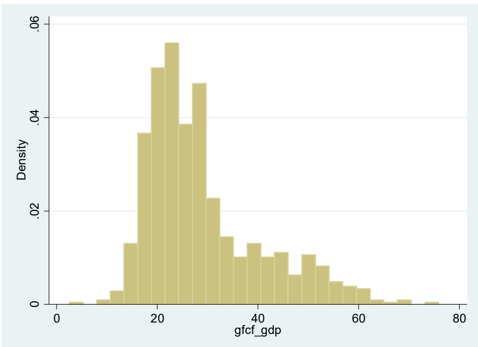
```
             |                                               |
 fdtax2 overall |  1874.088    1686.612    24.22969    7933.152 |     N =     732
        between |              1595.647    187.5087    5569.518 |     n =      64
        within  |               850.337   -2761.155    4477.108 | T-bar = 11.4375
                |                                               |
 fdgrant overall |  1659.112    1628.876    15.80564    9039.757 |     N =     732
         between |              1523.031    34.84422    7358.923 |     n =      64
         within  |              594.4738   -933.0373    4975.472 | T-bar = 11.4375
                 |                                               |
expsize1 overall |  21.46573    24.61945           0    90.41772 |     N =     732
         between |              25.74051           0    72.64894 |     n =      64
         within  |              8.427286   -20.19082    43.97073 | T-bar = 11.4375
                 |                                               |
revsize1 overall |  21.64004     24.5582           0    87.73891 |     N =     736
         between |              25.67181           0    72.00077 |     n =      64
         within  |              8.419279   -20.51972    39.47989 | T-bar =    11.5
                 |                                               |
grants~1 overall |  14.38918     15.9488           0    51.61188 |     N =     732
         between |              16.23175           0    44.39889 |     n =      64
         within  |              5.613671    2.268464    40.46418 | T-bar = 11.4375
```

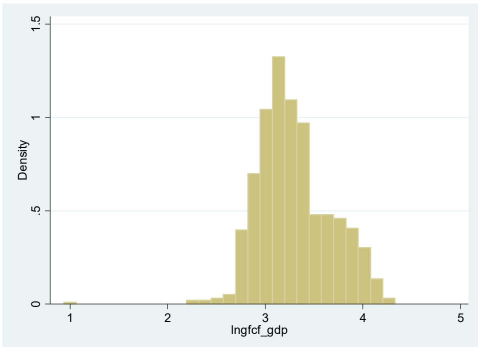
Appendix 5.3 Diagnostics

Appendix 5.3.1 Ladder Stata command for Investment

```
. ladder gfcf_gdp

Transformation         formula               chi2(2)       P(chi2)
------------------------------------------------------------------
cubic                  gfcf_gdp^3                  .         0.000
square                 gfcf_gdp^2                  .         0.000
identity               gfcf_gdp                    .         0.000
square root            sqrt(gfcf_gdp)          47.98         0.000
log                    log(gfcf_gdp)           25.89         0.000
1/(square root)        1/sqrt(gfcf_gdp)            .         0.000
inverse                1/gfcf_gdp                  .         0.000
1/square               1/(gfcf_gdp^2)              .             .
1/cubic                1/(gfcf_gdp^3)              .             .
```

Before   After





Appendix 5.3.2 Unit Root Test

```
. xtunitroot fisher  fdexp, pp lag(1) demean


Fisher-type unit-root test for fdexp
Based on Phillips-Perron tests
--------------------------------------
Ho: All panels contain unit roots           Number of panels       =     64
Ha: At least one panel is stationary        Avg. number of periods =  11.44

AR parameter:    Panel-specific             Asymptotics: T -> Infinity
Panel means:     Included
```

```
Time trend:      Not included              Cross-sectional means removed
Newey-West lags: 1 lag
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(128)  P       292.7475       0.0000
 Inverse normal            Z        -8.2429       0.0000
 Inverse logit t(324)      L*       -8.5783       0.0000
 Modified inv. chi-squared Pm       10.2967       0.0000
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------

. xtunitroot fisher  fdtax, pp lag(1) demean

Fisher-type unit-root test for fdtax
Based on Phillips-Perron tests
--------------------------------------
Ho: All panels contain unit roots          Number of panels       =     64
Ha: At least one panel is stationary       Avg. number of periods =  11.50

AR parameter:    Panel-specific            Asymptotics: T -> Infinity
Panel means:     Included
Time trend:      Not included              Cross-sectional means removed
Newey-West lags: 1 lag
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(128)  P       278.6194       0.0000
 Inverse normal            Z        -6.4581       0.0000
 Inverse logit t(324)      L*       -7.0034       0.0000
 Modified inv. chi-squared Pm        9.4137       0.0000
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------

. xtunitroot fisher  fdgrant, pp lag(1) demean

Fisher-type unit-root test for fdgrant
Based on Phillips-Perron tests
----------------------------------------
Ho: All panels contain unit roots          Number of panels       =     64
Ha: At least one panel is stationary       Avg. number of periods =  11.44

AR parameter:    Panel-specific            Asymptotics: T -> Infinity
Panel means:     Included
Time trend:      Not included              Cross-sectional means removed
Newey-West lags: 1 lag
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(128)  P       535.5551       0.0000
 Inverse normal            Z       -14.0915       0.0000
 Inverse logit t(324)      L*      -17.5739       0.0000
 Modified inv. chi-squared Pm       25.4722       0.0000
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------
xtunitroot fisher realgdppercapita , pp lag(1) demean

Fisher-type unit-root test for realgdppercapita
Based on Phillips-Perron tests
-----------------------------------------------
Ho: All panels contain unit roots          Number of panels       =     64
Ha: At least one panel is stationary       Avg. number of periods =  12.17

AR parameter:    Panel-specific            Asymptotics: T -> Infinity
Panel means:     Included
Time trend:      Not included              Cross-sectional means removed
Newey-West lags: 1 lag
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(128)  P       176.2696       0.0030
```

```
 Inverse normal           Z        -0.8299       0.2033
 Inverse logit t(284)     L*       -1.6563       0.0494
 Modified inv. chi-squared Pm       3.0168       0.0013
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------

. xtunitroot fisher reallngdpini , pp lag(1) demean

Fisher-type unit-root test for reallngdpini
Based on Phillips-Perron tests
-------------------------------------------
Ho: All panels contain unit roots           Number of panels       =     64
Ha: At least one panel is stationary        Avg. number of periods =  12.17

AR parameter:    Panel-specific             Asymptotics: T -> Infinity
Panel means:     Included
Time trend:      Not included               Cross-sectional means removed
Newey-West lags: 1 lag
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(128)  P       157.9698       0.0371
 Inverse normal           Z        -3.0588       0.0011
 Inverse logit t(254)     L*       -3.3769       0.0004
 Modified inv. chi-squared Pm       1.8731       0.0305
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------

. xtunitroot fisher lag1realgdp , pp lag(1) demean

Fisher-type unit-root test for lag1realgdp
Based on Phillips-Perron tests
------------------------------------------
Ho: All panels contain unit roots           Number of panels       =     64
Ha: At least one panel is stationary        Avg. number of periods =  12.17

AR parameter:    Panel-specific             Asymptotics: T -> Infinity
Panel means:     Included
Time trend:      Not included               Cross-sectional means removed
Newey-West lags: 1 lag
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(128)  P       144.8426       0.1466
 Inverse normal           Z         1.3723       0.9150
 Inverse logit t(314)     L*        1.2360       0.8913
 Modified inv. chi-squared Pm       1.0527       0.1462
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------

. xtunitroot fisher popgrowth , pp lag(1) demean

Fisher-type unit-root test for popgrowth
Based on Phillips-Perron tests
----------------------------------------
Ho: All panels contain unit roots           Number of panels       =     64
Ha: At least one panel is stationary        Avg. number of periods =  12.17

AR parameter:    Panel-specific             Asymptotics: T -> Infinity
Panel means:     Included
Time trend:      Not included               Cross-sectional means removed
Newey-West lags: 1 lag
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(128)  P       409.0381       0.0000
 Inverse normal           Z       -13.3690       0.0000
 Inverse logit t(324)     L*      -13.7616       0.0000
 Modified inv. chi-squared Pm      17.5649       0.0000
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
```

```
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------

. xtunitroot fisher educ2 , pp lag(1) demean

Fisher-type unit-root test for educ2
Based on Phillips-Perron tests
------------------------------------
Ho: All panels contain unit roots           Number of panels       =     64
Ha: At least one panel is stationary        Avg. number of periods =  11.16

AR parameter:    Panel-specific             Asymptotics: T -> Infinity
Panel means:     Included
Time trend:      Not included               Cross-sectional means removed
Newey-West lags: 1 lag
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(128)  P       246.4743       0.0000
 Inverse normal            Z        -1.9537       0.0254
 Inverse logit t(319)      L*       -1.9246       0.0276
 Modified inv. chi-squared Pm        7.4046       0.0000
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------

. xtunitroot fisher educ3_n , pp lag(1) demean

Fisher-type unit-root test for educ3_n
Based on Phillips-Perron tests
--------------------------------------
Ho: All panels contain unit roots           Number of panels       =     64
Ha: At least one panel is stationary        Avg. number of periods =  11.34

AR parameter:    Panel-specific             Asymptotics: T -> Infinity
Panel means:     Included
Time trend:      Not included               Cross-sectional means removed
Newey-West lags: 1 lag
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(128)  P        82.2326       0.9994
 Inverse normal            Z         9.2537       1.0000
 Inverse logit t(324)      L*       10.4652       1.0000
 Modified inv. chi-squared Pm       -2.8605       0.9979
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------

. xtunitroot fisher lngfcf_gdp , pp lag(1) demean

Fisher-type unit-root test for lngfcf_gdp
Based on Phillips-Perron tests
-----------------------------------------
Ho: All panels contain unit roots           Number of panels       =     64
Ha: At least one panel is stationary        Avg. number of periods =  11.92

AR parameter:    Panel-specific             Asymptotics: T -> Infinity
Panel means:     Included
Time trend:      Not included               Cross-sectional means removed
Newey-West lags: 1 lag
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(128)  P       414.8845       0.0000
 Inverse normal            Z        -8.1305       0.0000
 Inverse logit t(324)      L*      -11.5602       0.0000
 Modified inv. chi-squared Pm       17.9303       0.0000
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------

. xtunitroot fisher trade, pp lag(1) demean
```

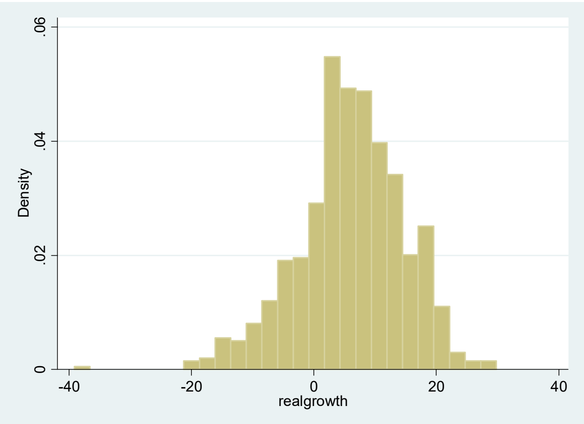
```
Fisher-type unit-root test for trade
Based on Phillips-Perron tests
------------------------------------
Ho: All panels contain unit roots           Number of panels       =     64
Ha: At least one panel is stationary        Avg. number of periods =  12.17

AR parameter:    Panel-specific             Asymptotics: T -> Infinity
Panel means:     Included
Time trend:      Not included               Cross-sectional means removed
Newey-West lags: 1 lag
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(128)  P       126.0572       0.5320
 Inverse normal            Z        -0.3825       0.3510
 Inverse logit t(324)      L*       -0.4277       0.3346
 Modified inv. chi-squared Pm       -0.1214       0.5483
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------

. xtunitroot fisher eu, pp lag(1) demean

Fisher-type unit-root test for eu
Based on Phillips-Perron tests
---------------------------------
Ho: All panels contain unit roots           Number of panels       =     64
Ha: At least one panel is stationary        Avg. number of periods =  12.17

AR parameter:    Panel-specific             Asymptotics: T -> Infinity
Panel means:     Included
Time trend:      Not included               Cross-sectional means removed
Newey-West lags: 1 lag
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(128)  P       363.3001       0.0000
 Inverse normal            Z       -11.9667       0.0000
 Inverse logit t(254)      L*      -13.5747       0.0000
 Modified inv. chi-squared Pm       14.7063       0.0000
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------
```

Appendix 5.3.3 Identifying outliers

```
. lv realgrowth

 #    779               realgrowth
             ---------------------------------
 M    390   |             6.1308              |    spread  pseudosigma
 F    195.5 |  1.402649   6.626893   11.85114 |  10.44849    7.760956
 E     98   | -3.858819    5.92945   15.71772 |  19.57654    8.520485
 D     49.5 | -7.804677   5.304547   18.41377 |  26.21845    8.571728
 C     25   |   -12.702   3.789001      20.28 |    32.982    8.880144
 B     13   |   -15.212   3.379586   21.97117 |  37.18317    8.695266
 A      7   |   -16.264   3.969118   24.20224 |  40.46624    8.485748
 Z      4   |   -18.686   3.993143   26.67229 |  45.35829    8.733507
 Y      2.5 | -19.41361   4.209615   27.83284 |  47.24645    8.520111
 X      1.5 | -29.54811  -.2247248   29.09866 |  58.64677    9.878676
        1   |   -39.103  -4.647674   29.80765 |  68.91065    11.02885
            |                                 |
            |                                 |   # below     # above
inner fence | -14.27008              27.52387 |        19           2
outer fence | -29.94282               43.1966 |         1           0

. lv fdexp

 #    732                 fdexp
             ---------------------------------
 M    366.5 |            37.00857             |    spread  pseudosigma
 F    183.5 |     25.53   37.42872   49.32744 |  23.79744    17.65044
```

```
E       92    |      20.45    42.71342    64.97684 |  44.52684     19.36757
D       46.5  |      12.32    43.34182    74.36364 |  62.04364     20.27914
C       23.5  |      9.315    44.16348    79.01197 |  69.69697     18.76295
B       12    |       8.08    44.78739    81.49479 |  73.41479      17.1039
A        6.5  |      7.435    46.11491    84.79481 |  77.35981     16.18299
Z        3.5  |      6.885    47.42155     87.9581 |   81.0731     15.43862
Y        2    |       5.72    46.88139    88.04278 |  82.32278     14.50795
X        1.5  |   5.321183    47.27572    89.23025 |  83.90906     14.22582
         1    |   4.922366    47.67004    90.41772 |  85.49535     13.76399
              |                                    |
              |                                    |   # below      # above
inner fence   |  -10.16616                 85.0236 |         0            6
outer fence   |  -45.86232                120.7198 |         0            0

. lv fdtax

 #      736                   fdtax
               ----------------------------------
 M      368.5 |               36.79296             |    spread  pseudosigma
 F      184.5 |   24.84435    36.93457    49.02479 |  24.18044     17.93446
 E       92.5 |   19.85934    42.61022    65.36109 |  45.50174     19.79154
 D       46.5 |      12.09    43.07323    74.05647 |  61.96647     20.21728
 C       23.5 |      9.435    43.89562    78.35623 |  68.92123     18.52995
 B       12   |       7.66    44.57739    81.49479 |  73.83479     17.18433
 A        6.5 |   7.231351    45.34619    83.46102 |  76.22967     15.93325
 Z        3.5 |   5.565439    45.16452    84.76359 |  79.19815     15.07094
 Y        2   |   4.954809    45.21889    85.48298 |  80.52817     14.18299
 X        1.5 |   4.938588    45.77477    86.61094 |  81.67236     13.83871
          1   |   4.922366    46.33064    87.73891 |  82.81654     13.32582
              |                                    |
              |                                    |   # below      # above
inner fence   |  -11.42632                85.29546 |         0            2
outer fence   |  -47.69698                121.5661 |         0            0

. lv fdgrant

 #      732                  fdgrant
               ----------------------------------
 M      366.5 |               37.98702             |    spread  pseudosigma
 F      183.5 |     18.585    32.60136    46.61771 |  28.03271     20.79172
 E       92   |      13.36    34.96509    56.57019 |  43.21019     18.79487
 D       46.5 |    9.13951     38.4163    67.69308 |  58.55357      19.1384
 C       23.5 |   7.713619     42.7428    77.77198 |  70.05837     18.86024
 B       12   |   6.754138    46.15072    85.54729 |  78.79316     18.35693
 A        6.5 |   5.362568    46.20354    87.04452 |  81.68195     17.08715
 Z        3.5 |    4.65778    47.57298    90.48819 |  85.83041     16.34455
 Y        2   |   4.342444    48.55487     92.7673 |  88.42485     15.58333
 X        1.5 |   4.159038    49.04075    93.92247 |  89.76343     15.21836
          1   |   3.975631    49.52663    95.07764 |  91.10201     14.66661
              |                                    |
              |                                    |   # below      # above
inner fence   |  -23.46407                88.66678 |         0            5
outer fence   |  -65.51313                130.7158 |         0            0
```

Appendix 5.3.4 Normality test



Appendix 5.3.5 Homoscedasticity

```
****With outliers***
. qui xtreg realgrowth popgrowth educ2 educ3_n lag1realgdp lngfcf_gdp fdexp fdgrant
trade year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12 year13
year14, fe

. xttest3
Modified Wald test for groupwise heteroskedasticity
in fixed effect regression model
H0: sigma(i)^2 = sigma^2 for all i

chi2 (64)  =     749.86
Prob>chi2 =      0.0000


***Dropping outliers****
. qui xtreg realgrowth popgrowth educ2 educ3_n lag1realgdp lngfcf_gdp fdexp fdgrant
trade year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12 year13
year14 if realgrowth<=30 & realgrowth>=-15, fe

. xttest3
Modified Wald test for groupwise heteroskedasticity
in fixed effect regression model
H0: sigma(i)^2 = sigma^2 for all i

chi2 (64)  =    1003.62
Prob>chi2 =      0.0000
```

Appendix 5.3.6 Autocorrelation

```
xtserial realgrowth popgrowth educ2 educ3_n lag1realgdp lngfcf_gdp fdexp fdgrant
trade year2 year3 year4 year5 year6 year7 year8 yea
> r9 year10 year11 year12 year13 year14

Wooldridge test for autocorrelation in panel data
H0: no first order autocorrelation
    F(  1,      63) =     38.231
           Prob > F =      0.0000
```

Appendix 5.3.7 Cross-Sectional Dependence

```
*****without time dummies******

. xtreg realgrowth popgrowth educ2 educ3_n lag1realgdp lngfcf_gdp fdexp fdgrant trade
if realgrowth<=30 & realgrowth>=-15, fe

Fixed-effects (within) regression               Number of obs      =       669
Group variable: idall                           Number of groups   =        64

R-sq:  within  = 0.2902                         Obs per group: min =         7
       between = 0.1194                                        avg =      10.5
       overall = 0.0794                                        max =        12

                                                F(8,597)           =     30.52
corr(u_i, Xb)  = -0.9028                        Prob > F           =    0.0000

------------------------------------------------------------------------------
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |  -.4183127    .118117    -3.54   0.000     -.650288   -.1863375
       educ2 |   .0076948   .0327736     0.23   0.814    -.0566708    .0720603
     educ3_n |  -.0459317    .049002    -0.94   0.349     -.142169    .0503055
 lag1realgdp |  -.0031765   .0002737   -11.60   0.000    -.0037141   -.0026389
  lngfcf_gdp |   4.067299   1.946801     2.09   0.037     .2438886     7.89071
       fdexp |   .2383808   .0341916     6.97   0.000     .1712304    .3055312
     fdgrant |   -.045293   .0501883    -0.90   0.367    -.1438601    .0532742
       trade |   .1243071   .0285906     4.35   0.000     .0681568    .1804575
       _cons |   -6.11794   7.992235    -0.77   0.444    -21.81426    9.578376
-------------+----------------------------------------------------------------
     sigma_u |  11.163831
     sigma_e |  6.9652431
```

```
         rho |  .71980477   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(63, 597) =     2.97             Prob > F = 0.0000

. xtcsd, pesaran abs


Pesaran's test of cross sectional independence =    33.628, Pr = 0.0000

Average absolute value of the off-diagonal elements =     0.394


****including time dummies***

. xtreg realgrowth popgrowth educ2 educ3_n lag1realgdp lngfcf_gdp fdexp fdgrant trade
year2 year3 year4 year5 year6 year7 year8 year9
> year10 year11 year12 year13 year14 if realgrowth<=30 & realgrowth>=-15, fe

Fixed-effects (within) regression               Number of obs      =       669
Group variable: idall                           Number of groups   =        64

R-sq:  within  = 0.5306                         Obs per group: min =         7
       between = 0.1953                                        avg =      10.5
       overall = 0.1804                                        max =        12

                                                F(21,584)          =     31.43
corr(u_i, Xb)  = -0.8681                        Prob > F           =    0.0000

------------------------------------------------------------------------------
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |   -.242587   .1002954    -2.42   0.016    -.4395707   -.0456033
       educ2 |   .0081899   .0283083     0.29   0.772    -.0474086    .0637885
     educ3_n |  -.0801628   .0483738    -1.66   0.098    -.1751705     .014845
 lag1realgdp |  -.0026865   .0003303    -8.13   0.000    -.0033352   -.0020379
  lngfcf_gdp |   1.259192   1.714181     0.73   0.463    -2.107517    4.625902
       fdexp |   .1778083   .0365334     4.87   0.000     .1060554    .2495612
     fdgrant |  -.0709146    .056173    -1.26   0.207    -.1812404    .0394112
       trade |  -.1246322   .0400838    -3.11   0.002    -.2033583   -.0459062
       year2 |  -8.820741   1.662856    -5.30   0.000    -12.08665   -5.554834
       year3 |  -12.73947   1.737666    -7.33   0.000     -16.1523   -9.326632
       year4 |  -9.043643   1.937196    -4.67   0.000    -12.84836   -5.238925
       year5 |  -1.376149   2.108844    -0.65   0.514    -5.517991    2.765692
       year6 |  -2.096433   2.269688    -0.92   0.356    -6.554179    2.361313
       year7 |    .533932   2.398841     0.22   0.824    -4.177473    5.245337
       year8 |  -1.469232   2.536233    -0.58   0.563     -6.45048    3.512016
       year9 |  -13.52662    2.50869    -5.39   0.000    -18.45377   -8.599464
      year10 |  -.6514758   2.673554    -0.24   0.808    -5.902428    4.599476
      year11 |  -.0353899   3.041463    -0.01   0.991    -6.008927    5.938147
      year12 |  -1.420576   3.245357    -0.44   0.662    -7.794568    4.953416
      year13 |   1.404725   3.796158     0.37   0.711     -6.05106    8.860509
      year14 |   4.828693   3.893724     1.24   0.215    -2.818715     12.4761
       _cons |   36.36807   7.952961     4.57   0.000     20.74818    51.98796
-------------+----------------------------------------------------------------
     sigma_u |  11.336428
     sigma_e |  5.7272126
         rho |  .79666585   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(63, 584) =     1.96             Prob > F = 0.0000

. xtcsd, pesaran abs


Pesaran's test of cross sectional independence =     2.308, Pr = 0.0210

Average absolute value of the off-diagonal elements =     0.397
```

Appendix 5.3.8 Functional Form

```
***RESET for xtreg***
. xtreg realgrowth popgrowth educ2 educ3_n lag1realgdp lngfcf_gdp fdexp fdgrant trade
year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12 year13 year14 if
realgrowth<=30 & realgrowth>=-15
```

```
Random-effects GLS regression                   Number of obs      =       669
Group variable: idall                           Number of groups   =        64

R-sq:  within  = 0.4744                         Obs per group: min =         7
       between = 0.7475                                        avg =      10.5
       overall = 0.5002                                        max =        12

                                                Wald chi2(21)      =    647.43
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
  realgrowth |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |  -.3053841     .10075    -3.03   0.002    -.5028505   -.1079177
       educ2 |   .0403119   .0172398     2.34   0.019     .0065225    .0741013
     educ3_n |   .0497641   .0158726     3.14   0.002     .0186543    .0808739
 lag1realgdp |  -.0007108    .000132    -5.39   0.000    -.0009695   -.0004521
  lngfcf_gdp |  -.9404628   .9832033    -0.96   0.339    -2.867506    .9865802
       fdexp |   .0712317   .0195578     3.64   0.000     .0328992    .1095642
     fdgrant |  -.0355276    .016337    -2.17   0.030    -.0675476   -.0035076
       trade |  -.0127822   .0124326    -1.03   0.304    -.0371496    .0115853
       year2 |  -11.00391   1.666136    -6.60   0.000    -14.26948   -7.738343
       year3 |  -14.29718   1.574477    -9.08   0.000     -17.3831   -11.21126
       year4 |  -10.41351   1.608699    -6.47   0.000     -13.5665   -7.260514
       year5 |  -4.138969   1.611203    -2.57   0.010    -7.296869   -.9810696
       year6 |  -7.116558    1.59485    -4.46   0.000    -10.24241    -3.99071
       year7 |  -6.079895   1.575838    -3.86   0.000     -9.16848    -2.99131
       year8 |  -9.593036   1.578768    -6.08   0.000    -12.68736   -6.498708
       year9 |  -22.57517   1.594258   -14.16   0.000    -25.69986   -19.45048
      year10 |  -10.03412   1.575501    -6.37   0.000    -13.12205   -6.946198
      year11 |  -11.88917   1.619493    -7.34   0.000    -15.06332   -8.715025
      year12 |  -14.28328     1.6162    -8.84   0.000    -17.45098   -11.11559
      year13 |  -14.42433   1.865947    -7.73   0.000    -18.08152   -10.76714
      year14 |  -9.363481   2.174853    -4.31   0.000    -13.62611   -5.100848
       _cons |   19.69646   3.044443     6.47   0.000     13.72946    25.66346
-------------+----------------------------------------------------------------
     sigma_u |          0
     sigma_e |  5.7272126
         rho |          0   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. gen yhat2 = yhat^2
(120 missing values generated)

. gen yhat3 = yhat^3
(120 missing values generated)

. xtreg realgrowth popgrowth educ2 educ3_n lag1realgdp lngfcf_gdp fdexp fdgrant trade
year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12 year13 year14
yhat2 yhat3 if realgrowth<=30 & realgrowth>=-15

Random-effects GLS regression                   Number of obs      =       669
Group variable: idall                           Number of groups   =        64

R-sq:  within  = 0.4748                         Obs per group: min =         7
       between = 0.7475                                        avg =      10.5
       overall = 0.5006                                        max =        12

                                                Wald chi2(23)      =    646.51
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
  realgrowth |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |  -.2983005   .1263398    -2.36   0.018    -.5459219   -.0506791
       educ2 |   .0393466   .0189375     2.08   0.038     .0022297    .0764634
     educ3_n |   .0491711   .0162728     3.02   0.003      .017277    .0810651
 lag1realgdp |  -.0006927   .0001429    -4.85   0.000    -.0009729   -.0004126
  lngfcf_gdp |  -.8775312   .9881047    -0.89   0.374    -2.814181    1.059118
       fdexp |   .0700181   .0209014     3.35   0.001     .0290521    .1109841
     fdgrant |  -.0350289   .0166132    -2.11   0.035    -.0675901   -.0024677
       trade |  -.0130207   .0131055    -0.99   0.320     -.038707    .0126656
       year2 |  -10.46563   3.858258    -2.71   0.007    -18.02768   -2.903587
       year3 |  -13.74227   4.123849    -3.33   0.001    -21.82487   -5.659678
       year4 |  -9.755506   3.658801    -2.67   0.008    -16.92663   -2.584388
       year5 |  -3.869517   1.978495    -1.96   0.050    -7.747295    .0082606
       year6 |  -6.514919   3.049158    -2.14   0.033    -12.49116   -.5386796
```

```
       year7 |  -5.508926   2.926745    -1.88   0.060    -11.24524    .2273892
       year8 |  -9.008699   3.646635    -2.47   0.013    -16.15597   -1.861425
       year9 |  -21.60192   4.093737    -5.28   0.000    -29.62549   -13.57834
      year10 |   -9.44166   3.661181    -2.58   0.010    -16.61744   -2.265877
      year11 |  -11.35544   3.862532    -2.94   0.003    -18.92587   -3.785019
      year12 |  -13.81131   3.992568    -3.46   0.001     -21.6366    -5.98602
      year13 |  -13.98936   3.959244    -3.53   0.000    -21.74933   -6.229382
      year14 |  -8.730653   3.932239    -2.22   0.026     -16.4377   -1.023606
       yhat2 |  -.0075022   .0121593    -0.62   0.537     -.031334    .0163296
       yhat3 |   .0005404   .0008324     0.65   0.516    -.0010911    .0021719
       _cons |    19.0862   4.839946     3.94   0.000     9.600084    28.57232
-------------+----------------------------------------------------------------
     sigma_u |          0
     sigma_e |  5.7280388
         rho |          0   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. xtreg realgrowth popgrowth educ2 educ3_n lag1realgdp lngfcf_gdp fdexp fdgrant trade
year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12 year13 year14
yhat2 if realgrowth<=30 & realgrowth>=-15

Random-effects GLS regression                   Number of obs      =       669
Group variable: idall                           Number of groups   =        64

R-sq:  within  = 0.4742                         Obs per group: min =         7
       between = 0.7492                                        avg =      10.5
       overall = 0.5003                                        max =        12

                                                Wald chi2(22)      =    646.67
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
  realgrowth |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |  -.3267993   .1184153    -2.76   0.006    -.5588891   -.0947095
       educ2 |   .0424383   .0183207     2.32   0.021     .0065303    .0783463
     educ3_n |   .0506723   .0161004     3.15   0.002     .0191161    .0822286
 lag1realgdp |  -.0007216   .0001358    -5.32   0.000    -.0009877   -.0004556
  lngfcf_gdp |  -.9229541   .9851831    -0.94   0.349    -2.853877    1.007969
       fdexp |   .0731339   .0203338     3.60   0.000     .0332803    .1129875
     fdgrant |  -.0362808   .0164935    -2.20   0.028    -.0686074   -.0039541
       trade |  -.0140797   .0129978    -1.08   0.279    -.0395548    .0113955
       year2 |  -11.92088   3.138915    -3.80   0.000    -18.07304   -5.768716
       year3 |  -15.31218   3.338948    -4.59   0.000     -21.8564   -8.767965
       year4 |  -11.23105   2.865968    -3.92   0.000    -16.84824   -5.613856
       year5 |  -4.410145   1.793905    -2.46   0.014    -7.926135    -.894155
       year6 |  -7.734754   2.400368    -3.22   0.001    -12.43939   -3.030119
       year7 |  -6.666535   2.319825    -2.87   0.004    -11.21331   -2.119762
       year8 |  -10.43522    2.90899    -3.59   0.000    -16.13673     -4.7337
       year9 |  -23.43562   2.961932    -7.91   0.000     -29.2409   -17.63034
      year10 |  -10.87923   2.914346    -3.73   0.000    -16.59124   -5.167215
      year11 |  -12.81586   3.138473    -4.08   0.000    -18.96715   -6.664562
      year12 |  -15.27326   3.295433    -4.63   0.000     -21.7322   -8.814334
      year13 |  -15.37594   3.332273    -4.61   0.000    -21.90708   -8.844806
      year14 |  -10.18602   3.229201    -3.15   0.002    -16.51514   -3.856905
       yhat2 |  -.0036609   .0106178    -0.34   0.730    -.0244714    .0171496
       _cons |   20.67851   4.170599     4.96   0.000     12.50429    28.85273
-------------+----------------------------------------------------------------
     sigma_u |          0
     sigma_e |   5.724321
         rho |          0   (fraction of variance due to u_i)
------------------------------------------------------------------------------
*RESET Test FEVD
. xtfevd realgrowth popgrowth educ2_n educ3_n  lngfcf_gdp reallngdpini fdexp fdgrant
trade  yhat2 yhat3 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12
year13 year14 if realgrowth<=30 & realgrowth>=-13, invariant(educ2_n educ3_n
reallngdpini)

panel fixed effects regression with vector decomposition

degrees of freedom fevd    =       575          number of obs       =       661
mean squared error         = 31.26329           F( 24, 575)         = 18.12829
root mean squared error    = 5.591359           Prob > F            = 2.95e-52
Residual Sum of Squares    = 20665.03           R-squared           = .5184994
Total Sum of Squares       = 42917.98           adj. R-squared      =  .447321
Estimation Sum of Squares  = 22252.95
```

```
------------------------------------------------------------------------------
             |                fevd
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |  -.2724502   .1266528    -2.15   0.032    -.5212087   -.0236917
  lngfcf_gdp |  -1.010445   2.059429    -0.49   0.624    -5.055366    3.034475
       fdexp |   .1597166   .0340486     4.69   0.000     .0928419    .2265913
     fdgrant |  -.1501723    .062525    -2.40   0.017    -.2729776    -.027367
       trade |  -.0581034   .0436191    -1.33   0.183    -.1437756    .0275687
       yhat2 |   .0084141   .0158427     0.53   0.596    -.0227025    .0395306
       yhat3 |  -.0004634   .0007851    -0.59   0.555    -.0020053    .0010785
       year3 |  -9.820639   2.026451    -4.85   0.000    -13.80079   -5.840491
       year4 |  -6.728839   1.973726    -3.41   0.001    -10.60543   -2.852248
       year5 |   .2051343   1.931182     0.11   0.915    -3.587897    3.998166
       year6 |  -2.312014   1.732616    -1.33   0.183    -5.715041    1.091014
       year7 |  -1.215559   1.680642    -0.72   0.470    -4.516505    2.085387
       year8 |  -5.146013   1.867608    -2.76   0.006    -8.814178   -1.477848
       year9 |  -17.21488   2.035661    -8.46   0.000    -21.21311   -13.21664
      year10 |  -3.580859   1.913578    -1.87   0.062    -7.339314    .1775962
      year11 |  -4.916126   2.185113    -2.25   0.025    -9.207903   -.6243489
      year12 |  -7.762492   2.335994    -3.32   0.001    -12.35061   -3.174371
      year13 |  -5.830134   2.552403    -2.28   0.023     -10.8433   -.8169629
      year14 |  -5.101441   3.335199    -1.53   0.127     -11.6521    1.449217
     educ2_n |   .1091982   .0595806     1.83   0.067    -.0078239    .2262203
     educ3_n |   .0102609   .0260056     0.39   0.693    -.0408166    .0613383
reallngdpini |  -3.153497   1.619467    -1.95   0.052    -6.334289    .0272957
         eta |          1          .        .       .            .           .
       _cons |   38.93111    13.1591     2.96   0.003     13.08535    64.77688
------------------------------------------------------------------------------


. . test yhat2=yhat3=0

 ( 1)  yhat2 - yhat3 = 0
 ( 2)  yhat2 = 0

       F(  2,   575) =    0.18
            Prob > F =    0.8333

*RESET Test Dynamic
. xtabond2 realgrowth l.realgrowth reallngdpini popgrowth l.educ2_n l.educ3_n
lngfcf_gdp fdexp fdgrant l.trade yhat2 yhat3 year3 year4 year5 year6 year7 year8
year9 year10 year11 year12 year13 year14  if realgrowth <=30, gmm( l.realgrowth,
laglimits(2 4)collapse) gmm(lngfcf_gdp, laglimits(2 3) collapse)  iv( popgrowth
l.educ2_n l.educ3_n fdgrant fdexp l.trade year3-year14)
>  two robust small
Favoring speed over space. To switch, type or click on mata: mata set matafavor
space, perm.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: idall                           Number of obs      =       667
Time variable : year                            Number of groups   =        64
Number of instruments = 26                      Obs per group: min =         7
F(23, 63)     =     76.74                                      avg =     10.42
Prob > F      =     0.000                                      max =        12
------------------------------------------------------------------------------
             |              Corrected
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  realgrowth |
         L1. |  -.0009635   .3929579    -0.00   0.998    -.7862272    .7843002
             |
reallngdpini |  -19.70279   7.357228    -2.68   0.009    -34.40504   -5.000545
   popgrowth |   .0050057   .1624543     0.03   0.976    -.3196332    .3296447
             |
     educ2_n |
         L1. |  -.3386138   .1606796    -2.11   0.039    -.6597063   -.0175213
             |
     educ3_n |
         L1. |   .1948775   .0625555     3.12   0.003     .0698703    .3198847
             |
  lngfcf_gdp |   11.28738   5.354646     2.11   0.039     .5869737    21.98779
       fdexp |   .1906859   .0861288     2.21   0.030     .0185711    .3628007
     fdgrant |    .050353   .0421773     1.19   0.237    -.0339316    .1346375
             |
       trade |
```

```
         L1. |   .1789727   .0840319     2.13   0.037     .0110482    .3468971
             |
       yhat2 |   .0132235   .0150384     0.88   0.383    -.0168283    .0432754
       yhat3 |  -.0017391   .0017593    -0.99   0.327    -.0052549    .0017767
       year3 |  -14.64703   3.266658    -4.48   0.000    -21.17493   -8.119136
       year4 |  -6.591996   4.301584    -1.53   0.130    -15.18803    2.004034
       year5 |   .7643628   5.706901     0.13   0.894    -10.63997     12.1687
       year6 |  -7.906766   2.203418    -3.59   0.001    -12.30995   -3.503585
       year7 |  -9.133904   2.698658    -3.38   0.001    -14.52674   -3.741066
       year8 |  -15.26392   4.351717    -3.51   0.001    -23.96013   -6.567703
       year9 |  -31.78117   6.265399    -5.07   0.000    -44.30157   -19.26077
      year10 |  -11.94481   7.893823    -1.51   0.135    -27.71935    3.829739
      year11 |  -16.95982   4.285321    -3.96   0.000    -25.52335   -8.396294
      year12 |  -22.36979   4.963173    -4.51   0.000     -32.2879   -12.45168
      year13 |  -19.45937   4.911118    -3.96   0.000    -29.27346   -9.645287
      year14 |  -18.30647   5.016179    -3.65   0.001     -28.3305   -8.282435
       _cons |   126.8855   47.71868     2.66   0.010      31.5273    222.2436
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(popgrowth L.educ2_n L.educ3_n fdgrant fdexp L.trade year3 year4
    year5 year6 year7 year8 year9 year10 year11 year12 year13 year14)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(2/3).lngfcf_gdp collapsed
    L(2/4).L.realgrowth collapsed
Instruments for levels equation
  Standard
    popgrowth L.educ2_n L.educ3_n fdgrant fdexp L.trade year3 year4 year5
    year6 year7 year8 year9 year10 year11 year12 year13 year14
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.lngfcf_gdp collapsed
    DL.L.realgrowth collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -1.85  Pr > z =  0.064
Arellano-Bond test for AR(2) in first differences: z =   0.63  Pr > z =  0.528
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(2)    =   1.40  Prob > chi2 =  0.495
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(2)    =   1.91  Prob > chi2 =  0.385
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(0)    =   0.00  Prob > chi2 =      .
    Difference (null H = exogenous): chi2(2)    =   1.91  Prob > chi2 =  0.385


. . test yhat2=yhat3=0

 ( 1)  yhat2 - yhat3 = 0
 ( 2)  yhat2 = 0

       F(  2,    63) =    0.58
            Prob > F =    0.5607
```

Appendix 5.3.9 Coefficent of the lagged dependent variable

a) Using fdexp and fdgrant

```
. xtabond2 realgrowth l.realgrowth reallngdpini popgrowth l.educ2_n l.educ3_n
lngfcf_gdp fdexp fdgrant l.trade year3 year4 year5 year6 year7 year8 year9
> year10 year11 year12 year13 year14  if realgrowth <=30, gmm( l.realgrowth,
laglimits(2 4)collapse) gmm(lngfcf_gdp, laglimits(2 3) collapse)  iv( popgrowth
> l.educ2_n l.educ3_n fdgrant fdexp l.trade year3-year14) two robust small
Favoring speed over space. To switch, type or click on mata: mata set matafavor
space, perm.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: idall                           Number of obs      =       667
Time variable : year                            Number of groups   =        64
Number of instruments = 26                      Obs per group: min =         7
F(21, 63)      =     60.70                                     avg =     10.42
```

```
Prob > F      =     0.000                                      max =        12
------------------------------------------------------------------------------
             |              Corrected
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  realgrowth |
         L1. |  -.0215056    .257595    -0.08   0.934    -.5362681     .493257
             |
reallngdpini |  -14.23625   2.348011    -6.06   0.000    -18.92837   -9.544124
   popgrowth |   .0322902   .1460944     0.22   0.826    -.2596561    .3242365
             |
     educ2_n |
         L1. |  -.2424439   .0554968    -4.37   0.000    -.3533455   -.1315423
             |
     educ3_n |
         L1. |   .1527514   .0318387     4.80   0.000     .0891268     .216376
             |
  lngfcf_gdp |   9.449319   4.546604     2.08   0.042     .3636563    18.53498
       fdexp |   .1291647   .0411546     3.14   0.003     .0469237    .2114056
     fdgrant |   .0390249   .0367483     1.06   0.292    -.0344107    .1124605
             |
       trade |
         L1. |   .1277195   .0378302     3.38   0.001     .0521218    .2033172
             |
       year3 |  -12.37479   2.375815    -5.21   0.000    -17.12248   -7.627101
       year4 |   -5.70202   3.259109    -1.75   0.085    -12.21483    .8107892
       year5 |  -.9707039   2.739709    -0.35   0.724    -6.445575    4.504167
       year6 |  -6.530602   1.641922    -3.98   0.000    -9.811722   -3.249482
       year7 |  -7.205479   2.112292    -3.41   0.001    -11.42656     -2.9844
       year8 |  -11.67449   2.167961    -5.39   0.000    -16.00682   -7.342166
       year9 |  -25.28787   2.344321   -10.79   0.000    -29.97262   -20.60311
      year10 |  -9.884496   6.053253    -1.63   0.107    -21.98096    2.211966
      year11 |  -13.30136   2.647067    -5.02   0.000    -18.59111   -8.011622
      year12 |  -18.10939   2.723987    -6.65   0.000    -23.55284   -12.66593
      year13 |  -16.02542    3.76306    -4.26   0.000    -23.54529    -8.50554
      year14 |  -14.85026   3.901311    -3.81   0.000    -22.64641   -7.054114
       _cons |    89.5537   20.36747     4.40   0.000     48.85256    130.2548
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(popgrowth L.educ2_n L.educ3_n fdgrant fdexp L.trade year3 year4
    year5 year6 year7 year8 year9 year10 year11 year12 year13 year14)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(2/3).lngfcf_gdp collapsed
    L(2/4).L.realgrowth collapsed
Instruments for levels equation
  Standard
    popgrowth L.educ2_n L.educ3_n fdgrant fdexp L.trade year3 year4 year5
    year6 year7 year8 year9 year10 year11 year12 year13 year14
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.lngfcf_gdp collapsed
    DL.L.realgrowth collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -2.61  Pr > z =  0.009
Arellano-Bond test for AR(2) in first differences: z =   0.94  Pr > z =  0.346
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(4)    =   2.25  Prob > chi2 =  0.689
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(4)    =   2.77  Prob > chi2 =  0.596
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(2)    =   0.05  Prob > chi2 =  0.976
    Difference (null H = exogenous): chi2(2)    =   2.73  Prob > chi2 =  0.256
  gmm(L.realgrowth, collapse lag(2 4))
    Hansen test excluding group:     chi2(0)    =   0.00  Prob > chi2 =      .
    Difference (null H = exogenous): chi2(4)    =   2.77  Prob > chi2 =  0.596
  gmm(lngfcf_gdp, collapse lag(2 3))
    Hansen test excluding group:     chi2(1)    =   1.46  Prob > chi2 =  0.227
    Difference (null H = exogenous): chi2(3)    =   1.32  Prob > chi2 =  0.725


. xtreg realgrowth l.realgrowth reallngdpini popgrowth l.educ2_n l.educ3_n lngfcf_gdp
fdexp fdgrant l.trade year3 year4 year5 year6 year7 year8 year9 yea
> r10 year11 year12 year13 year14  if realgrowth <=30
```

```
Random-effects GLS regression                   Number of obs      =       667
Group variable: idall                           Number of groups   =        64

R-sq:  within  = 0.5171                         Obs per group: min =         7
       between = 0.7876                                        avg =      10.4
       overall = 0.5459                                        max =        12

                                                Wald chi2(21)      =    775.45
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
  realgrowth |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  realgrowth |
         L1. |   -.072779   .0390392    -1.86   0.062    -.1492944    .0037364
             |
reallngdpini |  -4.948618   .7701883    -6.43   0.000    -6.458159   -3.439076
   popgrowth |  -.2693042   .1029602    -2.62   0.009    -.4711024    -.067506
             |
     educ2_n |
         L1. |   .0276192   .0203987     1.35   0.176    -.0123616       .0676
             |
     educ3_n |
         L1. |   .0275357   .0127629     2.16   0.031     .0025209    .0525506
             |
  lngfcf_gdp |  -1.542935   1.070919    -1.44   0.150    -3.641897    .5560269
       fdexp |   .0877579   .0197154     4.45   0.000     .0491164    .1263993
     fdgrant |  -.0600467   .0196918    -3.05   0.002    -.0986419   -.0214515
             |
       trade |
         L1. |   .0274704   .0129218     2.13   0.034     .0021441    .0527967
             |
       year3 |  -9.984609   1.733652    -5.76   0.000     -13.3825   -6.586713
       year4 |  -3.831231   1.727011    -2.22   0.027     -7.21611   -.4463514
       year5 |   2.655208   1.689345     1.57   0.116     -.655847    5.966262
       year6 |  -.4229342    1.63342    -0.26   0.796    -3.624378     2.77851
       year7 |  -.3245804   1.654308    -0.20   0.844    -3.566965    2.917804
       year8 |  -4.586645     1.6682    -2.75   0.006    -7.856257   -1.317032
       year9 |  -19.94905   1.661123   -12.01   0.000    -23.20479   -16.69331
      year10 |  -5.827508   1.898897    -3.07   0.002    -9.549278   -2.105738
      year11 |  -7.305296   1.725583    -4.23   0.000    -10.68738   -3.923215
      year12 |  -10.47275   1.792599    -5.84   0.000    -13.98618   -6.959324
      year13 |  -9.180348   1.811875    -5.07   0.000    -12.73156   -5.629139
      year14 |  -8.810776   2.095283    -4.21   0.000    -12.91746   -4.704096
       _cons |   50.44317   6.919431     7.29   0.000     36.88134    64.00501
-------------+----------------------------------------------------------------
     sigma_u |          0
     sigma_e |  5.8195132
         rho |          0   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. xtreg realgrowth l.realgrowth reallngdpini popgrowth l.educ2_n l.educ3_n lngfcf_gdp
fdexp fdgrant l.trade year3 year4 year5 year6 year7 year8 year9 yea
> r10 year11 year12 year13 year14  if realgrowth <=30, fe
note: reallngdpini omitted because of collinearity

Fixed-effects (within) regression               Number of obs      =       667
Group variable: idall                           Number of groups   =        64

R-sq:  within  = 0.5527                         Obs per group: min =         7
       between = 0.0093                                        avg =      10.4
       overall = 0.1935                                        max =        12

                                                F(20,583)          =     36.02
corr(u_i, Xb)  = -0.7077                        Prob > F           =    0.0000

------------------------------------------------------------------------------
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  realgrowth |
         L1. |  -.1474614   .0405483    -3.64   0.000    -.2270999   -.0678228
             |
reallngdpini |          0  (omitted)
   popgrowth |  -.3157947   .1047889    -3.01   0.003    -.5216044   -.1099849
             |
     educ2_n |
```

```
         L1. |   .0922034    .034999     2.63   0.009     .0234639     .160943
             |
     educ3_n |
         L1. |  -.1899787   .0527734    -3.60   0.000     -.293628   -.0863295
             |
  lngfcf_gdp |   .8518609   1.892637     0.45   0.653    -2.865356    4.569078
       fdexp |   .1509231   .0334451     4.51   0.000     .0852356    .2166107
      fdgrant |  -.0858196    .0560904    -1.53   0.127    -.1959834    .0243443
             |
       trade |
         L1. |   .1492256   .0406274     3.67   0.000     .0694317    .2290195
             |
       year3 |  -10.36309    1.80732    -5.73   0.000    -13.91274   -6.813435
       year4 |  -5.513337   1.920255    -2.87   0.004    -9.284797   -1.741877
       year5 |   1.495242   1.962297     0.76   0.446     -2.35879    5.349275
       year6 |  -.9241435   1.948156    -0.47   0.635    -4.750402    2.902115
       year7 |  -2.006022   2.012716    -1.00   0.319     -5.95908    1.947035
       year8 |  -6.162189   2.078339    -2.96   0.003    -10.24413   -2.080246
       year9 |  -20.90535   2.103326    -9.94   0.000    -25.03637   -16.77433
      year10 |  -6.457066   2.210416    -2.92   0.004    -10.79841   -2.115719
      year11 |  -7.852106    2.24909    -3.49   0.001    -12.26941     -3.4348
      year12 |  -12.14036   2.527083    -4.80   0.000    -17.10365    -7.17706
      year13 |  -11.50789   2.680381    -4.29   0.000    -16.77227   -6.243507
      year14 |  -11.15938   3.046645    -3.66   0.000    -17.14311   -5.175642
       _cons |  -3.856166   8.145727    -0.47   0.636    -19.85471    12.14238
-------------+----------------------------------------------------------------
     sigma_u |  8.1098291
     sigma_e |  5.8195132
         rho |  .66009562   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(63, 583) =     2.04             Prob > F = 0.0000
```

b) Using fdtax and fdgrant

```
. xtabond2 realgrowth l.realgrowth reallngdpini popgrowth l.educ2_n l.educ3_n
lngfcf_gdp fdtax fdgrant l.trade year3 year4 year5 year6 year7 year8 year9
> year10 year11 year12 year13 year14  if realgrowth <=30, gmm( l.realgrowth,
laglimits(2 3)collapse) gmm(lngfcf_gdp, laglimits(2 4) collapse)  iv( popgrowth
> l.educ2_n l.educ3_n fdgrant fdtax l.trade  year3-year14) two robust small
Favoring speed over space. To switch, type or click on mata: mata set matafavor
space, perm.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: idall                           Number of obs      =       667
Time variable : year                            Number of groups   =        64
Number of instruments = 26                      Obs per group: min =         7
F(21, 63)     =     63.68                                      avg =     10.42
Prob > F      =     0.000                                      max =        12
------------------------------------------------------------------------------
             |              Corrected
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  realgrowth |
         L1. |  -.1419756   .2603648    -0.55   0.587    -.6622731    .3783219
             |
reallngdpini |  -15.73245   2.480122    -6.34   0.000    -20.68858   -10.77632
   popgrowth |  -.0115606   .1772633    -0.07   0.948    -.3657931    .3426719
             |
     educ2_n |
         L1. |  -.2266404   .0585138    -3.87   0.000     -.343571   -.1097099
             |
     educ3_n |
         L1. |   .1500531   .0301169     4.98   0.000     .0898693     .210237
             |
  lngfcf_gdp |   8.157901   3.800084     2.15   0.036     .5640378    15.75176
       fdtax |   .1859658   .0462113     4.02   0.000       .09362    .2783116
     fdgrant |   .0205592   .0414437     0.50   0.622    -.0622594    .1033779
             |
       trade |
         L1. |   .1276025   .0391622     3.26   0.002      .049343     .205862
             |
       year3 |  -13.75813   2.361802    -5.83   0.000    -18.47781   -9.038441
       year4 |  -7.847596   3.608922    -2.17   0.033    -15.05945   -.6357411
       year5 |  -2.174529   3.085238    -0.70   0.484    -8.339884    3.990827
```

```
       year6 |  -6.615933   1.760505    -3.76   0.000    -10.13402   -3.097844
       year7 |  -7.922245   2.128078    -3.72   0.000    -12.17487   -3.669621
       year8 |   -13.2305   2.293328    -5.77   0.000    -17.81335    -8.64765
       year9 |  -27.13567   2.809651    -9.66   0.000    -32.75031   -21.52103
      year10 |  -13.33582   6.510628    -2.05   0.045    -26.34627   -.3253692
      year11 |  -14.66722   3.106959    -4.72   0.000    -20.87598   -8.458455
      year12 |  -20.31179   3.017584    -6.73   0.000    -26.34195   -14.28163
      year13 |  -17.87656   4.067021    -4.40   0.000    -26.00385   -9.749266
      year14 |  -17.48385   4.208439    -4.15   0.000    -25.89375   -9.073956
       _cons |   106.4017   21.63519     4.92   0.000     63.16719    149.6361
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(popgrowth L.educ2_n L.educ3_n fdgrant fdtax L.trade year3 year4
    year5 year6 year7 year8 year9 year10 year11 year12 year13 year14)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(2/4).lngfcf_gdp collapsed
    L(2/3).L.realgrowth collapsed
Instruments for levels equation
  Standard
    popgrowth L.educ2_n L.educ3_n fdgrant fdtax L.trade year3 year4 year5
    year6 year7 year8 year9 year10 year11 year12 year13 year14
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.lngfcf_gdp collapsed
    DL.L.realgrowth collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -2.24  Pr > z =  0.025
Arellano-Bond test for AR(2) in first differences: z =   0.52  Pr > z =  0.604
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(4)    =   4.55  Prob > chi2 =  0.337
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(4)    =   4.26  Prob > chi2 =  0.372
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(2)    =   0.38  Prob > chi2 =  0.828
    Difference (null H = exogenous): chi2(2)    =   3.89  Prob > chi2 =  0.143
  gmm(L.realgrowth, collapse lag(2 3))
    Hansen test excluding group:     chi2(1)    =   3.72  Prob > chi2 =  0.054
    Difference (null H = exogenous): chi2(3)    =   0.54  Prob > chi2 =  0.909
  gmm(lngfcf_gdp, collapse lag(2 4))
    Hansen test excluding group:     chi2(0)    =   0.00  Prob > chi2 =      .
    Difference (null H = exogenous): chi2(4)    =   4.26  Prob > chi2 =  0.372


. xtreg realgrowth l.realgrowth reallngdpini popgrowth l.educ2_n l.educ3_n lngfcf_gdp
fdtax fdgrant l.trade year3 year4 year5 year6 year7 year8 year9 yea
> r10 year11 year12 year13 year14  if realgrowth <=30

Random-effects GLS regression                   Number of obs      =       667
Group variable: idall                           Number of groups   =        64

R-sq:  within  = 0.5277                         Obs per group: min =         7
       between = 0.7837                                        avg =      10.4
       overall = 0.5546                                        max =        12

                                                Wald chi2(21)      =    803.28
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
  realgrowth |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  realgrowth |
         L1. |  -.0791386   .0386965    -2.05   0.041    -.1549823    -.003295
             |
reallngdpini |  -5.693035   .7824621    -7.28   0.000    -7.226632   -4.159437
   popgrowth |  -.3111691   .1026406    -3.03   0.002    -.5123409   -.1099972
             |
     educ2_n |
         L1. |   .0309598   .0201758     1.53   0.125    -.0085841    .0705037
             |
     educ3_n |
         L1. |   .0307171    .012597     2.44   0.015     .0060274    .0554067
             |
  lngfcf_gdp |  -2.271227   1.077219    -2.11   0.035    -4.382538   -.1599159
```

```
       fdtax |   .1165167   .0203332     5.73   0.000     .0766645     .156369
     fdgrant |  -.0685605   .0195611    -3.50   0.000    -.1068996   -.0302215
             |
       trade |
         L1. |   .0303207   .0127105     2.39   0.017     .0054086    .0552329
             |
       year3 |  -10.50502   1.721527    -6.10   0.000    -13.87915   -7.130886
       year4 |  -4.571366   1.716992    -2.66   0.008    -7.936609   -1.206123
       year5 |    1.77418   1.686351     1.05   0.293    -1.531007    5.079367
       year6 |  -1.105234   1.623108    -0.68   0.496    -4.286468       2.076
       year7 |  -.9980931   1.635388    -0.61   0.542    -4.203395    2.207209
       year8 |  -5.358999   1.650589    -3.25   0.001    -8.594093   -2.123905
       year9 |  -20.84808   1.657412   -12.58   0.000    -24.09654   -17.59961
      year10 |  -6.409421   1.871195    -3.43   0.001     -10.0769   -2.741946
      year11 |  -7.926905   1.696632    -4.67   0.000    -11.25224   -4.601567
      year12 |  -11.18331   1.761021    -6.35   0.000    -14.63485   -7.731774
      year13 |  -9.710675   1.788893    -5.43   0.000    -13.21684   -6.204508
      year14 |  -9.588007    2.06305    -4.65   0.000    -13.63151   -5.544502
       _cons |   58.17324   7.111111     8.18   0.000     44.23572    72.11076
-------------+----------------------------------------------------------------
     sigma_u |          0
     sigma_e |  5.7658724
         rho |          0   (fraction of variance due to u_i)
------------------------------------------------------------------------------


. xtreg realgrowth l.realgrowth reallngdpini popgrowth l.educ2_n l.educ3_n lngfcf_gdp
fdtax fdgrant l.trade year3 year4 year5 year6 year7 year8 year9 yea
> r10 year11 year12 year13 year14  if realgrowth <=30, fe
note: reallngdpini omitted because of collinearity

Fixed-effects (within) regression               Number of obs      =       667
Group variable: idall                           Number of groups   =        64

R-sq:  within  = 0.5609                         Obs per group: min =         7
       between = 0.0136                                        avg =      10.4
       overall = 0.1816                                        max =        12

                                                F(20,583)          =     37.24
corr(u_i, Xb)  = -0.7289                        Prob > F           =    0.0000

------------------------------------------------------------------------------
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  realgrowth |
         L1. |  -.1456837   .0401016    -3.63   0.000     -.224445   -.0669224
             |
reallngdpini |          0  (omitted)
   popgrowth |  -.3520739   .1042348    -3.38   0.001    -.5567954   -.1473524
             |
     educ2_n |
         L1. |   .1163874   .0353995     3.29   0.001     .0468613    .1859135
             |
     educ3_n |
         L1. |  -.1618967   .0528602    -3.06   0.002    -.2657164    -.058077
             |
  lngfcf_gdp |  -.4329691   1.888143    -0.23   0.819     -4.14136    3.275422
       fdtax |   .1863825    .033134     5.63   0.000     .1213058    .2514591
     fdgrant |  -.0766169   .0553145    -1.39   0.167    -.1852569    .0320232
             |
       trade |
         L1. |   .1657165   .0402019     4.12   0.000     .0867583    .2446746
             |
       year3 |  -10.56633   1.791404    -5.90   0.000    -14.08472   -7.047936
       year4 |  -6.111884   1.907776    -3.20   0.001    -9.858835   -2.364933
       year5 |   .6271252   1.961855     0.32   0.749     -3.22604     4.48029
       year6 |   -1.67647   1.943557    -0.86   0.389    -5.493696    2.140757
       year7 |  -2.706148   2.003354    -1.35   0.177    -6.640818    1.228522
       year8 |  -7.105887   2.078218    -3.42   0.001    -11.18759   -3.024181
       year9 |  -22.05531   2.107888   -10.46   0.000    -26.19529   -17.91533
      year10 |  -6.798347   2.186525    -3.11   0.002    -11.09277   -2.503921
      year11 |  -8.637126   2.240798    -3.85   0.000    -13.03815   -4.236106
      year12 |  -13.22349   2.525023    -5.24   0.000    -18.18274    -8.26424
      year13 |  -12.30996   2.656919    -4.63   0.000    -17.52826   -7.091659
      year14 |  -12.17663   3.030236    -4.02   0.000    -18.12814   -6.225122
       _cons |  -5.411605   8.042776    -0.67   0.501    -21.20795    10.38474
-------------+----------------------------------------------------------------
```

```
     sigma_u |  8.4958517
     sigma_e |  5.7658724
         rho |  .68465398   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(63, 583) =     2.22             Prob > F = 0.0000
```

Appendix 5.4 Static

Appendix 5.4.1 FE vs RE

Appendix 5.4.2 FE with Driscoll-Kraay SEs

```
. xtscc realgrowth popgrowth educ2_n educ3_n lag1realgdp lngfcf_gdp fdexp fdgrant trade
year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12 year13 year14 if
realgrowth<=30 & realgrowth>=-15, fe ase


Regression with Driscoll-Kraay standard errors   Number of obs     =       669
Method: Fixed-effects regression                 Number of groups  =        64
Group variable (i): idall                        F( 21,     13)    =9515766.36
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.5403

------------------------------------------------------------------------------
             |             Drisc/Kraay
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |  -.2274672   .1276371    -1.78   0.098    -.5032103    .0482759
     educ2_n |   .1128129   .0602703     1.87   0.084    -.0173932     .243019
     educ3_n |  -.1386301   .0563061    -2.46   0.029     -.260272   -.0169882
 lag1realgdp |  -.0025648   .0006905    -3.71   0.003    -.0040565    -.001073
  lngfcf_gdp |   .2050885   2.768467     0.07   0.942     -5.77582    6.185997
       fdexp |   .1930638   .0935809     2.06   0.060    -.0091054    .3952331
     fdgrant |    -.09527   .1203717    -0.79   0.443    -.3553171    .1647772
       trade |  -.1156998    .126169    -0.92   0.376    -.3882713    .1568716
       year2 |  -7.960085   1.288373    -6.18   0.000    -10.74344   -5.176726
       year3 |  -13.07735   1.904099    -6.87   0.000    -17.19091   -8.963795
       year4 |  -9.402944   2.091447    -4.50   0.001    -13.92124   -4.884648
       year5 |  -1.504252   2.361936    -0.64   0.535    -6.606905    3.598401
       year6 |  -1.970548   2.706815    -0.73   0.480    -7.818265     3.87717
       year7 |   .6417761   2.907795     0.22   0.829    -5.640132    6.923684
       year8 |  -1.410353   3.369087    -0.42   0.682    -8.688824    5.868118
       year9 |   -13.3551   4.476218    -2.98   0.011    -23.02539   -3.684823
      year10 |  -.3744608   4.081756    -0.09   0.928    -9.192558    8.443636
      year11 |   .2358591   4.808068     0.05   0.962    -10.15134    10.62306
      year12 |  -1.219533   5.291292    -0.23   0.821    -12.65068    10.21161
      year13 |   2.259697   8.120588     0.28   0.785    -15.28377    19.80316
      year14 |   5.191583   7.300607     0.71   0.490    -10.58042    20.96358
       _cons |    34.7774    22.6646     1.53   0.149     -14.1865     83.7413
------------------------------------------------------------------------------


. xtscc realgrowth popgrowth educ2_n educ3_n lag1realgdp lngfcf_gdp fdtax fdgrant trade
year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12 year13 year14 if
realgrowth<=30 & realgrowth>=-15, fe ase

Regression with Driscoll-Kraay standard errors   Number of obs     =       669
Method: Fixed-effects regression                 Number of groups  =        64
Group variable (i): idall                        F( 21,     13)    = 305474.50
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.5553

------------------------------------------------------------------------------
             |             Drisc/Kraay
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |  -.2687311   .1191757    -2.25   0.042    -.5261945   -.0112677
     educ2_n |   .1333719   .0579798     2.30   0.039     .0081141    .2586297
     educ3_n |  -.0876136   .0520435    -1.68   0.116    -.2000468    .0248196
 lag1realgdp |  -.0028657   .0007103    -4.03   0.001    -.0044003   -.0013311
  lngfcf_gdp |  -.9749396   2.386329    -0.41   0.690     -6.13029    4.180411
       fdtax |   .2548001   .1085874     2.35   0.035     .0202114    .4893888
```

```
     fdgrant |  -.0703874   .1164344    -0.60   0.556    -.3219285    .1811538
       trade |  -.1166722   .1239706    -0.94   0.364    -.3844944    .1511499
       year2 |  -7.831025   1.198562    -6.53   0.000    -10.42036    -5.24169
       year3 |  -13.56622   1.562191    -8.68   0.000    -16.94113   -10.19132
       year4 |  -10.19046   1.692629    -6.02   0.000    -13.84717    -6.53376
       year5 |  -2.516188   1.882741    -1.34   0.204    -6.583604    1.551227
       year6 |  -2.521747   2.379971    -1.06   0.309    -7.663363    2.619868
       year7 |   .4084139   2.693756     0.15   0.882    -5.411092    6.227919
       year8 |   -1.64442   3.063565    -0.54   0.600     -8.26285    4.974011
       year9 |  -13.76033   3.860383    -3.56   0.003    -22.10018   -5.420475
      year10 |   -.170116   3.888515    -0.04   0.966    -8.570743    8.230511
      year11 |    .333904    4.61999     0.07   0.943    -9.646978    10.31479
      year12 |  -1.213879   5.051886    -0.24   0.814    -12.12781    9.700057
      year13 |   3.478123   7.879069     0.44   0.666    -13.54357    20.49982
      year14 |   5.488471   6.899758     0.80   0.441     -9.41755    20.39449
       _cons |    33.5163   22.32844     1.50   0.157    -14.72137    81.75396
------------------------------------------------------------------------------
```

Appendix 5.4.3 FEVD

```
. xtfevd realgrowth popgrowth educ2_n educ3_n  lngfcf_gdp reallngdpini fdexp fdgrant
trade year2  year3 year4 year5 year6 year7 year8 year9 year10 year11 year12 year13
year14 if realgrowth<=30 & realgrowth>=-13, invariant(educ2_n educ3_n reallngdpini)

panel fixed effects regression with vector decomposition

degrees of freedom fevd      =       576           number of obs        =       661
mean squared error           = 29.01479            F( 23, 576)          = 23.53302
root mean squared error      = 5.386537            Prob > F             = 5.37e-64
Residual Sum of Squares      = 19178.77            R-squared            = .5531296
Total Sum of Squares         = 42917.98            adj. R-squared       = .4879611
Estimation Sum of Squares    = 23739.21

------------------------------------------------------------------------------
             |                fevd
  realgrowth |      Coef.   Std. Err.       t     P>|t|      [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |  -.2419379   .1028971    -2.35   0.019    -.4440373   -.0398386
  lngfcf_gdp |   .2781031   2.036055     0.14   0.891    -3.720895    4.277101
       fdexp |   .1471188   .0303256     4.85   0.000     .0875566    .2066811
     fdgrant |  -.1613122   .0503258    -3.21   0.001    -.2601567   -.0624676
       trade |  -.0566451   .0395621    -1.43   0.153    -.1343488    .0210585
       year2 |  -10.98195   1.687535    -6.51   0.000    -14.29642   -7.667474
       year3 |  -16.76406   1.664407   -10.07   0.000    -20.03311   -13.49502
       year4 |   -13.6688   1.829267    -7.47   0.000    -17.26165   -10.07595
       year5 |  -7.020689   1.944688    -3.61   0.000    -10.84023   -3.201145
       year6 |  -9.630435   1.977851    -4.87   0.000    -13.51511   -5.745756
       year7 |  -8.571584    1.99276    -4.30   0.000    -12.48555   -4.657622
       year8 |  -12.62383    2.01884    -6.25   0.000    -16.58901   -8.658641
       year9 |  -24.54286   1.882814   -13.04   0.000    -28.24088   -20.84484
      year10 |  -11.16359   2.108688    -5.29   0.000    -15.30524   -7.021933
      year11 |  -12.65407   2.397021    -5.28   0.000    -17.36204   -7.946106
      year12 |   -15.7554   2.463256    -6.40   0.000    -20.59346   -10.91734
      year13 |  -14.16536   2.898872    -4.89   0.000    -19.85901   -8.471714
      year14 |  -12.95331    3.59975    -3.60   0.000    -20.02355   -5.883071
     educ2_n |   .1021735   .0498234     2.05   0.041     .0043157    .2000313
     educ3_n |   .0130987   .0242821     0.54   0.590    -.0345936    .0607911
reallngdpini |  -3.383575   1.626055    -2.08   0.038    -6.577295    -.189854
         eta |          1          .        .       .            .           .
       _cons |   45.27855   12.95102     3.50   0.001     19.84157    70.71553
------------------------------------------------------------------------------

. xtfevd realgrowth popgrowth educ2_n educ3_n  lngfcf_gdp reallngdpini fdtax fdgrant
trade year2 year3 year4 year5 year6 year7 year8  year9 year10 year11 year12 year13
year14 if realgrowth<=30 & realgrowth>=-13, invariant(educ2_n educ3_n reallngdpini)

panel fixed effects regression with vector decomposition

degrees of freedom fevd      =       576           number of obs        =       661
mean squared error           = 28.78852            F( 23, 576)          = 24.33771
root mean squared error      = 5.365493            Prob > F             = 6.98e-66
Residual Sum of Squares      = 19029.21            R-squared            = .5566145
Total Sum of Squares         = 42917.98            adj. R-squared       = .4919541
Estimation Sum of Squares    = 23888.77
```

```
------------------------------------------------------------------------------
             |               fevd
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |  -.2702019   .1022411    -2.64   0.008    -.4710127    -.069391
  lngfcf_gdp |  -.4826856   2.088677    -0.23   0.817    -4.585038    3.619666
       fdtax |    .166246   .0310654     5.35   0.000     .1052307    .2272613
     fdgrant |  -.1584631   .0475069    -3.34   0.001    -.2517711   -.0651552
       trade |   -.054764   .0390418    -1.40   0.161    -.1314456    .0219175
       year2 |  -11.15736   1.671133    -6.68   0.000    -14.43962   -7.875103
       year3 |  -17.26961   1.659697   -10.41   0.000    -20.52941   -14.00982
       year4 |  -14.30693   1.821597    -7.85   0.000    -17.88471   -10.72915
       year5 |  -7.914307   1.941038    -4.08   0.000    -11.72668   -4.101932
       year6 |  -10.39037    1.96091    -5.30   0.000    -14.24178   -6.538968
       year7 |  -9.185404    1.94896    -4.71   0.000    -13.01334   -5.357469
       year8 |  -13.36376   1.976165    -6.76   0.000    -17.24513   -9.482395
       year9 |  -25.62112   1.881643   -13.62   0.000    -29.31684    -21.9254
      year10 |  -11.70688   2.056225    -5.69   0.000    -15.74549   -7.668266
      year11 |  -13.37574   2.337153    -5.72   0.000    -17.96613   -8.785363
      year12 |  -16.60292    2.39986    -6.92   0.000    -21.31647   -11.88938
      year13 |  -14.75065   2.857085    -5.16   0.000    -20.36222   -9.139073
      year14 |  -13.85814   3.546165    -3.91   0.000    -20.82313   -6.893152
     educ2_n |   .1056802   .0473336     2.23   0.026     .0127127    .1986477
     educ3_n |   .0179089   .0229693     0.78   0.436    -.0272049    .0630227
reallngdpini |  -3.942554   1.577674    -2.50   0.013    -7.041249   -.8438596
         eta |          1          .        .       .            .           .
       _cons |   51.55832   12.92517     3.99   0.000     26.17212    76.94453
------------------------------------------------------------------------------
```

Appendix 5.4.4 IV

```
. xtivreg2 realgrowth lag1realgdp popgrowth fdexp (lngfcf_gdp trade educ2_n educ3_n
fdgrant =  l2.fdgrant l.fdgrant  l2.trade l.

> educ2_n l.educ3_n l.lngfcf_gdp )  year3 year4 year5 year6 year7 year8 year9 year10
year11 year12 year13 year14 if realgrowth >=-15 & r
> ealgrowth <=30,  fe  endog(fdgrant educ2_n educ3_n lngfcf_gdp trade )small
Warning - collinearities detected
Vars dropped:        year14

FIXED EFFECTS ESTIMATION
------------------------
Number of groups =       64                    Obs per group: min =         5
                                                              avg =       8.5
                                                              max =        10

Warning - collinearities detected
Vars dropped:  year14

IV (2SLS) estimation
--------------------

Estimates efficient for homoskedasticity only
Statistics consistent for homoskedasticity only

                                                      Number of obs =      541
                                                      F( 19,    458) =    20.74
                                                      Prob > F      =   0.0000
Total (centered) SS     =  33361.77512                Centered R2   =   0.3669
Total (uncentered) SS   =  33361.77512                Uncentered R2 =   0.3669
Residual SS             =  21122.69117                Root MSE      =    6.791

------------------------------------------------------------------------------
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  lngfcf_gdp |  -5.008173   4.604825    -1.09   0.277    -14.05738    4.041031
       trade |   -.138472   .1285538    -1.08   0.282    -.3911004    .1141565
     educ2_n |   .1365208   .0618982     2.21   0.028     .0148811    .2581604
     educ3_n |  -.1326677   .0904972    -1.47   0.143     -.310509    .0451735
     fdgrant |  -.8091767   .2629698    -3.08   0.002    -1.325954   -.2923998
 lag1realgdp |  -.0033607   .0005323    -6.31   0.000    -.0044068   -.0023145
   popgrowth |  -.2852369   .1290261    -2.21   0.028    -.5387934   -.0316803
       fdexp |   .0520936   .0544524     0.96   0.339    -.0549138    .1591011
       year3 |  -16.09725   8.848705    -1.82   0.070    -33.48634    1.291847
       year4 |  -13.22861   6.857586    -1.93   0.054    -26.70485     .247619
```

```
       year5 |  -7.561851   5.669481    -1.33   0.183    -18.70327    3.579569
       year6 |  -5.794031   5.012661    -1.16   0.248     -15.6447    4.056636
       year7 |  -1.420696   4.660195    -0.30   0.761    -10.57871    7.737319
       year8 |  -3.477481   4.522639    -0.77   0.442    -12.36518    5.410215
       year9 |  -17.53242    5.40573    -3.24   0.001    -28.15553   -6.909311
      year10 |  -4.360209   3.902767    -1.12   0.264    -12.02976    3.309342
      year11 |  -2.341687   2.880263    -0.81   0.417    -8.001857    3.318482
      year12 |    -4.5418   2.438538    -1.86   0.063     -9.33391    .2503109
      year13 |  -6.693948   2.665563    -2.51   0.012     -11.9322   -1.455698
      year14 |          0  (omitted)
------------------------------------------------------------------------------
Underidentification test (Anderson canon. corr. LM statistic):          44.348
                                                   Chi-sq(2) P-val =    0.0000
------------------------------------------------------------------------------
Weak identification test (Cragg-Donald Wald F statistic):                7.807
Stock-Yogo weak ID test critical values:                       <not available>
------------------------------------------------------------------------------
Sargan statistic (overidentification test of all instruments):           0.873
                                                   Chi-sq(1) P-val =    0.3502
-endog- option:
Endogeneity test of endogenous regressors:                              41.150
                                                   Chi-sq(5) P-val =    0.0000
Regressors tested:    fdgrant educ2_n educ3_n lngfcf_gdp trade
------------------------------------------------------------------------------
Instrumented:         lngfcf_gdp trade educ2_n educ3_n fdgrant
Included instruments: lag1realgdp popgrowth fdexp year3 year4 year5 year6
                      year7 year8 year9 year10 year11 year12 year13
Excluded instruments: L2.fdgrant L.fdgrant L2.trade L.educ2_n L.educ3_n
                      L.lngfcf_gdp
Dropped collinear:    year14
------------------------------------------------------------------------------

. xtivreg2 realgrowth lag1realgdp popgrowth (lngfcf_gdp trade educ2_n educ3_n fdgrant
fdtax =  l.fdgrant l.trade l.educ2_n l2.educ
> 2_n l.lngfcf_gdp l2.fdtax l.educ3_n )  year2 year3 year4 year5 year6 year7 year8
year9 year10 year11 year12 year13 year14 if realgro
> wth<=30 & realgrowth >=-15,  fe  endog(fdgrant educ2_n educ3_n lngfcf_gdp trade
fdgrant fdtax) small
Warning - collinearities detected
Vars dropped:       year2 year14

FIXED EFFECTS ESTIMATION
------------------------
Number of groups =        64                  Obs per group: min =         5
                                                             avg =       8.5
                                                             max =        10
Warning - collinearities detected
Vars dropped:  year2 year14

IV (2SLS) estimation
--------------------

Estimates efficient for homoskedasticity only
Statistics consistent for homoskedasticity only

                                                      Number of obs =      542
                                                      F( 19,    459) =    15.79
                                                      Prob > F      =   0.0000
Total (centered) SS     =  33375.70079                Centered R2   =   0.1076
Total (uncentered) SS   =  33375.70079                Uncentered R2 =   0.1076
Residual SS             =   29783.8816                Root MSE      =    8.055

------------------------------------------------------------------------------
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  lngfcf_gdp |  -7.802771   5.295762    -1.47   0.141    -18.20972    2.604172
       trade |   .0477698   .1014644     0.47   0.638    -.1516225    .2471621
     educ2_n |   .4793432   .1045667     4.58   0.000     .2738544     .684832
     educ3_n |   .0834982   .0969753     0.86   0.390    -.1070724    .2740688
     fdgrant |  -.7039298   .3397071    -2.07   0.039    -1.371504   -.0363557
       fdtax |    .914775    .239395     3.82   0.000     .4443289    1.385221
 lag1realgdp |  -.0058024   .0009188    -6.31   0.000     -.007608   -.0039967
   popgrowth |  -.5596328   .1532702    -3.65   0.000     -.860831   -.2584346
       year2 |          0  (omitted)
       year3 |  -2.911603   8.581253    -0.34   0.735    -19.77502    13.95181
       year4 |  -14.05061   7.541552    -1.86   0.063    -28.87086     .769638
       year5 |  -10.69551   6.665172    -1.60   0.109    -23.79355     2.40252
```

```
       year6 |  -6.001201   5.715279    -1.05   0.294    -17.23256    5.230155
       year7 |  -1.460512   5.412405    -0.27   0.787    -12.09668    9.175652
       year8 |  -3.170562   5.220352    -0.61   0.544    -13.42931     7.08819
       year9 |  -11.24989   5.082736    -2.21   0.027    -21.23821   -1.261574
      year10 |  -1.115751   4.004304    -0.28   0.781    -8.984792     6.75329
      year11 |  -1.473312   3.393034    -0.43   0.664    -8.141118    5.194493
      year12 |  -4.938078   2.938838    -1.68   0.094    -10.71332    .8371664
      year13 |   9.008515   5.503278     1.64   0.102    -1.806229    19.82326
      year14 |          0  (omitted)
------------------------------------------------------------------------------
Underidentification test (Anderson canon. corr. LM statistic):          25.009
                                                   Chi-sq(2) P-val =    0.0000
------------------------------------------------------------------------------
Weak identification test (Cragg-Donald Wald F statistic):                3.612
Stock-Yogo weak ID test critical values:                       <not available>
------------------------------------------------------------------------------
Sargan statistic (overidentification test of all instruments):           0.212
                                                   Chi-sq(1) P-val =    0.6450
-endog- option:
Endogeneity test of endogenous regressors:                              80.120
                                                   Chi-sq(6) P-val =    0.0000
Regressors tested:    fdgrant educ2_n educ3_n lngfcf_gdp trade fdtax
------------------------------------------------------------------------------
Instrumented:         lngfcf_gdp trade educ2_n educ3_n fdgrant fdtax
Included instruments: lag1realgdp popgrowth year3 year4 year5 year6 year7 year8
                      year9 year10 year11 year12 year13
Excluded instruments: L.fdgrant L.trade L.educ2_n L2.educ2_n L.lngfcf_gdp
                      L2.fdtax L.educ3_n
Dropped collinear:    year2 year14
------------------------------------------------------------------------------
```

Appendix 5.4.5 Size

A. Individual Country Regressions

```
. xtscc realgrowth fdexp fdgrant popgrowth educ2_n educ3_n lag1realgdp lngfcf_gdp trade
year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12 year13 year14 if
realgrowth<=30 & realgrowth>=-15 &id_country==1, fe

Regression with Driscoll-Kraay standard errors   Number of obs     =       132
Method: Fixed-effects regression                 Number of groups  =        12
Group variable (i): idall                        F( 21,     10)    =     41.46
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.5787

------------------------------------------------------------------------------
             |             Drisc/Kraay
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       fdexp |   .5755361   .5015687     1.15   0.278    -.5420285    1.693101
     fdgrant |   .6138695   .4901383     1.25   0.239    -.4782266    1.705966
   popgrowth |  -.5124956   .0885245    -5.79   0.000    -.7097405   -.3152507
     educ2_n |  -1.095926   .6763451    -1.62   0.136    -2.602917    .4110644
     educ3_n |   .4964625   .1106678     4.49   0.001     .2498793    .7430458
 lag1realgdp |  -.0087755   .0056339    -1.56   0.150    -.0213286    .0037776
  lngfcf_gdp |  -6.163087   4.472417    -1.38   0.198    -16.12825    3.802079
       trade |   .7173494   .1177055     6.09   0.000     .4550851    .9796137
       year2 |          0  (omitted)
       year3 |   8.719219   1.291815     6.75   0.000     5.840875    11.59756
       year4 |   13.03313   1.468361     8.88   0.000     9.761419    16.30485
       year5 |    9.30062   1.297905     7.17   0.000     6.408707    12.19253
       year6 |   6.412858   1.318446     4.86   0.001     3.475178    9.350538
       year7 |          0  (omitted)
       year8 |   5.611332   .6067613     9.25   0.000     4.259383     6.96328
       year9 |          0  (omitted)
      year10 |   1.762161   .4276627     4.12   0.002     .8092688    2.715052
      year11 |  -7.728621   1.130355    -6.84   0.000    -10.24721   -5.210034
      year12 |          0  (omitted)
      year13 |          0  (omitted)
      year14 |          0  (omitted)
       _cons |          0  (omitted)
------------------------------------------------------------------------------
```

```
. xtscc realgrowth fdexp fdgrant popgrowth educ2_n educ3_n lag1realgdp lngfcf_gdp trade
year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12 year13 year14 if
realgrowth<=30 & realgrowth>=-15 &id_country==2, fe

Regression with Driscoll-Kraay standard errors   Number of obs     =        98
Method: Fixed-effects regression                 Number of groups  =        14
Group variable (i): idall                        F( 21,     6)     =  23548.80
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.9348

------------------------------------------------------------------------------
             |             Drisc/Kraay
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       fdexp |  -.0912573    .041925    -2.18   0.072    -.1938441    .0113294
     fdgrant |   -.038051   .0939718    -0.40   0.700    -.2679918    .1918898
   popgrowth |   1.933757   .7780051     2.49   0.047     .0300469    3.837467
     educ2_n |   .2180523   .2405229     0.91   0.400    -.3704859    .8065905
     educ3_n |   .0370647   .0587049     0.63   0.551     -.106581    .1807104
 lag1realgdp |  -.0036763   .0006999    -5.25   0.002     -.005389   -.0019637
  lngfcf_gdp |  -2.910686   1.415732    -2.06   0.086    -6.374856    .5534849
       trade |   .2794505   .0865955     3.23   0.018      .067559     .491342
       year2 |          0  (omitted)
       year3 |          0  (omitted)
       year4 |          0  (omitted)
       year5 |          0  (omitted)
       year6 |          0  (omitted)
       year7 |   17.81899    1.51466    11.76   0.000     14.11275    21.52522
       year8 |   21.66275   1.627476    13.31   0.000     17.68046    25.64504
       year9 |   10.51159   2.122943     4.95   0.003     5.316932    15.70624
      year10 |   15.54685   .6862094    22.66   0.000     13.86776    17.22595
      year11 |   14.89125   1.356515    10.98   0.000     11.57198    18.21053
      year12 |   5.664095    2.30563     2.46   0.049     .0224224    11.30577
      year13 |          0  (omitted)
      year14 |          0  (omitted)
       _cons |          0  (omitted)
------------------------------------------------------------------------------
```

```
. xtscc realgrowth fdexp fdgrant popgrowth educ2_n educ3_n lag1realgdp lngfcf_gdp trade
year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12 year13 year14 if
realgrowth<=30 & realgrowth>=-15 &id_country==3, fe

Regression with Driscoll-Kraay standard errors   Number of obs     =        78
Method: Fixed-effects regression                 Number of groups  =         7
Group variable (i): idall                        F( 21,    11)     =  12003.24
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.9184

------------------------------------------------------------------------------
             |             Drisc/Kraay
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       fdexp |  -.0402264   .1205211    -0.33   0.745    -.3054915    .2250388
     fdgrant |  -.1811015   .2056314    -0.88   0.397    -.6336932    .2714903
   popgrowth |   .4841777   .3716398     1.30   0.219    -.3337959    1.302151
     educ2_n |   .4154964   .2177222     1.91   0.083    -.0637069    .8946997
     educ3_n |   .0129972   .1825873     0.07   0.945    -.3888748    .4148692
 lag1realgdp |  -.0007433   .0004115    -1.81   0.098     -.001649    .0001624
  lngfcf_gdp |  -.4080374    3.76303    -0.11   0.916    -8.690411    7.874336
       trade |   .0426601    .174423     0.24   0.811    -.3412424    .4265625
       year2 |   4.574203   3.104713     1.47   0.169    -2.259224    11.40763
       year3 |  -7.653497     4.4794    -1.71   0.116    -17.51259    2.205595
       year4 |  -8.035228   4.759659    -1.69   0.119    -18.51117    2.440711
       year5 |  -5.674905   4.857831    -1.17   0.267    -16.36692     5.01711
       year6 |  -17.22582   2.310894    -7.45   0.000    -22.31207   -12.13958
       year7 |  -11.26605   2.094311    -5.38   0.000     -15.8756   -6.656504
       year8 |  -9.481471   2.043616    -4.64   0.001    -13.97944   -4.983502
       year9 |  -27.85451   1.988669   -14.01   0.000    -32.23154   -23.47748
      year10 |  -13.56333    2.39975    -5.65   0.000    -18.84514   -8.281512
      year11 |  -13.26625   3.614539    -3.67   0.004     -21.2218   -5.310703
      year12 |  -20.77867    3.37816    -6.15   0.000    -28.21395   -13.34339
      year13 |          0  (omitted)
      year14 |          0  (omitted)
       _cons |          0  (omitted)
------------------------------------------------------------------------------
```

```
. xtscc realgrowth fdexp fdgrant popgrowth educ2_n educ3_n lag1realgdp lngfcf_gdp trade
year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12 year13 year14 if
realgrowth<=30 & realgrowth>=-15 &id_country==4, fe

Regression with Driscoll-Kraay standard errors   Number of obs     =       178
Method: Fixed-effects regression                 Number of groups  =        15
Group variable (i): idall                        F( 21,     11)    =  13624.77
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.8068

------------------------------------------------------------------------------
             |             Drisc/Kraay
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       fdexp |  -.0865165   .0466904    -1.85   0.091    -.1892814    .0162484
     fdgrant |    .246113   .1523274     1.62   0.134    -.0891575    .5813834
   popgrowth |   .7705019   .5267736     1.46   0.172    -.3889191    1.929923
     educ2_n |   .0701899   .0390426     1.80   0.100    -.0157423     .156122
     educ3_n |    1.94972   .6084913     3.20   0.008     .6104396       3.289
 lag1realgdp |  -.0035383    .001365    -2.59   0.025    -.0065426    -.000534
  lngfcf_gdp |  -46.25209   9.731163    -4.75   0.001    -67.67023   -24.83394
       trade |   .3153281   .0069098    45.63   0.000     .3001197    .3305365
       year2 |          0  (omitted)
       year3 |   19.24111   6.450047     2.98   0.012     5.044651    33.43757
       year4 |   12.95833   4.919671     2.63   0.023     2.130206    23.78645
       year5 |    17.2022   4.148603     4.15   0.002     8.071186    26.33321
       year6 |   26.28064   3.893547     6.75   0.000       17.711    34.85028
       year7 |   33.31304   3.418662     9.74   0.000     25.78861    40.83746
       year8 |   11.08297   3.656344     3.03   0.011     3.035409    19.13053
       year9 |          0  (omitted)
      year10 |  -4.927855   1.334161    -3.69   0.004    -7.864325   -1.991386
      year11 |          0  (omitted)
      year12 |   1.254466   1.015833     1.23   0.243    -.9813683      3.4903
      year13 |  -1.975232   1.826505    -1.08   0.303    -5.995342    2.044879
      year14 |   1.067686   2.599265     0.41   0.689    -4.653258    6.788629
       _cons |          0  (omitted)
------------------------------------------------------------------------------
```

```
. xtscc realgrowth fdexp fdgrant popgrowth educ2_n educ3_n lag1realgdp lngfcf_gdp
trade
year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12 year13 year14 if
realgrowth<=30 & realgrowth>=-15 &id_country==5, fe

Regression with Driscoll-Kraay standard errors   Number of obs     =       183
Method: Fixed-effects regression                 Number of groups  =        16
Group variable (i): idall                        F( 21,     11)    = 187059.62
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.9647

------------------------------------------------------------------------------
             |             Drisc/Kraay
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       fdexp |   .0532338   .0156876     3.39   0.006     .0187056     .087762
     fdgrant |    .064907   .0700253     0.93   0.374    -.0892177    .2190318
   popgrowth |   .2395949   .1492968     1.60   0.137    -.0890051     .568195
     educ2_n |   .0130353   .1361969     0.10   0.925     -.286732    .3128026
     educ3_n |   .0252643   .0180103     1.40   0.188    -.0143761    .0649048
 lag1realgdp |  -.0009179   .0003528    -2.60   0.025    -.0016945   -.0001414
  lngfcf_gdp |  -2.741412   1.366141    -2.01   0.070    -5.748269    .2654448
       trade |   .4049824   .1589724     2.55   0.027     .0550865    .7548783
       year2 |  -14.98825   1.732885    -8.65   0.000    -18.80231    -11.1742
       year3 |  -28.09188   3.247474    -8.65   0.000    -35.23952   -20.94424
       year4 |  -18.72412   3.930726    -4.76   0.001    -27.37559   -10.07265
       year5 |  -2.304191   4.084075    -0.56   0.584    -11.29318    6.684798
       year6 |  -10.60975    5.39472    -1.97   0.075    -22.48345    1.263945
       year7 |  -11.16754   5.847534    -1.91   0.083    -24.03788    1.702792
       year8 |  -9.833915   5.657896    -1.74   0.110    -22.28686    2.619029
       year9 |  -31.31661   5.555066    -5.64   0.000    -43.54323   -19.08999
      year10 |  -9.569749   6.270069    -1.53   0.155    -23.37008     4.23058
      year11 |  -21.01815    6.83676    -3.07   0.011    -36.06576   -5.970543
      year12 |  -22.24656   7.202731    -3.09   0.010    -38.09967   -6.393459
      year13 |          0  (omitted)
      year14 |          0  (omitted)
       _cons |          0  (omitted)
```

```
------------------------------------------------------------------------------
```

B. Split Dataset

```
***Large size country regression using FE with Driscoll-Kraay SEs***

. xtscc realgrowth fdexp fdgrant popgrowth educ2_n educ3_n lag1realgdp lngfcf_gdp
trade year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12 year13
year14 if realgrowth<=30 & realgrowth>=-15 &id_country!=1 & id_country!=4, fe ase

Regression with Driscoll-Kraay standard errors   Number of obs     =       359
Method: Fixed-effects regression                 Number of groups  =        37
Group variable (i): idall                        F( 21,     12)    = 680434.87
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.8689

------------------------------------------------------------------------------
             |             Drisc/Kraay
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       fdexp |   .0840202   .0369872     2.27   0.042      .003432    .1646085
     fdgrant |  -.2561229   .1264182    -2.03   0.066    -.5315644    .0193186
   popgrowth |  -.5811108   .3146849    -1.85   0.090     -1.26675    .1045287
     educ2_n |   .2066917   .2698675     0.77   0.459    -.3812992    .7946825
     educ3_n |  -.0299326   .0312791    -0.96   0.357    -.0980838    .0382186
 lag1realgdp |  -.0027635   .0003868    -7.14   0.000    -.0036062   -.0019207
  lngfcf_gdp |  -7.430558   2.110301    -3.52   0.004    -12.02851   -2.832608
       trade |   -.532332   .0836566    -6.36   0.000    -.7146041   -.3500599
       year2 |  -7.849763   1.194008    -6.57   0.000    -10.45128   -5.248242
       year3 |  -15.61672   1.132764   -13.79   0.000     -18.0848   -13.14864
       year4 |  -9.806171   1.134051    -8.65   0.000    -12.27706   -7.335285
       year5 |   2.343709   1.442985     1.62   0.130    -.8002861    5.487704
       year6 |   3.646532   1.636134     2.23   0.046     .0817029    7.211362
       year7 |   9.671106   1.875559     5.16   0.000     5.584614     13.7576
       year8 |   12.33213   1.776456     6.94   0.000     8.461569     16.2027
       year9 |  -10.51144   1.993768    -5.27   0.000    -14.85549   -6.167393
      year10 |   10.82622   2.054321     5.27   0.000     6.350238     15.3022
      year11 |   12.39411   2.415534     5.13   0.000     7.131118    17.65711
      year12 |   9.327615   2.602644     3.58   0.004     3.656939    14.99829
      year13 |   11.59176   4.547157     2.55   0.026     1.684351    21.49916
      year14 |          0  (omitted)
       _cons |   99.84969   8.345237    11.96   0.000     81.66698    118.0324
------------------------------------------------------------------------------

. xtscc realgrowth fdtax fdgrant popgrowth educ2_n educ3_n lag1realgdp lngfcf_gdp
trade year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12 year13
year14 if realgrowth<=30 & realgrowth>=-15 &id_country!=1 & id_country!=4, fe ase

Regression with Driscoll-Kraay standard errors   Number of obs     =       359
Method: Fixed-effects regression                 Number of groups  =        37
Group variable (i): idall                        F( 21,     12)    = 808582.92
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.8720

------------------------------------------------------------------------------
             |             Drisc/Kraay
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       fdtax |   .1350007   .0514314     2.62   0.022     .0229413    .2470602
     fdgrant |  -.2137301   .1276412    -1.67   0.120    -.4918364    .0643762
   popgrowth |  -.5625794   .2965892    -1.90   0.082    -1.208792     .083633
     educ2_n |   .2249042   .2507943     0.90   0.387    -.3215296     .771338
     educ3_n |  -.0380791   .0311999    -1.22   0.246    -.1060578    .0298996
 lag1realgdp |  -.0027342    .000388    -7.05   0.000    -.0035796   -.0018889
  lngfcf_gdp |  -7.162547   2.094597    -3.42   0.005    -11.72628   -2.598813
       trade |  -.5177433   .0791643    -6.54   0.000    -.6902274   -.3452592
       year2 |  -7.721584   1.142108    -6.76   0.000    -10.21002   -5.233144
       year3 |  -15.40526   1.139999   -13.51   0.000    -17.88911   -12.92142
       year4 |  -9.968026   .9884921   -10.08   0.000    -12.12176   -7.814286
       year5 |   2.069389   1.240197     1.67   0.121    -.6327682    4.771545
       year6 |   3.268657   1.455414     2.25   0.044     .0975822    6.439732
       year7 |   9.230745   1.654583     5.58   0.000     5.625718    12.83577
       year8 |    11.7381   1.593569     7.37   0.000     8.266012    15.21019
       year9 |  -10.80364   1.746935    -6.18   0.000    -14.60989   -6.997399
      year10 |   10.53574   1.854807     5.68   0.000     6.494467    14.57702
```

```
      year11 |   11.89628   2.201454     5.40   0.000     7.099727    16.69284
      year12 |   8.786697   2.344442     3.75   0.003     3.678598     13.8948
      year13 |   13.64753   4.954213     2.75   0.017     2.853229    24.44184
      year14 |          0  (omitted)
       _cons |   94.09072   10.07466     9.34   0.000     72.13992    116.0415
------------------------------------------------------------------------------
```

Small size countries regression using FE with Driscoll-Kraay SEs

```
. xtscc realgrowth fdexp fdgrant popgrowth educ2_n educ3_n lag1realgdp lngfcf_gdp
trade year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12 year13
year14 if realgrowth<=30 & realgrowth>=-15 &id_country!=2 & id_country!=3 &
id_country!=5, fe ase

Regression with Driscoll-Kraay standard errors   Number of obs     =       310
Method: Fixed-effects regression                 Number of groups  =        27
Group variable (i): idall                        F( 21,    12)     =   3112.14
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.5100

------------------------------------------------------------------------------
             |             Drisc/Kraay
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       fdexp |   .2337083   .1966062     1.19   0.258    -.1946598    .6620764
     fdgrant |   .0565813    .099504     0.57   0.580    -.1602194    .2733819
   popgrowth |  -.3001621   .1163366    -2.58   0.024    -.5536377   -.0466864
     educ2_n |   .1335032   .0431114     3.10   0.009     .0395716    .2274348
     educ3_n |  -.3757673   .1197277    -3.14   0.009    -.6366315    -.114903
 lag1realgdp |  -.0036612   .0011601    -3.16   0.008    -.0061888   -.0011337
  lngfcf_gdp |    -11.635   4.748841    -2.45   0.031    -21.98184   -1.288168
       trade |   .1777573   .0816095     2.18   0.050    -.0000547    .3555692
       year2 |   34.85039   20.50873     1.70   0.115    -9.834302    79.53508
       year3 |   35.56277   21.17681     1.68   0.119    -10.57753    81.70307
       year4 |   38.06877   20.95849     1.82   0.094    -7.595847     83.7334
       year5 |    41.9361   21.11313     1.99   0.070     -4.06545    87.93766
       year6 |   45.67452   21.60847     2.11   0.056    -1.406298    92.75533
       year7 |   48.61747    21.7655     2.23   0.045     1.194521    96.04042
       year8 |   38.97263   21.51538     1.81   0.095    -7.905349    85.85061
       year9 |   34.21051   21.08101     1.62   0.131    -11.72106    80.14208
      year10 |   38.91541   21.04862     1.85   0.089    -6.945592    84.77641
      year11 |   40.41275   21.45298     1.88   0.084    -6.329277    87.15477
      year12 |   45.09509   21.57569     2.09   0.059    -1.914293    92.10448
      year13 |   43.78691   21.97202     1.99   0.070    -4.086016    91.65984
      year14 |    47.3577   22.54739     2.10   0.058    -1.768833    96.48423
       _cons |          0  (omitted)
------------------------------------------------------------------------------


. xtscc realgrowth fdtax fdgrant popgrowth educ2_n educ3_n lag1realgdp lngfcf_gdp
trade year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12 year13
year14 if realgrowth<=30 & realgrowth>=-15 &id_country!=2 & id_country!=3 &
id_country!=5, fe ase

Regression with Driscoll-Kraay standard errors   Number of obs     =       310
Method: Fixed-effects regression                 Number of groups  =        27
Group variable (i): idall                        F( 21,    12)     = 242423.01
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.5071

------------------------------------------------------------------------------
             |             Drisc/Kraay
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       fdtax |   .0781224    .177126     0.44   0.667     -.307802    .4640468
     fdgrant |  -.0844877   .1154362    -0.73   0.478    -.3360016    .1670262
   popgrowth |    -.29975   .1142603    -2.62   0.022    -.5487018   -.0507982
     educ2_n |   .1310128   .0440544     2.97   0.012     .0350264    .2269992
     educ3_n |  -.3291449   .1724988    -1.91   0.081    -.7049875    .0466977
 lag1realgdp |  -.0034803   .0011637    -2.99   0.011    -.0060158   -.0009449
  lngfcf_gdp |  -11.44961    5.02613    -2.28   0.042     -22.4006   -.4986101
       trade |    .179901   .0861477     2.09   0.059    -.0077987    .3676007
       year2 |   44.97715   17.79455     2.53   0.027     6.206158    83.74814
       year3 |   46.29892   18.40204     2.52   0.027      6.20432    86.39352
       year4 |   48.35869   18.45874     2.62   0.022     8.140549    88.57683
       year5 |   51.81333   18.78428     2.76   0.017     10.88589    92.74077
```

```
       year6 |   55.55716   19.13273     2.90   0.013     13.87052     97.2438
       year7 |   58.40693   19.47359     3.00   0.011     15.97761    100.8362
       year8 |   48.44906   19.57185     2.48   0.029     5.805669    91.09245
       year9 |    43.5852   19.34799     2.25   0.044     1.429545    85.74086
      year10 |   49.06009   18.87406     2.60   0.023     7.937045    90.18314
      year11 |   50.14728   19.45411     2.58   0.024     7.760409    92.53415
      year12 |   54.19062   20.17942     2.69   0.020     10.22345    98.15779
      year13 |   52.50679   20.54315     2.56   0.025     7.747105    97.26647
      year14 |   56.74734   21.03895     2.70   0.019      10.9074    102.5873
       _cons |          0  (omitted)
------------------------------------------------------------------------------
```

C. Using size as a dummy variable and interactions of size with FD measures

```
. xtscc realgrowth popgrowth educ2_n educ3_n lag1realgdp lngfcf_gdp fdexp fdgrant
trade size expsize1 grantsize1 year2 year3 year4 year5 year6 year7 year8 year9 year10
year11 year12 year13 year14 if realgrowth<=30 & realgrowth>=-15, fe ase

Regression with Driscoll-Kraay standard errors   Number of obs     =       669
Method: Fixed-effects regression                 Number of groups  =        64
Group variable (i): idall                        F( 24,      13)   =  28367.67
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.5443

------------------------------------------------------------------------------
             |             Drisc/Kraay
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |  -.2263604   .1275028    -1.78   0.099    -.5018135    .0490928
     educ2_n |    .095761   .0597901     1.60   0.133    -.0334078    .2249297
     educ3_n |  -.1250174   .0515856    -2.42   0.031    -.2364614   -.0135735
 lag1realgdp |  -.0025346   .0007077    -3.58   0.003    -.0040635   -.0010056
  lngfcf_gdp |   -.379786   2.621335    -0.14   0.887    -6.042837    5.283265
       fdexp |   .2978049   .2644556     1.13   0.280    -.2735167    .8691264
     fdgrant |   .0783662    .199415     0.39   0.701    -.3524437    .5091761
       trade |  -.1118831   .1253271    -0.89   0.388    -.3826358    .1588697
        size |          0  (omitted)
    expsize1 |  -.0985313   .2093502    -0.47   0.646    -.5508048    .3537422
  grantsize1 |  -.2492124   .1722478    -1.45   0.172    -.6213311    .1229063
       year2 |  -9.159446   1.827156    -5.01   0.000    -13.10678   -5.212115
       year3 |  -14.20511   1.946895    -7.30   0.000    -18.41112   -9.999095
       year4 |  -10.75572   2.246409    -4.79   0.000    -15.60879   -5.902652
       year5 |  -2.912309   2.665276    -1.09   0.294    -8.670288     2.84567
       year6 |  -3.660097   3.193385    -1.15   0.272    -10.55898    3.238791
       year7 |  -1.157297   3.465084    -0.33   0.744    -8.643156    6.328562
       year8 |  -3.098277   3.871526    -0.80   0.438     -11.4622    5.265647
       year9 |  -15.14251   4.740648    -3.19   0.007    -25.38406   -4.900966
      year10 |  -2.288465   4.399895    -0.52   0.612    -11.79386    7.216929
      year11 |  -1.777419   5.248424    -0.34   0.740    -13.11595    9.561112
      year12 |  -3.302042   5.821673    -0.57   0.580      -15.879    9.274918
      year13 |   .2244923   8.406606     0.03   0.979    -17.93688    18.38586
      year14 |   3.296984   7.310172     0.45   0.659    -12.49568    19.08965
       _cons |   32.89683   20.96103     1.57   0.141    -12.38672    78.18039
------------------------------------------------------------------------------
```

```
. xtscc realgrowth popgrowth educ2_n educ3_n lag1realgdp lngfcf_gdp fdtax fdgrant
trade size revsize1 grantsize1 year2 year3 year4 year5 year6 year7 year8 year9 year10
year11 year12 year13 year14 if realgrowth<=30 & realgrowth>=-15, fe ase

Regression with Driscoll-Kraay standard errors   Number of obs     =       669
Method: Fixed-effects regression                 Number of groups  =        64
Group variable (i): idall                        F( 24,      13)   =  74746.29
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.5602

------------------------------------------------------------------------------
             |             Drisc/Kraay
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |  -.2898318    .102954    -2.82   0.015    -.5122504   -.0674132
     educ2_n |   .1245263   .0576741     2.16   0.050    -.0000711    .2491237
     educ3_n |  -.0422192    .043382    -0.97   0.348    -.1359403    .0515019
 lag1realgdp |  -.0029169   .0006674    -4.37   0.001    -.0043587    -.001475
  lngfcf_gdp |  -1.897798   2.510362    -0.76   0.463    -7.321106    3.525511
       fdtax |   .4013102   .1353498     2.96   0.011     .1089049    .6937156
```

```
     fdgrant |   .1157542   .0910673     1.27   0.226    -.0809849    .3124932
       trade |  -.1167944   .1238874    -0.94   0.363    -.3844368     .150848
        size |          0  (omitted)
    revsize1 |  -.1544337   .1175132    -1.31   0.212    -.4083056    .0994382
  grantsize1 |  -.2729436   .1152288    -2.37   0.034    -.5218802    -.024007
       year2 |  -8.892648   1.562567    -5.69   0.000    -12.26837   -5.516926
       year3 |  -14.93401   1.835953    -8.13   0.000    -18.90034   -10.96767
       year4 |  -11.77138   2.042284    -5.76   0.000    -16.18347   -7.359295
       year5 |  -4.223847   2.305985    -1.83   0.090    -9.205624    .7579306
       year6 |  -4.350775   2.853373    -1.52   0.151    -10.51511    1.813563
       year7 |  -1.390907   3.146105    -0.44   0.666    -8.187653    5.405839
       year8 |  -3.323831   3.407153    -0.98   0.347    -10.68454    4.036876
       year9 |  -15.67975   4.067994    -3.85   0.002    -24.46812   -6.891387
      year10 |  -1.893297   4.163053    -0.45   0.657    -10.88703    7.100431
      year11 |  -1.531207   4.967325    -0.31   0.763    -12.26246    9.200045
      year12 |  -3.225434   5.383189    -0.60   0.559    -14.85511    8.404239
      year13 |   1.013951   7.998459     0.13   0.901    -16.26567    18.29357
      year14 |   3.538467   7.108391     0.50   0.627    -11.81828    18.89521
       _cons |   30.91281   20.33035     1.52   0.152    -13.00825    74.83387
------------------------------------------------------------------------------

. xtfevd realgrowth popgrowth educ2_n educ3_n  lngfcf_gdp reallngdpini fdexp fdgrant
trade  size expsize grantsize year2 year3 year4 year5 year6 year7 year8 year9 year10
year11 year12 year13 year14 if realgrowth<=30 & realgrowth>=-13, invariant(educ2_n
educ3_n reall
> ngdpini size expsize grantsize)

panel fixed effects regression with vector decomposition

degrees of freedom fevd    =       573          number of obs       =       661
mean squared error         = 28.70954          F( 26, 573)         = 23.57837
root mean squared error    = 5.358128          Prob > F            = 5.40e-70
Residual Sum of Squares    =    18977          R-squared           = .5578309
Total Sum of Squares       = 42917.98          adj. R-squared      = .4906953
Estimation Sum of Squares  = 23940.98

------------------------------------------------------------------------------
             |              fevd
  realgrowth |      Coef.   Std. Err.       t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |  -.2405992   .1025758    -2.35   0.019    -.4420696   -.0391287
  lngfcf_gdp |  -.3857742   2.062612    -0.19   0.852    -4.436976    3.665428
       fdexp |   .2435635   .0675948     3.60   0.000     .1107998    .3763273
     fdgrant |   .0152017   .1116782     0.14   0.892    -.2041468    .2345502
       trade |  -.0523833   .0463228    -1.13   0.259    -.1433666    .0385999
       year2 |  -12.31905   1.798757    -6.85   0.000    -15.85201   -8.786091
       year3 |  -17.98576   1.695818   -10.61   0.000    -21.31654   -14.65499
       year4 |   -15.1698   1.891688    -8.02   0.000    -18.88529   -11.45432
       year5 |  -8.586126   1.984848    -4.33   0.000    -12.48459   -4.687661
       year6 |  -11.47843   2.026933    -5.66   0.000    -15.45956   -7.497309
       year7 |  -10.51938   2.104469    -5.00   0.000    -14.65279   -6.385963
       year8 |  -14.42698   2.143296    -6.73   0.000    -18.63666   -10.21731
       year9 |  -26.42854   2.104419   -12.56   0.000    -30.56186   -22.29523
      year10 |  -13.21872   2.328193    -5.68   0.000    -17.79155   -8.645885
      year11 |  -14.78765   2.656398    -5.57   0.000    -20.00511   -9.570182
      year12 |  -17.97204   2.777257    -6.47   0.000    -23.42689    -12.5172
      year13 |  -16.31202   3.746363    -4.35   0.000     -23.6703    -8.95374
      year14 |   -14.8596   3.814777    -3.90   0.000    -22.35225   -7.366945
     educ2_n |   .0965985   .0426241     2.27   0.024     .0128799     .180317
     educ3_n |  -.0097203   .0345983    -0.28   0.779    -.0776752    .0582346
reallngdpini |     .06303   3.918057     0.02   0.987    -7.632475    7.758535
        size |   8.206552   4.674544     1.76   0.080    -.9747802    17.38788
    expsize1 |  -.0432681   .0466846    -0.93   0.354    -.1349619    .0484258
  grantsize1 |  -.1089168   .1115208    -0.98   0.329    -.3279563    .1101228
         eta |          1          .        .       .            .           .
       _cons |   10.82552   32.28197     0.34   0.737     -52.5799    74.23094
------------------------------------------------------------------------------


. xtfevd realgrowth popgrowth educ2_n educ3_n  lngfcf_gdp reallngdpini fdtax fdgrant
trade size revsize grantsize year3 year4 year5 year6 year7 year8 year9 year10 year11
year12 year13 year14 if realgrowth<=30 & realgrowth>=-13, invariant(educ2_n educ3_n
reallngdpini
>  size revsize grantsize)

panel fixed effects regression with vector decomposition
```

```
degrees of freedom fevd    =      574          number of obs       =      661
mean squared error         = 31.13122          F( 25, 574)         = 18.68027
root mean squared error    = 5.579535          Prob > F            = 2.13e-55
Residual Sum of Squares    = 20577.73          R-squared           = .5205335
Total Sum of Squares       = 42917.98          adj. R-squared      = .4486971
Estimation Sum of Squares  = 22340.25

------------------------------------------------------------------------------
             |                fevd
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |  -.2870534   .1065427    -2.69   0.007    -.4963146   -.0777923
  lngfcf_gdp |  -1.649795   2.210767    -0.75   0.456    -5.991973    2.692384
       fdtax |    .145189   .0621248     2.34   0.020     .0231695    .2672086
     fdgrant |  -.1856172   .1051678    -1.76   0.078    -.3921779    .0209435
       trade |  -.0555923    .048356    -1.15   0.251    -.1505686    .0393841
       year3 |  -10.35463    1.44841    -7.15   0.000    -13.19946     -7.5098
       year4 |  -7.244845   1.686295    -4.30   0.000    -10.55691   -3.932783
       year5 |  -.6515512   1.796191    -0.36   0.717    -4.179461    2.876358
       year6 |  -2.874941   1.829639    -1.57   0.117    -6.468544    .7186615
       year7 |  -1.605052    1.95231    -0.82   0.411    -5.439595    2.229491
       year8 |   -5.76399   2.019903    -2.85   0.004    -9.731292   -1.796687
       year9 |  -17.99416   1.874046    -9.60   0.000    -21.67499   -14.31334
      year10 |  -4.038084   2.286762    -1.77   0.078    -8.529526    .4533581
      year11 |  -5.582322   2.666107    -2.09   0.037    -10.81884    -.345808
      year12 |  -8.670562     2.7934    -3.10   0.002    -14.15709   -3.184029
      year13 |  -6.435834   3.740471    -1.72   0.086    -13.78251    .9108449
      year14 |  -5.805238   3.973366    -1.46   0.145    -13.60935    1.998872
     educ2_n |   .1827887   .0452807     4.04   0.000     .0938527    .2717247
     educ3_n |  -.0044291   .0352845    -0.13   0.900    -.0737316    .0648734
reallngdpini |  -3.374455    3.91626    -0.86   0.389     -11.0664    4.317493
        size |   2.164532   4.290235     0.50   0.614    -6.261943    10.59101
    revsize1 |  -.0001439   .0422767    -0.00   0.997    -.0831797     .082892
  grantsize1 |   .0522301   .1088688     0.48   0.632    -.1615998      .26606
         eta |          1          .        .       .            .           .
       _cons |    39.9461   31.07125     1.29   0.199     -21.0811    100.9733
------------------------------------------------------------------------------
```

```
. xtivreg2 realgrowth lag1realgdp popgrowth fdexp expsize1 size1 (lngfcf_gdp trade
educ2_n educ3_n fdgrant =  l2.fdgrant l.grantle
> xp  l2.trade l.educ2_n l.educ3_n l.lngfcf_gdp l.grantsize1  ) year3 year4 year5
year6 year7 year8 year9 year10 year11 year12 year13 ye
> ar14 if realgrowth >=-15 & realgrowth <=30,  fe  endog(fdgrant educ2_n educ3_n
lngfcf_gdp trade ) small
Warning - collinearities detected
Vars dropped:       size1 year14

FIXED EFFECTS ESTIMATION
------------------------
Number of groups =        64                   Obs per group: min =         5
                                                              avg =       8.5
                                                              max =        10

Warning - collinearities detected
Vars dropped:  size1 year14

IV (2SLS) estimation
--------------------

Estimates efficient for homoskedasticity only
Statistics consistent for homoskedasticity only

                                                     Number of obs =      541
                                                     F( 20,   457) =    17.36
                                                     Prob > F      =   0.0000
Total (centered) SS     =  33361.77512               Centered R2   =   0.2163
Total (uncentered) SS   =  33361.77512               Uncentered R2 =   0.2163
Residual SS             =  26144.86178               Root MSE      =    7.564

------------------------------------------------------------------------------
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  lngfcf_gdp |  -3.886603    5.06258    -0.77   0.443    -13.83543     6.06222
       trade |   .1343126   .1493284     0.90   0.369    -.1591429    .4277682
     educ2_n |   .0202362   .0627702     0.32   0.747    -.1031178    .1435902
     educ3_n |  -.0435968   .0946454    -0.46   0.645     -.229591    .1423973
     fdgrant |  -1.807873   .3133201    -5.77   0.000    -2.423599   -1.192146
```

```
 lag1realgdp |  -.0021646   .0006018    -3.60   0.000    -.0033472   -.0009819
   popgrowth |  -.2420516   .1400952    -1.73   0.085    -.5173622     .033259
       fdexp |  -1.634049   .3001858    -5.44   0.000    -2.223965   -1.044133
    expsize1 |   1.902566    .321508     5.92   0.000     1.270749    2.534383
       size1 |          0  (omitted)
       year3 |   9.453231   10.34849     0.91   0.361    -10.88329    29.78975
       year4 |  -.4965948   7.647085    -0.06   0.948    -15.52441    14.53122
       year5 |   .1001368   6.229653     0.02   0.987    -12.14218    12.34246
       year6 |  -1.489954   5.216088    -0.29   0.775    -11.74045    8.760537
       year7 |   1.254286   4.654348     0.27   0.788    -7.892292    10.40086
       year8 |  -.6066338    4.42314    -0.14   0.891     -9.29885    8.085582
       year9 |  -15.01686   5.495326    -2.73   0.007     -25.8161   -4.217621
      year10 |  -1.700058   4.034359    -0.42   0.674    -9.628253    6.228138
      year11 |  -4.177566   2.776791    -1.50   0.133    -9.634428    1.279296
      year12 |  -10.13566   2.523682    -4.02   0.000    -15.09512   -5.176197
      year13 |  -13.77155   3.218045    -4.28   0.000    -20.09555   -7.447552
      year14 |          0  (omitted)
------------------------------------------------------------------------------
Underidentification test (Anderson canon. corr. LM statistic):          51.507
                                                   Chi-sq(3) P-val =    0.0000
------------------------------------------------------------------------------
Weak identification test (Cragg-Donald Wald F statistic):                7.868
Stock-Yogo weak ID test critical values:                       <not available>
------------------------------------------------------------------------------
Sargan statistic (overidentification test of all instruments):           1.822
                                                   Chi-sq(2) P-val =    0.4021
-endog- option:
Endogeneity test of endogenous regressors:                              93.423
                                                   Chi-sq(5) P-val =    0.0000
Regressors tested:    fdgrant educ2_n educ3_n lngfcf_gdp trade
------------------------------------------------------------------------------
Instrumented:         lngfcf_gdp trade educ2_n educ3_n fdgrant
Included instruments: lag1realgdp popgrowth fdexp expsize1 year3 year4 year5
                      year6 year7 year8 year9 year10 year11 year12 year13
Excluded instruments: L2.fdgrant L.fdgrant L2.trade L.educ2_n L.educ3_n
                      L.lngfcf_gdp L.grantsize1
Dropped collinear:    size1 year14
------------------------------------------------------------------------------

.
. xtivreg2 realgrowth lag1realgdp popgrowth revsize grantsize (lngfcf_gdp trade
educ2_n educ3_n fdgrant fdtax =  l.fdgrant l2.fdgrant l2.trade l2.educ2_n
l.lngfcf_gdp l2.fdtax l.fdtax l.educ3_n) year4 year5 year6 year7 year8 year9 year10
year11 year12 year13
>  year14 if realgrowth >=-15,  fe  endog(fdgrant educ2_n educ3_n lngfcf_gdp trade
fdgrant fdtax) small

FIXED EFFECTS ESTIMATION
------------------------
Number of groups =        64                    Obs per group: min =         5
                                                               avg =       8.5
                                                               max =        10

IV (2SLS) estimation
--------------------

Estimates efficient for homoskedasticity only
Statistics consistent for homoskedasticity only

                                                      Number of obs =      541
                                                      F( 21,   456) =    16.45
                                                      Prob > F      =   0.0000
Total (centered) SS     =  33361.77512                Centered R2   =   0.2646
Total (uncentered) SS   =  33361.77512                Uncentered R2 =   0.2646
Residual SS             =  24535.47696                Root MSE      =    7.335

------------------------------------------------------------------------------
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  lngfcf_gdp |   -8.42234   5.259897    -1.60   0.110    -18.75898    1.914303
       trade |  -.1071922   .0957928    -1.12   0.264    -.2954423    .0810579
     educ2_n |   .3826296   .1350989     2.83   0.005      .117136    .6481233
     educ3_n |   .1259205   .1523008     0.83   0.409     -.173378    .4252189
     fdgrant |  -.6400543    .723555    -0.88   0.377     -2.06197    .7818614
       fdtax |   1.181298   .6814852     1.73   0.084    -.1579433    2.520539
 lag1realgdp |  -.0055771   .0009926    -5.62   0.000    -.0075278   -.0036265
   popgrowth |  -.5911663   .1891335    -3.13   0.002    -.9628476    -.219485
```

```
    revsize1 |  -.9015162   .6440265    -1.40   0.162    -2.167144    .3641118
  grantsize1 |   .4579035     .72872     0.63   0.530    -.9741625     1.88997
       year4 |   3.128261   3.043765     1.03   0.305    -2.853284    9.109806
       year5 |   9.649389   3.559493     2.71   0.007     2.654345    16.64443
       year6 |   15.13252   3.933165     3.85   0.000     7.403145     22.8619
       year7 |   20.43093   4.476676     4.56   0.000     11.63346    29.22841
       year8 |   17.81939   4.377438     4.07   0.000      9.21694    26.42185
       year9 |    8.29451   4.048675     2.05   0.041     .3381348    16.25088
      year10 |   19.99957   4.438077     4.51   0.000     11.27796    28.72119
      year11 |   21.79206   5.557154     3.92   0.000     10.87125    32.71287
      year12 |   20.11754   5.932693     3.39   0.001     8.458732    31.77635
      year13 |    23.1472   6.727873     3.44   0.001     9.925714    36.36868
      year14 |   20.94616   6.522755     3.21   0.001     8.127776    33.76455
------------------------------------------------------------------------------
Underidentification test (Anderson canon. corr. LM statistic):          18.487
                                                   Chi-sq(3) P-val =    0.0003
------------------------------------------------------------------------------
Weak identification test (Cragg-Donald Wald F statistic):                2.288
Stock-Yogo weak ID test critical values:                       <not available>
------------------------------------------------------------------------------
Sargan statistic (overidentification test of all instruments):           0.158
                                                   Chi-sq(2) P-val =    0.9241
-endog- option:
Endogeneity test of endogenous regressors:                              43.120
                                                   Chi-sq(6) P-val =    0.0000
Regressors tested:    fdgrant educ2_n educ3_n lngfcf_gdp trade fdtax
------------------------------------------------------------------------------
Instrumented:         lngfcf_gdp trade educ2_n educ3_n fdgrant fdtax
Included instruments: lag1realgdp popgrowth revsize1 grantsize1 year4 year5
                      year6 year7 year8 year9 year10 year11 year12 year13 year14
Excluded instruments: L.fdgrant L2.fdgrant L2.trade L2.educ2_n L.lngfcf_gdp
                      L2.fdtax L.fdtax L.educ3_n
------------------------------------------------------------------------------
```

Appendix 5.4.6 Alternative Estimators

```
A. GSL
. xtgls realgrowth popgrowth educ2_n educ3_n lag1realgdp lngfcf_gdp fdexp fdgrant
trade year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12 year13
year14 if realgrowth<=30 & realgrowth>=-15, panels (correlated)

panels must be balanced
r(459);

B. PCSE
xtpcse realgrowth popgrowth educ2_n educ3_n lag1realgdp lngfcf_gdp fdexp fdgrant
trade year1 year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12 if
realgrowth<=30 & realgrowth>=-15, corr(ar1)

Number of gaps in sample:  12
(note: computations for rho restarted at each gap)
(note: the number of observations per panel, e(n_sigma) = 4,
       used to compute the disturbance of covariance matrix e(Sigma)
       is less than half of the average number of observations per panel,
       e(n_avg) = 10.453125; you may want to consider the pairwise option)

Prais-Winsten regression, correlated panels corrected standard errors (PCSEs)

Group variable:   idall                        Number of obs      =       669
Time variable:    year                         Number of groups   =        64
Panels:           correlated (unbalanced)      Obs per group: min =         7
Autocorrelation:  common AR(1)                                avg =  10.45313
Sigma computed by casewise selection                          max =        12
Estimated covariances      =      2080         R-squared          =    0.4961
Estimated autocorrelations =         1         Wald chi2(20)      =  2.74e+06
Estimated coefficients     =        21         Prob > chi2        =    0.0000

------------------------------------------------------------------------------
             |           Panel-corrected
  realgrowth |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |  -.2689364   .2169682    -1.24   0.215    -.6941863    .1563135
     educ2_n |   .0811141    .049207     1.65   0.099    -.0153298     .177558
     educ3_n |    .043049   .0310735     1.39   0.166    -.0178539    .1039519
 lag1realgdp |  -.0006326   .0003199    -1.98   0.048    -.0012595   -5.72e-06
```

```
  lngfcf_gdp |  -2.531669   1.969058    -1.29   0.199    -6.390952    1.327613
       fdexp |   .0756925   .0374114     2.02   0.043     .0023674    .1490176
     fdgrant |  -.0718231   .0430732    -1.67   0.095    -.1562449    .0125988
       trade |  -.0129411   .0374241    -0.35   0.729     -.086291    .0604087
       year1 |   13.43242   5.456437     2.46   0.014     2.737997    24.12684
       year2 |   2.665406   5.051152     0.53   0.598    -7.234671    12.56548
       year3 |  -1.494598   4.130072    -0.36   0.717    -9.589389    6.600194
       year4 |   1.997925    4.33191     0.46   0.645    -6.492463    10.48831
       year5 |   8.527806   4.307131     1.98   0.048     .0859838    16.96963
       year6 |   5.769288   4.072119     1.42   0.157    -2.211919    13.75049
       year7 |   6.981455   3.911506     1.78   0.074    -.6849553    14.64787
       year8 |   3.241208   3.863124     0.84   0.401    -4.330376    10.81279
       year9 |  -9.855975   3.989276    -2.47   0.013    -17.67481   -2.037138
      year10 |   2.664547   3.851306     0.69   0.489    -4.883874    10.21297
      year11 |   .9364599   3.724219     0.25   0.801    -6.362875    8.235794
      year12 |  -1.604839   3.691338    -0.43   0.664    -8.839728    5.630051
       _cons |   10.37417   9.583152     1.08   0.279    -8.408459    29.15681
-------------+----------------------------------------------------------------
         rho |   .0549704
------------------------------------------------------------------------------

.
```

Appendix 5.5 Dynamic

Appendix 5.5.1 Baseline specification, using FDexp and FDgrant

```
. xtabond2 realgrowth l.realgrowth reallngdpini popgrowth l.educ2_n l.educ3_n
lngfcf_gdp fdexp fdgrant l.trade year3 year4 year5 year6 year7 year8 year9 year10
year11 year12 year13 year14  if realgrowth <=30, gmm( l.realgrowth, laglimits(2
4)collapse) gmm(lngfcf_gdp, laglimits(2 3) collapse) iv( popgrowth l.educ2_n l.educ3_n
fdgrant fdexp l.trade year3-year14) two robust small
Favoring speed over space. To switch, type or click on mata: mata set matafavor
space, perm.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: idall                           Number of obs      =       667
Time variable : year                            Number of groups   =        64
Number of instruments = 26                      Obs per group: min =         7
F(21, 63)     =     60.70                                      avg =     10.42
Prob > F      =     0.000                                      max =        12
------------------------------------------------------------------------------
             |              Corrected
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  realgrowth |
         L1. |  -.0215056    .257595    -0.08   0.934    -.5362681     .493257
             |
reallngdpini |  -14.23625   2.348011    -6.06   0.000    -18.92837   -9.544124
   popgrowth |   .0322902   .1460944     0.22   0.826    -.2596561    .3242365
             |
     educ2_n |
         L1. |  -.2424439   .0554968    -4.37   0.000    -.3533455   -.1315423
             |
     educ3_n |
         L1. |   .1527514   .0318387     4.80   0.000     .0891268     .216376
             |
  lngfcf_gdp |   9.449319   4.546604     2.08   0.042     .3636563    18.53498
       fdexp |   .1291647   .0411546     3.14   0.003     .0469237    .2114056
     fdgrant |   .0390249   .0367483     1.06   0.292    -.0344107    .1124605
             |
       trade |
         L1. |   .1277195   .0378302     3.38   0.001     .0521218    .2033172
             |
       year3 |  -12.37479   2.375815    -5.21   0.000    -17.12248   -7.627101
       year4 |   -5.70202   3.259109    -1.75   0.085    -12.21483    .8107892
       year5 |  -.9707039   2.739709    -0.35   0.724    -6.445575    4.504167
       year6 |  -6.530602   1.641922    -3.98   0.000    -9.811722   -3.249482
       year7 |  -7.205479   2.112292    -3.41   0.001    -11.42656     -2.9844
       year8 |  -11.67449   2.167961    -5.39   0.000    -16.00682   -7.342166
       year9 |  -25.28787   2.344321   -10.79   0.000    -29.97262   -20.60311
      year10 |  -9.884496   6.053253    -1.63   0.107    -21.98096    2.211966
      year11 |  -13.30136   2.647067    -5.02   0.000    -18.59111   -8.011622
      year12 |  -18.10939   2.723987    -6.65   0.000    -23.55284   -12.66593
```

```
      year13 |  -16.02542    3.76306    -4.26   0.000    -23.54529    -8.50554
      year14 |  -14.85026   3.901311    -3.81   0.000    -22.64641   -7.054114
       _cons |    89.5537   20.36747     4.40   0.000     48.85256    130.2548
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(popgrowth L.educ2_n L.educ3_n fdgrant fdexp L.trade year3 year4
    year5 year6 year7 year8 year9 year10 year11 year12 year13 year14)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(2/3).lngfcf_gdp collapsed
    L(2/4).L.realgrowth collapsed
Instruments for levels equation
  Standard
    popgrowth L.educ2_n L.educ3_n fdgrant fdexp L.trade year3 year4 year5
    year6 year7 year8 year9 year10 year11 year12 year13 year14
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.lngfcf_gdp collapsed
    DL.L.realgrowth collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -2.61  Pr > z =  0.009
Arellano-Bond test for AR(2) in first differences: z =   0.94  Pr > z =  0.346
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(4)    =   2.25  Prob > chi2 =  0.689
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(4)    =   2.77  Prob > chi2 =  0.596
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(2)    =   0.05  Prob > chi2 =  0.976
    Difference (null H = exogenous): chi2(2)    =   2.73  Prob > chi2 =  0.256
  gmm(L.realgrowth, collapse lag(2 4))
    Hansen test excluding group:     chi2(0)    =   0.00  Prob > chi2 =      .
    Difference (null H = exogenous): chi2(4)    =   2.77  Prob > chi2 =  0.596
  gmm(lngfcf_gdp, collapse lag(2 3))
    Hansen test excluding group:     chi2(1)    =   1.46  Prob > chi2 =  0.227
    Difference (null H = exogenous): chi2(3)    =   1.32  Prob > chi2 =  0.725
```

Appendix 5.5.2 Baseline specification using FDtax and FDgrant

```
. xtabond2 realgrowth l.realgrowth reallngdpini popgrowth l.educ2_n l.educ3_n
lngfcf_gdp fdtax fdgrant l.trade year3 year4 year5 year6 year7 year8 year9 year10
year11 year12 year13 year14  if realgrowth <=30, gmm( l.realgrowth, laglimits(2
3)collapse) gmm(lngfcf_gdp, laglimits(2 4) collapse)  iv( popgrowth l.educ2_n l.educ3_n
fdgrant fdtax l.trade  year3-year14) two robust small
Favoring speed over space. To switch, type or click on mata: mata set matafavor
space, perm.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: idall                           Number of obs      =       667
Time variable : year                            Number of groups   =        64
Number of instruments = 26                      Obs per group: min =         7
F(21, 63)      =     63.68                                     avg =     10.42
Prob > F       =     0.000                                     max =        12
------------------------------------------------------------------------------
             |              Corrected
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  realgrowth |
         L1. |  -.1419756   .2603648    -0.55   0.587    -.6622731    .3783219
             |
reallngdpini |  -15.73245   2.480122    -6.34   0.000    -20.68858   -10.77632
   popgrowth |  -.0115606   .1772633    -0.07   0.948    -.3657931    .3426719
             |
     educ2_n |
         L1. |  -.2266404   .0585138    -3.87   0.000     -.343571   -.1097099
             |
     educ3_n |
         L1. |   .1500531   .0301169     4.98   0.000     .0898693     .210237
             |
  lngfcf_gdp |   8.157901   3.800084     2.15   0.036     .5640378    15.75176
       fdtax |   .1859658   .0462113     4.02   0.000       .09362    .2783116
```

```
     fdgrant |   .0205592   .0414437     0.50   0.622    -.0622594    .1033779
             |
       trade |
         L1. |   .1276025   .0391622     3.26   0.002      .049343     .205862
             |
       year3 |  -13.75813   2.361802    -5.83   0.000    -18.47781   -9.038441
       year4 |  -7.847596   3.608922    -2.17   0.033    -15.05945   -.6357411
       year5 |  -2.174529   3.085238    -0.70   0.484    -8.339884    3.990827
       year6 |  -6.615933   1.760505    -3.76   0.000    -10.13402   -3.097844
       year7 |  -7.922245   2.128078    -3.72   0.000    -12.17487   -3.669621
       year8 |   -13.2305   2.293328    -5.77   0.000    -17.81335    -8.64765
       year9 |  -27.13567   2.809651    -9.66   0.000    -32.75031   -21.52103
      year10 |  -13.33582   6.510628    -2.05   0.045    -26.34627   -.3253692
      year11 |  -14.66722   3.106959    -4.72   0.000    -20.87598   -8.458455
      year12 |  -20.31179   3.017584    -6.73   0.000    -26.34195   -14.28163
      year13 |  -17.87656   4.067021    -4.40   0.000    -26.00385   -9.749266
      year14 |  -17.48385   4.208439    -4.15   0.000    -25.89375   -9.073956
       _cons |   106.4017   21.63519     4.92   0.000     63.16719    149.6361
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(popgrowth L.educ2_n L.educ3_n fdgrant fdtax L.trade year3 year4
    year5 year6 year7 year8 year9 year10 year11 year12 year13 year14)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(2/4).lngfcf_gdp collapsed
    L(2/3).L.realgrowth collapsed
Instruments for levels equation
  Standard
    popgrowth L.educ2_n L.educ3_n fdgrant fdtax L.trade year3 year4 year5
    year6 year7 year8 year9 year10 year11 year12 year13 year14
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.lngfcf_gdp collapsed
    DL.L.realgrowth collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -2.24  Pr > z =  0.025
Arellano-Bond test for AR(2) in first differences: z =   0.52  Pr > z =  0.604
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(4)     =   4.55  Prob > chi2 =  0.337
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(4)     =   4.26  Prob > chi2 =  0.372
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(2)     =   0.38  Prob > chi2 =  0.828
    Difference (null H = exogenous): chi2(2)     =   3.89  Prob > chi2 =  0.143
  gmm(L.realgrowth, collapse lag(2 3))
    Hansen test excluding group:     chi2(1)     =   3.72  Prob > chi2 =  0.054
    Difference (null H = exogenous): chi2(3)     =   0.54  Prob > chi2 =  0.909
  gmm(lngfcf_gdp, collapse lag(2 4))
    Hansen test excluding group:     chi2(0)     =   0.00  Prob > chi2 =      .
    Difference (null H = exogenous): chi2(4)     =   4.26  Prob > chi2 =  0.372
```

Appendix 5.5.3 Baseline augmented with size, using FDexp and FDgrant

```
. xtabond2 realgrowth l.realgrowth reallngdpini popgrowth l.educ2_n l.educ3_n
lngfcf_gdp i.size1 i.size1#c.fdgrant i.size1#c.fdexp  l.trade year3 year4 year5 year6
year7 year8 year9 year10 year11 year12 year13 year14  if realgrowth <=30, gmm(
l.realgrowth, laglimits(3 4)collapse) gmm(lngfcf_gdp, laglimits(2 4) collapse)  iv(
popgrowth l.educ2_n l.educ3_n fdgrant fdexp size1 l.trade year3-year14) two robust
small
Favoring speed over space. To switch, type or click on mata: mata set matafavor
space, perm.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: idall                           Number of obs      =       667
Time variable : year                            Number of groups   =        64
Number of instruments = 27                      Obs per group: min =         7
F(25, 63)     =     62.49                                      avg =     10.42
Prob > F      =     0.000                                      max =        12
----------------------------------------------------------------------------------
                  |              Corrected
```

```
       realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
------------------+----------------------------------------------------------------
       realgrowth |
              L1. |   .0373983   .1724843     0.22   0.829     -.307284    .3820806
                  |
     reallngdpini |  -12.17918   4.889815    -2.49   0.015    -21.95069   -2.407661
        popgrowth |   .0852375   .1234282     0.69   0.492    -.1614142    .3318892
                  |
          educ2_n |
              L1. |  -.1748466   .1054819    -1.66   0.102    -.3856354    .0359421
                  |
          educ3_n |
              L1. |   .1358595    .044518     3.05   0.003     .0468974    .2248215
                  |
       lngfcf_gdp |   12.16556   6.776653     1.80   0.077    -1.376502    25.70762
                  |
            size1 |
               0  |          0  (empty)
               1  |   37.88208   55.46126     0.68   0.497    -72.94841    148.7126
                  |
  size1#c.fdgrant |
               0  |   .4521887    .592118     0.76   0.448    -.7310648    1.635442
               1  |  -.1150694   .2333368    -0.49   0.624    -.5813558    .3512169
                  |
    size1#c.fdexp |
               0  |   .4016541   .5818887     0.69   0.493    -.7611576    1.564466
               1  |   .1703354   .0953787     1.79   0.079    -.0202638    .3609345
                  |
            trade |
              L1. |   .1203079   .0510279     2.36   0.022     .0183368     .222279
                  |
            year3 |  -12.36339   2.604463    -4.75   0.000    -17.56799   -7.158783
            year4 |  -6.570524   4.296892    -1.53   0.131    -15.15718    2.016129
            year5 |  -1.505164   4.509664    -0.33   0.740    -10.51701    7.506682
            year6 |  -7.603831   3.754831    -2.03   0.047    -15.10726   -.1004005
            year7 |  -8.411591   4.080871    -2.06   0.043    -16.56656   -.2566209
            year8 |  -13.28055   3.903757    -3.40   0.001    -21.08159   -5.479516
            year9 |  -26.06301   4.046162    -6.44   0.000    -34.14862    -17.9774
           year10 |   -9.56338   5.461167    -1.75   0.085    -20.47665    1.349891
           year11 |  -14.11013   3.599098    -3.92   0.000    -21.30236    -6.91791
           year12 |  -18.65042   3.763606    -4.96   0.000    -26.17139   -11.12945
           year13 |  -15.92152   3.831725    -4.16   0.000    -23.57861   -8.264427
           year14 |  -14.81515   3.928584    -3.77   0.000     -22.6658   -6.964505
            _cons |    27.6023   88.83317     0.31   0.757    -149.9166    205.1212
-----------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(popgrowth L.educ2_n L.educ3_n fdgrant fdexp size1 L.trade year3
    year4 year5 year6 year7 year8 year9 year10 year11 year12 year13 year14)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(2/4).lngfcf_gdp collapsed
    L(3/4).L.realgrowth collapsed
Instruments for levels equation
  Standard
    popgrowth L.educ2_n L.educ3_n fdgrant fdexp size1 L.trade year3 year4
    year5 year6 year7 year8 year9 year10 year11 year12 year13 year14
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.lngfcf_gdp collapsed
    DL2.L.realgrowth collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -2.92  Pr > z =  0.003
Arellano-Bond test for AR(2) in first differences: z =   1.51  Pr > z =  0.130
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(1)    =   2.89  Prob > chi2 =  0.259
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(1)    =   1.98  Prob > chi2 =  0.359
  (Robust, but weakened by many instruments.


.
. margins, dydx (fdexp fdgrant) at (size1= (0,1)) vsquish force level(90)
Warning: cannot perform check for estimable functions.
(note: default prediction is a function of possibly stochastic quantities other than
e(b))

Average marginal effects                          Number of obs   =        667
```

```
Model VCE    : Corrected

Expression   : Fitted Values, predict()
dy/dx w.r.t. : fdgrant fdexp
1._at        : size1           =           0
2._at        : size1           =           1

------------------------------------------------------------------------------
             |            Delta-method
             |      dy/dx   Std. Err.      z    P>|z|     [90% Conf. Interval]
-------------+----------------------------------------------------------------
fdgrant      |
         _at |
          1  |   .4521887    .592118     0.76   0.445    -.5217588    1.426136
          2  |  -.1150694   .2333368    -0.49   0.622    -.4988743    .2687354
-------------+----------------------------------------------------------------
fdexp        |
         _at |
          1  |   .4016541   .5818887     0.69   0.490    -.5554676    1.358776
          2  |   .1703354   .0953787     1.79   0.074     .0134514    .3272194
------------------------------------------------------------------------------
.
. marginsplot

  Variables that uniquely identify margins: size1 _deriv
```

Appendix 5.5.4 Baseline augmented with size, using FDtax and FDgrant

```
. xtabond2 realgrowth l.realgrowth reallngdpini popgrowth l.educ2_n l.educ3_n
lngfcf_gdp i.size1 i.size1#c.fdgrant i.size1#c.fdtax l.trade year3 year4 year5 year6
year7 year8 year9 year10 year11 year12 year13 year14 if realgrowth <=30, gmm(
l.realgrowth, laglimits(2 4)collapse) gmm(lngfcf_gdp, laglimits(2 4) collapse) iv(
popgrowth l.educ2_n l.educ3_n fdgrant fdtax size1 l.trade year3-year14) two robust
small
Favoring speed over space. To switch, type or click on mata: mata set matafavor
space, perm.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: idall                           Number of obs      =       667
Time variable : year                            Number of groups   =        64
Number of instruments = 28                      Obs per group: min =         7
F(25, 63)     =     73.71                                      avg =     10.42
Prob > F      =     0.000                                      max =        12
-----------------------------------------------------------------------------------
                  |              Corrected
       realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
------------------+----------------------------------------------------------------
       realgrowth |
              L1. |   .3823445   .5526201     0.69   0.492    -.7219787    1.486668
                  |
     reallngdpini |  -18.55774   5.041193    -3.68   0.000    -28.63176   -8.483721
        popgrowth |   .2552381   .2861188     0.89   0.376    -.3165247    .8270009
                  |
          educ2_n |
              L1. |  -.1758276   .1254084    -1.40   0.166    -.4264363    .0747811
                  |
          educ3_n |
              L1. |    .171339   .0439164     3.90   0.000      .083579     .259099
                  |
       lngfcf_gdp |   10.58582   6.523998     1.62   0.110    -2.451354    23.62299
                  |
            size1 |
               0  |          0  (empty)
               1  |   23.10664   50.80697     0.45   0.651    -78.42299    124.6363
                  |
  size1#c.fdgrant |
               0  |   .2666893   .5016275     0.53   0.597    -.7357333    1.269112
               1  |  -.1516315   .2068613    -0.73   0.466    -.5650108    .2617478
                  |
    size1#c.fdtax |
               0  |   .2443569    .553973     0.44   0.661    -.8626697    1.351383
               1  |   .3091209   .1091939     2.83   0.006     .0909143    .5273275
                  |
            trade |
```

```
          L1. |   .1772831   .0579398     3.06   0.003     .0614996    .2930666
              |
        year3 |  -9.742817   5.203112    -1.87   0.066    -20.14041    .6547715
        year4 |   -4.33805    5.88765    -0.74   0.464    -16.10358    7.427479
        year5 |  -1.564677   4.143214    -0.38   0.707    -9.844229    6.714875
        year6 |   -9.46046   3.562573    -2.66   0.010    -16.57969   -2.341225
        year7 |  -9.480268   3.593854    -2.64   0.010    -16.66201   -2.298525
        year8 |  -14.77176   3.418559    -4.32   0.000     -21.6032   -7.940312
        year9 |  -26.44201   3.760747    -7.03   0.000    -33.95726   -18.92676
       year10 |  -2.695064   11.12062    -0.24   0.809    -24.91785    19.52773
       year11 |  -13.37479    4.15353    -3.22   0.002    -21.67496   -5.074622
       year12 |  -18.71778    4.36107    -4.29   0.000    -27.43268   -10.00288
       year13 |  -13.02813   6.652308    -1.96   0.055    -26.32171    .2654461
       year14 |  -12.51652   6.766893    -1.85   0.069    -26.03907    1.006039
        _cons |   87.17293   70.33607     1.24   0.220     -53.3825    227.7284
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(popgrowth L.educ2_n L.educ3_n fdgrant fdtax size1 L.trade year3
    year4 year5 year6 year7 year8 year9 year10 year11 year12 year13 year14)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(2/4).lngfcf_gdp collapsed
    L(2/4).L.realgrowth collapsed
Instruments for levels equation
  Standard
    popgrowth L.educ2_n L.educ3_n fdgrant fdtax size1 L.trade year3 year4
    year5 year6 year7 year8 year9 year10 year11 year12 year13 year14
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.lngfcf_gdp collapsed
    DL.L.realgrowth collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -1.83  Pr > z =  0.067
Arellano-Bond test for AR(2) in first differences: z =   1.30  Pr > z =  0.195
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(2)    =   0.68  Prob > chi2 =  0.710
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(2)    =   0.64  Prob > chi2 =  0.725
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(0)    =   0.06  Prob > chi2 =      .
    Difference (null H = exogenous): chi2(2)    =   0.58  Prob > chi2 =  0.748


. margins, dydx (fdtax fdgrant) at (size1= (0,1)) vsquish force level(90)
Warning: cannot perform check for estimable functions.
(note: default prediction is a function of possibly stochastic quantities other than
e(b))

Average marginal effects                        Number of obs   =        667
Model VCE    : Corrected

Expression   : Fitted Values, predict()
dy/dx w.r.t. : fdgrant fdtax
1._at        : size1           =           0
2._at        : size1           =           1

------------------------------------------------------------------------------
             |            Delta-method
             |      dy/dx   Std. Err.      z    P>|z|     [90% Conf. Interval]
-------------+----------------------------------------------------------------
  fdgrant    |
         _at |
          1  |   .2666893   .5016275     0.53   0.595    -.5584145    1.091793
          2  |  -.1516315   .2068613    -0.73   0.464     -.491888    .1886251
-------------+----------------------------------------------------------------
  fdtax      |
         _at |
          1  |   .2443569    .553973     0.44   0.659    -.6668476    1.155561
          2  |   .3091209   .1091939     2.83   0.005     .1295129    .4887288
------------------------------------------------------------------------------

.
. marginsplot
```

```
  Variables that uniquely identify margins: size1 _deriv
```

Appendix 5.5.5 Claiming FD measures as Endogenous (FDexp and FDgrant Endogenous)

```
.  xtabond2  realgrowth  l.realgrowth  reallngdpini  popgrowth  l.educ2_n  l.educ3_n
lngfcf_gdp fdexp l.fdgrant l.trade year3 year4 year5 year6 year 7 year8 year9 year10
year11  year12  year13  year14   if  realgrowth  <=30,  gmm(  l.realgrowth,  laglimits(2
4)collapse) gmm(lngfcf_gdp, laglimits(2 3)collapse)  iv( popgrowth l.educ2_n l.educ3_n
l.fdgrant fdexp l.trade year3-year14) two robust small

Favoring speed over space. To switch, type or click on mata: mata set matafavor
space, perm.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: idall                           Number of obs      =       652
Time variable : year                            Number of groups   =        64
Number of instruments = 26                      Obs per group: min =         6
F(21, 63)      =     70.19                                     avg =     10.19
Prob > F       =     0.000                                     max =        12
------------------------------------------------------------------------------
             |              Corrected
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  realgrowth |
         L1. |   .1032034   .3189545     0.32   0.747    -.5341763    .7405831
             |
reallngdpini |  -5.693756   2.255108    -2.52   0.014    -10.20023   -1.187282
   popgrowth |   .0458669   .1760366     0.26   0.795    -.3059142     .397648
             |
     educ2_n |
         L1. |  -.0965311    .056026    -1.72   0.090    -.2084902     .015428
             |
     educ3_n |
         L1. |   .0492029   .0281383     1.75   0.085    -.0070271    .1054329
             |
  lngfcf_gdp |   9.901963   5.366851     1.85   0.070    -.8228331    20.62676
       fdexp |   .0295339   .0492401     0.60   0.551    -.0688646    .1279323
             |
     fdgrant |
         L1. |  -.0166783   .0418949    -0.40   0.692    -.1003985     .067042
             |
       trade |
         L1. |   .0243971   .0314929     0.77   0.441    -.0385364    .0873307
             |
       year3 |  -10.28672    3.28146    -3.13   0.003    -16.84419   -3.729247
       year4 |  -2.688172   4.827677    -0.56   0.580    -12.33552    6.959172
       year5 |   2.717779   4.474418     0.61   0.546    -6.223633    11.65919
       year6 |  -2.953065   2.892719    -1.02   0.311    -8.733702    2.827573
       year7 |  -1.432791   3.542712    -0.40   0.687    -8.512336    5.646754
       year8 |  -6.821999   2.826293    -2.41   0.019     -12.4699   -1.174102
       year9 |  -19.79108   4.084067    -4.85   0.000    -27.95244   -11.62972
      year10 |  -3.028997    8.41443    -0.36   0.720    -19.84389     13.7859
      year11 |  -6.420718   4.263123    -1.51   0.137    -14.93989    2.098454
      year12 |  -10.08665   4.081271    -2.47   0.016    -18.24242    -1.93088
      year13 |  -8.575476    4.76724    -1.80   0.077    -18.10204    .9510931
      year14 |  -6.069059   5.377954    -1.13   0.263    -16.81604    4.677925
       _cons |   25.52211   23.78519     1.07   0.287     -22.0088    73.05301
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(popgrowth L.educ2_n L.educ3_n L.fdgrant fdexp L.trade year3 year4
    year5 year6 year7 year8 year9 year10 year11 year12 year13 year14)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(2/3).lngfcf_gdp collapsed
    L(2/4).L.realgrowth collapsed
Instruments for levels equation
  Standard
    popgrowth L.educ2_n L.educ3_n L.fdgrant fdexp L.trade year3 year4
    year5 year6 year7 year8 year9 year10 year11 year12 year13 year14
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
```

```
    DL.lngfcf_gdp collapsed
    DL.L.realgrowth collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -2.26  Pr > z =  0.024
Arellano-Bond test for AR(2) in first differences: z =   1.20  Pr > z =  0.232
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(4)    =   2.28  Prob > chi2 =  0.685
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(4)    =   3.67  Prob > chi2 =  0.452
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(2)    =   1.68  Prob > chi2 =  0.432
    Difference (null H = exogenous): chi2(2)    =   1.99  Prob > chi2 =  0.369
  gmm(L.realgrowth, collapse lag(2 4))
    Hansen test excluding group:     chi2(0)    =   0.00  Prob > chi2 =      .
    Difference (null H = exogenous): chi2(4)    =   3.67  Prob > chi2 =  0.452
  gmm(lngfcf_gdp, collapse lag(2 3))
    Hansen test excluding group:     chi2(1)    =   0.55  Prob > chi2 =  0.460
    Difference (null H = exogenous): chi2(3)    =   3.13  Prob > chi2 =  0.373
```

Appendix 5.5.6 Claiming FD measures as Endogenous (FDtax Endogenous and FDgrant Endogenous)

```
. xtabond2 realgrowth l.realgrowth reallngdpini popgrowth l.educ2_n l.educ3_n
lngfcf_gdp l.fdtax l.fdgrant l.trade year3 year4 year5 year6 year7 year8 year9 year10
year11 year12 year13 year14  if realgrowth <=30, gmm( l.realgrowth, laglimits(2
3)collapse) gmm(lngfcf_gdp, laglimits(3 4) collapse) iv( popgrowth l.educ2_n l.educ3_n
l.fdgrant l.fdtax l.trade  year3-year14) two robust small

Favoring speed over space. To switch, type or click on mata: mata set matafavor
space, perm.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: idall                           Number of obs      =       666
Time variable : year                            Number of groups   =        64
Number of instruments = 25                      Obs per group: min =         7
F(21, 63)     =     87.88                                      avg =     10.41
Prob > F      =     0.000                                      max =        12
------------------------------------------------------------------------------
             |              Corrected
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  realgrowth |
         L1. |  -.3027681   .1972632    -1.53   0.130    -.6969671    .0914309
             |
reallngdpini |  -13.04213   3.642065    -3.58   0.001    -20.32021   -5.764043
   popgrowth |  -.0939538   .1772605    -0.53   0.598    -.4481807    .2602732
             |
     educ2_n |
         L1. |  -.0232202   .0578655    -0.40   0.690    -.1388552    .0924148
             |
     educ3_n |
         L1. |   .0897993   .0386479     2.32   0.023     .0125677     .167031
             |
  lngfcf_gdp |  -3.997402   6.279436    -0.64   0.527    -16.54585    8.551049
             |
       fdtax |
         L1. |   .1888687   .0517834     3.65   0.001     .0853878    .2923496
             |
     fdgrant |
         L1. |  -.1230401   .0409497    -3.00   0.004    -.2048716   -.0412087
             |
       trade |
         L1. |   .1086342    .065201     1.67   0.101    -.0216597    .2389281
             |
       year3 |  -13.95839   1.986873    -7.03   0.000    -17.92884   -9.987945
       year4 |  -10.46889   2.995705    -3.49   0.001    -16.45533   -4.482453
       year5 |  -4.394976   2.769914    -1.59   0.118    -9.930206    1.140255
       year6 |  -6.485301    2.29128    -2.83   0.006    -11.06406   -1.906543
       year7 |  -6.395599   2.838496    -2.25   0.028    -12.06788   -.7233177
```

```
       year8 |  -11.80352    2.53156    -4.66   0.000    -16.86244   -6.744601
       year9 |  -29.92556   3.034553    -9.86   0.000    -35.98963   -23.86149
      year10 |  -17.04467   5.931841    -2.87   0.006    -28.89851   -5.190833
      year11 |  -15.11248   3.000875    -5.04   0.000    -21.10925   -9.115706
      year12 |  -20.34659   3.111476    -6.54   0.000    -26.56438    -14.1288
      year13 |  -22.79989   3.799303    -6.00   0.000    -30.39219   -15.20759
      year14 |  -16.55434   3.392325    -4.88   0.000    -23.33336    -9.77532
       _cons |   124.2355   38.61626     3.22   0.002     47.06707    201.4039
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(popgrowth L.educ2_n L.educ3_n L.fdgrant L.fdtax L.trade year3 year4
    year5 year6 year7 year8 year9 year10 year11 year12 year13 year14)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(3/4).lngfcf_gdp collapsed
    L(2/3).L.realgrowth collapsed
Instruments for levels equation
  Standard
    popgrowth L.educ2_n L.educ3_n L.fdgrant L.fdtax L.trade year3 year4
    year5 year6 year7 year8 year9 year10 year11 year12 year13 year14
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL2.lngfcf_gdp collapsed
    DL.L.realgrowth collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -2.01  Pr > z =  0.044
Arellano-Bond test for AR(2) in first differences: z =  -0.56  Pr > z =  0.574
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(3)    =   1.49  Prob > chi2 =  0.685
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(3)    =   1.94  Prob > chi2 =  0.585
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(1)    =   0.24  Prob > chi2 =  0.622
    Difference (null H = exogenous): chi2(2)    =   1.70  Prob > chi2 =  0.428
  gmm(L.realgrowth, collapse lag(2 3))
    Hansen test excluding group:     chi2(0)    =   0.00  Prob > chi2 =      .
    Difference (null H = exogenous): chi2(3)    =   1.94  Prob > chi2 =  0.585
  gmm(lngfcf_gdp, collapse lag(3 4))
    Hansen test excluding group:     chi2(0)    =   0.00  Prob > chi2 =      .
    Difference (null H = exogenous): chi2(3)    =   1.94  Prob > chi2 =  0.585
```

Appendix 5.5.7 Endogenous and Size, using FDexp and FDgrant

```
. xtabond2 realgrowth l.realgrowth reallngdpini popgrowth l.educ2_n l.educ3_n
lngfcf_gdp i.size1 i.size1#c.l.fdgrant i.size1#c.fdexp l.trade year3 year4 year5 year6
year7 year8 year9 year10 year11 year12 year13 year14  if realgrowth <=30, gmm(
l.realgrowth, laglimits(2 4)collapse) gmm (lngfcf_gdp, laglimits(1 4) collapse) iv(
popgrowth l.educ2_n l.educ3_n fdexp l.fdgrant size1 l.trade year3-year14) two robust
small
Favoring speed over space. To switch, type or click on mata: mata set matafavor
space, perm.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: idall                           Number of obs      =       652
Time variable : year                            Number of groups   =        64
Number of instruments = 29                      Obs per group: min =         6
F(24, 63)     =    151.78                                      avg =     10.19
Prob > F      =     0.000                                      max =        12
--------------------------------------------------------------------------------
               |              Corrected
    realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
---------------+----------------------------------------------------------------
    realgrowth |
           L1. |   .2928349   .4724772     0.62   0.538    -.6513354    1.237005
               |
  reallngdpini |  -3.838237   3.859826    -0.99   0.324    -11.55148    3.875011
     popgrowth |   .1148845   .2199439     0.52   0.603    -.3246383    .5544072
               |
       educ2_n |
           L1. |  -.0896585   .0495181    -1.81   0.075    -.1886126    .0092955
```

```
             |
     educ3_n |
         L1. |   .0205055   .0321537     0.64   0.526    -.0437486    .0847596
             |
  lngfcf_gdp |   2.581694   4.775868     0.54   0.591    -6.962116    12.12551
       size1 |  -4.241406    12.5932    -0.34   0.737    -29.40692     20.9241
             |
size1#cL.fdgrant |
          0  |    .006327   .0964826     0.07   0.948    -.1864781    .1991321
          1  |  -.2872746   .1013186    -2.84   0.006    -.4897436   -.0848057
             |
 size1#c.fdexp |
          0  |   -.063121   .1626192    -0.39   0.699    -.3880895    .2618475
          1  |   .1474027   .0721642     2.04   0.045     .0031942    .2916113
             |
       trade |
         L1. |   .0273199   .0468606     0.58   0.562    -.0663235    .1209632
             |
       year3 |  -9.126625   5.077475    -1.80   0.077    -19.27315    1.019899
       year4 |  -2.662913   7.507797    -0.35   0.724    -17.66605    12.34022
       year5 |   1.680633   5.900937     0.28   0.777    -10.11145    13.47272
       year6 |  -5.676941   3.910432    -1.45   0.152    -13.49132    2.137433
       year7 |  -4.443733   4.926093    -0.90   0.370    -14.28774    5.400279
       year8 |  -8.451371   4.854192    -1.74   0.087     -18.1517    1.248958
       year9 |  -21.76865   5.376378    -4.05   0.000    -32.51249   -11.02482
      year10 |  -2.837716   12.56975    -0.23   0.822    -27.95635    22.28092
      year11 |  -8.301734   5.891301    -1.41   0.164    -20.07456    3.471091
      year12 |  -11.59128   5.883897    -1.97   0.053    -23.34931    .1667506
      year13 |  -7.916721   7.150201    -1.11   0.272    -22.20526    6.371815
      year14 |  -6.908704   7.259222    -0.95   0.345     -21.4151    7.597693
       _cons |   40.27425   30.11216     1.34   0.186    -19.90009    100.4486
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(popgrowth L.educ2_n L.educ3_n fdexp L.fdgrant size1 L.trade year3
    year4 year5 year6 year7 year8 year9 year10 year11 year12 year13 year14)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/4).lngfcf_gdp collapsed
    L(2/4).L.realgrowth collapsed
Instruments for levels equation
  Standard
    popgrowth L.educ2_n L.educ3_n fdexp L.fdgrant size1 L.trade year3
    year4 year5 year6 year7 year8 year9 year10 year11 year12 year13 year14
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    D.lngfcf_gdp collapsed
    DL.L.realgrowth collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -1.90  Pr > z =  0.058
Arellano-Bond test for AR(2) in first differences: z =   1.18  Pr > z =  0.237
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(4)    =   6.85  Prob > chi2 =  0.254
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(4)    =   4.78  Prob > chi2 =  0.410
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(2)    =   4.19  Prob > chi2 =  0.123
    Difference (null H = exogenous): chi2(2)    =   0.59  Prob > chi2 =  0.743
  gmm(L.realgrowth, collapse lag(2 4))
    Hansen test excluding group:     chi2(0)    =   0.00  Prob > chi2 =      .
    Difference (null H = exogenous): chi2(4)    =   4.78  Prob > chi2 =  0.310

. margins, dydx (fdexp l.fdgrant) at (size1= (0,1)) vsquish force level(90)
Warning: cannot perform check for estimable functions.
(note: default prediction is a function of possibly stochastic quantities other than
e(b))

Average marginal effects                         Number of obs   =        652
Model VCE    : Corrected

Expression   : Fitted Values, predict()
dy/dx w.r.t. : L.fdgrant fdexp
1._at        : size1          =           0
2._at        : size1          =           1
```

```
------------------------------------------------------------------------------
             |            Delta-method
             |      dy/dx   Std. Err.      z    P>|z|     [90% Conf. Interval]
-------------+----------------------------------------------------------------
  L.fdgrant  |
         _at |
          1  |    .006327   .0965596     0.07   0.948    -.1524994    .1651534
          2  |  -.2872746   .1013995    -2.83   0.005    -.4540619   -.1204874
-------------+----------------------------------------------------------------
  fdexp      |
         _at |
          1  |   -.063121    .162749    -0.39   0.698    -.3308193    .2045773
          2  |   .1474027   .0722218     2.04   0.041     .0286085     .266197
------------------------------------------------------------------------------

. marginsplot

  Variables that uniquely identify margins: size1 _deriv
```

Appendix 5.5.8 Endogenous and Size, using FDtax and FDgrant

```
.  xtabond2  realgrowth  l.realgrowth  reallngdpini  popgrowth  l.educ2_n  l.educ3_n
lngfcf_gdp  i.size1 i.size1#c.l.fdgrant i.size1#c.l.fdtax  l.trade year3 year4 year5
year6 year7 year8 year9 year10 year11 year12 year13 year14  if realgrowth <=30, gmm(
l.realgrowth, laglimits(2 4)collapse) gmm(lngfcf_gdp, laglimits(2 4) collapse) iv(
popgrowth l.educ2_n l.educ3_n size1 l.fdtax l.fdgrant l.trade year3-year14) two robust
small
Favoring speed over space. To switch, type or click on mata: mata set matafavor
space, perm.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: idall                           Number of obs      =       666
Time variable : year                            Number of groups   =        64
Number of instruments = 28                      Obs per group: min =         7
F(25, 63)      =     85.85                                     avg =     10.41
Prob > F       =     0.000                                     max =        12
------------------------------------------------------------------------------------
                   |              Corrected
        realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------------+----------------------------------------------------------------
        realgrowth |
               L1. |    .405286   .5324463     0.76   0.449    -.6587231    1.469295
                   |
      reallngdpini |   4.568156   9.092159     0.50   0.617    -13.60107    22.73739
         popgrowth |   .0664533   .3088452     0.22   0.830    -.5507247    .6836312
                   |
           educ2_n |
               L1. |  -.2000428   .0831692    -2.41   0.019    -.3662432   -.0338424
                   |
           educ3_n |
               L1. |  -.0163576   .0446055    -0.37   0.715    -.1054946    .0727793
                   |
        lngfcf_gdp |   14.24668   5.935662     2.40   0.019     2.385207    26.10815
                   |
             size1 |
                0  |          0  (empty)
                1  |   3.137881   74.42495     0.04   0.967    -145.5885    151.8643
                   |
  size1#cL.fdgrant |
                0  |    .146985   .7544521     0.19   0.846    -1.360667    1.654637
                1  |  -.1712161   .0999803    -1.71   0.092    -.3710107    .0285785
                   |
    size1#cL.fdtax |
                0  |  -.0559733   .8144099    -0.07   0.945    -1.683442    1.571495
                1  |  -.0820085   .2037567    -0.40   0.689    -.4891839    .3251668
                   |
             trade |
               L1. |  -.0455669   .0531971    -0.86   0.395    -.1518728     .060739
                   |
             year3 |  -7.613172   6.182476    -1.23   0.223    -19.96787    4.741521
             year4 |   3.726124   9.449855     0.39   0.695    -15.15791    22.61015
             year5 |   8.948533   8.507262     1.05   0.297    -8.051873    25.94894
```

```
             year6 |    1.03593    5.57349     0.19   0.853    -10.1018    12.17366
             year7 |   3.142342   7.323405     0.43   0.669   -11.49231      17.777
             year8 |   -2.10449   8.053057    -0.26   0.795   -18.19724    13.98826
             year9 |  -13.62786   10.24481    -1.33   0.188   -34.10047    6.844757
            year10 |    6.72417   17.72619     0.38   0.706    -28.6988    42.14714
            year11 |  -.3507409   10.63559    -0.03   0.974   -21.60428     20.9028
            year12 |  -2.424127   11.65382    -0.21   0.836   -25.71243    20.86417
            year13 |  -.1677367   14.20193    -0.01   0.991   -28.54802    28.21255
            year14 |    1.31292   10.61025     0.12   0.902   -19.88998    22.51582
             _cons |  -62.74202   145.1978    -0.43   0.667   -352.8966    227.4126
------------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(popgrowth L.educ2_n L.educ3_n size1 L.fdtax L.fdgrant L.trade year3
    year4 year5 year6 year7 year8 year9 year10 year11 year12 year13 year14)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(2/4).lngfcf_gdp collapsed
    L(2/4).L.realgrowth collapsed
Instruments for levels equation
  Standard
    popgrowth L.educ2_n L.educ3_n size1 L.fdtax L.fdgrant L.trade year3
    year4 year5 year6 year7 year8 year9 year10 year11 year12 year13 year14
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.lngfcf_gdp collapsed
    DL.L.realgrowth collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -1.97  Pr > z =  0.049
Arellano-Bond test for AR(2) in first differences: z =   1.26  Pr > z =  0.209
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(2)    =   1.41  Prob > chi2 =  0.493
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(2)    =   2.33  Prob > chi2 =  0.312
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(0)    =   0.49  Prob > chi2 =      .
    Difference (null H = exogenous): chi2(2)    =   1.84  Prob > chi2 =  0.399


. margins, dydx (l.fdtax l.fdgrant) at (size1= (0,1)) vsquish force level(90)
Warning: cannot perform check for estimable functions.
(note: default prediction is a function of possibly stochastic quantities other than
e(b))

Average marginal effects                          Number of obs   =        666
Model VCE    : Corrected

Expression   : Fitted Values, predict()
dy/dx w.r.t. : L.fdgrant L.fdtax
1._at        : size1          =           0
2._at        : size1          =           1

------------------------------------------------------------------------------
             |            Delta-method
             |      dy/dx   Std. Err.      z    P>|z|     [90% Conf. Interval]
-------------+----------------------------------------------------------------
  L.fdgrant  |
         _at |
          1  |    .146985   .7544521     0.19   0.846    -1.093978    1.387948
          2  |  -.1712161   .0999803    -1.71   0.087     -.335669   -.0067632
-------------+----------------------------------------------------------------
  L.fdtax    |
         _at |
          1  |  -.0559733   .8144099    -0.07   0.945    -1.395558    1.283612
          2  |  -.0820085   .2037567    -0.40   0.687    -.4171585    .2531415
------------------------------------------------------------------------------

. marginsplot

  Variables that uniquely identify margins: size1 _deriv
```

Appendix 5.5.9 Using Weights

```
. xtabond2 realgrowth l.realgrowth reallngdpini popgrowth l.educ2_n l.educ3_n
lngfcf_gdp fdexp fdgrant l.trade year3 year4 year5 year6 year7 year8 year9 year10
year11 year12 year13 year14  if realgrowth <=30 [pweight= id_region ], gmm(
l.realgrowth, laglimits(2 4)collapse) gmm(lngfcf_gdp, laglimits(2 3) collapse)  iv(
popgrowth l.educ2_n l.educ3_n fdgrant fdexp l.trade year3-year14) two robust small

Favoring speed over space. To switch, type or click on mata: mata set matafavor
space, perm.
(sum of weights is 4867)

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: idall                           Number of obs      =       667
Time variable : year                            Number of groups   =        64
Number of instruments = 26                      Obs per group: min =         7
F(21, 63)     =     59.02                                      avg =     10.42
Prob > F      =     0.000                                      max =        12
------------------------------------------------------------------------------
             |              Corrected
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  realgrowth |
         L1. |   .2358873   .5788393     0.41   0.685    -.9208307    1.392605
             |
reallngdpini |  -14.59519   3.334197    -4.38   0.000    -21.25805    -7.93233
   popgrowth |   .1100485   .2286843     0.48   0.632    -.3469406    .5670377
             |
     educ2_n |
         L1. |  -.2481736     .06942    -3.57   0.001    -.3868984   -.1094487
             |
     educ3_n |
         L1. |   .1667282   .0479542     3.48   0.001     .0708993    .2625571
             |
  lngfcf_gdp |   3.346348   6.608682     0.51   0.614    -9.860049    16.55274
       fdexp |     .12366   .0430334     2.87   0.006     .0376647    .2096554
     fdgrant |   .0582895    .041621     1.40   0.166    -.0248835    .1414624
             |
       trade |
         L1. |   .1565931   .0510554     3.07   0.003      .054567    .2586192
             |
       year3 |  -8.327504   7.459176    -1.12   0.268    -23.23348     6.57847
       year4 |   .0667575    8.60825     0.01   0.994    -17.13546    17.26897
       year5 |   4.901335   7.326184     0.67   0.506    -9.738874    19.54154
       year6 |  -2.158495   3.508141    -0.62   0.541    -9.168956    4.851966
       year7 |   -2.48412   4.970796    -0.50   0.619    -12.41746    7.449224
       year8 |  -7.448378   5.234908    -1.42   0.160    -17.90951    3.012751
       year9 |  -20.85893   5.956501    -3.50   0.001    -32.76205   -8.955811
      year10 |  -1.120793   15.55693    -0.07   0.943    -32.20885    29.96726
      year11 |  -9.147094   6.946319    -1.32   0.193    -23.02821    4.734017
      year12 |  -13.42175   8.136695    -1.65   0.104    -29.68164    2.838137
      year13 |  -11.74617   9.634127    -1.22   0.227    -30.99844    7.506092
      year14 |  -9.756257   10.54478    -0.93   0.358    -30.82832    11.31581
       _cons |   102.3549   24.63087     4.16   0.000     53.13401    151.5757
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(popgrowth L.educ2_n L.educ3_n fdgrant fdexp L.trade year3 year4
    year5 year6 year7 year8 year9 year10 year11 year12 year13 year14)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(2/3).lngfcf_gdp collapsed
    L(2/4).L.realgrowth collapsed
Instruments for levels equation
  Standard
    popgrowth L.educ2_n L.educ3_n fdgrant fdexp L.trade year3 year4 year5
    year6 year7 year8 year9 year10 year11 year12 year13 year14
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.lngfcf_gdp collapsed
    DL.L.realgrowth collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -1.47  Pr > z =  0.141
Arellano-Bond test for AR(2) in first differences: z =   1.02  Pr > z =  0.308
------------------------------------------------------------------------------
```

```
Sargan test of overid. restrictions: chi2(4)    =   6.88  Prob > chi2 =  0.248
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(4)    =   6.51  Prob > chi2 =  0.264
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(2)    =   2.86  Prob > chi2 =  0.240
    Difference (null H = exogenous): chi2(2)    =   3.65  Prob > chi2 =  0.161
  gmm(L.realgrowth, collapse lag(2 4))
    Hansen test excluding group:     chi2(0)    =   0.00  Prob > chi2 =      .
    Difference (null H = exogenous): chi2(4)    =   6.51  Prob > chi2 =  0.164
  gmm(lngfcf_gdp, collapse lag(2 3))
    Hansen test excluding group:     chi2(1)    =   2.19  Prob > chi2 =  0.139
    Difference (null H = exogenous): chi2(3)    =   4.32  Prob > chi2 =  0.229


. xtabond2 realgrowth l.realgrowth reallngdpini popgrowth l.educ2_n l.educ3_n
lngfcf_gdp fdexp fdgrant l.trade year3 year4 year5 year6 year7 year8 year9
> year10 year11 year12 year13 year14  if realgrowth <=30, gmm( l.realgrowth,
laglimits(2 4)collapse) gmm(lngfcf_gdp, laglimits(2 3) collapse)  iv( popgrowth
> l.educ2_n l.educ3_n fdgrant fdexp l.trade year3-year14) two robust small
Favoring speed over space. To switch, type or click on mata: mata set matafavor
space, perm.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: idall                           Number of obs      =       667
Time variable : year                            Number of groups   =        64
Number of instruments = 26                      Obs per group: min =         7
F(21, 63)     =     60.70                                      avg =     10.42
Prob > F      =     0.000                                      max =        12
------------------------------------------------------------------------------
             |              Corrected
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  realgrowth |
         L1. |  -.0215056    .257595    -0.08   0.934    -.5362681     .493257
             |
reallngdpini |  -14.23625   2.348011    -6.06   0.000    -18.92837   -9.544124
   popgrowth |   .0322902   .1460944     0.22   0.826    -.2596561    .3242365
             |
     educ2_n |
         L1. |  -.2424439   .0554968    -4.37   0.000    -.3533455   -.1315423
             |
     educ3_n |
         L1. |   .1527514   .0318387     4.80   0.000     .0891268     .216376
             |
  lngfcf_gdp |   9.449319   4.546604     2.08   0.042     .3636563    18.53498
       fdexp |   .1291647   .0411546     3.14   0.003     .0469237    .2114056
     fdgrant |   .0390249   .0367483     1.06   0.292    -.0344107    .1124605
             |
       trade |
         L1. |   .1277195   .0378302     3.38   0.001     .0521218    .2033172
             |
       year3 |  -12.37479   2.375815    -5.21   0.000    -17.12248   -7.627101
       year4 |   -5.70202   3.259109    -1.75   0.085    -12.21483    .8107892
       year5 |  -.9707039   2.739709    -0.35   0.724    -6.445575    4.504167
       year6 |  -6.530602   1.641922    -3.98   0.000    -9.811722   -3.249482
       year7 |  -7.205479   2.112292    -3.41   0.001    -11.42656     -2.9844
       year8 |  -11.67449   2.167961    -5.39   0.000    -16.00682   -7.342166
       year9 |  -25.28787   2.344321   -10.79   0.000    -29.97262   -20.60311
      year10 |  -9.884496   6.053253    -1.63   0.107    -21.98096    2.211966
      year11 |  -13.30136   2.647067    -5.02   0.000    -18.59111   -8.011622
      year12 |  -18.10939   2.723987    -6.65   0.000    -23.55284   -12.66593
      year13 |  -16.02542    3.76306    -4.26   0.000    -23.54529    -8.50554
      year14 |  -14.85026   3.901311    -3.81   0.000    -22.64641   -7.054114
       _cons |    89.5537   20.36747     4.40   0.000     48.85256    130.2548
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(popgrowth L.educ2_n L.educ3_n fdgrant fdexp L.trade year3 year4
    year5 year6 year7 year8 year9 year10 year11 year12 year13 year14)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(2/3).lngfcf_gdp collapsed
    L(2/4).L.realgrowth collapsed
```

```
Instruments for levels equation
  Standard
    popgrowth L.educ2_n L.educ3_n fdgrant fdexp L.trade year3 year4 year5
    year6 year7 year8 year9 year10 year11 year12 year13 year14
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.lngfcf_gdp collapsed
    DL.L.realgrowth collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -2.61  Pr > z =  0.009
Arellano-Bond test for AR(2) in first differences: z =   0.94  Pr > z =  0.346
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(4)    =   2.25  Prob > chi2 =  0.689
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(4)    =   2.77  Prob > chi2 =  0.596
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(2)    =   0.05  Prob > chi2 =  0.976
    Difference (null H = exogenous): chi2(2)    =   2.73  Prob > chi2 =  0.256
  gmm(L.realgrowth, collapse lag(2 4))
    Hansen test excluding group:     chi2(0)    =   0.00  Prob > chi2 =      .
    Difference (null H = exogenous): chi2(4)    =   2.77  Prob > chi2 =  0.596
  gmm(lngfcf_gdp, collapse lag(2 3))
    Hansen test excluding group:     chi2(1)    =   1.46  Prob > chi2 =  0.227
    Difference (null H = exogenous): chi2(3)    =   1.32  Prob > chi2 =  0.725
```

Appendix 5.6 Sensitivity Analysis

Appendix 5.6.1 Optimal Size

A. FE with Driscoll-Kraay SEs

```
. xtscc realgrowth popgrowth educ2_n educ3_n lag1realgdp lngfcf_gdp fdexp fdgrant
trade fdexp2 fdgrant2 year2 year3 year4 year5 year6 year7 year8 year9 year10 year11
year12 year13 year14 if realgrowth<=30 & realgrowth>=-15, fe


Regression with Driscoll-Kraay standard errors   Number of obs     =       669
Method: Fixed-effects regression                 Number of groups  =        64
Group variable (i): idall                        F( 23,     13)    =  87533.66
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.5593

------------------------------------------------------------------------------
             |             Drisc/Kraay
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |   -.198711   .1225142    -1.62   0.129    -.4633868    .0659648
     educ2_n |   .1001557    .060113     1.67   0.120    -.0297105     .230022
     educ3_n |  -.1184599   .0520941    -2.27   0.041    -.2310025   -.0059174
 lag1realgdp |  -.0023977   .0007995    -3.00   0.010    -.0041248   -.0006705
  lngfcf_gdp |  -.5173298   2.237293    -0.23   0.821    -5.350707    4.316047
       fdexp |   .6411635   .1149617     5.58   0.000     .3928038    .8895232
     fdgrant |  -.1033778   .2265737    -0.46   0.656    -.5928604    .3861048
       trade |  -.0887034    .135456    -0.65   0.524    -.3813383    .2039315
      fdexp2 |  -.0047616   .0012529    -3.80   0.002    -.0074684   -.0020547
    fdgrant2 |   .0008738   .0027308     0.32   0.754    -.0050258    .0067734
       year2 |  -9.341347   1.940095    -4.81   0.000    -13.53267   -5.150027
       year3 |  -15.02422   2.160188    -6.96   0.000    -19.69103   -10.35742
       year4 |  -12.92551   2.782294    -4.65   0.000    -18.93629    -6.91473
       year5 |  -5.080208   3.203886    -1.59   0.137    -12.00178    1.841368
       year6 |  -5.984165   3.868662    -1.55   0.146     -14.3419     2.37357
       year7 |  -3.539861   4.126774    -0.86   0.407    -12.45521    5.375494
       year8 |  -5.689935   4.461562    -1.28   0.225    -15.32855    3.948684
       year9 |  -18.00336   5.366733    -3.35   0.005    -29.59748   -6.409238
      year10 |  -5.357159   5.304444    -1.01   0.331    -16.81672    6.102396
      year11 |  -4.982377   6.166653    -0.81   0.434    -18.30462    8.339868
      year12 |  -6.045656   6.549752    -0.92   0.373    -20.19553    8.104223
      year13 |  -3.793933   9.009246    -0.42   0.681    -23.25722    15.66936
      year14 |   .0137467   8.528404     0.00   0.999    -18.41075    18.43824
```

```
       _cons |   27.00123   17.27028     1.56   0.142    -10.30894    64.31141
------------------------------------------------------------------------------

. testparm fdexp fdexp2

 ( 1)  fdexp = 0
 ( 2)  fdexp2 = 0

       F(  2,    13) =   15.78
            Prob > F =    0.0003

. testparm fdgrant fdgrant2

 ( 1)  fdgrant = 0
 ( 2)  fdgrant2 = 0

       F(  2,    13) =    0.12
            Prob > F =    0.8866

. xtscc realgrowth popgrowth educ2_n educ3_n lag1realgdp lngfcf_gdp fdtax fdgrant
trade fdtax2 fdgrant2 year2 year3 year4 year5 year6 year7 year8 year9 year10 year11
year12 year13 year14 if realgrowth<=30 & realgrowth>=-15, fe

Regression with Driscoll-Kraay standard errors   Number of obs     =       669
Method: Fixed-effects regression                 Number of groups  =        64
Group variable (i): idall                        F( 23,    13)     = 162081.36
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.5830

------------------------------------------------------------------------------
             |             Drisc/Kraay
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |  -.2540886   .0959436    -2.65   0.020    -.4613622   -.0468151
     educ2_n |   .1330534    .052822     2.52   0.026     .0189384    .2471684
     educ3_n |  -.0182939   .0478258    -0.38   0.708    -.1216153    .0850275
 lag1realgdp |  -.0028191   .0007592    -3.71   0.003    -.0044593    -.001179
  lngfcf_gdp |  -2.372337   2.326314    -1.02   0.326    -7.398031    2.653358
       fdtax |   .7184224   .0884748     8.12   0.000     .5272843    .9095605
     fdgrant |  -.0173847    .174387    -0.10   0.922    -.3941249    .3593555
       trade |   -.085768   .1298386    -0.66   0.520    -.3662671    .1947312
      fdtax2 |  -.0052033   .0014349    -3.63   0.003    -.0083032   -.0021033
    fdgrant2 |  -.0001513   .0017866    -0.08   0.934    -.0040111    .0037084
       year2 |  -9.173724   1.834139    -5.00   0.000    -13.13614   -5.211309
       year3 |  -16.02809    2.01495    -7.95   0.000    -20.38112   -11.67505
       year4 |  -14.23312   2.673236    -5.32   0.000    -20.00829   -8.457942
       year5 |  -6.961606   3.123205    -2.23   0.044    -13.70888   -.2143321
       year6 |  -7.111706    3.77798    -1.88   0.082    -15.27354    1.050123
       year7 |  -3.925779   3.876667    -1.01   0.330    -12.30081     4.44925
       year8 |  -6.150404   4.144424    -1.48   0.162    -15.10389     2.80308
       year9 |  -19.19862   5.022845    -3.82   0.002    -30.04981   -8.347419
      year10 |  -5.302528    5.15525    -1.03   0.322    -16.43977    5.834712
      year11 |  -5.062523   5.951977    -0.85   0.410    -17.92099    7.795942
      year12 |  -6.327666   6.287648    -1.01   0.333     -19.9113    7.255973
      year13 |  -3.758737   8.919442    -0.42   0.680    -23.02802    15.51055
      year14 |   .0838673   8.068103     0.01   0.992    -17.34621    17.51394
       _cons |   25.06251   16.32119     1.54   0.149    -10.19728    60.32229
------------------------------------------------------------------------------

testparm fdtax fdtax2

 ( 1)  fdtax = 0
 ( 2)  fdtax2 = 0

       F(  2,    13) =   39.89
            Prob > F =    0.0000

. testparm fdgrant fdgrant2

 ( 1)  fdgrant = 0
 ( 2)  fdgrant2 = 0

       F(  2,    13) =    0.06
            Prob > F =    0.9376
```

B. FEVD

```
. xtfevd realgrowth popgrowth educ2_n educ3_n  lngfcf_gdp reallngdpini fdexp fdgrant
trade fdexp2 fdgrant2 year2 year3 year4 year5 year6 year7 year8 year9 year10 year11
year12 year13 year14 if realgrowth<=30 & realgrowth>=-13, invariant(educ2_n educ3_n
reallngdpini)

panel fixed effects regression with vector decomposition

degrees of freedom fevd     =       574          number of obs        =       661
mean squared error          = 27.41468           F( 25, 574)          = 23.66684
root mean squared error     = 5.235903           Prob > F             = 2.65e-68
Residual Sum of Squares     =  18121.1           R-squared            = .5777736
Total Sum of Squares        = 42917.98           adj. R-squared       = .5145132
Estimation Sum of Squares   = 24796.88

------------------------------------------------------------------------------
             |                fevd
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |  -.1906312   .1005503    -1.90   0.058    -.3881226    .0068602
  lngfcf_gdp |   -.129356   2.106047    -0.06   0.951    -4.265854    4.007142
       fdexp |   .6815049   .1102378     6.18   0.000     .4649861    .8980236
     fdgrant |   -.068517   .1078979    -0.64   0.526    -.2804398    .1434058
       trade |  -.0322918   .0390797    -0.83   0.409    -.1090486    .0444649
      fdexp2 |  -.0056519   .0011459    -4.93   0.000    -.0079026   -.0034012
    fdgrant2 |  -.0001639    .001089    -0.15   0.880    -.0023028     .001975
       year2 |  -11.95107    1.71102    -6.98   0.000     -15.3117   -8.590448
       year3 |  -18.69567   1.632928   -11.45   0.000    -21.90292   -15.48843
       year4 |  -17.33311   1.844936    -9.39   0.000    -20.95675   -13.70946
       year5 |  -10.58136   1.934019    -5.47   0.000    -14.37998   -6.782745
       year6 |  -13.46657   2.001244    -6.73   0.000    -17.39722   -9.535915
       year7 |  -12.46723   2.071747    -6.02   0.000    -16.53636   -8.398098
       year8 |  -16.56103   2.087664    -7.93   0.000    -20.66142   -12.46064
       year9 |  -28.80104   2.024002   -14.23   0.000     -32.7764   -24.82569
      year10 |   -15.7831   2.216271    -7.12   0.000    -20.13609   -11.43011
      year11 |  -17.36217   2.501773    -6.94   0.000    -22.27592   -12.44842
      year12 |   -19.8833   2.528844    -7.86   0.000    -24.85022   -14.91639
      year13 |  -19.65344   3.057341    -6.43   0.000    -25.65838    -13.6485
      year14 |  -17.24099   3.611802    -4.77   0.000    -24.33495   -10.14703
     educ2_n |   .0288144    .054925     0.52   0.600     -.079064    .1366928
     educ3_n |   .0145384   .0238332     0.61   0.542    -.0322726    .0613494
reallngdpini |   -3.53224   1.612384    -2.19   0.029    -6.699131   -.3653486
         eta |          1          .        .       .            .           .
       _cons |   39.99153   13.12356     3.05   0.002     14.21548    65.76758
------------------------------------------------------------------------------

. testparm fdgrant fdgrant2
 ( 1)  fdgrant = 0
 ( 2)  fdgrant2 = 0
       F(  2,   574) =    0.98
            Prob > F =    0.3763

. testparm fdexp fdexp2
 ( 1)  fdexp = 0
 ( 2)  fdexp2 = 0
       F(  2,   574) =   25.51
            Prob > F =    0.0000

. xtfevd realgrowth popgrowth educ2_n educ3_n  lngfcf_gdp reallngdpini fdtax fdgrant
trade fdtax2 fdgrant2 year2 year3 year4 year5 year6 year7 year8 year9 year10 year11
year12 year13 year14 if realgrowth<=30 & realgrowth>=-13, invariant(educ2_n educ3_n
reallngdpini)

panel fixed effects regression with vector decomposition

degrees of freedom fevd     =       574          number of obs        =       661
mean squared error          = 27.10927           F( 25, 574)          =  26.9489
root mean squared error     = 5.206656           Prob > F             = 3.75e-76
Residual Sum of Squares     = 17919.23           R-squared            = .5824774
Total Sum of Squares        = 42917.98           adj. R-squared       = .5199218
Estimation Sum of Squares   = 24998.76

------------------------------------------------------------------------------
             |                fevd
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
```

```
-------------+----------------------------------------------------------------
   popgrowth |  -.2457157    .099645    -2.47   0.014     -.441429   -.0500024
 lngfcf_gdp |   -1.55114   2.147745    -0.72   0.470    -5.769537    2.667257
      fdtax |   .6323086   .0816183     7.75   0.000     .4720017    .7926156
    fdgrant |  -.0286904   .1012135    -0.28   0.777    -.2274844    .1701036
      trade |  -.0292962   .0379619    -0.77   0.441    -.1038575     .045265
     fdtax2 |  -.0051969   .0008613    -6.03   0.000    -.0068886   -.0035051
   fdgrant2 |  -.0010266    .001062    -0.97   0.334    -.0031124    .0010592
      year2 |  -12.11531   1.661276    -7.29   0.000    -15.37823   -8.852387
      year3 |  -19.55209   1.621788   -12.06   0.000    -22.73745   -16.36673
      year4 |   -18.0773   1.803087   -10.03   0.000    -21.61875   -14.53584
      year5 |  -11.99898   1.913218    -6.27   0.000    -15.75674   -8.241214
      year6 |  -14.50997   1.934453    -7.50   0.000    -18.30944    -10.7105
      year7 |  -13.01092   1.930252    -6.74   0.000    -16.80214   -9.219704
      year8 |   -17.3858   1.948929    -8.92   0.000     -21.2137   -13.55789
      year9 |  -30.52404    1.92071   -15.89   0.000    -34.29652   -26.75157
     year10 |  -16.23704   2.036659    -7.97   0.000    -20.23725   -12.23683
     year11 |    -18.074   2.310298    -7.82   0.000    -22.61167   -13.53633
     year12 |  -20.96434   2.371176    -8.84   0.000    -25.62158    -16.3071
     year13 |  -21.15489   2.805745    -7.54   0.000    -26.66567   -15.64411
     year14 |   -18.4427   3.482923    -5.30   0.000    -25.28352   -11.60187
    educ2_n |   .0581542   .0473332     1.23   0.220    -.0348132    .1511215
    educ3_n |   .0130512   .0222232     0.59   0.557    -.0305975    .0566999
reallngdpini |  -4.560088   1.565154    -2.91   0.004    -7.634215   -1.485961
        eta |          1          .        .       .            .           .
      _cons |   53.13847   12.76808     4.16   0.000     28.06061    78.21633
------------------------------------------------------------------------------

. testparm fdtax fdtax2
 ( 1)  fdtax = 0
 ( 2)  fdtax2 = 0
      F(  2,   574) =   34.48
           Prob > F =    0.0000
```

C. IV

```
. xtivreg2 realgrowth lag1realgdp popgrowth fdexp fdexp2 (lngfcf_gdp trade educ2_n
educ3_n fdgrant2 fdgrant = l.fdgrant2 l2.fdgrant2 l2.fdgrant l.fdgrant  l2.trade
l.educ2_n l.educ3_n l.lngfcf_gdp ) year3 year4 year5 year6 year7 year8 year9 year10
year11 year12 year13 year14 if realgrowth >=-15 & realgrowth <=30,  fe  endog(fdgrant
educ2_n educ3_n lngfcf_gdp trade fdgrant2 )small Warning - collinearities detected Vars
dropped:       year14

FIXED EFFECTS ESTIMATION
------------------------
Number of groups =        64                    Obs per group: min =         5
                                                               avg =       8.5
                                                               max =        10

Warning - collinearities detected
Vars dropped:  year14

IV (2SLS) estimation
--------------------

Estimates efficient for homoskedasticity only
Statistics consistent for homoskedasticity only

                                                      Number of obs =      541
                                                      F( 21,    456) =    20.54
                                                      Prob > F      =   0.0000
Total (centered) SS     =  33361.77512                Centered R2   =   0.3873
Total (uncentered) SS   =  33361.77512                Uncentered R2 =   0.3873
Residual SS             =  20440.47747                Root MSE      =    6.695

------------------------------------------------------------------------------
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  lngfcf_gdp |  -.1033773   5.782591    -0.02   0.986    -11.46721    11.26046
       trade |   .1213971   .1984709     0.61   0.541     -.268634    .5114281
     educ2_n |   .1601445   .0598899     2.67   0.008     .0424501    .2778389
     educ3_n |  -.0395555   .0894342    -0.44   0.658    -.2153098    .1361988
    fdgrant2 |    .006393    .010865     0.59   0.557    -.0149587    .0277447
     fdgrant |  -1.428705   .7542744    -1.89   0.059     -2.91099    .0535801
 lag1realgdp |  -.0029946   .0006713    -4.46   0.000    -.0043137   -.0016754
   popgrowth |  -.3255925   .1378041    -2.36   0.019    -.5964024   -.0547826
       fdexp |   .7860238   .4932965     1.59   0.112    -.1833927     1.75544
```

```
      fdexp2 |  -.0076939   .0046152    -1.67   0.096    -.0167636    .0013759
       year3 |   5.996668   15.41725     0.39   0.697      -24.301    36.29434
       year4 |  -.1057988   10.35349    -0.01   0.992    -20.45227    20.24067
       year5 |   2.715491   8.257567     0.33   0.742    -13.51211     18.9431
       year6 |   1.972557   6.062706     0.33   0.745    -9.941752    13.88687
       year7 |   4.731118   4.976285     0.95   0.342    -5.048177    14.51041
       year8 |   2.652911    5.01399     0.53   0.597    -7.200481     12.5063
       year9 |  -8.561766   6.699484    -1.28   0.202    -21.72746    4.603927
      year10 |    1.51202   4.783017     0.32   0.752     -7.88747    10.91151
      year11 |   .1621441   2.769305     0.06   0.953    -5.280038    5.604326
      year12 |  -2.232888   2.452859    -0.91   0.363    -7.053197    2.587421
      year13 |  -8.028426   2.729791    -2.94   0.003    -13.39296   -2.663896
      year14 |          0  (omitted)
------------------------------------------------------------------------------
Underidentification test (Anderson canon. corr. LM statistic):          12.786
                                                   Chi-sq(3) P-val =    0.0051
------------------------------------------------------------------------------
Weak identification test (Cragg-Donald Wald F statistic):                1.563
Stock-Yogo weak ID test critical values:                       <not available>
------------------------------------------------------------------------------
Sargan statistic (overidentification test of all instruments):           2.814
                                                   Chi-sq(2) P-val =    0.2449
-endog- option:
Endogeneity test of endogenous regressors:                              50.362
                                                   Chi-sq(6) P-val =    0.0000
Regressors tested:    fdgrant educ2_n educ3_n lngfcf_gdp trade fdgrant2
------------------------------------------------------------------------------
Instrumented:         lngfcf_gdp trade educ2_n educ3_n fdgrant2 fdgrant
Included instruments: lag1realgdp popgrowth fdexp fdexp2 year3 year4 year5
                      year6 year7 year8 year9 year10 year11 year12 year13
Excluded instruments: L.fdgrant2 L2.fdgrant2 L2.fdgrant L.fdgrant
                      L2.trade L.educ2_n L.educ3_n L.lngfcf_gdp
Dropped collinear:    year14
------------------------------------------------------------------------------
```

```
. xtivreg2 realgrowth lag1realgdp popgrowth (lngfcf_gdp trade educ2_n educ3_n fdgrant fdtax fdtax2 fdgrant2 = l.fdgrant2 l.fdtax l.fdgrant l.trade l.educ2_n l2.educ2_n l.lngfcf_gdp l2.fdtax l.educ3_n ) year4 year5 year6 year7 year8 year9 year10 year11 year12 year13 year14 if realgrowth<=30 & realgrowth >=-15,  fe  endog(fdgrant educ2_n educ3_n lngfcf_gdp trade fdgrant fdtax fdtax2 fdgrant2) small
```

```
FIXED EFFECTS ESTIMATION
------------------------
Number of groups =        64                    Obs per group: min =         5
                                                               avg =       8.5
                                                               max =        10

IV (2SLS) estimation
--------------------

Estimates efficient for homoskedasticity only
Statistics consistent for homoskedasticity only

                                                      Number of obs =      542
                                                      F( 21,   457) =    11.92
                                                      Prob > F      =   0.0000
Total (centered) SS     =  33375.70079                Centered R2   =  -0.0914
Total (uncentered) SS   =  33375.70079                Uncentered R2 =  -0.0914
Residual SS             =  36425.42484                Root MSE      =    8.928

------------------------------------------------------------------------------
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  lngfcf_gdp |  -9.139434   7.597046    -1.20   0.230    -24.06891    5.790041
       trade |  -.0092173   .2453016    -0.04   0.970    -.4912762    .4728416
     educ2_n |   .5257241   .1980942     2.65   0.008     .1364356    .9150126
     educ3_n |   .0627073   .1633208     0.38   0.701    -.2582456    .3836601
     fdgrant |  -.5312973   1.682389    -0.32   0.752    -3.837475     2.77488
       fdtax |   .7671649   .7252065     1.06   0.291     -.657988    2.192318
      fdtax2 |   .0034086   .0095068     0.36   0.720     -.015274    .0220911
    fdgrant2 |   -.001702   .0205153    -0.08   0.934    -.0420181     .038614
 lag1realgdp |  -.0062373   .0020731    -3.01   0.003    -.0103112   -.0021634
   popgrowth |  -.5904861   .2208572    -2.67   0.008    -1.024508   -.1564645
       year4 |  -10.75428    5.24254    -2.05   0.041    -21.05675   -.4518019
       year5 |  -6.622879   5.549429    -1.19   0.233    -17.52844    4.282684
       year6 |   -.751315   8.395117    -0.09   0.929    -17.24914    15.74651
```

```
       year7 |   4.191678   10.07343     0.42   0.678    -15.60432    23.98767
       year8 |   2.617504   9.625094     0.27   0.786    -16.29743    21.53244
       year9 |  -5.178494   10.76145    -0.48   0.631    -26.32656    15.96957
      year10 |   5.028532   11.41176     0.44   0.660    -17.39751    27.45457
      year11 |   5.360189   14.99346     0.36   0.721    -24.10449    34.82487
      year12 |   1.672231   15.12511     0.11   0.912    -28.05116    31.39562
      year13 |   20.31775   26.96984     0.75   0.452    -32.68252    73.31802
      year14 |   7.336661   17.25309     0.43   0.671    -26.56857    41.24189
------------------------------------------------------------------------------
Underidentification test (Anderson canon. corr. LM statistic):           4.490
                                                   Chi-sq(2) P-val =    0.1059
------------------------------------------------------------------------------
Weak identification test (Cragg-Donald Wald F statistic):                0.480
Stock-Yogo weak ID test critical values:                       <not available>
------------------------------------------------------------------------------
Sargan statistic (overidentification test of all instruments):           0.034
                                                   Chi-sq(1) P-val =    0.8529
-endog- option:
Endogeneity test of endogenous regressors:                              81.567
                                                   Chi-sq(8) P-val =    0.0000
Regressors tested:    fdgrant educ2_n educ3_n lngfcf_gdp trade fdtax
                      fdtax2 fdgrant2
------------------------------------------------------------------------------
Instrumented:         lngfcf_gdp trade educ2_n educ3_n fdgrant fdtax
                      fdtax2 fdgrant2
Included instruments: lag1realgdp popgrowth year4 year5 year6 year7 year8 year9
                      year10 year11 year12 year13 year14
Excluded instruments: L.fdgrant2 L.fdtax L.fdgrant L.trade L.educ2_n
                      L2.educ2_n L.lngfcf_gdp L2.fdtax L.educ3_n
------------------------------------------------------------------------------
```

D. Dynamic Baseline Specification

```
. xtabond2 realgrowth l.realgrowth reallngdpini popgrowth l.educ2_n l.educ3_n
lngfcf_gdp fdtax fdtax2 fdgrant l.trade year2 year3
> year4 year5 year6 year7 year8 year9 year10 year11 year12 year13 year14  if
realgrowth <=30, gmm( l.realgrowth, laglimits(2 3)collapse)
>  gmm(lngfcf_gdp, laglimits(2 4) collapse)  iv( popgrowth l.educ2_n l.educ3_n
fdgrant fdtax fdtax2 fdgrant2 l.trade  year2-year
> 14) two robust small
Favoring speed over space. To switch, type or click on mata: mata set matafavor
space, perm.
year11 dropped due to collinearity
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-step
estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: idall                           Number of obs      =       667
Time variable : year                            Number of groups   =        64
Number of instruments = 28                      Obs per group: min =         7
F(22, 63)     =     74.07                                      avg =     10.42
Prob > F      =     0.000                                      max =        12
------------------------------------------------------------------------------
             |              Corrected
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  realgrowth |
         L1. |  -.1157926   .2244159    -0.52   0.608     -.564252    .3326668
             |
reallngdpini |  -14.67169   2.048484    -7.16   0.000    -18.76526   -10.57812
   popgrowth |   .0163364   .1220877     0.13   0.894    -.2276363    .2603091
             |
     educ2_n |
         L1. |  -.2423469   .0468948    -5.17   0.000    -.3360587   -.1486352
             |
     educ3_n |
         L1. |   .1304509   .0247167     5.28   0.000     .0810584    .1798434
             |
  lngfcf_gdp |   7.220434   4.651214     1.55   0.126    -2.074275    16.51514
       fdtax |   .5547213   .1046631     5.30   0.000     .3455687    .7638738
      fdtax2 |  -.0042461   .0010227    -4.15   0.000    -.0062898   -.0022023
     fdgrant |   .0553721   .0402531     1.38   0.174    -.0250673    .1358115
             |
```

```
       trade |
         L1. |   .1298575   .0331746     3.91   0.000     .0635634    .1961516
             |
       year2 |   15.20275   2.810111     5.41   0.000     9.587193    20.81831
       year3 |   1.556475   1.142458     1.36   0.178    -.7265458    3.839496
       year4 |   6.095721   1.490798     4.09   0.000     3.116598    9.074843
       year5 |    11.7643   1.081126    10.88   0.000     9.603842    13.92476
       year6 |   7.606946   1.929089     3.94   0.000      3.75197    11.46192
       year7 |   6.604564   1.348951     4.90   0.000     3.908901    9.300227
       year8 |   1.628844   1.453549     1.12   0.267    -1.275841    4.533529
       year9 |   -13.3573   .9579401   -13.94   0.000    -15.27159   -11.44301
      year10 |   1.984235   3.416297     0.58   0.563     -4.84269    8.811159
      year12 |    -4.9918   .8278388    -6.03   0.000    -6.646104   -3.337496
      year13 |  -3.956444   1.376828    -2.87   0.006    -6.707816   -1.205072
      year14 |   -3.74277   1.331327    -2.81   0.007    -6.403214   -1.082326
       _cons |   80.22454   19.74329     4.06   0.000     40.77073    119.6783
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(popgrowth L.educ2_n L.educ3_n fdgrant fdtax fdtax2 fdgrant2
    L.trade year2 year3 year4 year5 year6 year7 year8 year9 year10 year11
    year12 year13 year14)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(2/4).lngfcf_gdp collapsed
    L(2/3).L.realgrowth collapsed
Instruments for levels equation
  Standard
    popgrowth L.educ2_n L.educ3_n fdgrant fdtax fdtax2 fdgrant2
    L.trade year2 year3 year4 year5 year6 year7 year8 year9 year10 year11
    year12 year13 year14
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.lngfcf_gdp collapsed
    DL.L.realgrowth collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -2.58  Pr > z =  0.010
Arellano-Bond test for AR(2) in first differences: z =   0.61  Pr > z =  0.543
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(5)    =   3.88  Prob > chi2 =  0.567
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(5)    =   4.07  Prob > chi2 =  0.539
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(3)    =   0.08  Prob > chi2 =  0.994
    Difference (null H = exogenous): chi2(2)    =   3.99  Prob > chi2 =  0.136
  gmm(L.realgrowth, collapse lag(2 3))
    Hansen test excluding group:     chi2(2)    =   2.16  Prob > chi2 =  0.340
    Difference (null H = exogenous): chi2(3)    =   1.91  Prob > chi2 =  0.590
  gmm(lngfcf_gdp, collapse lag(2 4))
    Hansen test excluding group:     chi2(1)    =   0.18  Prob > chi2 =  0.669
    Difference (null H = exogenous): chi2(4)    =   3.89  Prob > chi2 =  0.421

. xtabond2 realgrowth l.realgrowth reallngdpini popgrowth l.educ2_n l.educ3_n
lngfcf_gdp fdexp fdgrant fdexp2 fdgrant2 l.trade y
> ear2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12 year13 year14
if realgrowth <=30, gmm( l.realgrowth, laglimits(2
> 4)collapse) gmm(lngfcf_gdp, laglimits(2 3) collapse)  iv( popgrowth l.educ2_n
l.educ3_n fdgrant fdexp fdexp2 fdgrant2 l.trade
> year2-year14) two robust small
Favoring speed over space. To switch, type or click on mata: mata set matafavor
space, perm.
year11 dropped due to collinearity
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-step
estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: idall                           Number of obs      =       667
Time variable : year                            Number of groups   =        64
Number of instruments = 28                      Obs per group: min =         7
F(23, 63)     =     86.52                                      avg =     10.42
Prob > F      =     0.000                                      max =        12
------------------------------------------------------------------------------
```

```
             |              Corrected
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  realgrowth |
         L1. |   .0436167   .2713048     0.16   0.873    -.4985427    .5857761
             |
reallngdpini |  -12.14422   2.850419    -4.26   0.000    -17.84033   -6.448117
   popgrowth |   .0611839   .1379818     0.44   0.659    -.2145507    .3369185
             |
     educ2_n |
         L1. |  -.2438132   .0533728    -4.57   0.000    -.3504701   -.1371562
             |
     educ3_n |
         L1. |   .1297924   .0319017     4.07   0.000     .0660419    .1935429
             |
  lngfcf_gdp |   8.949275   4.752091     1.88   0.064     -.547021    18.44557
       fdexp |   .4269111   .0982943     4.34   0.000     .2304857    .6233366
     fdgrant |  -.0418303    .118442    -0.35   0.725    -.2785177    .1948571
      fdexp2 |  -.0033171   .0010792    -3.07   0.003    -.0054737   -.0011605
    fdgrant2 |   .0013986   .0014687     0.95   0.345    -.0015364    .0043335
             |
       trade |
         L1. |   .1175025   .0427232     2.75   0.008      .032127    .2028779
             |
       year2 |   13.72487   2.906984     4.72   0.000     7.915723    19.53401
       year3 |   1.836656   1.013608     1.81   0.075    -.1888774    3.862189
       year4 |   7.538822   1.617294     4.66   0.000     4.306917    10.77073
       year5 |   12.48378   1.137344    10.98   0.000     10.21098    14.75658
       year6 |    6.65623   2.001277     3.33   0.001     2.656997    10.65546
       year7 |   6.132008   1.285697     4.77   0.000     3.562748    8.701268
       year8 |   1.803592   1.584676     1.14   0.259    -1.363131    4.970314
       year9 |  -12.25255   .9061575   -13.52   0.000    -14.06337   -10.44174
      year10 |   4.356402   4.184277     1.04   0.302    -4.005208    12.71801
      year12 |  -4.094374   1.091043    -3.75   0.000    -6.274649     -1.9141
      year13 |  -2.547082   1.697072    -1.50   0.138    -5.938409    .8442454
      year14 |  -1.619921   1.690332    -0.96   0.342     -4.99778    1.757937
       _cons |   57.78776   25.57141     2.26   0.027     6.687378    108.8881
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(popgrowth L.educ2_n L.educ3_n fdgrant fdexp fdexp2 fdgrant2
    L.trade year2 year3 year4 year5 year6 year7 year8 year9 year10 year11
    year12 year13 year14)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(2/3).lngfcf_gdp collapsed
    L(2/4).L.realgrowth collapsed
Instruments for levels equation
  Standard
    popgrowth L.educ2_n L.educ3_n fdgrant fdexp fdexp2 fdgrant2
    L.trade year2 year3 year4 year5 year6 year7 year8 year9 year10 year11
    year12 year13 year14
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.lngfcf_gdp collapsed
    DL.L.realgrowth collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -2.60  Pr > z =  0.009
Arellano-Bond test for AR(2) in first differences: z =   1.06  Pr > z =  0.288
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(4)    =   1.62  Prob > chi2 =  0.805
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(4)    =   1.47  Prob > chi2 =  0.832
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(2)    =   0.09  Prob > chi2 =  0.956
    Difference (null H = exogenous): chi2(2)    =   1.38  Prob > chi2 =  0.501
  gmm(L.realgrowth, collapse lag(2 4))
    Hansen test excluding group:     chi2(0)    =   0.00  Prob > chi2 =      .
    Difference (null H = exogenous): chi2(4)    =   1.47  Prob > chi2 =  0.832
  gmm(lngfcf_gdp, collapse lag(2 3))
    Hansen test excluding group:     chi2(1)    =   0.91  Prob > chi2 =  0.339
    Difference (null H = exogenous): chi2(3)    =   0.56  Prob > chi2 =  0.906
```

E. Dynamic – Endogenous FD measures

```
.  xtabond2  realgrowth  l.realgrowth  reallngdpini  popgrowth  l.educ2_n  l.educ3_n
lngfcf_gdp fdexp l.fdgrant l.fdexp2 l.fdgrant2 l.trade year2 year3 year4 year5 year6
year7  year8  year9  year10  year11  year12  year13  year14   if  realgrowth  <=30,  gmm(
l.realgrowth,  laglimits(2  4)collapse)  gmm(lngfcf_gdp,  laglimits(3  4)  collapse)   iv(
popgrowth l.educ2_n l.educ3_n l.fdgrant fdexp l.fdgrant2 l.fdexp2 l.trade year2-year14)
two robust small
Favoring speed over space. To switch, type or click on mata: mata set matafavor
space, perm.
year6 dropped due to collinearity
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-step
estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: idall                           Number of obs      =       652
Time variable : year                            Number of groups   =        64
Number of instruments = 28                      Obs per group: min =         6
F(23, 63)     =     70.63                                      avg =     10.19
Prob > F      =     0.000                                      max =        12
------------------------------------------------------------------------------
             |              Corrected
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  realgrowth |
         L1. |  -.0232712   .3064143    -0.08   0.940    -.6355912    .5890489
             |
reallngdpini |  -13.56606   4.526486    -3.00   0.004    -22.61152   -4.520594
   popgrowth |    .046976   .1373832     0.34   0.734    -.2275623    .3215144
             |
     educ2_n |
         L1. |   .0145813   .0685469     0.21   0.832    -.1223988    .1515615
             |
     educ3_n |
         L1. |   .0742745   .0393647     1.89   0.064    -.0043897    .1529386
             |
  lngfcf_gdp |  -9.617048   7.682723    -1.25   0.215    -24.96974    5.735649
       fdexp |   .1577248   .0422377     3.73   0.000     .0733195    .2421301
             |
     fdgrant |
         L1. |  -.0588978   .1975887    -0.30   0.767    -.4537474    .3359517
             |
      fdexp2 |
         L1. |   .0010353   .0004286     2.42   0.019     .0001788    .0018919
             |
    fdgrant2 |
         L1. |  -.0011835   .0022125    -0.53   0.595    -.0056049    .0032379
             |
       trade |
         L1. |    .129269   .0837192     1.54   0.128    -.0380304    .2965683
             |
       year2 |   6.238643   2.374704     2.63   0.011     1.493176    10.98411
       year3 |  -4.491915   3.989142    -1.13   0.264    -12.46358    3.479749
       year4 |  -1.664149   3.727192    -0.45   0.657    -9.112348    5.784051
       year5 |   3.735068   2.324303     1.61   0.113    -.9096821    8.379818
       year7 |   .6062976   1.173518     0.52   0.607    -1.738791    2.951386
       year8 |  -4.997195   2.276533    -2.20   0.032    -9.546483   -.4479064
       year9 |  -21.09173   2.275749    -9.27   0.000    -25.63945   -16.54401
      year10 |  -4.880125   6.581363    -0.74   0.461    -18.03193    8.271679
      year11 |  -7.718016   2.137422    -3.61   0.001    -11.98931   -3.446719
      year12 |  -12.81088   2.809303    -4.56   0.000    -18.42483   -7.196941
      year13 |  -11.37695   3.854941    -2.95   0.004    -19.08043   -3.673462
      year14 |  -8.604567   3.965296    -2.17   0.034    -16.52858   -.6805553
       _cons |    131.944   41.70563     3.16   0.002     48.60197    215.2861
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(popgrowth L.educ2_n L.educ3_n L.fdgrant fdexp L.fdgrant2
    L.fdexp2 L.trade year2 year3 year4 year5 year6 year7 year8 year9 year10
    year11 year12 year13 year14)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(3/4).lngfcf_gdp collapsed
    L(2/4).L.realgrowth collapsed
```

```
Instruments for levels equation
  Standard
    popgrowth L.educ2_n L.educ3_n L.fdgrant fdexp L.fdgrant2 L.fdexp2
    L.trade year2 year3 year4 year5 year6 year7 year8 year9 year10 year11
    year12 year13 year14
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL2.lngfcf_gdp collapsed
    DL.L.realgrowth collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -1.77  Pr > z =  0.076
Arellano-Bond test for AR(2) in first differences: z =   0.30  Pr > z =  0.763
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(4)    =   2.85  Prob > chi2 =  0.584
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(4)    =   5.74  Prob > chi2 =  0.280
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(2)    =   0.45  Prob > chi2 =  0.798
    Difference (null H = exogenous): chi2(2)    =   5.29  Prob > chi2 =  0.071
  gmm(L.realgrowth, collapse lag(2 4))
    Hansen test excluding group:     chi2(0)    =   0.00  Prob > chi2 =      .
    Difference (null H = exogenous): chi2(4)    =   5.74  Prob > chi2 =  0.220
  gmm(lngfcf_gdp, collapse lag(3 4))
    Hansen test excluding group:     chi2(1)    =   0.13  Prob > chi2 =  0.716
    Difference (null H = exogenous): chi2(3)    =   5.60  Prob > chi2 =  0.133

. xtabond2 realgrowth l.realgrowth reallngdpini popgrowth l.educ2_n l.educ3_n
lngfcf_gdp l.fdtax l.fdgrant l.fdtax2 l.fdgrant2 l.trade year2 year3 year4 year5 year6
year7 year8 year9 year10 year11 year12 year13 year14  if realgrowth <=30, gmm(
l.realgrowth, laglimits(2 4)collapse) gmm(lngfcf_gdp, laglimits(2 4) collapse) iv(
popgrowth l.educ2_n l.educ3_n l.fdgrant l.fdtax l.trade l.fdtax2 l.fdgrant2  year2-
year14) two robust small
Favoring speed over space. To switch, type or click on mata: mata set matafavor
space, perm.
year10 dropped due to collinearity
Warning: Two-step estimated covariance matrix of moments is singular.
  Using a generalized inverse to calculate optimal weighting matrix for two-step
estimation.
  Difference-in-Sargan/Hansen statistics may be negative.

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: idall                           Number of obs      =       666
Time variable : year                            Number of groups   =        64
Number of instruments = 29                      Obs per group: min =         7
F(23, 63)     =     83.41                                      avg =     10.41
Prob > F      =     0.000                                      max =        12
------------------------------------------------------------------------------
             |              Corrected
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  realgrowth |
         L1. |   .2696413   .3610466     0.75   0.458    -.4518528    .9911354
             |
reallngdpini |  -.9866165   2.777191    -0.36   0.724    -6.536391    4.563158
   popgrowth |   .0063276   .1606988     0.04   0.969    -.3148033    .3274585
             |
     educ2_n |
         L1. |   -.090423   .0528053    -1.71   0.092     -.195946       .0151
             |
     educ3_n |
         L1. |   .0190089   .0276496     0.69   0.494    -.0362445    .0742624
             |
  lngfcf_gdp |   14.10446   4.648088     3.03   0.003     4.815995    23.39292
             |
       fdtax |
         L1. |  -.0070178   .2369757    -0.03   0.976     -.480576    .4665404
             |
     fdgrant |
         L1. |  -.3999493   .0958296    -4.17   0.000    -.5914496   -.2084491
             |
      fdtax2 |
         L1. |  -.0000139   .0021622    -0.01   0.995    -.0043346    .0043068
             |
```

```
    fdgrant2 |
         L1. |   .0047801   .0011428     4.18   0.000     .0024965    .0070637
             |
       trade |
         L1. |  -.0164008   .0270896    -0.61   0.547     -.070535    .0377334
             |
       year2 |   -3.79128   11.27241    -0.34   0.738     -26.3174    18.73484
       year3 |  -11.99964   7.119756    -1.69   0.097    -26.22734    2.228057
       year4 |  -1.185613   5.081242    -0.23   0.816    -11.33967    8.968439
       year5 |   4.057546   5.955268     0.68   0.498    -7.843107     15.9582
       year6 |   -3.07521   8.435847    -0.36   0.717     -19.9329    13.78248
       year7 |  -1.570722   7.307869    -0.21   0.831    -16.17433    13.03289
       year8 |  -6.540273   7.520946    -0.87   0.388    -21.56969    8.489139
       year9 |  -19.02598   5.624997    -3.38   0.001    -30.26663   -7.785316
      year11 |  -5.827564   5.533992    -1.05   0.296    -16.88636    5.231235
      year12 |   -8.21587   5.570113    -1.47   0.145    -19.34685    2.915112
      year13 |  -6.844053   4.447362    -1.54   0.129     -15.7314     2.04329
      year14 |  -3.371878   4.212951    -0.80   0.427    -11.79079    5.047033
       _cons |  -15.83024   23.03077    -0.69   0.494    -61.85356    30.19308
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(popgrowth L.educ2_n L.educ3_n L.fdgrant L.fdtax L.trade L.fdtax2
    L.fdgrant2 year2 year3 year4 year5 year6 year7 year8 year9 year10 year11
    year12 year13 year14)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(2/4).lngfcf_gdp collapsed
    L(2/4).L.realgrowth collapsed
Instruments for levels equation
  Standard
    popgrowth L.educ2_n L.educ3_n L.fdgrant L.fdtax L.trade L.fdtax2
    L.fdgrant2 year2 year3 year4 year5 year6 year7 year8 year9 year10 year11
    year12 year13 year14
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.lngfcf_gdp collapsed
    DL.L.realgrowth collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -2.58  Pr > z =  0.010
Arellano-Bond test for AR(2) in first differences: z =   1.54  Pr > z =  0.123
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(5)    =   1.63  Prob > chi2 =  0.897
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(5)    =   1.94  Prob > chi2 =  0.857
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(3)    =   0.87  Prob > chi2 =  0.833
    Difference (null H = exogenous): chi2(2)    =   1.07  Prob > chi2 =  0.585
  gmm(L.realgrowth, collapse lag(2 4))
    Hansen test excluding group:     chi2(1)    =   0.09  Prob > chi2 =  0.765
    Difference (null H = exogenous): chi2(4)    =   1.85  Prob > chi2 =  0.763
  gmm(lngfcf_gdp, collapse lag(2 4))
    Hansen test excluding group:     chi2(1)    =   0.00  Prob > chi2 =  0.998
    Difference (null H = exogenous): chi2(4)    =   1.94  Prob > chi2 =  0.747
```

Appendix 5.6.2 Government Consumption

```
. xtscc realgrowth popgrowth educ2_n educ3_n lag1realgdp lngfcf_gdp fdexp fdgrant
trade govcons year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12
year13 year14 if realgrowth<=30 & realgrowth>=-15, fe ase

Regression with Driscoll-Kraay standard errors   Number of obs     =       669
Method: Fixed-effects regression                 Number of groups  =        64
Group variable (i): idall                        F( 22,      13)    =2094056.94
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.5538

------------------------------------------------------------------------------
             |             Drisc/Kraay
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |  -.2430345   .1235368    -1.97   0.071    -.5099195    .0238505
```

```
     educ2_n |   .0453335   .0657747     0.69   0.503     -.096764     .187431
     educ3_n |  -.1307293   .0671955    -1.95   0.074    -.2758964    .0144378
 lag1realgdp |  -.0023729   .0006377    -3.72   0.003    -.0037506   -.0009951
  lngfcf_gdp |  -2.334594   2.201467    -1.06   0.308    -7.090574    2.421386
       fdexp |   .2028512   .0984314     2.06   0.060     -.009797    .4154994
     fdgrant |  -.0671721   .1368534    -0.49   0.632    -.3628259    .2284817
       trade |  -.1630131   .1363475    -1.20   0.253    -.4575738    .1315477
     govcons |  -1.835776   1.058868    -1.73   0.107    -4.123323    .4517701
       year2 |   -7.99521   1.407772    -5.68   0.000    -11.03652   -4.953904
       year3 |  -12.15945   2.657626    -4.58   0.001     -17.9009   -6.417999
       year4 |  -9.216503   2.553286    -3.61   0.003    -14.73254   -3.700463
       year5 |  -1.488856   2.925208    -0.51   0.619    -7.808384    4.830672
       year6 |  -2.558545   3.178749    -0.80   0.435    -9.425815    4.308725
       year7 |  -.1883155   3.335862    -0.06   0.956    -7.395007    7.018376
       year8 |  -1.045396    4.31694    -0.24   0.812    -10.37158    8.280785
       year9 |    -11.539   6.062362    -1.90   0.079    -24.63594    1.557933
      year10 |   1.535178   5.895011     0.26   0.799    -11.20022    14.27057
      year11 |    1.15841   6.282201     0.18   0.857    -12.41346    14.73028
      year12 |  -.7005764   6.639016    -0.11   0.918     -15.0433    13.64215
      year13 |   4.456671   10.66206     0.42   0.683     -18.5773    27.49065
      year14 |   7.733028   9.896103     0.78   0.449     -13.6462    29.11226
       _cons |   81.03465   24.16575     3.35   0.005     28.82772    133.2416
------------------------------------------------------------------------------

. xtscc realgrowth popgrowth educ2_n educ3_n lag1realgdp lngfcf_gdp fdtax fdgrant
trade govcons year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12
year13 year14 if realgrowth<=30 & realgrowth>=-15, fe

Regression with Driscoll-Kraay standard errors   Number of obs     =       669
Method: Fixed-effects regression                 Number of groups  =        64
Group variable (i): idall                        F( 22,      13)   =  17289.81
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.5709

------------------------------------------------------------------------------
             |             Drisc/Kraay
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |  -.2879438   .1237681    -2.33   0.037    -.5553286    -.020559
     educ2_n |   .0622612   .0640643     0.97   0.349    -.0761413    .2006638
     educ3_n |  -.0761171   .0629351    -1.21   0.248      -.21208    .0598459
 lag1realgdp |  -.0026789   .0007117    -3.76   0.002    -.0042166   -.0011413
  lngfcf_gdp |  -3.771302   2.057418    -1.83   0.090    -8.216082    .6734786
       fdtax |   .2699177   .1233498     2.19   0.048     .0034367    .5363987
     fdgrant |    -.0381     .145178    -0.26   0.797     -.351738    .2755379
       trade |  -.1675776   .1427706    -1.17   0.262    -.4760147    .1408595
     govcons |  -1.970664    1.16331    -1.69   0.114    -4.483842    .5425136
       year2 |  -7.857487   1.405322    -5.59   0.000     -10.8935   -4.821473
       year3 |  -12.60961   2.460978    -5.12   0.000    -17.92623   -7.292991
       year4 |  -10.04041    2.23197    -4.50   0.001    -14.86228   -5.218528
       year5 |  -2.560739   2.528403    -1.01   0.330     -8.02302    2.901543
       year6 |  -3.184742   2.983503    -1.07   0.305    -9.630208    3.260724
       year7 |  -.4976126   3.266412    -0.15   0.881    -7.554268    6.559042
       year8 |  -1.267828   4.201503    -0.30   0.768    -10.34462    7.808967
       year9 |  -11.82857   5.792979    -2.04   0.062    -24.34354    .6864023
      year10 |   1.895434   6.088562     0.31   0.761     -11.2581    15.04897
      year11 |   1.334042   6.460735     0.21   0.840    -12.62353    15.29161
      year12 |  -.6522168   6.773278    -0.10   0.925      -15.285    13.98056
      year13 |     5.9353   11.23881     0.53   0.606    -18.34468    30.21528
      year14 |    8.24022   10.14458     0.81   0.431    -13.67581    30.15625
       _cons |   83.04238   25.82075     3.22   0.007     27.26004    138.8247
------------------------------------------------------------------------------
```

Appendix 5.6.3 Capital City

```
. xtscc realgrowth popgrowth educ2_n educ3_n lag1realgdp lngfcf_gdp fdexp fdgrant
trade expcapital grantcapital year3 year4 year5 ye
> ar6 year7 year8 year9 year10 year11 year12 year13 year14 if realgrowth<=30 &
realgrowth>=-15, fe

Regression with Driscoll-Kraay standard errors   Number of obs     =       669
Method: Fixed-effects regression                 Number of groups  =        64
Group variable (i): idall                        F( 22,      13)   = 343246.56
maximum lag: 2                                   Prob > F          =    0.0000
```

```
                                                within R-squared  =    0.5223

------------------------------------------------------------------------------
             |             Drisc/Kraay
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |  -.2361993   .1319107    -1.79   0.097     -.521175    .0487763
     educ2_n |   .1406253   .0763202     1.84   0.088    -.0242545     .305505
     educ3_n |  -.1778735   .0807165    -2.20   0.046    -.3522509   -.0034961
 lag1realgdp |  -.0028944   .0006801    -4.26   0.001    -.0043637   -.0014252
  lngfcf_gdp |  -.7800883   3.337271    -0.23   0.819    -7.989824    6.429647
       fdexp |   .2134754   .1017265     2.10   0.056    -.0062914    .4332422
     fdgrant |  -.0858015   .1348863    -0.64   0.536    -.3772055    .2056025
       trade |  -.1193263   .1375284    -0.87   0.401    -.4164385    .1777858
  expcapital |   -.094699   .1391316    -0.68   0.508    -.3952746    .2058766
grantcapital |  -.0922796   .2189387    -0.42   0.680    -.5652679    .3807087
       year3 |  -8.114598   1.464671    -5.54   0.000    -11.27883   -4.950369
       year4 |  -4.297437   1.655367    -2.60   0.022    -7.873641   -.7212338
       year5 |   3.867668   1.888284     2.05   0.061     -.211722    7.947057
       year6 |   3.828308   2.541921     1.51   0.156    -1.663178    9.319793
       year7 |   6.656094   2.890138     2.30   0.038     .4123309    12.89986
       year8 |   4.862773   3.213498     1.51   0.154    -2.079567    11.80511
       year9 |  -6.913085   3.857919    -1.79   0.096    -15.24761    1.421443
      year10 |   5.947931   4.108079     1.45   0.171    -2.927033     14.8229
      year11 |   6.861683   5.258325     1.30   0.215    -4.498238     18.2216
      year12 |   5.590695   5.718616     0.98   0.346    -6.763624    17.94501
      year13 |   9.754142   8.829752     1.10   0.289    -9.321376    28.82966
      year14 |   12.50393   7.557143     1.65   0.122    -3.822284    28.83015
       _cons |   34.34019   24.72642     1.39   0.188    -19.07799    87.75836
------------------------------------------------------------------------------


. xtscc realgrowth popgrowth educ2_n educ3_n lag1realgdp lngfcf_gdp fdtax fdgrant
trade revcapital grantcapital year3 year4 year5 ye
> ar6 year7 year8 year9 year10 year11 year12 year13 year14 if realgrowth<=30 &
realgrowth>=-15, fe

Regression with Driscoll-Kraay standard errors   Number of obs     =       669
Method: Fixed-effects regression                 Number of groups  =        64
Group variable (i): idall                        F( 22,     13)    =   5143.40
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.5378

------------------------------------------------------------------------------
             |             Drisc/Kraay
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |  -.2772035   .1213335    -2.28   0.040    -.5393287   -.0150783
     educ2_n |   .1604887   .0743235     2.16   0.050    -.0000774    .3210548
     educ3_n |  -.1198145   .0728976    -1.64   0.124    -.2773002    .0376713
 lag1realgdp |  -.0032195   .0006875    -4.68   0.000    -.0047047   -.0017343
  lngfcf_gdp |  -2.017642   2.998299    -0.67   0.513    -8.495073    4.459789
       fdtax |   .2711192   .1174564     2.31   0.038       .01737    .5248683
     fdgrant |  -.0723588   .1293211    -0.56   0.585    -.3517401    .2070225
       trade |  -.1215466   .1346822    -0.90   0.383    -.4125099    .1694166
  revcapital |   .0114279   .1325379     0.09   0.933    -.2749029    .2977586
grantcapital |   .0729921   .1939417     0.38   0.713    -.3459934    .4919777
       year3 |  -8.707094     1.2214    -7.13   0.000    -11.34577    -6.06842
       year4 |  -5.280121   1.288088    -4.10   0.001    -8.062865   -2.497377
       year5 |   2.643115    1.49783     1.76   0.101      -.59275     5.87898
       year6 |   3.110451   2.387463     1.30   0.215     -2.04735    8.268252
       year7 |   6.284545   2.870543     2.19   0.047     .0831139    12.48598
       year8 |   4.491954   3.085457     1.46   0.169     -2.17377    11.15768
       year9 |  -7.500658   3.294877    -2.28   0.040    -14.61881   -.3825078
      year10 |   6.006523   4.069029     1.48   0.164    -2.784079    14.79713
      year11 |   6.816921   5.229933     1.30   0.215    -4.481663     18.1155
      year12 |   5.452037   5.632618     0.97   0.351    -6.716495    17.62057
      year13 |   10.65802   8.678255     1.23   0.241    -8.090209    29.40625
      year14 |   12.61684   7.274727     1.73   0.106    -3.099251    28.33294
       _cons |   33.24289   24.50387     1.36   0.198    -19.69451    86.18028
------------------------------------------------------------------------------
```

Appendix 5.6.4 EU

```
xtscc realgrowth popgrowth educ2_n educ3_n lag1realgdp lngfcf_gdp fdexp fdgrant trade
expeu granteu year3 year4 year5 year6 year7 year8 year9 year10 year11 year12 year13
year14 if realgrowth<=30 & realgrowth>=-15, fe

Regression with Driscoll-Kraay standard errors   Number of obs     =       669
Method: Fixed-effects regression                 Number of groups  =        64
Group variable (i): idall                        F( 22,     13)    =  14309.98
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.5256

------------------------------------------------------------------------------
             |             Drisc/Kraay
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |  -.2329802   .1331926    -1.75   0.104    -.5207252    .0547648
     educ2_n |   .1196251   .0742928     1.61   0.131    -.0408748    .2801249
     educ3_n |  -.1730872   .0912415    -1.90   0.080    -.3702025    .0240281
 lag1realgdp |  -.0026315   .0007565    -3.48   0.004    -.0042658   -.0009972
  lngfcf_gdp |  -.5253273   2.959396    -0.18   0.862    -6.918714    5.868059
       fdexp |   .3031406    .091458     3.31   0.006     .1055576    .5007236
     fdgrant |  -.0385375   .1112461    -0.35   0.735    -.2788701    .2017951
       trade |  -.1070079   .1384327    -0.77   0.453    -.4060737    .1920578
       expeu |  -.1233123   .0835566    -1.48   0.164    -.3038253    .0572007
     granteu |   .0492654   .1032123     0.48   0.641    -.1737112    .2722419
       year3 |  -8.604505   1.558237    -5.52   0.000    -11.97087   -5.238139
       year4 |  -3.294832   2.191655    -1.50   0.157    -8.029616    1.439952
       year5 |   4.913283   2.287927     2.15   0.051    -.0294824    9.856048
       year6 |   4.671435   2.871564     1.63   0.128    -1.532202    10.87507
       year7 |   7.444334   3.125063     2.38   0.033     .6930465    14.19562
       year8 |   5.394674   3.363474     1.60   0.133     -1.87167    12.66102
       year9 |  -6.332145   3.467009    -1.83   0.091    -13.82216    1.157871
      year10 |   6.280233    4.43377     1.42   0.180    -3.298345    15.85881
      year11 |   7.047982   5.682048     1.24   0.237    -5.227335     19.3233
      year12 |    5.89658   6.007444     0.98   0.344    -7.081713    18.87487
      year13 |   9.569226   8.737584     1.10   0.293    -9.307176    28.44563
      year14 |   12.87482   7.378887     1.74   0.105    -3.066298    28.81593
       _cons |   27.81431   24.30356     1.14   0.273    -24.69035    80.31896
------------------------------------------------------------------------------
```

```
. xtscc realgrowth popgrowth educ2_n educ3_n lag1realgdp lngfcf_gdp fdtax fdgrant
trade taxeu granteu year3 year4 year5 year6 year7
> year8 year9 year10 year11 year12 year13 year14 if realgrowth<=30 & realgrowth>=-15,
fe

Regression with Driscoll-Kraay standard errors   Number of obs     =       669
Method: Fixed-effects regression                 Number of groups  =        64
Group variable (i): idall                        F( 22,     13)    =  73600.11
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.5415

------------------------------------------------------------------------------
             |             Drisc/Kraay
  realgrowth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   popgrowth |  -.2893952   .1141257    -2.54   0.025    -.5359488   -.0428416
     educ2_n |   .1488297   .0737362     2.02   0.065    -.0104676     .308127
     educ3_n |  -.0963386   .0949462    -1.01   0.329    -.3014573    .1087801
 lag1realgdp |  -.0029511   .0007786    -3.79   0.002     -.004633   -.0012691
  lngfcf_gdp |  -2.064748   2.619126    -0.79   0.445    -7.723025     3.59353
       fdtax |   .3547782   .0913115     3.89   0.002     .1575118    .5520446
     fdgrant |  -.0329765   .1011385    -0.33   0.750     -.251473      .18552
       trade |  -.1104622   .1375152    -0.80   0.436    -.4075458    .1866213
       taxeu |  -.1191116   .0874655    -1.36   0.196    -.3080693     .069846
     granteu |   .0595848   .1032358     0.58   0.574    -.1634427    .2826122
       year3 |  -9.355721   1.440228    -6.50   0.000    -12.46714   -6.244297
       year4 |  -4.730584   2.318625    -2.04   0.062    -9.739668    .2785003
       year5 |   3.212943   2.408251     1.33   0.205    -1.989768    8.415654
       year6 |   3.485304   3.090424     1.13   0.280    -3.191152    10.16176
       year7 |   6.656717   3.409088     1.95   0.073    -.7081692     14.0216
       year8 |   4.606536   3.547598     1.30   0.217    -3.057584    12.27066
       year9 |  -7.364879    3.09251    -2.38   0.033    -14.04584   -.6839162
      year10 |   6.019647   4.672222     1.29   0.220    -4.074075    16.11337
      year11 |   6.617479   5.989621     1.10   0.289    -6.322309    19.55727
      year12 |    5.30545   6.318092     0.84   0.416    -8.343959    18.95486
```

year13	9.977782	9.086196	1.10	0.292	-9.651752	29.60732
year14	12.51074	7.516451	1.66	0.120	-3.727562	28.74905
_cons	27.54524	23.89533	1.15	0.270	-24.07749	79.16796

```
. xtscc realgrowth popgrowth educ2_n educ3_n lag1realgdp lngfcf_gdp fdexp fdgrant
granteu year3 year4 year5 year6 year7 year8 year9
>  year10 year11 year12 year13 year14 if realgrowth<=30 & realgrowth>=-15 &
id_country!=1, fe
```

```
Regression with Driscoll-Kraay standard errors   Number of obs     =       537
Method: Fixed-effects regression                 Number of groups  =        52
Group variable (i): idall                        F( 20,    13)     =5948362.87
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.6177
```

realgrowth	Coef.	Drisc/Kraay Std. Err.	t	P>|t|	[95% Conf.	Interval]
popgrowth	1.167538	1.199133	0.97	0.348	-1.423031	3.758107
educ2_n	.186763	.0759487	2.46	0.029	.0226859	.3508401
educ3_n	.001019	.1005137	0.01	0.992	-.2161277	.2181657
lag1realgdp	-.0030219	.0009471	-3.19	0.007	-.0050681	-.0009757
lngfcf_gdp	3.773137	2.161736	1.75	0.104	-.8970091	8.443283
fdexp	.2011882	.09388	2.14	0.052	-.0016273	.4040037
fdgrant	-.163049	.1231129	-1.32	0.208	-.4290182	.1029203
granteu	.0569572	.1147803	0.50	0.628	-.1910104	.3049249
year3	-12.29891	1.621984	-7.58	0.000	-15.80299	-8.794827
year4	-13.0465	2.290069	-5.70	0.000	-17.9939	-8.09911
year5	-2.091411	1.988413	-1.05	0.312	-6.387116	2.204295
year6	-3.795241	1.837594	-2.07	0.059	-7.765122	.174639
year7	-.1090134	1.907098	-0.06	0.955	-4.229049	4.011022
year8	-3.375113	2.192198	-1.54	0.148	-8.111069	1.360843
year9	-13.94261	3.493968	-3.99	0.002	-21.49087	-6.394352
year10	-1.134517	2.710169	-0.42	0.682	-6.98948	4.720446
year11	-1.730694	2.911271	-0.59	0.562	-8.020111	4.558724
year12	-4.923499	3.40071	-1.45	0.171	-12.27029	2.423288
year13	-1.583683	5.56893	-0.28	0.781	-13.61462	10.44726
year14	2.222509	5.465843	0.41	0.691	-9.585728	14.03074
_cons	5.999562	12.72895	0.47	0.645	-21.49966	33.49878

```
. xtscc realgrowth popgrowth educ2_n educ3_n lag1realgdp lngfcf_gdp fdtax fdgrant
trade year3 year4 year5 year6 year7 year8 year9 year10 year11 year12 year13 year14 if
realgrowth<=30 & realgrowth>=-15 & id_country!=1, fe
```

```
Regression with Driscoll-Kraay standard errors   Number of obs     =       537
Method: Fixed-effects regression                 Number of groups  =        52
Group variable (i): idall                        F( 20,    13)     =  2.15e+07
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.6350
```

realgrowth	Coef.	Drisc/Kraay Std. Err.	t	P>|t|	[95% Conf.	Interval]
popgrowth	.8187216	1.054075	0.78	0.451	-1.458469	3.095913
educ2_n	.1692946	.0714761	2.37	0.034	.01488	.3237093
educ3_n	-.0007682	.0885939	-0.01	0.993	-.1921637	.1906274
lag1realgdp	-.003337	.0009687	-3.44	0.004	-.0054298	-.0012442
lngfcf_gdp	2.866984	2.28075	1.26	0.231	-2.060277	7.794245
fdtax	.2387015	.10785	2.21	0.045	.0057058	.4716973
fdgrant	-.0529499	.1524641	-0.35	0.734	-.3823286	.2764288
trade	-.1515545	.151534	-1.00	0.335	-.4789239	.1758149
year3	-11.33218	1.74641	-6.49	0.000	-15.10507	-7.559296
year4	-9.073462	2.516101	-3.61	0.003	-14.50917	-3.637756
year5	2.128926	3.356454	0.63	0.537	-5.122252	9.380104
year6	2.002726	4.866866	0.41	0.687	-8.511499	12.51695
year7	6.403802	5.578272	1.15	0.272	-5.647321	18.45493
year8	3.186127	5.98336	0.53	0.603	-9.740137	16.11239
year9	-9.745635	5.961113	-1.63	0.126	-22.62384	3.132567
year10	5.723227	6.994418	0.82	0.428	-9.387294	20.83375
year11	7.207713	8.785302	0.82	0.427	-11.77178	26.1872
year12	4.783402	9.681829	0.49	0.630	-16.13292	25.69972

```
      year13 |   9.679319    12.7282     0.76   0.461    -17.81829    37.17693
      year14 |    12.6853   11.93527     1.06   0.307    -13.09927    38.46988
       _cons |   20.81547   19.73723     1.05   0.311    -21.82424    63.45517
------------------------------------------------------------------------------
```

Appendix 5.6.5 Long Run

A. Baseline

```
. nlcom _b[fdexp] / (1 - _b[L.realgrowth])

       _nl_1:  _b[fdexp] / (1 - _b[L.realgrowth])

------------------------------------------------------------------------------
  realgrowth |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       _nl_1 |   .1264454   .0571474     2.21   0.027     .0144385    .2384522
------------------------------------------------------------------------------


. nlcom _b[fdgrant] / (1 - _b[L.realgrowth])

       _nl_1:  _b[fdgrant] / (1 - _b[L.realgrowth])

------------------------------------------------------------------------------
  realgrowth |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       _nl_1 |   .0382033   .0407584     0.94   0.349    -.0416818    .1180884
------------------------------------------------------------------------------

. nlcom _b[fdtax] / (1 - _b[L.realgrowth])

       _nl_1:  _b[fdtax] / (1 - _b[L.realgrowth])

------------------------------------------------------------------------------
  realgrowth |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       _nl_1 |   .1628457   .0565209     2.88   0.004     .0520668    .2736246
------------------------------------------------------------------------------

. nlcom _b[fdgrant] / (1 - _b[L.realgrowth])

       _nl_1:  _b[fdgrant] / (1 - _b[L.realgrowth])

------------------------------------------------------------------------------
  realgrowth |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       _nl_1 |   .0180032   .0377837     0.48   0.634    -.0560514    .0920578
------------------------------------------------------------------------------
```

B. Endogenous

```
. nlcom _b[fdexp] / (1 - _b[L.realgrowth])

       _nl_1:  _b[fdexp] / (1 - _b[L.realgrowth])

------------------------------------------------------------------------------
  realgrowth |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       _nl_1 |   .0329326   .0543042     0.61   0.544    -.0735017     .139367
------------------------------------------------------------------------------

. nlcom _b[l.fdgrant] / (1 - _b[L.realgrowth])

       _nl_1:  _b[l.fdgrant] / (1 - _b[L.realgrowth])

------------------------------------------------------------------------------
  realgrowth |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       _nl_1 |  -.0185976   .0443938    -0.42   0.675    -.1056078    .0684126
------------------------------------------------------------------------------

. nlcom _b[l.fdtax] / (1 - _b[L.realgrowth])

       _nl_1:  _b[l.fdtax] / (1 - _b[L.realgrowth])

------------------------------------------------------------------------------
  realgrowth |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
```

```
       _nl_1 |   .1449749   .0408592     3.55   0.000     .0648923    .2250576
------------------------------------------------------------------------------

. nlcom _b[l.fdgrant] / (1 - _b[L.realgrowth])

       _nl_1:  _b[l.fdgrant] / (1 - _b[L.realgrowth])

------------------------------------------------------------------------------
  realgrowth |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       _nl_1 |  -.0944451   .0317655    -2.97   0.003    -.1567044   -.0321859
------------------------------------------------------------------------------
```