Staffordshire University
Business School

Monetary-regime switch from exchange-rate targeting to inflation targeting: with reference to developing economies

Marjan PETRESKI

A thesis submitted in partial fulfilment of the requirements of

Staffordshire University for the degree of

Doctor of Philosophy

March, 2011

Abstract

The objective of this thesis is to investigate whether a switch from exchange-rate targeting (de-facto a fixed exchange rate) to inflation targeting will facilitate a more appropriate monetary policy and a more stable macroeconomic environment in developing economies. To achieve this objective, the thesis starts by developing the argument that the exchange-rate peg, as a nominal variable, might be unimportant for affecting long-run growth performance, but detrimental to short-run output stability, particularly in times of real shocks. By using a dynamic system-GMM panel estimator, the research finds that the exchange-rate regime is not significant in explaining growth, either overall or in developing countries. Next, the Hausman-Taylor panel method is used to investigate whether the exchange-rate regime is important in determining output volatility. To overcome the spurious-regression problem arising from the potentially persistent rolling-standard-deviation based measure of output volatility, a new measure is defined; namely, the difference between the potential and the actual output, which might arise from either economic policies or external disturbances. The empirical evidence suggests that, for the overall sample and for the developing countries, a terms-of-trade shock larger than 7 percentage points under a fixed, and larger than 9 percentage points under limited-flexible and flexible exchange-rate regimes, will give higher output volatility compared to a float. These findings are in line with the expectation that pegs provide early gains in terms of inflation stabilization, but longer pegs begin to develop into a threat for output stabilization in the aftermath of an aggregate-supply shock and as the economy becomes more financially integrated. Given these findings, the thesis suggests the exchange rate be made flexible and a new nominal anchor established. The thesis argues that the direct targeting of inflation is a rational choice in the aftermath of peg exit. To investigate whether monetary-policy responses change and produce a more stable macroeconomic environment under regime switching from exchange-rate targeting to inflation targeting, allowing for the possibility of an endogenous switch, the thesis adopts the framework of a fairly classical Taylor rule, augmented by the exchange rate. Two modelling approaches are used to undertake the empirical research: a panel switching regression; and a Markov-switching VAR. Results from both suggest that inflation targeting represented a real switch in developing countries and is characterized by a more stable economic environment, by more independent monetary-policy conduct, by policy geared to strict observation of inflation and by marginal consideration of the real fluctuations of the economy.

Contents

Contents of figures

Contents of tables

List of abbreviations

ACF	Autocorrelation Function
ADF	Augmented Dickey-Fuller
AR	Auto-regressive
ARDL	Auto-regressive distributed lag
BC	Bias-corrected
B-S	Balassa-Samuelson (effect)
CEE	Central and Eastern Europe
CFA	Communauté française d'Afrique (French community of Africa)
CUE	Continuous updating estimator
DD-MS-VAR	Duration-dependent Markov-switching vector autoregression
DF	Dickey-Fuller
DSGE	Dynamic stochastic general equilibrium
ECB	European Central Bank
ECM	Error correction mechanism
EM	Expectation Maximization
EME	Emerging market economies
EMS	European Monetary System
EMU	European Monetary Union
ER	Exchange rate
ERM	Exchange-rate mechanism
ERR	Exchange-rate regime
ERT	Exchange-rate targeting
EU	European Union
EU-15	European Union of 15 members
FE	Fixed effects
FED	Federal Reserves
FGLS	Feasible generalized least squares
GARCH	Generalized Auto Regressive Conditional Heteroskedasticity
GC	Government consumption
GDP	Gross domestic product
GMM	Generalized method of moments
GNP	Gross National Product
HAC	Heteroskedasticity and autocorrelation corrected (standard errors)
HP	Hodrick-Prescott
HT	Hausman-Taylor
IMF	International Monetary Fund
IS	Investment-savings (curve)
ISLM	Investment-savings-liquidity-money (model)
IT	Inflation targeting

IV	Instrumental variables
LIML	Limited-information maximum-likelihood
LM	Liquidity-money (curve)
LSDV	Least squares dummy variable
LYS	Levy-Yeyati and Sturzenegger (2005)
M2	Monetary aggregate M2
ML	Maximum likelihood
MS	Markov switching
MSP	Markov switching panel
MS-VAR	Markov switching vector auto-regression
MS-VECM	Markov switching vector error correction model
NE	Natural experiment
NEER	Nominal effective exchange rate
NLS	Non-linear least squares
OECD	Organization for Economic Cooperation and Development
OLS	Ordinary least squares
PP	Phillip-Perron
p.p.	percentage points
R&D	Research and development
RE	Random effects
RR	Reinhart and Rogoff (2004)
SIC	Schwarz information criterion
SD	Standard deviation
SETAR	Self-exciting threshold autoregressive
STIT	Strict inflation targeting
TAR	Threshold auto-regression
TOT	Terms of trade
TVTP	Time-varying transition probabilities
2SLS	Two-stage least squares
UK	United Kingdom
US	United States
VAR	Vector auto-regression
WWII	World War II

Declaration

I certify that except where due acknowledgement has been made, the work is that of the author alone; the work has not been submitted previously, in whole or in part, to qualify for any other academic award; the content of the thesis is the result of work which has been carried out since the official commencement date of the approved research program; and, any editorial work, paid or unpaid, carried out by a third party is acknowledged.

Marjan Petreski

Staffordshire University

March 2011

Acknowledgments

"I've come up with a set of rules that describe our reactions to technologies:

1. *Anything that is in the world when you're born is normal and ordinary and is just a natural part of the way the world works.*
2. *Anything that's invented between when you're fifteen and thirty-five is new and exciting and revolutionary and you can probably get a career in it.*
3. *Anything invented after you're thirty-five is against the natural order of things."*

— Douglas Adams, *The Salmon of Doubt*, Harmony Books, 2002, p.95
English humorist & science fiction novelist (1952 - 2001)

This thesis and the degree constitute a realization of a dream, a guiding thought that steered me since I entered academia as an undergraduate student. I do not try to say that all my wishes became a truth - it is, yet, nice to dream... At this scientific road, my due gratitude is bestowed to my everlasting beloved, Blagica, for her moral support and endless economic discussions... I couldn't have thought that I will ever find such an ally, enthusiast on the stiffer road, a follower and a soul mate. I hope that I will have the opportunity to make her up all my home-leaves, travels and time dedicated to this work very soon. I would also like to express my deepest gratitude to my closest family - my mother Liljana, my father Zoran and my sister Despina. "If I have seen further than others, it is because of standing upon the shoulders of giants." (Issac Newton, 1642-1727).

On the academic side, my principal supervisor Prof. Geoff Pugh deserves the deepest gratitude, as well as my second supervisor Prof. Jean Mangan. They gave me a systematic guidance over the endless frontiers of research; their research experience and continuous feedback were invaluable for the achieved quality of my research work. My deepest thanks also go to Prof. Iraj Hashi who, loosely speaking, gave me the opportunity to study on this PhD program and who continued to give me academic and social inspiration while in Stoke. I hope these three people do not wonder why I was writing papers for journals and conferences, consuming part of my precious time for work on the thesis. An academic gratitude follows to Dr. Nikica Mojsoska-Blazevski, a friend, local supervisor and a colleague at the Faculty of economics within the University of American College - Skopje, for her encouragement and personal support towards achieving my PhD goal. I am personally looking forward to continue the collaboration with her at the University in the years that follow. Finally, I thank to all my research fellows, for the valuable process of exchanging ideas, assistance with software and codes and ever-inspiring conversations. I look forward to continue the cooperation with them also.

On the social side, I would like to thank my fellows and roommates here in Stoke, in particular: Sandra Hlivnjak, Belma Colakovic, Jane Bogoev, Viktorija Atanasovska and Natasa Trajkova. We shared many of the joyful and most memorable moments here in the United Kingdom.

Meanwhile, I continue to be very excited and enthusiastic about life, people and economics. I hope the reason is not likely to be the fact that I am twenty-eight.

- Marjan Petreski, Stoke-on-Trent, United Kingdom, 2011

Post Scriptum

In March 2010, the Macedonian Academy of Sciences and Arts awarded me, in an open competition, the Young Scientist Award 2009 for my continuous scientific work.

Later, in November 2010, the paper "An Overhaul of a Doctrine: Has Inflation Targeting Opened a New Era in Developing-country Peggers?", based on Chapter 6 of this thesis, won the Olga Radzyner Award 2010 from The Oesterreichische Nationalbank.

From today's perspective, these were bright, but binding recognitions.

Post post scriptum

A couple of months before the submission of this thesis, me and Blagica were blessed by the birth of our son, Darian. He turned out to be my little big ally in the final round.

Credits

Parts of this thesis were presented at conferences and/or published, as follows:

- Exchange-rate regime and economic growth: A review of the theoretical and empirical literature.
    - *Conference on International trade in the 21st century,* Staffordshire University, 05 December 2008.
    - *E-journal Economics Discussion Papers,* No. 2009-31, 2009, p.1-19.
- To fix or to float from the perspective of output volatility and vulnerability to crisis. *CEA Journal of Economics,* 2008, 3(1), p.9-24.
- Analysis of exchange-rate regime effect on growth: Theoretical channels and empirical evidence with panel data.
    - *XVII Scientific* c*onference "Growth and development patterns: The role of institutions in a comparative perspective",* University of Perugia, 25-27. June 2009.
    - *E-journal Economics Discussion Papers*, No. 2009-49, 2009, p.1-31.
- A critique on inflation targeting. *CEA Journal of Economics,* 4(2), 2009, p.11-25.
- Exchange-rate regimes and output volatility: Empirical investigation with panel data.
    - *The XVth Spring Meeting of Young Economists (SMYE-2010),* University of Luxemburg, Luxembourg, 15-17. April 2010.
    - *Second Joint OEI/APB Summer Academy on Central and Eastern Europe,* Osteuropa-Institut Regensburg, Germany, 14-16. July 2010.
    - *International Journal of Monetary Economics and Finance,* 3(1), 2010, p.69-99.

- An Overhaul of a Doctrine: Has Inflation Targeting Opened a New Era in Developing-country Peggers?
    - *Conference on European Economic Integration (CEEI)*, The Oesterreichische National Bank, 15-16. November 2010.
    - *Workshop on Institutional Analysis,* The Ronald Coase Institute and the University of Chicago, 16-21. May 2011.
- A Markov Switch to Inflation Targeting in Emerging-market Peggers: with Focus on Czech Republic, Poland and Hungary. *Focus on European Economic Integration*, 3(11).

The work in the thesis highly benefited from three formal training courses outside Staffordshire University:

- *Macroeconomic forecasting*, Joint Vienna Institute – Vienna, July 2008;
- *Dynamic and non-linear panel data analysis*, University Pompeu Fabra – Barcelona, July 2009;
- *Advanced macroeconometrics - Programming in MatLab*, University of Salento – Lecce, August 2009.

Notes

Unless otherwise stated, all fractional results have been rounded to the displayed number of decimal figures.

Whenever the source of a table/figure is not reported, it means it has been drawn from the author's estimation results.

All chapters, sections, tables and figures are cross-referenced with links and can be accessed with ctrl+click. Cross-referenced pages can be similarly accessed.

INTRODUCTION

I.1. Stylised facts and figures

"Throughout the world, monetary-policy regimes have changed dramatically over the decade of the 1990s. … The biggest transformation has been the move away from focusing on intermediate objectives, such as money and exchange rates, toward the direct targeting of inflation." (Cecchetti and Ehrmann, 1999, p.1). New Zealand was the pioneering economy to adopt inflation targeting in the early 1990s. Since then twenty nine countries[1] adopted this monetary strategy as a flexible way to conduct monetary policy with "constrained discretion" and oriented toward domestic objectives. This group includes advanced and developing economies, countries with different starting levels of inflation and with different prior monetary strategies.

There has also been a move towards exchange-rate regimes with greater flexibility: the percentage of countries with an intermediate exchange-rate regime doubled from 23% to 50% between 1972 and 2007 (Reinhart web site, 2010). Similarly, for developing economies, the preferred exchange-rate regime has evolved over the last two decades. Targeting the exchange rate to a strong anchor currency (often the dollar or the deutsche mark) was popular in the early 1990s — especially for transition economies that were seeking to stabilize their economies after their initial price liberalizations. However, the 1990s also saw a spate of currency crises in developing countries, with sharp reversals of capital inflows leading to collapsing currencies and underscoring the fragility of such fixed exchange rate regimes.

By the end of the 1990s, the received wisdom was that simple pegs (including soft and crawling pegs and bands) were too prone to crisis and that countries should adopt either "hard" pegs — such as monetary unions or currency boards — or, at the other end of the spectrum, free floats in which the market determines a currency's value without government intervention (Ghosh and Ostry, 2009). This bipolar view became

[1] The current number of inflation targeters is 26, since Finland, Spain and Slovakia joined the Euro area, but no country has left inflation targeting for other reasons.

known as the "hollowing-out" hypothesis (Fisher, 2001). The bipolar prescription for developing countries proved short lived, however. The pressures on the Czech, Polish and Thai hard pegs in the late 1990s and the collapse of the Argentinean currency board in early 2000 cast doubt on the hard end of the bipolar spectrum. The other end, although less 'visited' by developing economies, also proved weak: many de-jure floaters were intervening in the foreign-exchange market, because they were "fearing to float" (Calvo and Reinhart, 2004). Intermediate regimes came into fashion again. Hence, as many countries, including developing economies, decided to abandon a preannounced peg, they faced the need to adopt a new nominal anchor. Fourteen exchange-rate targeters embarked on a new monetary strategy of inflation targeting. Nine out of those were developing economies.

I.2. Context of the research

It has been theoretically argued and empirically supported that the result of exchange-rate pegging is anchoring inflation at low, sustainable levels by imposing a credible but tied monetary policy (Chang and Velasco, 2000). However, under increased international capital mobility "the traditional trade-off [between a fixed and floating exchange-rate regime] has narrowed down to a price stability – growth dilemma" (Levy-Yeyati-and-Sturzenegger, 2001, p.63). This poses the question of whether pegs, which introduce and maintain low inflation, continue to be desirable because they are deemed to hinder growth. A consensus on the effect of the exchange-rate regime on growth has not been reached at the theoretical level; hence, the issue becomes an empirical question. At the empirical level, though, agreement is also lacking (Levy-Yeyati and Sturzenegger, 2002; Huang and Malhotra, 2005; Bleaney and Francisco, 2007).

Goldstein (2002) argues that the exchange rate, as a nominal variable, similar to inflation, might not be related to the long-run growth performance of the economy at all, but to the short-run deviation of output from its long-run trend, i.e. to output volatility. For small, open economies, an exchange-rate peg might transmit external shocks to output volatility. Increased capital mobility in modern times makes such external shocks more likely, by raising the exposure to capital flight and making the peg a less desirable option (Obstfeld and Rogoff, 1995; Tavlas, 2003). Moreover, large-enough external shocks are argued to force even a peg exit, which is frequently converted into the exchange-rate-system demise and severe recession (Aizenman and

Glick, 2008; Frankel and Rose, 1996). Over time, therefore, the initial gains of the exchange-rate peg in terms of credibility and low inflation may become exhausted. In consequence, relaxing the exchange rate may help by mitigating vulnerability to external currency disturbances and by allowing an independent monetary policy to focus to a limited extent on other domestic considerations as well as inflation. There is a range of flexible exchange rates, which can potentially serve as output-variance smoothers and reduce the vulnerability to shocks. However, peg exit necessitates the need for new nominal anchor for inflation (Mishkin, 1999).

Given that the link between broad money and inflation weakened in the 1970s, making monetary targeting impractical, and that an implicit nominal anchor has proven feeble in constraining inflation expectations in small, open economies (Jonas and Mishkin, 2003), twenty six countries in the world today apply the strategy of direct inflation targeting (hereafter IT). New Zealand was the pioneering country among ITers and the group now encompasses many developing economies. An IT central bank commits to a numerical target for a measure of inflation over a given time horizon and the inflation forecast over that horizon serves as an intermediate target (Svensson, 2000, 2007). Some (Mishkin and Scmidt-Hebbel, 2001, p.33) argue that the advantage of IT over other strategies and its success in "controlling inflation and improving the performance of the economy" has made it a commonly used framework for conducting monetary policy. Indeed, no country yet has been forced to exit IT. However, several objections can be made to the general move to favour IT. To name a few: the general switch toward IT coincided with the 'Great Moderation', i.e. a period of global growth and macro-economic stability, making it important to disentangle the two effects; the evidence is usually exposed to an identification-strategy problem, given both explicit ITers and implicit targeters; the analyses have largely ignored the possibility that switchers were self-selected into IT, i.e. that the switch might have emerged endogenously; and that the IT effect on output volatility has not reached a consensus (Lee 1999a; Ceccheti and Ehrman, 1999; Arestis *et al.* 2002). In addition, while IT has been well documented in advanced economies, its analysis in developing economies has been scarce and largely descriptive. An important question is whether these countries achieved better monetary policy responses and more stable macroeconomic environments once they left the peg and embarked on IT. In addition to the usual discussion about the trade-off between inflation- and output- volatility, the literature argues that the exchange rate is important for these economies for various reasons: large shocks or capital flows cause significant volatility in the exchange rate in small, open economies; because of its complex macro-interactions, like exchange rate pass-through; and because of the high level of currency substitution and foreign-denominated debt in those economies.

Given the above discussion, the vulnerability of the peg in times of aggregate shocks and the favoured role of IT in the last decade or so gives rise to an important issue: can IT be an alternative strategy for former exchange-rate targeting (ERT) developing economies? In other words, can IT, as compared to ERT, enable central banks in developing economies to achieve better policy responses in terms of inflation and output volatility, accounting for the exchange-rate considerations? To progress knowledge on this question is the main aim of this thesis.

I.3. Objectives of the thesis

The thesis has the following specific objectives:

- To critically assess the theoretical and empirical literature on the manner in which the exchange-rate regime affects output growth and volatility;
- To design a modelling framework and investigate if and how an exchange-rate peg affects growth and output volatility, with special emphasis on the role of shocks hitting the economy;
- To survey the literature on inflation targeting and to explain why inflation targeting may be seen as an alternative strategy for former exchange-rate targeters;
- To critically assess the literature on the policy responses and economic outcomes under IT, with special reference to developing economies;
- To develop and implement empirical models for analysing monetary-policy responses in developing economies that switched from ERT to IT, while taking into account the changed, international macroeconomic environment.

I.4. Structure of the thesis

In order to pursue these objectives, the thesis is organized as follows.

Chapter one presents a critical literature review of the economics of exchange-rate regimes and particularly of the effects of exchange-rate pegging on growth. The chapter explains the channels through which the exchange-rate regime might influence growth. Then the empirical literature on the topic is summarized and critically assessed. Given that the literature on the topic is not in agreement on if and how the exchange-rate regime affects growth, the chapter argues that, according to the Natural Rate hypothesis, the exchange-rate regime as a nominal variable might be not be important in affecting long-run growth but instead affects its short-run fluctuations.

Chapter two is the second stage of the review of the theoretical and empirical literature, focusing on the relationship between a peg and output volatility. This chapter retrieves the older debate on fixed versus flexible exchange rates and, in particular, the un-sustainability of the exchange-rate peg under the increasing inclusion of an economy in the international capital markets. As an economy becomes increasingly involved in the global financial markets, real exogenous shocks become increasingly apparent, hence supporting the adoption of a flexible rate to serve the function of absorber of such disturbances. Then, the chapter critically assesses the current empirical literature on this topic and sets the background to empirical investigation of the issue.

Chapter three empirically investigates whether and how the exchange-rate regime affects growth and output volatility, and aims to address drawbacks in current empirical studies. A minimally specified growth model, based on core variables found in the literature, is defined together with a framework for analysing the exchange rate regime's impact on output volatility, whereby shocks hitting the economy play a crucial role. The chapter also addresses other important issues, which are - partially or entirely - missing from the current exchange-rate regimes literature. The investigation: contrasts use of the de-jure (IMF) versus a de-facto (Reinhart and Rogoff, 2004) exchange-rate classification; discusses the measure of output volatility; draws attention to the Lucas critique; and discusses and addresses possible endogeneity bias. The empirical investigation covers the post-Bretton-Woods era (1976-2006), includes 169 countries and uses IV methods. From the viewpoint of monetary policy, the chapter aims to answer if flexibilization of the exchange-rate policy is beneficial in giving a reduced volatility of output.

Chapter four analyses at the theoretical level the options that the central bank has in the aftermath of a peg exit. The chapter discusses preconditions that a country needs to fulfil in order to become a successful inflation targeter. In the second part, the chapter gives a broad, but rather technical, definition of IT. It describes IT as a pre-emptive monetary strategy that uses an information-inclusive framework in order to achieve the pre-announced numerical target in a given time horizon. The chapter explains that an IT central bank would be interested in curbing inflation and bringing it immediately on target, except that this may sacrifice a large portion of output. Pragmatically, hence, the IT central bank may opt for a not-so-fast inflation decrease, at the same time considering the reducing of output fluctuations and exchange-rate volatility. Therefore, IT appears to be able to produce the desired inflation outcomes, as ERT does, but also takes into account the effects on the real economy in times of foreign shocks, contrary to ERT.

Chapter five is a deeper examination of some of the issues raised in Chapter 4. The crucial question raised in this chapter is whether IT, in the manner in which it is defined, contradicts the theoretical consensus and empirically established regularity of the existence of a short-run trade-off between inflation- and output volatility. Since inflation and its volatility declined after IT was introduced (Nadal-de-Simone, 2001b) and since we argue in Chapter 1 that both ERT and IT anchor inflation expectations, the emphasis is on the aspects in which these two monetary regimes differ – output volatility and exchange-rate issues. However, this does not mean that our discussion will not consider the issues related to inflation. We put the discussion in a context of developing economies. The chapter argues an IT central bank of a developing country would be interested in managing the exchange rate, but would not want to prevent the exchange rate reaching its market-determined equilibrium over the long-run horizon. In that light, considering the exchange-rate volatility, the exchange-rate pass-through to prices and the level of euroization gains in importance within an IT framework and is highlighted in this chapter.

Chapter six is an empirical analysis of whether the conduct of monetary policy has significantly changed with the switch from ERT to IT in developing countries, i.e. we investigate if the switch from ERT to IT represents a real switch in policy. We argue that the literature examining the issue for developing countries is basically descriptive. The available literature for the advanced economies usually suffers from the identification-strategy problem, the problem that the switch is pre-determined and largely ignores the possibility that switchers are self-selected into IT, i.e. the switch emerged endogenously. We construct a treatment group of all developing switchers from ERT to IT and a control group of comparable countries that, in the same period, continued to target the exchange rate. The economic model we use is a classical Taylor rule, augmented with the exchange rate, to capture its specific role for developing countries as small and open economies. The sample period is 1991:1-2009:12. Firstly, the analysis uses a panel switching regression whereby the switch is observable; we allow for all covariates in the regression to switch and address the possible switch endogeneity. Given that this approach cannot potentially capture episodes geared toward IT that were followed even before IT was officially introduced and/or explain how overall international monetary environment under both regimes changed, we employ another modelling approach, whereby the regime switching is an outcome of an unobservable random variable – the Markov-switching regression. The economic model is in a reduced-form VAR format for each of the nine countries-switchers, allowing the intercept, autoregressive terms and variance to switch between regimes.

The final chapter gives an overall summary of the main findings and conclusions, recommendations, limitations of the investigation and the modelling strategy and, based on that, offers some grounds for further research.

CHAPTER 1

Macroeconomic effects of fixed exchange rate

1.1. Introduction

The assessment of the macroeconomic implications of the exchange-rate regime continues to evoke heated debates and "remains perhaps one of the most important questions in international finance" (Levy-Yeyati and Sturzenegger, 2001, p.62). Consensus over exchange-rate regime effects on important macroeconomic variables has not yet been reached. There is no exchange-rate regime which is superior to the others in all respects: stabilizing prices and interest rates; easing short-term fluctuations and supporting long-term output growth and stability (Caramazza and Aziz, 1998). However, in a world of increased international capital mobility "the traditional trade-off [between fixed and flexible exchange-rate regime] has narrowed down to a price stability–growth dilemma" (Levy-Yeyati and Sturzenegger, 2001, p.63). To start investigating whether a country can rethink its exchange-rate and monetary policy, we start developing this thesis by observing how exchange-rate pegging potentially affects growth and volatility of output. The main objective of this chapter is to look at the first stage of the theoretical background, which is the macroeconomic effects of a fixed exchange rate with particular focus on the growth effects, and to review the empirical approaches used to study these effects. Also, the chapter clarifies the distinction between monetary- and exchange-rate regimes, as these are often not clearly distinguished in the literature.

The chapter is organized as follows. Section 1.2 reviews the different exchange-rate and monetary-policy regimes. Section 1.3 reviews the exchange-rate targeting literature, concentrating on the macroeconomic effects of the chosen exchange-rate regime. In particular, after defining ERT, this section reviews the channels and the empirical work of the effects of ERT on inflation and growth. Section 1.4 concludes.

1.2. Exchange-rate and monetary-policy regimes

In exploring the exchange-rate and monetary-policy regimes, defining price stability and the role of a nominal anchor is a good starting point. A consensus has been reached in recent years that price stability is the principal long-term goal of monetary policy. This, in turn, implies at least two things: i) operationalising a set of monetary instruments with which monetary policy will be implemented, and ii) anchoring inflation expectations in an appropriate manner for attaining the desirable stable prices. Whereas the first aspect is related to which central-bank techniques and prerequisites are used to conduct monetary policy, the second aspect is more oriented towards central-banking policymaking. In the light of the latter, the role of a nominal anchor and of a monetary-policy regime is of importance.

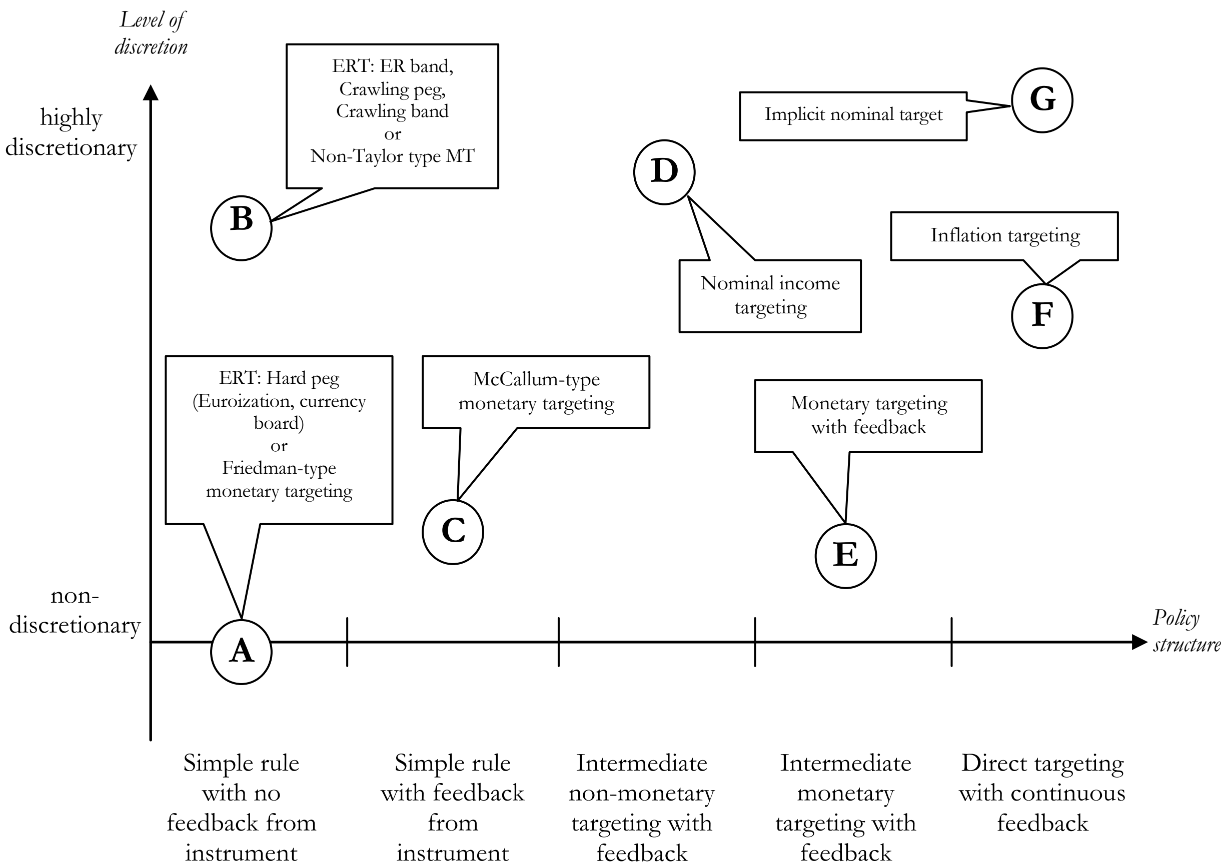
A *nominal anchor* is a variable or its forecast which is held under control in order to act as a constraint on the domestic money supply and hence to anchor inflation expectations (Mishkin, 1999). A nominal anchor is necessary to mitigate the time-inconsistency problem, whereby in a dynamic context monetary policymakers have different preferences, i.e. preferences that change over time. A nominal anchor will prevent overly expansionary monetary policy that aims at higher output and employment in the short run; without the anchor, economic agents accommodate their price and wage expectations and in the long run prices are higher but output is not. Kydland and Prescott (1977) and Calvo (1978) argued that pursuing short-run objectives without taking into account long-run outcomes leads to the time-inconsistency trap, because economic agents are rational as their actions "depend in part upon their expectations of future policy actions" (Kydland and Prescott, 1977, p.474). These future policy actions then affect current decisions, an issue that is addressed by the Lucas critique (Lucas, 1976). These issues are revisited later in the study.

A *monetary-policy regime*[2] refers to a framework in which monetary policy is conducted by specifying a clear definition of the ultimate goal, a nominal anchor and a set of operational measures and instruments to achieve the goal. Frederic Mishkin (1999, 2000b) classifies them into five basic types: exchange-rate targeting; inflation targeting; monetary-supply targeting; nominal-income targeting; and a monetary policy with an implicit nominal target. However, the literature also offers a more detailed

[2] The adjectives "monetary-policy" and "monetary" and the nouns "regime", "framework" and "strategy" will be used interchangeably, referring to the subject in this definition.

classification. For instance, Lindsey (1986) categorizes monetary strategies by looking at two characteristics: monetary-policy structure or systematic operating procedure (e.g. instruments used and type of feedback) and policy mode or the level of discretion exercised by the central bank. Figure 1.1 gives an illustration of the possible monetary regimes when these two dimensions are considered and will be further used in explaining the different regimes.

Figure 1.1. Monetary-policy regimes



Source: Adopted and supplemented by the author from Lindsey (1986)

Exchange-rate targeting (hereafter ERT) is a monetary regime whereby the nominal exchange rate serves as a nominal anchor of monetary policy; it is the intermediate target for achieving the final goal of price stability. In that respect, monetary policymakers target a level of the exchange rate (in the form of a currency board, irrevocable peg or exchange-rate band) or some growth rate of it (crawling peg or crawling band). Point A on Figure 1.1 indicates an irrevocable peg which could come in the form of a currency board or even giving up of the domestic currency and accepting a credible one (dollarization/euroization), hence reflecting a completely subordinated monetary policy (no discretion) and no feedback from other economic variables

(Masson *et al.* 1997). Using discretion in this context implies one-time devaluations of the central parity or a crawling rate/band, i.e. point B. All these cases fall within the broader category of exchange-rate targeting and, as such, will be further analysed in this chapter.

Within an *inflation-targeting* regime (hereafter IT), the ultimate goal is targeted directly; more precisely, the medium-term inflation forecast serves as an intermediate target. Mishkin (2001) argues that this is an information-inclusive strategy, as it uses the entire available arsenal of the monetary policy to achieve the target, thus providing full instrument feedback. However, the central bank faces "restrained discretion", as missing the target invokes considerable economic and political costs (point F). Further analysis of inflation targeting follows in Chapter 4.

Within a *monetary-targeting* regime, the central bank announces a target for the domestic money supply, targeting either its level or (more naturally) its growth rate. Whereas the former is not present in practice, the latter, which became known as the Friedman rule, was adopted by many central banks in the 1970s. Monetary targeting enables the central bank to pursue an independent monetary policy by choosing the desired inflation rate and to possibly over output variances. However, fixing money growth at k-percent leaves no room for manoeuvre for the central bank, thus leading to point A; still in practice, these rules became flexible enough enabling k+x percentage accommodative function of the regime, as shown at point B (Masson *et al.* 1997). Further, point C refers to the so-called McCallum rule (McCallum, 1999) which derives its value from the Quantity Theory equation. This rule targets nominal income using the monetary base as its instrument whilst making an allowance for any on-going changes in money velocity. Finally, point E refers to the monetary-targeting frameworks usually observed in practice, i.e. those mainly pursued in the 1970s with the typical deviation from the pattern of the standard Taylor rule: it is a monetary regime whereby communication with the public is emphasized with a focus on long-run considerations and the control of inflation.

In general, the monetary-targeting strategy is coupled with relative transparency, as figures for monetary aggregates are typically published periodically with short lags (Mishkin, 1999). Money targets send immediate signals to the public and markets, enabling them to evaluate the stance of monetary policy and thus build it into their inflation expectations. In this manner, monetary targeting could be a solid monetary strategy for anchoring inflation expectations. Yet the latter will be the case only if a strong relationship between the targeted variable (the particular definition of money) and the ultimate goal of monetary policy (prices) exists. The literature offers considerable evidence (for instance, Estrela and Mishkin, 1997; Mishkin and Savastano, 2002) that over time this linkage became increasingly feeble. With a fragile link, this strategy is powerless to anchor inflation expectations, hence leading to poor inflation outcomes. This compromised the monetary-targeting role in the conduct of monetary policy and forced the majority of central banks to substantially deviate from the Friedman-type strategy and ultimately to abandon it. Moreover, a possible drawback of the strategy is the ability of central banks to actually control monetary aggregates.

Two other monetary strategies attract attention. One is the *nominal income targeting*, a strategy exemplified by considerably high discretion (point D), which implicitly entails central banks targeting real output and inflation at the same time. As this is difficult and frequently leads to conflicting policy responses, no country has so far adopted this approach. However, nominal income targeting avoids the problem of velocity shocks and the time-inconsistency problem and allows for a completely independent monetary policy (Mishkin and Posen, 1998). *Implicit nominal targeting* is short of an explicit target of monetary policy, but instead is based on a forward-looking and pre-emptive monetary-policy rule and uses a broad information-inclusive approach towards achieving the target. Mishkin (2004) evaluates this "just do it" strategy as sufficiently flexible, but lacking in transparency thus adding confusion to financial markets as to the central bank's future steps. Moreover, accountability within this framework remains arguably feeble, as no criteria for judgement are announced. The lack of an explicit nominal anchor can however be compensated with the credibility, skills and trustworthiness of the governor, hence providing the maximal discretion to the strategy, concurrently using some advantages of inflation targeting (point G).

In summary, monetary targeting proved problematic in anchoring inflation expectations as the link between money supply and inflation became increasingly feeble. Use of an implicit nominal target is argued to be associated with the credibility and trustworthiness of the central-bank governor, which is unattainable for economies with institutional weaknesses. The latter is usually a characteristic of developing and transition economies, which are the ultimate focus of the thesis (see Chapter 6). Thus, the theoretical debate reduces to the remaining two monetary frameworks. Therefore, this thesis thereafter focuses on these two strategies: exchange-rate targeting and inflation targeting.

Before concluding this section, it is useful to make the distinction between exchange-rate regimes and monetary-policy regimes. It follows from the categorisation in Figure 1.1 that ERT could come in a variety of forms: euroization, currency board, irrevocable peg, exchange-rate band, crawling peg or crawling band. Whereas ERT is a monetary-policy regime, all the latter types of exchange-rate targets are referred as exchange-rate regimes. However, the list of exchange-rate regimes goes beyond ERT - managed floats and free floats, which are usually exercised under the umbrella of another monetary-policy regime. These two exchange-rate regimes are freed of any exchange-rate anchor: managed floats come in a framework whereby the official reserves can be used for attaining exchange-rate stability; whereas within a freely floating framework the exchange rate is entirely market-driven. Table 1.1 illustrates these ideas.

Table 1.1. Monetary-policy regimes vs. exchange-rate regimes

Monetary-policy regimes *(in order of discretion: from the least to the most discretionary)*		**Exchange-rate regimes** *(in order of flexibility: from the least to the most flexible)*
Exchange rate targeting	→ *Define the form of exchange-rate targeting (choose the exchange-rate regime)*	**Hard pegs:** Euroization Currency board **Soft pegs:** Conventional peg Exchange rate band Crawling peg Crawling band
Money-supply targeting Inflation targeting Nominal income targeting Implicit nominal target	← *Define the nominal anchor (choose the monetary-policy regime)*	Managed float Free float

Source: Drafted by the author and based on IMF recommendations

In light of this discussion, a question arises how ERT differs from a fixed exchange rate. It follows from Figure 1.1 that the former is a broader concept than the latter. Namely, a country could announce an exchange-rate target, but still not commit to a fixed exchange rate, i.e. announce a wider or moving band around the target. It is important to acknowledge that throughout this thesis, we will treat exchange-rate targeting as announcing a target for the exchange rate within very narrow defined bands, usually of up to ±2%, because this is the way in which it has been used in the countries that are the ultimate concern of the thesis (see Table 6.1 in Chapter 6).

Defined in this manner, exchange-rate targeting is close to a fixed exchange rate. Moreover, it is useful, at this point, to accentuate the differentiation between de-jure and de-facto exchange-rate regimes, i.e. between what authorities assert to be an official exchange-rate strategy and what they actually do in practice (more on this in Section 3.2.4). Namely, a country can announce that the exchange rate will be determined by the market forces solely, but in reality it will heavily intervene on the foreign-exchange market to maintain a chosen parity or to stick to some (narrow) bands. Hence, the de-jure exchange-rate regime is managed floating, but the de-facto one is conventional peg or exchange-rate band. However, note that the reason for pegging might matter in this respect: countries with high inflation might be more dedicated to tightly maintain a chosen parity, even though they declare a different exchange-rate peg regime. A parity defense occurs by a heavy intervention in the foreign exchange market. When just the stable nominal rate and the volatile reserves are considered, then taking the criteria of Levy-Yeyati and Sturzenegger (2005), the de-facto regime will be considered a peg (refer to p.101 for details of their classification). However, when pegging is made for competitiveness purposes, then pressure on the exchange rate will likely result in one or a series of parity changes. Hence, the changing nominal rate and the stable reserves result in a de-facto regime distinct from a peg, despite that the country declares an official peg. As we will see in Section 3.2.4, in this thesis, we argue in favour of and use a de-facto classification of the exchange-rate regimes, since using the de-jure one might blur the real picture.

The next section introduces the economics of fixed exchange rates. Later on, in Section 3.2.4, we will introduce the de-facto exchange-rate regimes and there the primary interest will be in the first category - the narrow ERT. Given this discussion, part one of the thesis (Chapters 1-3) entirely deals with exchange-rate targeting: explanation; macroeconomic effects in theory; empirical evidence and analysis of its effect on growth and output volatility. Part two (Chapters 4 and 5) explains the necessity for a new nominal anchor once ERT is abandoned; then explores inflation targeting as a strategy that might arguably provide better monetary-policy outcomes. Part three (Chapter 6) empirically analyses monetary-policy conduct when the regime switches from ERT to IT for a set of developing/transition economies.

1.3. Economics of fixed exchange rates

1.3.1. The scope of exchange-rate targeting: definition

Exchange-rate targeting (hereafter ERT) is exemplified by a long history and a growing body of literature analyses this strategy in different contexts. It is a monetary strategy whereby the exchange rate is used as an intermediate target of monetary policy. In general, ERT could come in a variety of forms, which are depicted in Table 1.1, but its original definition relates to a fixed exchange rate and this is the viewpoint from which it is interesting in this thesis[3]. Hence, from the aspect of an exchange-rate regime, it refers to a fixed exchange rate, whereby the central bank stands ready to buy and sell the domestic currency in terms of a foreign currency at a predetermined rate (Obstfeld and Rogoff, 1995). By doing so, the central bank subordinates the entire monetary system to that of the anchoring country, i.e. no room for independent monetary policy exists. Thus the use of monetary policy for stabilization purposes is forgone. However, by putting monetary policy on autopilot, this regime directly mitigates the time-inconsistency problem discussed earlier; it prevents the use of expansionary monetary policy that will result in real short-run gains, but will impair nominal long-run outcomes (Mishkin, 1999). For a small, open economy, the exchange rate serves as an important economic indicator and there is considerable evidence that it is the core transmission channel of monetary policy (for instance, Flamini, 2007). Within such an environment, targeting the nominal exchange rate would provide a reliable indicator of future price movements, given that in a small-open economy, import prices are a crucial determinant of the overall price level.

In order to analyse ERT, at an outset the price level is described as a weighted average of prices in the tradable and non-tradable sectors:

$$P_d = \alpha P_n + (1-\alpha) P_t \qquad (1.1)$$

According to Krueger (1997), the price of tradable goods can be expected to follow the time path of the exchange rate fairly closely, while that of the non-tradable sector depend on real wages:

$$P_t = eP_m; \qquad P_n = w_n - \pi \qquad (1.2)$$

[3] And, this implies that, at least in this thesis, exchange-rate targeting, pegging and fixing are synonyms and will be used interchangeably.

If (1.2) is substituted in (1.1), it yields:

$$P_d = \alpha(w_n - \pi) + (1-\alpha)eP_m \qquad (1.3)$$

In (1.1)–(1.3), P refers to the price level, subscripts *d, t, n* and *m* refer to the domestic, tradable and non-tradable sectors and the international price of imported goods, respectively; $w_n - \pi$ stands for the real wage (nominal wage minus inflation) in the non-tradable sector, e is the nominal exchange rate, and α the share. In a small, open economy $1-\alpha > \alpha$, i.e. the share of tradable sector is greater than the share of non-tradable sector. Since with ERT the exchange rate is held fixed and hence $\Delta e = 0$, the domestic price level is mainly determined by the foreign price level.

When the exchange rate is fixed, a negative external demand shock would have an amplified effect on domestic output and employment; the peg provides no vehicle for a short-run adjustment in relative prices, thus leading to deteriorating real outcomes in the economy. Within a financially integrated world, the impossible trinity rule (see, for instance, Mundell, 1961; Mohsin, 2003) implies that the domestic interest rate could not be set to compensate for the shock and to help the demand recover. Instead, inside a triangle of a peg, dependent monetary policy and capital mobility, the domestic nominal interest rate must equal the foreign one[4], which is another way of expressing the tied hands of monetary authorities. Hence, any attempt to expand money supply will invoke pressures on the foreign-exchange market from the demand side, by agents' supplying domestic money and demanding foreign currency at the promised rate (Obstfeld and Rogoff, 1995). Hence, the attempt to increase money supply will fail; under a fixed rate, the central bank exercises no control over domestic money supply; the latter is endogenous in the framework. Let us look at the money-demand function, whereby money demand ($\frac{M}{P}$) is a function of real income (Y) and the interest rate (r):

$$\frac{M}{P} = f(Y, r) \qquad (1.4)$$

By taking log-linear form, it follows (lower-case letters refer to logarithms):

$$m = p + \gamma_1 y - \gamma_2 r \qquad (1.5)$$

[4] Hypothetically, abstracting from the country risk.

Where γ_1 and γ_2 are parameters and the parameter on p is assumed to be unity. Following purchasing-power-parity theory, the following equations for the exchange rate (E) can be written:

$$E = \frac{P}{P_f} \tag{1.6}$$

$$e = p - p_f \tag{1.7}$$

Whereby, the subscript f refers to foreign (world) variable and the exchange rate is expressed as units of domestic per unit of foreign currency. From the earlier discussion, increased capital mobility implies the same domestic and foreign interest rates, i.e.:

$$r = r_f \tag{1.8}$$

If we express (1.5) by p and substitute in (1.7), we obtain:

$$e = m - \gamma_1 y + \gamma_2 r - p_f \tag{1.9}$$

Assuming an analogous pattern for the foreign money demand $p_f = m - \delta_1 y_f + \delta_2 r_f$, we obtain the determination of the exchange rate ($\delta_1 ; \delta_2$ referring to the parameters in the foreign money-demand function):

$$e = m - \gamma_1 y + \gamma_2 r - m_f + \delta_1 y_f - \delta_2 r_f$$

$$e = (m - m_f) - (\gamma_1 y - \delta_1 y_f) + (\gamma_2 r - \delta_2 r_f) \tag{1.10}$$

If the central bank fixes the exchange rate in (1.10), $\Delta e = 0$, it will have to face the limitation to changes in money supply and interest rates. The former is entirely subordinated to the money supply in the anchoring country, i.e. m can be changed only if m_f changes, given that the income and the interest-rate differentials stay constant. If the central bank pursues an expansionary monetary policy (expands m, without income being changed), at the predetermined exchange rate agents will supply domestic currency and demand a foreign one; official reserves, as a first-line defender of the peg, will decrease. In such a scenario, the peg is under pressure, which will cease either when interest rates increases sufficiently to balance (1.10) (so that $\Delta e = 0$)[5]; or when devaluation or a switch to more flexible option occurred (so that no longer $\Delta e = 0$ and/or reserves decreased).

Arguably, fiscal policy can be fully effective under a real shock (that would otherwise put the peg under pressure). For instance, rising import prices of some commodities or oil that threaten to convert into inflation and wage pressures, may be combated by fiscal policy before these pressures are transmitted to the foreign-exchange market (due to expectations of devaluation). Fiscal policy, in such conditions, might subsidize agriculture or reduce the tax burden on some products to reduce the inflationary effect. However, given that the focus of this thesis is on developing economies, two caveats apply here: i) such use of fiscal policy might be limited due to these countries' limited capacity to borrow on international markets and to raise taxes as well as due to their likely high levels of public indebtness; and ii) even when the peg is not under pressure, fiscal authorities in those countries might be reluctant to coordinate with the monetary-policy authority to support the business cycle, i.e to favour immediate gains. The latter would create a burden on monetary-policy conduct under a peg which, in the long run, will be likely to be more detrimental than under other exchange-rate strategies. Given these considerations, the thesis focuses on what can be done on the monetary-policy side, leaving the fiscal behaviour aside.

Getting back to the earlier discussion, despite ERT's limitation stemming from the surrender of monetary independence, it appeared to be a firm vehicle for curbing inflation, as the potentially damaging volatility implied by a float is forgone. This is especially the case for transition and developing economies, which have typically faced accelerating inflation rates. Moreover, the uncertainty imposed by exchange-rate flexibility is thought to be damaging for the real economy, reducing international trade and discouraging investment. However, at a theoretical level, it is hard to establish firm relationships because of the many channels through which the exchange rate affects the economy and is being affected by the other macroeconomic variables. These issues are analysed in the next two sections.

---

[5] Note that under such a nominal shock, in practice, the condition $r = r_f$ will no longer hold. The fact that the peg is under threat will imply that the domestic interest rate will embed a risk premium over the foreign interest rate.

1.3.2. Theoretical insights and empirical evidence on the effects of a fixed exchange rate on inflation

When the macroeconomic implications of the fixed exchange rate are discussed, nominal variables in the economy are first considered to be influenced, i.e. the peg's effect on inflation is expected to prevail. Mishkin (1999) articulates that by anchoring the domestic currency to a credible foreign currency prices of the internationally traded goods are fixed, hence directly contributing to lowering domestic inflation. In light of the exposition in Section 1.3.1, Xu (2004) and Levy-Yeyati and Sturzenegger (2001) argue that peg's effect on inflation is achieved through the domestic money-creation process which is determined by the same process in the anchoring country (equation [1.10]). That is why, "the typical association of fixed exchange rates with lower inflation rates is based primarily on the belief that a peg may play a role of a commitment mechanism for monetary authorities … and that the failure to comply with the commitment entails some political cost to the authorities" (Levy-Yeyati and Sturzenegger, 2001, p.6) and, hence, "the need to maintain fixed exchange-rate parity ensures that governments do not expand their money supplies at inflationary rates" (Xu, 2004, p.219). In that manner, a peg commits governments by denying negligent monetary behaviour (Rogoff *et al.* 2004). In addition to the money-creation limitation, inflationary expectations are reduced which, in turn, stabilizes money velocity and reduces interest rates. Also, in considerably euroized economies, a credible peg will reduce inflation inertia and lower the probability that devaluation could occur. This core effect of a fixed exchange rate is referred to as ensuring monetary discipline.

Closely related to monetary discipline is the concept of the credibility of monetary policy imposed by pegging to a hard foreign currency (Chang and Velasco, 2000). Credibility is important for anchoring inflation expectations (Tavlas, 2003) and works in the following way. Assume an economy without an exchange-rate anchor; if the labour market is not freed of frictions, then wage-setters will bargain for a higher wages, which are not optimal compared to the market-clearing wage within a frictionless labour market, thus resulting in lower output. However, the authorities desire the optimum output level and the central bank with such an implicit objective will increase inflation in a world of sticky nominal wages, once these have been set, in order to reduce real wages and increase output. However, this falls in the time-inconsistency trap – it sacrifices the long-run objective in favour of the short-run one. Hence, in turn, the central bank will have to promise a low inflationary environment, as it is conducive to growth in the long run and to anchor inflation expectations. But time-inconsistency might persist and the central bank might again pursue inflationary policy to boost output (Moreno, 2000). However, as discussed in the context of the Lucas critique on p.28, once agents understand the central-bank's game, they will build this behaviour into their expectations. Ultimately, higher inflationary expectations lead to higher ex-post inflation, with no corresponding output gains. The remedy for such a poor scenario is to anchor the exchange rate. In doing so, the central bank will help restoring lost credibility. Since the peg enhances non-inflationary monetary credibility, it will anchor inflation expectations, prevent inflation escalating and will aid its reduction. Moreover, the more firm the fix, the more successful it will be in providing credibility (Edwards and Magendzo, 2003). Canavan and Tommasi (1997) add that the credibility effect is deepened as that peg additionally provides greater transparency. Garofalo (2005) and Ghosh *et al.* (1997) add a confidence effect of the peg, which leads to an eagerness to hold the domestic currency, as a vehicle for reducing inflationary effects of a given monetary expansion.

The academic literature agrees that the main benefit from anchoring the exchange rate is reducing inflation and interest-rate variability. For instance, Ghosh *et al.* (1997); Moreno (2000) and Fisher *et al.* (1996) review the experience of transition and developing economies that became trapped in accelerating inflation and conclude that the exchange-rate anchor has been the core component of the disinflation packages that resulted in low and stable inflation. For instance, at the beginning of the 1990s, the Czech Republic, Hungary and Poland introduced stabilization programs whose core was the exchange-rate peg; Estonia and Lithuania established currency boards (Coricelli *et al.* 2006); Slovenia mainly targeted M3, but tightly managed the exchange rate; while Macedonia embarked on a de-facto[6] fixed exchange-rate regime after monetary targeting became unreliable as an anchor for inflation expectations. In all cases, inflation was immediately curbed following the introduction of the new regime.

In an attempt to reveal the extent to which an exchange-rate regime affects macroeconomic variables, empirical studies often employ a dummy variable in reduced form equations for inflation. The effect of the exchange-rate regime on the dependent variable is then measured by the estimated dummy coefficient. For instance Levy-Yeyati and Sturzenegger (2001) investigate a sample of 154 countries over the post-Breton-

[6] A discussion of de-facto versus de-jure regimes is offered in Chapter 3.

Woods era, engaging in cross country exchange-rate regime – inflation analysis. Their analysis is based on the de-facto behaviour of the exchange rate, whereas the identified pegs are distinguished between long (over five-year duration) and short pegs. This is consistent with Willett (1998) who argues that the distinction between permanent and temporary pegs matters in respect to disinflation and stabilization efforts, thus inducing an economic and political price to be paid for abandoning the peg. Levy-Yeyati and Sturzenegger (2001) model the exchange-rate target effect on inflation within a money-demand function and use panel-data estimation, whereby broad money, output, the nominal interest rate and money velocity are included as explanatory variables. Trade openness is added to control for the potential disciplinary effect of peg and lagged inflation is included to take into account the possibility of backward-looking indexation in the economy. Findings suggest a robust negative relation between pegs and low inflation, as well lower real interest rates under a peg. However, the former is for long pegs only and for non-industrial countries. Garofalo (2005) applied the same examination to Italy in the period 1861-1997 and found that under a hard peg Italian inflation was 2.9 percentage points lower that under a floating regime. However, it is argued in the empirical literature that not only could a credible peg impose a low inflationary environment, but that countries with greater price stability have better chances to implement sustainable pegs. Both Levy-Yeyati and Sturzenegger (2001) and Garofalo (2005) adjust for the possible endogeneity and the conclusions are maintained. However, a problem with such estimation might continue to exist if there is a correlation between the choice of the regime and the error term, and this is not investigated in these studies. Moreover, other regression coefficients do not change under regime change, which is not investigated in the studies and exposes them to the Lucas critique.

Given the problems associated with the above approaches, Domac *et al.* (2004a) analysed the relationship using a switching regression, by specifying separate regression for each regime. The variables employed are those in Levy-Yeyati and Sturzenegger (2001), along with the fiscal balance. Findings are in line with previous research: inflation is lower under more a rigid form of the exchange rate. However, by specifying separate regressions, the study again does not consider the possibility that the regime evolves endogenously. Furthermore the sample and period are small (22 countries and less than 10 years). Similarly, De Grauwe and Schnabl (2005) use a panel regression of 10 CEE countries to analyse how inflation and has been affected by the exchange-rate regime in the period 1994-2002. Findings conform to the negative link exchange-rate target – inflation for the 10 CEE countries, however only when the de-facto regime is considered.

In general, the theoretical insights, practical cases and empirical analyses suggest that the relationship between the fixed exchange rate and inflation is negative: the peg curbs inflation and maintains low inflation and interest-rate volatility. In particular, durable exchange-rate targeting ensures stable prices. Also, the conclusion is particularly robust for developing and transition economies, which lack monetary discipline and credibility of their central banking systems. Still, there are views that challenge this general conclusion. For instance, Tornell and Velasco (2000) take rather radical view that inflation reduced by pegging is only an illusion, since neither exchange-rate regime could stand in place of sound macroeconomic policies. Chang and Velasco (2000) state that the peg might restrict credit extension in the economy and produce harmful consequences for financial stability. Moreover, Edwards and Magendzo (2003) argue that, as the economy becomes increasingly dependent on international capital flows, "a larger fraction of the monetary aggregates needs to be backed to maintain the peg" (p.13). Increased capital mobility might expose the peg to intensified speculative attacks and ultimately lead to its demise. However, both Chang and Velasco's (2000) and Edwards and Magendzo's (2003) arguments refer to a period when the economy has achieved substantial price stability and might have oriented towards growth objectives. This could be an issue to be concerned with and we revisit it in Chapter 2. Still, its consideration does not render invalid our conclusion that a peg reduces inflation.

1.3.3. Exports, investment and productivity: Does having a fixed exchange rate matter for growth?

A narrow part of the academic literature (Domac *et al.* 2004b; Levy-Yeyati and Sturzenegger, 2002; Moreno, 2000; 2001; Edwards and Levy-Yeyati, 2005; Husain *et al.* 2005; De Grauwe and Schnabl, 2005; Eichengreen and Leblang, 2003; Bailliu *et al.* 2003) investigates the exchange-rate regime's effect on economic growth. However, investigation of the relation between peg and growth has evoked considerably less research than the material presented in the previous section, "probably due to the fact that nominal variables are typically considered to be unrelated to longer-term growth performance" (Levy-Yeyati and Sturzenegger, 2002, p.2). In that vein, Goldstein (2002) argues that the natural-rate hypothesis implies that the best that macroeconomic policy can hope to achieve is price stability in the medium-term. The nominal exchange rate can not be used to keep the unemployment rate away from its natural level on a sustained basis. An attempt to over-stimulate the economy, by expansionary monetary policy or currency devaluation will result in a higher rate of inflation, but no increase in real economic growth (Barro and Gordon, 1983). Hence, as a nominal variable, the exchange rate (regime) might not affect long-run growth. There is no unambiguous theoretical evidence on the impact of the exchange-rate regime on growth. Economic theory does not noticeably articulate if and how the exchange-rate regime might affect growth. Instead, arguments typically focus on its effect on investment and foreign trade, but still remain ambiguous in terms of the direction of influence. At least, some studies (Levy-Yeyati and Sturzenegger, 2002) agree that a relationship between the exchange-rate regime and economic growth exists, but argue that the sign of the influence is unclear.

De Grauwe and Schnabl (2005) argue that there will be higher output growth under a peg because of two factors. First, the exchange-rate risk is eliminated and this stimulates foreign trade and international division of labour. Also, fixing the exchange rate may enable faster growth in the medium and long run by supporting greater openness to international trade, as traders will not need to account for exchange-rate risk. In turn, openness may ease technology transfer, thus aiding the productivity growth, and supporting the overall economic growth (Moreno, 2001). Second, according to De Grauwe and Schnabl (2005), a credible fix promotes certainty, thus lowering the country-risk premium embedded in the interest rate. Lower interest rates in turn stimulate consumption, investment and growth. Macroeconomic certainty imposed by pegging promotes foreign trade, thus "stimulating economic efficiency and growth over the long haul and restraining inflation, which is also good for growth" (Gylfason, 2000, p.176).

Nilsson and Nilsson (2000) particularly explore the effect of the exchange-rate regime on exports for developing countries. They argue that for these countries, export-led growth is the *spiritus movens* for overall development, on the one hand, while on the other, developing-countriy exporters are severely affected by the more frequent exchange-rate misalignments and volatility under flexible rates, which, in turn might harmfully impinge on their market power and thus motivate them to reduce export quality. Brada and Mendez (1988) further deepen this hypothesis. They argue that flexible rates depress the volume of international trade in two ways: either through the exchange-rate uncertainty for conducting foreign trade, or throughout the erection of trade barriers as countries react to the increased exchange-rate volatility. Likewise, Domac *et al.* (2004b) point out that, because of the uncertainty imposed, a floating regime may hamper international trade. Moreover, advocates of pegs blame floats for throwing bewilderment at the international market as to the exporters' competitiveness (Grubel, 2000), consequently promoting resource misallocation (Gylfason, 2000) and in that manner harming growth. However, the same papers emphasize the efficiency of floats in correcting balance of payments disequilibria as their advantage, which in turn will enable internal macro-stability to be achieved quicker.

The preceding notions are related to the exchange-rate risk which stems from allowing the rate to float. This risk is restrained with an exchange-rate target, completely with a currency board or irrevocable peg or considerably with an exchange-rate band or crawling peg/band. Then the relation between an exchange-rate target and trade could be straightforward: a stable macroeconomic environment promotes bilateral trade. Contrary to this, however, Viaene and de Vries (1992) argue that such a straightforward assumption of a negative link between uncertainty and trade may not be appropriate, because agents might amplify their incentives to trade more under intensified exchange-rate fluctuations, depending on their risk aversion. Dellas and Zilberfarb (1995) found a significant positive link between exchange-rate variability and trade growth; they also emphasised that (exporters') risk-aversion matters. Namely, a low level of risk aversion could imply a positive effect; yet, a developed forward market could be helpful and serve as shock absorber by supplying a variety of hedging instruments. If, when risk aversion is not low, exporters are provided with an efficient vehicle for hedging exchange-rate risk such as forward markets, increased exchange-rate volatility could ultimately have no effect (Bailliu *et al.* 2003). However, such instruments are unavailable in developing markets. Hence, the relationahip between the exchange-rate volatility and trade is highly conditional, including on the hedging opportunities, as the meta-regression analysis of Ćorić and Pugh (2010) suggests.

In line with what has been said for the relationship between exchange-rate regime and trade, Bohm and Funke (2001) suggest that the channel through which the exchange-rate regime influences investment is the level of uncertainty. When uncertainty is reduced, investment is increased and, therefore, new-jobs creation and output (Bohm and Funke, 2001). The effect of uncertainty connected to the exchange-rate regime is the concern of the study of Dixit (1989), which states that instability leads to disinvestment or puts off already planned investment. Krugman (1991) affirms the belief that exchange-rate volatility will "warm up" reasons for taking on "a 'wait and see' attitude towards both investment and trading decisions" (p.3). However, although the literature relates the exchange-rate regime to investment via uncertainty, it offers negligible evidence of this relationship, which could be ascribed to the decision to invest internationally, or to engage in the international capital flows, is dependent not only on the exchange-rate system and the perception of uncertainty, but on other, probably more real factors as well (Crowley and Lee, 2003).

Although the preceding arguments are plausible, Bailliu *et al.* (2003) argue that, despite the regime's indirect effect on growth through trade and investment, growth could also be achieved directly - through the regime's effect on shock adjustment. The exchange rate has the power of "dampening or amplifying the impact and adjustment to economic shocks" (p.385), suggesting that a flexible rate will enable fast and easy accommodation and absorption of aggregate economic shocks. Consequently, "when the adjustment to shocks is smoother, one would expect the growth to be higher, given that the economy is, on average, operating closer to capacity" (p.385). Given this role of the flexible rate, Friedman (1953) further explains that adjustment under a peg must be channelled through change of relative prices. But, in a world of Keynesian prices, adjustment is slow, thus creating an excessive burden in the economy and ultimately harming growth. Moreover, Section 1.3.1 suggest that under perfect (or at least high) capital mobility, interest-rate changes produce high costs for the economy, in attempts to defend a peg when the currency is under attack. Given this, the strengthened capital mobility in modern times will make pegs unsustainable, leading to severe recessions in times of negative external shocks, which pegs will immediately transmit onto the real economy (Fisher, 2001). McKinnon and Schnabl (2004) illustrate that before the Asian crisis of 1997/98 exchange-rate stability against the US dollar contributed to low inflation and a sound fiscal position. The resulting stable expectations then promoted investment and boosted long-term growth, which became known as the East Asian miracle. But the miracle came to an end because it was inefficient in absorbing shocks!

The general conclusion to the above is that the lower the uncertainty gained by pegging the currency, the higher are trade and investment. However, there is a theoretical possibility (but limited amount of empirical evidence; see Ćorić and Pugh, 2010) that extremely risk averse traders will trade more when the exchange rate varies.

Moreover, the peg does not provide a buffer mechanism when external shock hits the economy. Still, there can be a second-line buffer - the level of development of the financial system. This is closely related to the peg's effect on productivity growth. Ghosh *et al.* (1997); Garofalo (2005); and Collins (1996) all deal with the relationship between the peg and (productivity) growth. The first paper argues that a peg enhances investment, but a float might produce faster productivity growth. Reverting to the production function and specifically to the Solow growth model, output growth could be promoted if one or both of the production factors (labour and capital) or the total factor productivity, or all three, increase. Therefore, if there is considerable evidence that an exchange-rate peg promotes investment, then the lower growth under a peg that some studies establish has to be associated with slower productivity growth. We consider this channel next.

A peg's impact on productivity growth is especially emphasised in emerging markets, where credit markets appear to be thin. The ultimate effect of the peg on economic growth, channelled through productivity growth, nevertheless remains unclear. For instance, Aghion *et al.* (2009) argue that an aggregate negative external shock under a peg transmits into real activity and causes a higher share of firms in the economy to experience credit constraints, given the under-developed financial market. Suppose that producers can decide whether to invest in short-run capital or in a long-term productivity-enhancing venture. Typically, the long-term productivity-enhancing investment creates a higher need for liquidity in order to face medium-term idiosyncratic liquidity shocks, the latter mainly stemming from an aggregate shock that hits the economy. With perfect credit markets, the necessary liquidity is always supplied, but this is no longer the case when credit markets are imperfect. The liquidity shock is only financed when the firm has enough profits, because only profitable firms can borrow enough to cover their liquidity costs. A negative aggregate shock, by making all firms less profitable, makes it less likely that the liquidity needs of any of them will be met. As a result, a fraction of the potentially productivity-enhancing long-term investments will go to waste, with apparent consequences for growth. A main implication is that firms in countries with better financial markets will deal better with an aggregate shock and therefore will tend to go more for long-term investments, which in turn should generate higher aggregate growth; while the shock in developing markets will result in the distorting of real activity and lower productivity growth. Given this exposition, although the literature seems consensual on this channel, still it remained little explored both theoretically and empirically.

In conclusion: there are some theoretical channels through which the exchange-rate regime might affect growth: i) uncertainty imposed on the economy and its effect on investment and trade; ii) the shock-adjustment mechanism and the level of financial development; and iii) the interaction of credit-market development with productivity growth. However, the directions in which the regime may impinge on productivity, investment, trade and thus, on output growth are still ambiguous. Hence, the relationship between the exchange-rate regime and growth becomes an empirical issue and is further debated in the next section, while empirically investigated in Chapter 3.

1.3.4. A review of the empirical evidence on exchange-rate-regime effects on growth

Since economic theory does not reveal clear foundations for the relationship between the exchange-rate regime and economic growth, the issue becomes empirical. However, the few published empirical studies give differing results. These are summarized in Table 1.2 at the end of this section and are reviewed as this section proceeds. The methodological approach of the studies is the criterion according to which these are examined in this section.

Two classic papers, Baxter and Stockman (1989) and Mundell (1995) compare growth between two periods: the period of the fixed exchange-rate system and the one under the generalized floating in the US and four other regions. The first study concluded that exchange-rate arrangements have little effect on key macroeconomic variables. The second found that the period of fixed rates achieved better performance in all respects, including real growth. However, these simple comparisons do not proceed with an econometric analysis to consider the independent effect of the factors of concern. Ghosh *et al.* (1997) provide descriptive analysis (means and standard-deviation comparisons across regimes) of growth performance under alternative regimes in 145 countries for 30 years after 1960 and found slightly higher GDP growth under a float (1.7% under a float compared to 1.4% under a peg). The study concludes that as investment rates contributed two percentage points (p.p.) of GDP growth, then the lower growth under a peg must be a result of a negative productivity growth. Higher productivity growth under a float also supported trade growth. However, the evidence is not overwhelming. Surprisingly, growth appeared to be the highest (2%) under an intermediate regime (soft pegs or managed float). Switching to a floating regime resulted to improved growth by 1 p.p. in three years. However, the study does not provide evidence on whether these results are statistically different from each other. Contrary to these findings, Moreno (2000; 2001) also using descriptive statistics, measured how regime (actual behaviour) affected GDP growth and volatility in two samples: 98 developing countries and East-Asian countries, respectively, over the period 1974-1999. His work supports the view that real growth was higher under a peg by 1.1 p.p. and 3 p.p., respectively. The difference is robust to excluding the periods of currency crises preceded by a peg and excluding the top 1% high-inflation episodes. However, Moreno accounts for the so-called survivor bias (he excludes sharp devaluation episodes which could be attributed to policies adopted while pegging) and finds that the growth difference between regimes significantly narrows. Both studies do not provide sufficient evidence that growth is an independent effect of the exchange-rate regime; in addition, as the growth of investment and output are opposite under certain regimes, the studies prescribe the result to productivity, which is the residual. However, there are no figures to confirm this.

In the article mentioned in Section 1.3.3, Levy-Yeyati and Sturzenegger (2002) examined the issue with a sample of 183 countries in the post-Breton-Woods era (1974-2000), using a pooled regression. The study presents a minimal growth framework necessary to examine the exchange-rate-regime effect on growth, and consistent with both the neoclassical and endogenous growth models; state variables included account for initial conditions and belong to the neoclassical framework; control variables capture differences in steady-state levels across countries and belong to the endogenous-growth model. The specification can be used to explain either what determines differences in transitional growth rates across countries as they converge to their respective steady states (consistent with a neoclassical framework), or what determines differences in steady-state growth rates across countries (consistent with an endogenous-growth framework). We will return to the growth framework in Chapter 3. Levy-Yeyati and Sturzenegger (2002) used the variables listed in Table 1.2; population variable controls for the size of the economy, as the choice of exchange-rate regime is expected to be related to size. Specifically, the study tests the effect of hard pegs, explaining that conventional pegs (which might exhibit flexibility to a limited extent) may fall short of credibility and thus making the strong commitment under hard pegs necessary. Findings for developing countries are that a peg is likely to be associated with slower growth; however, the conclusion does not hold for industrial countries. Edwards and Levy-Yeyati (2005); Husain *et al.* (2005) and Garofalo (2005) use the same growth specification as in Levy-Yeyati and Sturzenegger (2002) to investigate the same issue. The first study investigated the period 1973-2000 over a 183-country sample and using de-facto classification. It found that countries with fixed exchange-rate regimes have had a lower growth rate, ranging between 0.66 and 0.85 p.p. per year, than compared with a flexible regime. The second study investigated the period 1970-1999 over a 158-country sample using de-jure exchange-rate regimes and, differently, found that pegs do not harm growth nor flexible rates support growth. The hypothesis that exchange-rate regime affects growth is investigated by Garofalo (2005) for the case of Italy, over the period 1861-1998. The study used OLS and the results indicate, differently from the preceding two studies discussed, that Italy experienced the highest growth rates under some form of intermediate regime.

Because of possible simultaneity between growth performance and the exchange-rate regime, Levy-Yeyati and Sturzenegger (2002) and Garofalo (2005) use an IV estimator. As an instrument, they use the predicted value of the exchange-rate dummy from a logit model, whereby a country's economic size, land area, island dummy, level of reserves and a regional exchange-rate dummy are used as regressors. However, no discussion about instruments' strength is offered. Yet, the authors point out that endogeneity, if present, might be weaker for growth than for inflation (discussed in Section 1.3.2) with respect to exchange-rate regime, due to the general inconclusiveness of the channels through which exchange-rate regime might influence growth. The findings support the initial findings in both studies, suggesting that the relationship is robust to estimation allowing for potential endogeneity. The other two studies, although aware of the issue, do not allow for endogeneity in their empirical work.

Dubas *et al.* (2005) regress per capita growth on a set of control variables (listed in Table 1.2) and a set of exchange-rate dummies for 180 countries in the period 1960-2002. The study utilizes random-effects panel estimation. Contrary to the studies previously discussed, this study finds that the highest growth rates are associated with de-facto fixers, which experience, on average, 1% faster growth than de-facto floaters. However, the conclusion is statistically significant for the non-industrial countries only. The conclusion is robust to when exchange-rate dummies are replaced with an indicator for exchange-rate stability. However, the study does not report the coefficients on the control variables, which is important for considering if the growth model specified is suitable for such analysis. Still, the study makes a pioneering approach to the issue if the distinction between de-jure and de-facto exchange-rate regime matters for growth. The evidence that such a distinction matters for industrialized countries is scarce, but, expectedly, some important insights for non-industrial economies are found: countries that de-jure float, but de-facto peg are estimated to grow at 1.12% above countries that de-facto and de-jure float; countries that de-jure and de-facto peg are estimated to grow at 0.64% above countries that de-facto and de-jure float. Hence, countries displaying "fear of floating" (as introduced in Section 2.2), experience significantly higher growth. However, the study does not analyse the possibility that these results can be assigned to factors other than the exchange-rate regime. Namely, the sample might be biased towards countries that have experienced currency crises, which would have led to severe economic outcomes. The latter in turn, blurs the relationship between the regime and growth. Apparently, the study does not treat the potential endogeneity bias (not only of the exchange-rate dummy, but of the other regressors as well).

Huang and Malhotra (2005) examine the relationship between the exchange-rate regime and growth by paying attention to two aspects: exchange-rate-regime classification and differentiation between developing and developed economies. They augment the earlier approaches by considering the classification issue and achieve a firm de-facto classification of exchange-rate regimes. In addition, the differentiation of the level of development should help in considering if financially underdeveloped economies need a credible anchor, compared to developed economies. The study uses 12 developing Asian countries and 18 advanced European economies over the period 1976-2001. No special cautions are considered when constructing the sample. It utilizes descriptive statistics and regression variables as presented in Table 1.2; however, some of the arguably minimally-needed variables for a credible model are missing, which might lead to omitted-variables bias and, hence, giving endogeneity bias, because these variables could also be associated with the exchange-rate dummy (like inflation, population and the political indicator). Findings suggest that the exchange-rate regime matters for developing economies: fixed and managed floating regimes outperform the others in terms of growth. However, for advanced economies, no significant regularity is discovered. Similarly, Bleaney and Francisco (2007) pay attention to the regime classification. They utilize a de-facto classification, including 91 developing countries over the period 1984-2001. They regress the growth rate on its lagged value, exchange-rate dummies and time dummies and exclude high inflation periods. However, they do not estimate with a dynamic estimator, but with a standard OLS, although estimation in the presence of a lagged dependent variable using standard panel estimators yields biased estimates. Contrary to Huang and Malhotra (2005), their findings suggest that pegs are associated with significantly slower growth than soft pegs or floats. However, no theory-consistent growth framework is applied; endogeneity is not considered; robustness checks are not offered. It could be argued that this study cannot "see the forest for the trees": it pays to much attention on the classification schemes and too little to other important issues.

A different approach that opts to address the problems that undermine the robustness of the previous findings is carried out by Domac *et al.* (2004b). At the outset, they emphasise that the regime's effect on growth can not be independently revealed if macroeconomic fundamentals and institutional arrangements are not considered (the standard regressors in a growth model). Also, the study criticises the previously mentioned studies (and essentially all studies published on the topic) for their failure to capture the change in regression parameters when exchange-rate regime switches and hence to address the Lucas critique. In addition, as the sample-selection problem is not addressed in these earlier studies (since the choice of the exchange-rate regime depends on macro-fundamentals and is not random), Domac *et al.* (2004b) argue that the error term in a standard equation would be correlated with the regime choice and thus parameters would be biased. However, their findings are inconclusive. The study analyses the relationship between exchange-rate regime and growth with a switching regression. Based on the empirical results, it concludes that there is no particular exchange-rate regime that is superior to another in terms of growth performance. Although the technique seems superior over other techniques, some caution in interpreting the results is needed: the study uses a de-jure classification, a short time period (less than 10 years for the majority of countries in the 1990s) and 22 transition countries.

De Grauwe and Schnabl (2005) carried out a growth-model investigation of 10 CEE countries for the period 1994-2002. To the standard set of variables explaining growth (which, however, lack the initial condition; see Table 1.2), they added a measure of exchange-rate stability. The study takes account of the endogeneity issue by utilizing the GMM technique; GMM uses a full set of valid lags of all endogenous and exogenous variables as instruments. This technique is superior to that used in Domac *et al.*'s (2004b) as it may create more effective instruments. Without attempting an exhaustive explanation of the results, this study suggests that exchange-rate pegging promotes growth in the CEE countries, the results being more significant than from studies that use all-country samples. A similar approach using a dynamic model is applied by Eichengreen and Leblang (2003), who investigated the issue on a sample of 21 countries over the period 1880-1997. The dynamic panel estimator contains internal instruments to eliminate bias arising from possible endogeneity of the independent variables. The independent variables used are given in Table 1.2; averages over 5-year period are used; however, some of the standard-growth-regression variables are still missing. The study advances the issue of the inclusion of the economy in the global capital markets, approximating it by a dummy variable for capital controls. However, the study is problematic in another way: it uses a long period within which the international monetary environment has been subject to considerable change: the effect of the generalized pegging under Bretton Woods and that of pegging today on growth might be different (due to capital restrictions, say). Also, the sample could be biased towards countries that use a flexible or floating rate but are developed because of other reasons. The overall finding is that pegged economies perform worse than compared to flexible-rate ones by 5.2 to 8.6 p.p. per annum in terms of growth. These findings, though, seem implausibly high.

Distinct from previous studies, Bailliu *et al.*'s (2003) research turns the focus from the exchange-rate regime to another important aspect of the story, that is, the monetary-policy framework applied along with the exchange-rate regime. They accentuate their belief that the exchange-rate anchor is a monetary anchor simultaneously, thus providing firm grounds for appropriate assessment of the link regime-growth. On the other hand, intermediate and floating regimes might be associated with weak monetary regimes, which will reflect upon the mentioned relationship. Explicitly, Bailliu *et al.* (2003) assessed the impact of regime on growth on a panel data set of 60 countries over period 1973-1998 using dynamic GMM and taking account of endogeneity, and the correlation between the unobserved country-specific effects and the explanatory variables. Variables included are those identified in the other studies; these are averaged over 5-year periods. The exchange-rate regime is averaged as well, and grouped into pegged, intermediate and floating regime, but then augmented with the monetary regime: pegged; intermediate without anchor; intermediate with anchor; floating without anchor; and floating with anchor. However, averaging the exchange-rate regime might hide valuable information about regime switches, hence blurring the ultimate objective and findings of the study. The study finds that if a regime is accompanied by a monetary policy anchor, it "exert[s] a positive influence on economic growth", regardless of its type (p.398). On the contrary, when there is no monetary anchor, a regime other than a peg reduces growth. At this point, though, the study is ambiguous since it does not explain how a non-pegging country can have a no-anchor policy. Even some of the implicit targeters (defined in this study as no-anchors) use several indicators for controlling inflation and thus might be more efficient in their endeavour.

The following table summarizes the studies above.

Table 1.2. Summary of the empirical research of the exchange-rate regime effect on growth

Study	Data and sample	ER classification	Model	Technique	Endogeneity	Result (Peg and Growth)	Other problems
Baxter and Stockman (1989)	1946-1984; 49 countries	Only sub-periods of general fixing and general floating considered	Descriptive analysis	Averages and standard deviations	-	NO EFFECT No systematic relationship between real aggregates and exchange rate system	Unconditional analysis
Mundell (1995)	1947-1993; US, Japan, Canada, EC, other Europe	Only sub-periods of general fixing and general floating considered	Descriptive analysis	Average growth rates between two sub-periods	-	POSITIVE Considerable higher growth under generalized pegging	Unconditional analysis
Ghosh et al. (1997)	1960-1990; 145 countries	De-jure supplemented by categorizing non-floating regimes by the frequency of the parity changes	Descriptive analysis	Means and standard deviations comparison across ERRs	-	INCONCLUSIVE Slightly higher growth under a exchange-rate floating regime; Growth the highest under soft peg or managed float	Unconditional analysis; no evidence of whether ERR affects productivity; causal relationships and the effect on productivity only assumed
Moreno (2000 and 2001)	1974-1999; 98 developing countries East-Asia	De-facto classification	Descriptive analysis	Means and standard deviations comparison across ERRs	-	POSITIVE Higher growth under a peg by 1,1 p.p. and 3 p.p. respectively in both studies. The difference	Unconditional analysis

	countries					narrows when survivor bias considered	
Levy-Yeyati and Sturzenegger (2002)	1974-2000; 183 countries	De-facto	Pooled regression; Real growth = f (inv/GDP; ToT; GC; political instability; initial per capita GDP; population; openness; secondary enrolment; regional dummies and exchange-rate dummies)	OLS	2SLS to correct for endogeneity; Logit model estimated and predicted values used as instruments	NEGATIVE NO RELATION Slower growth under a peg for developing countries; No association for developed countries	
Edwards and Levy-Yeyati (2005)	1974-2000; 183 countries	De-facto	Pooled regression; Real growth = f (inv/GDP; GC; political instability; initial per capita GDP; population; openness; secondary enrolment; regional dummies and exchange-rate dummies)	FGLS	Not treated	NEGATIVE Lower growth under fixed regime then compared to flexible	
Husain *et al.* (2005)	1970-1999; 158 countries	De-jure	Pooled regression; Real growth = f(investment ratio; trade openness; terms of trade growth; average years of schooling; tax ratio; government balance; initial income/US income; population growth; population size; exchange rate dummies)	Fixed effects panel	Lagged values of the exchange-rate dummy used as an instrument	INCONCLUSIVE Pegs do not harm growth, but flexible rates do not deliver growth rates	Weak robustness checks; Classification issues
Garofalo (2005)	1861-1998; Italy	De-facto	Simple regression; Real growth = f (inv/GDP; ToT; GC; political instability; initial per capita GDP; population; openness; secondary enrolment; regional dummies and exchange-rate dummies)	OLS	2SLS to correct for endogeneity; Logit model estimated and predicted values used as instruments	INCONCLUSIVE Highest growth under soft peg or managed float	Weak robustness checks
Dubas et al. (2005)	1960-2002; 180 countries	De-facto versus de-jure especially	Random-effects panel regression; Real per capita growth = f(initial year GDP; initial year population;	Random-effects estimation	Not treated	POSITIVE De-facto fixers, on average, have 1 p.p. higher	No robustness or diagnostics checking. Other

		considered	population growth; investment to GDP; secondary education attainment; a political indicator of civil liberties; trade openness; terms of trade; dummies for transitional economies; regional dummies for Latin America and Africa; time-specific dummies; exchange-rate dummies)			growth than de-facto floaters; de-jure floaters - de-facto fixers grow at 1,12% above de-facto and de-jure floaters. Conclusions significant for non-industrialized economies only.	variables not reported if in line with theory.
Huang and Malhotra (2005)	1976-2001; 12 developing and 18 developed countries	De-facto	Panel regression; Per capita growth = f(Financial crisis; Openness; Government consumption; Initial GDP; Fertility rate; Secondary school enrolment ratio; exchange-rate dummies)	OLS	Not treated	INCONCLUSIVE NO RELATION For developing economies, fixed and managed float outperform the others in terms of growth; for developed economies, no relationship revealed	Weak growth-framework; no robustness checks
Bleaney and Francisco (2007)	1984-2001; 91 developing countries	De-facto	Growth = f(growth[-1]; exchange-rate dummies; time dummies)	OLS	Not treated	NEGATIVE Growth is slower under more rigid exchange-rate regime	Very weak growth specification; no robustness checks
Domac et al. (2004b)	10 years (1990s, different period for each country); 22 transition countries	De-jure	Growth = f (budget balance, lagged liberalization index, inflation, years under communism, share of industry, urbanization, share of CMEA trade)	Switching regression technique	Address endogeneity "through the assumption of constant covariance between the error term in the structural equation and the normally distributed random variable whose	INCONCLUSIVE There is an association ERR-growth, but the strength is different for different ERRs	Weak growth specification. Small period and small sample; does not account for de-facto exchange-rate behaviour.

					realization determines the exchange rate regime".		
De Grauwe and Schnabl (2005)	1994-2002; 10 CEE countries	De-facto	Real growth = f(inv/GDP, export, fiscal balance/GDP, short-term capital flows/GDP, real growth of EU-15, ER dummy)	GLS	Not treated	POSITIVE ER peg does not reduce economic growth	Weak growth specification. Short time period and small sample
Eichengreen and Leblang (2003)	1880-1997; 21 countries	De-jure	Real per capita growth = f(Per capita income as a share of US income; primary and secondary enrolment rates; capital controls and exchange-rate dummy)	Dynamic GMM and IV estimators	The technique generates internal instruments, but they also run probit model of the exchange-rate dummy to obtain fitted values, which are then used as instruments.	NEGATIVE More flexible exchange rates associated with faster growth	Weak growth specification. De-jure classification and sample selection; weak robustness
Bailliu et al. (2003)	1973-1998; 60 countries	De-jure and de-facto, but the latter more important in terms of findings	Real per capita growth = f(initial growth; investment-to-GDP; secondary schooling; real government share of GDP; trade-to-GDP; M2-to-GDP; private sector credit-to-GDP; domestic credit-to-GDP; gross private capital flows-to-GDP; exchange-rate dummies)	Dynamic GMM	Internal lags generated by the technique itself.	POSITIVE ERR exercised by any monetary anchor positively affects growth; otherwise, ERR other then peg destructs growth	Weak on robustness check

This review of the studies suggests that whereas one group of studies found that a pegged exchange rate stimulates growth, while a flexible one does not, another group concluded the opposite holds. Moreover, a third group of studies came up with no effect or inconclusive results. This could be due to a measurement error in the exchange-rate regimes' classifications (Levy-Yeyati and Sturzenegger, 2002), divergences in measuring exchange-rate uncertainty (Du and Zhu, 2001) or sampling bias (Huang and Malhotra, 2005). A great part of the studies focuses on the parameter of the exchange-rate dummy, but do not appropriately control for other country characteristics nor fully apply an appropriate growth framework (Bleaney and Francisco, 2007). Also, the issue of endogeneity is not treated at all or inappropriate instruments are repeatedly used (Huang and Malhotra, 2005; Bleaney and Francisco, 2007) in many of the studies. Moreover, all the published studies on the topic, except one, do not address the Lucas critique at all. Very few studies pay attention to capital controls, an issue closely related to the exchange-rate regime and only one study puts the issue in the context of nominal anchors, but its approach remains unjustified. Du and Zhu (2001) add that results from many empirical studies differ among counties when the same method of examination is applied and even for the same country at different points of time.

1.4. Conclusion

This chapter considered the variety of monetary-policy regimes and their differentiation from exchange-rate regimes. It focused on ERT, whereby the exchange rate serves as a nominal anchor of monetary policy. Then, the literature on the macroeconomic effects of a fixed exchange rate was reviewed and assessed. In summary, there is strong empirical support that the exchange-rate regime matters for inflation but the empirical support is ambiguous as to whether it affects the growth performance of a country. At the theoretical level, there are at least three channels through which the exchange-rate regime might affect growth: i) uncertainty imposed in the economy and its potentially positive effect on investment and trade; ii) shock adjustment under flexible rates and its potentially positive effect on growth; and iii) the level of credit-market development and its potentially positive influence on productivity growth under fixed exchange rate. However, the overall effect of these three channels remain unresolved in the literature and require empirical investigation. The relatively few empirical studies on the issue diverge in terms of the period covered, exchange-rate regime classification, growth-regression used and the technique applied. Some studies use models and techniques which are highly questionable and it is perhaps not surprising that there are conflicting results (positive, negative or no evidence). Hence, the chapter concludes that the issue is not resolved in the empirical literature.

However, the evidence from the chapter, gives two lines of inquiry to take forward. First, the inconclusiveness as to how the exchange-rate regime might affect growth in theory and practice gives rise to the belief that the exchange rate, similarly to inflation, may not be important in affecting long-term output, but rather its short-run departure from the long-run trend. These issues are further analysed in Chapter 2. Second, the chapter sketched the background necessary to develop a new empirical investigation of whether and how the exchange-rate regime might affect growth. This is developed in Chapter 3.

CHAPTER 2

To fix or to float: Output volatility, vulnerability to shocks and peg-exit

2.1. Introduction

The previous chapter discussed how exchange-rate pegging introduces the inflation of the anchor country into the domestic economy. This effect has been supported in the theoretical and empirical literature. However, the peg's effect on growth remains inconclusive even at an empirical level. In addition, "[t]he linkages among the international financial system, a country's exchange-rate regime and its domestic real and financial sectors are quite complex and dynamic, challenging our simple models and conventional understanding." (Piragic and Jameson, 2005, p.1465). The assertion stems from the fact that global capital mobility increased in the last decade, the conclusion being particularly relevant for developing economies. This revives the older debate of fixed versus flexible exchange rates and, in particular, the unsustainability of an exchange-rate peg under increased inclusion of the economy in the international capital markets. This chapter looks at a second stage of the review of the theoretical and empirical literature, focusing on the relationship between a peg and output volatility and the exit from a peg.

The chapter is organized as follows. Section 2.2 revisits the older debate of fixed versus flexible exchange rates; Section 2.3 puts particular emphasis on output variability and vulnerability to crises under alternative exchange-rate regimes; and Section 2.4 further debates peg exits. The last section concludes the chapter.

2.2. Fixed versus flexible exchange rates – revisiting an older debate

An issue that has long triggered heated debates in academia not least in empirical research from the post-WWII period is how a country chooses its exchange-rate regime. Even today, "debates on the appropriate exchange-rate regime for a country are perennially lively" (Rogoff *et al.* 2004, p.2). Two prominent studies considerably added towards the latter conclusion: "The Mirage of Fixed Exchange

Rates" (Obstfeld and Rogoff, 1995) and "The Fear of Floating" (Calvo and Reinhart, 2002). The former highlights that fixed rates are not so fixed given "literally only a handful of countries in the world today have continuously maintained tightly fixed exchange rates against any currency for five years or more." (p.87). The latter argues that floaters do not really float, because they fear of the large exchange-rate fluctuations that might harm the economy. This section revisits the major ambiguities in light of the question "to fix or to float?".

Although far from consensus, a general assertion widely present in the exchange-rate-regime economics is that there is no regime uniformly superior over another; different countries have different exchange-rate regimes; even a single country may adopt different regimes with changes in macroeconomic fundamentals and the macroeconomic objectives to be attained. IMF discussions[7] in late 1999 on exchange-rate regimes came to the view that there is no simple prescription for the choice of a country's exchange-rate regime. Instead, macroeconomic fundamentals should be first considered along with the consistency of the exchange-rate regime with the underlying macroeconomic policies. Several studies (Section 1.3.2) noted and offered evidence for the early gains of a peg for inflation; other studies (Sections 1.3.3 and 1.3.4) opted to explain the exchange-rate-regime role for growth. Nevertheless, the two influential articles referred in the previous paragraph suggest that a de-jure exchange-rate regime is not necessarily long lasting and not necessarilty the same as a de-facto one and are further supported by empirical research that finds no role for the declared exchange-rate regime on macroeconomic outcomes (see Chapter 1; Mussa, 1986; Flood and Rose, 1995). In consequence, the science of international finance faces an issue which is complex at both the theoretical and empirical level.

A country that opts to peg its currency in order to impose credibility and to reduce inflation gives up its monetary policy. The policy "trilemma" suggests that after capital markets became increasingly integrated and obstacles to the free movement of capital dwindled, a country could peg its currency but then ties its monetary policy decisions to those of the anchoring country; or it lets the currency float to pursue a monetary policy directed towards domestic considerations. However, the latter may be a privilege of the large and stable economies, which usually serve as anchor countries. Cooper (1999) suggests that with a floating exchange rate, a complete freedom in capital

[7] Summarized by Mussa *et al.* (2000)

movements for a small, open economy which lacks a developed financial market, might be unsustainable. A large disturbance might hit the economy; for instance, capital flight because of changed investors' incentives or political instability. Without capital restrictions, this will cause exchange-rate volatility, which is immediately transmitted onto the domestic economy, causing nominal and real distortions. Therefore, the choice is narrowed down to a floating rate with some restrictions on capital movements and considerable monetary autonomy vis-à-vis a hard pegged rate without any restrictions but with subordinated monetary policy. Fisher (2001) articulates this as the "hollowing out" hypothesis: the strengthened financial integration, while being beneficial for international trade, portfolio diversification and risk sharing (Tavlas, 2003), leads to corner exchange-rate regimes and makes any intermediate regime weak. (We will return to the "hollowing out" hypothesis in Section 2.4). However, many economists would not agree. Eichengreen (1994) explains that within a financially integrated world, even contingent monetary-policy rules (like exchange-rate pegs) will be no longer viable, as they do not shield the economy from external disturbances. This returns intermediate regimes to fashion; the issue is returned to in Sections 2.3 and 2.4.

The preceding discussion implicitly suggests that shocks play an important role in deciding which regime to establish. Namely, apart from macroeconomic effects which an exchange-rate regime might entail, policymakers are also concerned with the ability of the country to respond to different disturbances. Cavalho (2005) and Chang and Velasco (2000) state that a country should opt to peg its currency if it is exposed to nominal shocks, i.e. disturbances affecting the LM curve in a standard ISLM model (changes in money supply, autonomous changes in money demand). For instance, assume that bondholders' preferences change because interest rate on bonds becomes increasingly volatile and thus the demand for money increases. A peg ties monetary policy decisions to those of the anchoring country and subordinates interest rates to the world rates. In other words, a peg will decrease the volatility of interest rates. On the other hand, if shocks hitting the economy are predominantly originating from the real economy (IS curve: changes in autonomous consumer expenditure, changes in investment spending, changes in terms-of-trade, and so on), then a floating rate is preferable in order to serve the function of disturbances absorber. For example, assume that the terms of trade deteriorate so that exports become more expensive on the foreign market. If the exchange rate is held fixed, such a shock will reduce exports and ultimately output if not compensated by increasing productivity or government subsidy measures. However, these steps could be undertaken once the effect of the shock is realized. If the rate is flexible, then the terms-of-trade change will result in a depreciation of the currency and output will not diminish. Thus, the exchange rate acts as a smoother of external disturbances. We will return to this point in Section 2.3.

Earlier approaches to the exchange-rate regime choice were related to the size of the economy: small economies are usually open and the fixed rate will serve them better, and vice versa. But, recent literature (see Poirson, 2001 as a good representative) goes further by grouping factors determining the choice into two broad categories: political factors; and "fear of floating". Advocating the former approach, Collins (1996) explains that political instability might influence the choice of an exchange-rate regime by suggesting a floating rate, because the choice to peg the currency imposes a greater political commitment to defend the peg with unpopular measures, like higher interest rates, which may depress economic activity. Also, under a floating regime, exchange-rate adjustments are less visible to economic agents, compared to official devaluations under a peg. Edwards (1996) agrees that politically unstable countries are not willing to tie their hands by pegging the exchange rate, and by that forgo the opportunity to inflate, in order to create an illusion of augmented economic activity (in the short-run, at least). On the other hand, Calvo and Reinhart (2002) introduced the "fear of floating" approach, according to which authorities fear that the float might hinder the economy, in the worst case leading to default on foreign debt and a crash of the exchange-rate system; and usually choose to peg their currency in the face of unhedged foreign-currency debt, which creates large exchange-rate exposure. Moreover, small, open economies may also have a particular "fear of floating" because of relatively high exchange-rate pass through into the domestic price level, as suggested by Velickovski and Pugh (forthcoming). Fixing the rate in such a case (implicitly or explicitly) will protect the economy from a massive switch from the domestic currency to the foreign one, thus impeding excessive exchange-rate volatility (Berg and Borezensztein, 2000). The latter occurs because a larger interest elasticity of domestic money demand in a euroized economy makes the exchange rate more sensitive to expected changes in money supply.

Returning to the discussion of capital integration and aggregate shocks, it is probable that international capital flows make external real shocks more likely (Obstfeld and Rogoff, 1995), suggesting that the flexible option of the exchange rate is a more desired alternative today. It is argued that, by hitting the pegged rate, in turn, foreign shocks augment the variance of output. These aspects are analyzed in Section 2.3; we will get back to the "fear of floating" and the implication it might have for our empirical work in Chapter 3.

2.3. Output volatility and vulnerability to shocks under different exchange-rate

2.3.1. Theory and survey of evidence on exchange-rate regimes and output volatility

The discussion in Chapter 1 highlighted that the core assertion of the Natural Rate Theory is that inflation cannot affect output in the long run. Once nominal wages are set, based on the anticipated inflation rate, the labour supply meets labour demand and the market is cleared. If the central bank eases monetary policy and inflation increases, the real wage decreases because the nominal one is fixed. Firms have incentives to increase labour demand, hence increasing employment and output. In other words, overly expansionary monetary policy which aims at higher employment might shift output from its potential level and create a short-run effect of a booming economy (see, for instance, Mankiw, 2006). At this point, incentives of policymakers and consumers differ: the former try to surprise the latter after they have announced zero inflation. However, this behaviour of the central bank undermines its credibility: workers become rational instead of adaptive in their expectations, as Kydland and Prescott (1977) explained, and anticipate this "inflation bias". The game of the central bank is quickly understood by economic agents; they do not believe the central bank when it announces zero-inflation targets and increase their nominal-wage demands. On balance, in the long run, output gets back to its trend level but prices have increased. Hence, monetary policy cannot steer long-run output. Likewise, Levy-Yeyati and Sturzenegger (2001) state that the longer-term real performance of the economy is believed to be unaffected by the nominal exchange rate, similar to inflation. However, the theoretical survey of the literature in Section 1.3.3 and empirical studies of the exchange-rate regime effects on growth in Section 1.3.4 have demonstrated that the relationship between them, even if it exists, remains unclear. These views implicitly might suggest that the nominal exchange rate is not crucial for affecting output growth, but rather for responding to departures of output from its long-term level, i.e. for output volatility. However, the literature is not in agreement on this issue. Writers have been unclear; for instance, Moreno (2001), in the theoretical section of his study explains how the peg, which imposes monetary and fiscal restraint, causes increased output volatility under a shock, but later in the study, he says that pegging helps policymakers' ability to respond to shocks and reduce output volatility, without explaining how and why. What is the true relationship hence remains unclear and again is an empirical question.

As we have seen in the previous section, a general observation in the literature is that the origin of the shock matters. Following our exposition in the previous section on these matters, now let us expand this argument further. If a monetary shock hits the economy (shifts the LM curve), then the volatile interest rates which increase money demand will spill over to other interest rates in the financial system. Consumers and firms will be deterred from borrowing/investing (binding credit constraints) when the rate is unfavourable and vice versa. But, as interest rates are volatile, the behaviour of economic agents (households and firms) will result in volatile output as well (Chang and Velasco, 2000). Given this, as the peg provides macroeconomic stability, it stabilizes output volatility caused by domestic nominal disturbances. However, the peg will not insulate the economy from a shock hitting money demand in the anchoring economy. In this case, quite the contrary, the volatility of the foreign interest rates will be directly transmitted to the domestic economy.

Contrary to this, if the shock is rooted in the real economy (affects the IS curve) and if, in particular, the shock is coming from abroad, a floating rate will be desirable to smooth output fluctuations, as explained earlier. In the case of a negative real shock, depreciation will counteract the rise of the export prices and will increase import prices. If this was not the case, then output would have fallen further below its potential. Given frequent real disturbances, output volatility will be intensified under a peg. It is argued that increased capital mobility augments the exposure of economies to external shocks which are usually related to capital flight, conditional on changes in investors' incentives, domestic political factors or global considerations like oil shocks or even terrorism. Therefore, the view that a peg might be beneficial for trade and investment by imposing certainty in the economic environment, underscores the view that it might increase output volatility under aggregate shocks. In addition, Calvo (2001) warns that an exchange-rate peg attacked by capital flight or decline in exports must be defended by an increase of interest rates, which is further harmful for short-run output.

Another group of studies (McKenzie, 1999; Pugh *et al.* 1999), however, argues that floating rates, because of the exchange-rate volatility implied, spillover shocks onto output. Creedy *et al.* (1994), Pentecost (1993), and De Grauwe (1996) support the view that exchange rates are unpredictable by demonstrating that nominal exchange-rate movements under a floating regime may be represented as lacking in any periodicity, and hence as chaotic. Therefore, exchange-rate movements cannot be anticipated and, hence, create uncertainty in the economic environment. Moreover, exchange-rate movements over a longer period are argued to be no less unpredictable and to persist for several years (Pugh and Tyrrall, 2001). Rogoff (1999) argues that such variability could be transmitted into real output and consumption volatility, but in developing countries only. If the financial market is sufficiently developed, hedging instruments could serve the function of absorbers of exogenous shock, an assumption which is, as yet, unrealistic for developing economies. However, since long-run exchange-rate variability is less subject to hedging (Cooper, 2000), the absorber function of hedging instruments is unlikely to be that powerful for developed economies too.

From this discussion, it follows that the way in which an exchange-rate regime affects output volatility is not as unclear as the effect on growth, but is likely to be dependent on the nature of the shocks. In general, there is a tendency to conclude that a peg transmits real external shocks into output volatility, although there are studies that argue that floating rates, since volatile, make output vary as well, particularly when the financial system is underdeveloped. Moreover, Moreno (2001) argues that in a world of sticky wages, a peg will limit the transmission of a real shock (say, a shock to productivity) onto output: the adjustment of the real wages and labour supply is delayed. Hence, again, this issue has to be observed at an empirical level; yet, the literature published on this is very limited; studies are summarized in Table 2.1 and reviewed next.

To begin with, two studies pursue a descriptive approach. Basu and Taylor (1989) compared the volatility of output, consumption, investment and the current account under four different exchange-rate-regime periods: the gold standard (1870-1914); the inter-war period (1919-1939); the Bretton-Woods period (1946-1971); and the period of generalized floating (1972-1998). They found that the volatility of these real-economy measures was the highest during the inter-war period: 50% higher compared to the gold standard. The Bretton-Woods era experienced similar volatility to that of the gold standard, but the lowest volatility has been found under generalized floating. These results are indicative, but they are unconditional on other measures of economic activity or economic shocks.

Moreno (2001) focuses on a sample of 98 developing countries over the period 1974-1998 and calculates the average percentage changes of inflation, output growth and volatility under a peg vis-à-vis floating regime. However, contrary to the initial expectations, output volatility was not found to be higher under a peg; rather, it did not differ between the pegging and floating countries in the sample. Although results are indicative and point to the belief that the exchange-rate regime might not be related to output in general, there are some drawbacks to the study. It does not distinquish whether the category of a peg encompasses only hard pegs or both hard and soft pegs; yet the latter distinction may make a difference in terms of output volatility. Moreover, the study does not encompass other factors that might have influenced output volatility and thus may create a spurious impression that the exchange-rate regime is powerful: among others, the possibility of capital controls being imposed and their strength. The study excludes developed countries because "their institutional characteristics may influence the interpretation of results" (Moreno, 2001, p.26). However, this sampling strategy creates two types of biasness: the first originating from the fact that developing countries are more prone to adopt a rigid form of the exchange rate (because are they usually small and open and without a developed financial market); the second that the sample might be biased towards countries that did not commonly experience exchange-rate crisis. The former might blur the difference between the effect of the peg and that of the float on output volatility, given the dominance of peggers in the sample; whereas the latter would militate against the clear analysis of regime effects on output volatility after currency crisis.

A few other studies have taken a deeper empirical approach. Levy-Yeyati and Sturzenegger (2001) empirically tested the relationship between the exchange-rate regime and output volatility on a 183-country sample over the period 1974-2000. The volatility of real growth is regressed on the volatility of investment to GDP, terms of trade and government consumption, and on measures of political instability, initial per capita GDP, population, openness, secondary enrolment, regional dummies and exchange-rate dummies, the last distinguishing among hard pegs, intermediate regimes and freely floating rates. Volatility is approximated by the rolling standard deviation. The study found that pegs are associated with greater output volatility in developing countries. The study refers to previous studies which might have confirmed the relationship, but these are not cited, while the available literature on the topic is very scarce (see: Moreno, 2001; Bleaney and Fielding, 2002). For advanced economies, however, the relationship was found to be the reverse. The authors themselves ultimately conclude that the evidence of how exchange-rate regime [might] influence output volatility is mixed and depends on the level of development of the economy. Coupled with the effects of financial integration, the conclusion might highlight the fact that developing economies are usually small and open markets and hence more vulnerable to external shocks.

Some criticisms of the approach of this study can be made. The study constructs the regression by reference to the literature, but does not state which literature. However, if the reference to the literature is the growth literature, then the question of whether determinants of long-run growth and output volatility are the same remains open. For instance, the Natural-Rate theory mentioned earlier suggests that monetary policy could affect the output gap, but not long-run growth. This study does not make this distinction. Moreover, the assumption that volatility in some of the production factors will be contemporaneously transmitted onto output appears too strong, which raises the question as to why authors do not explore the potential dynamics of the relationship.

The possible problems with this study are investigated in Edwards and Levy-Yeyati (2005), using the same sample and period, but through partial-equilibrium model Firstly, the study constructs a long-run growth equation, according to the growth literature (Barro and Sala-i-Martin, 1995) (refer to Table 1.2). to obtain the fitted growth values, g_j^*. These are then used in the following model, outlining output volatility, Δg_{tj}:

$$\Delta g_{tj} = \lambda(g_j^* - g_{t-1,j}) + \varphi v_{tj} + \gamma u_{tj} + \xi_{tj} \quad (2.1)$$

Whereby: g_j^* are the fitted growth values from the growth regression (as explained in Table 1.2); $g_{t-1,j}$ are the lagged actual growth values; λ refers to the speed of adjustment of the growth to its long-run level; v_{tj} represents a terms-of-trade shock as measured by the change in the terms of trade defined as the relative price of exports to imports; u_{tj} refers to other shocks, including political ones (civil unrest used as a proxy). φ is the parameter of interest which is assumed to be positive, since a positive terms-of-trade shock should amplify the economic activity and vice versa; γ is also assumed to be positive, since a political shouck would amplify output volatility; ξ_{tj} is i.i.d. random shock. More importantly, the study tests how the coefficient φ changes under alternative exchange-rate regimes, by interacting v_{tj} with different exchange-rate-regime dummies. It also specifies separate regressions for groups of countries according to their regime. De-facto classification is used. Feasible generalised least squares (FGLS) is used to estimate the partial adjustment model and indicative results are obtained.

The main finding is that under a peg, a 10% deterioration of terms of trade is associated, on average, with a contemporaneous decline in growth of 0.8 p.p. Under flexible rates, this figure is 0.43 p.p. When separate regressions are used, the same finding is obtained: the more rigid the exchange-rate system, the more amplified the effect of the shock on growth is. Finally, no crucial differences between shock implications are determined if countries are observed as developing versus advanced. The study of Edwards and Levy-Yeyati (2005) is among the very few studies in the exchange-rate literature that in a comprehensive and theory-consistent manner captures the effect of exchange-rate regime on output. Not only are the determinants of growth are considered, but mostly importantly, shocks are considered in an appropriate manner. However, the model might be augmented by other variables as a proxy for certain shocks and certainly include variables representing buffers. A possible critique of the study is the way in which output volatility is measured – double differencing of output – which has neither theoretical rationale, nor econometric support. This is returned to in Chapter 3.

Following the widely presented argument that a peg produces output variance, Bleaney and Fielding (2002) are also confident that a flexible exchange rate safeguards output stability and test the hypothesis on a sample of 80 developing countries. The standard deviation of the real growth in the period 1980-1989 is regressed on a measure of the volatility of the terms of trade, the agricultural share, country size and dummies for pegged or floating rate, single-currency or basket-currency peg and regional dummies. This study makes crucial advancements in comparison to the above-discussed ones: by including the standard deviation of the annual change of the terms of trade, the model approximates the variation in the size of the output shocks among countries. Moreover, proxies for the country size and its economic structure are included to account for the possibility of easier absorption of an external shock. They find that a peg is associated with greater output volatility, a conclusion which is particularly strong for CFA-franc-zone countries, but "the difference in output variance … relative to countries with floating exchange rates was less marked" (p.14). However, the study only makes a differentiation between pegs and pure floats and uses de-jure classification.

A similar model, but using a different estimation technique and sample is used by Bastourre and Carrera (2004) who regress the measure of output volatility on per capita GDP, the same variable squared, GDP growth, trade openness, inflation volatility, terms-of-trade volatility, investment volatility and an institutional index. The regression includes exchange-rate dummies which represent de-facto and de-jure regimes separately. The study concentrates on the importance of the measure of output volatility and it uses two measures: inter-annual output volatility (proxied by the volatility of the industrial production which is published monthly) and three-year rolling output volatility, both measured through the standard deviation of the output measure. The study incorporates a terms-of-trade measure with the similar purpose to the other mentioned studies: to capture the effect of real external shocks on output volatility. Similarly, inflation volatility should capture the effect of domestic nominal shocks on real volatility. Another interesting advance made by study is the inclusion of the institutional setting as its level of development is argued to be a stabilizer of the real volatility.

The study utilizes four estimation approaches: fixed-effects panel; random-effects panel; random-effects panel with institutions included; and dynamic GMM (though, no arguments are given in support of the dynamic specification). The study concludes that pegs give higher output volatility than intermediate regimes or floats, irrespective of the way in which the volatility is measured, exchange-rate regime classification used or the estimation technique. In all econometric specifications it is found that inflation and investment volatility are positively associated to output volatility; in addition, in the case of three-year rolling volatility, the terms-of-trade is also found to be positively associated with output volatility. The inclusion of an institution index led to the expected conclusion: better institutions reduce real volatility. In such a manner, the study presents a theory-consistent and comprehensive way of treating the relationship between the exchange-rate regime and output volatility. Results are robust across the four econometric specifications and the study appropriately includes the sources of possible shocks and treats their effect on output volatility. A possible criticism to the study is the usage of dynamic-GMM versus static estimators, because: i) these are two distinct models, and there needs to be a discussion of the economic grounds for a dynamic or non-dynamic specification; and ii) which variables are instrumented is an important issue, but the choice is not explained.

A general criticism to a part of the limited number of published studies on the topic is that they use the rolling-standard deviation as a measure of output volatility. However, as it will be argued in Chapter 3, constructed in this manner, the measure adds persistence to the series which, if not accounted for in the estimation process, might lead to spurious results. This is especially the case for studies where the time dimension of the data is considerable, which is the case for nearly all the reviewed studies. This concern, at this point, could be supported by comparing the estimates in Bastourre and Carrera (2004) based on intra-annual industrial volatility vis-à-vis those based on rolling standard deviation (reviewed on p.29) – those are completely different. Moreover, measuring volatility as a difference is arguably problematic, since: i) it will not distinguish it from growth rate; and ii) double differencing (as in Edwards and Levy-Yeyati, 2005) has neither theoretical rationale (as giving a growth of growth) nor econometric support (further differencing of already stationary variable).

The next table gives a summary of the above-presented studies:

Table 2.1. Summary of the empirical research of the exchange-rate regime effect on output volatility

Study	Data and sample	ER classification	Model	Technique	Result (Peg and Output volatility)	Problems
Basu and Taylor (1989)	Four sub-samples during 1870-1998	Only general exchange-rate regimes considered	Descriptive analysis	Standard deviation of the included variables	POSITIVE Volatility has been the lowest under the generalized floating (1972-1998)	Unconditional analysis
Moreno (2001)	98 developing economies; 1974-1998	De jure	Descriptive analysis	Average changes in output volatility under alternative regimes	INCONCLUSIVE Output volatility does not differ between pegging and floating economies	Unconditional analysis
Levy-Yeyati and Sturzenegger (2001)	183 countries; 1974-2000	De facto	Volatility of real per capita GDP = f(volatility of inv-to-GDP; volatility of ToT; volatility of gov't consumption; political instability; initial per capita GDP; population; openness; secondary enrolment; regional dummies; exchange-rate dummies)	OLS	POSITIVE Pegs associated with greater output volatility for developing economies. The opposite for advance economies	Estimation technique?
Edwards and Levy-Yeyati (2005)	183 countries; 1974-2000	De facto	Change of real per capita GDP = f(level of adjustment of the growth rate towards its long-run equilibrium [difference between the term stemming from the growth equation presented in Table 1.2. and the lagged actual growth]; terms of trade; civil unrest)	FGLS	POSITIVE 10% deterioration of terms of trade lead to decline in per-capita growth of 0.8 p.p.	
Bleaney and Fielding (2002)	80 developing countries; 1980-1989	De jure	Standard deviation of real output growth = f(terms-of-trade volatility; agriculture share; country size; regional dummies; exchange-rate dummies)	OLS	POSITIVE Peg associated with greater output volatility	Estimation technique? ERR classification
Bastourre and Carrera (2004)	45 countries for the regression including the industrial production; 153 countries for the regression including the output as dependent variables; 1974-2000	De facto and de jure	Standard deviation of real output growth = f(per capita GDP, the same variables squared, GDP growth, trade openness, inflation volatility, terms-of-trade volatility, investment volatility, an institutional index, exchange-rate dummies)	Fixed and random effects; dynamic GMM	POSITIVE The more rigid the exchange-rate regime, the higher the output volatility - de-facto peg increases output volatility by about 0.005 p.p. (intra-annual volatility) - de-facto peg increases output volatility by about 0.9 p.p. (rolling-standard deviation volatility) - similar results for the de-jure classification	Not giving preference among the three estimators

In summary, the review of the empirical studies often reveals a positive relationship between the rigidity of the exchange-rate regime and output volatility. Nevertheless, these results are not overwhelming, because of the very small number of studies and their diversity, mostly in terms of the empirical strategy applied. They estimate models with different definitions of the dependent variable and also important differences in the control variables used. Moreover, the technique of examination differs and checks for robustness are usually lacking. A very important aspect in all those studies is that they all consider a moderately-large time dimension in their studies, which gives rise to stationarity issues. In particular, it is known in econometrics that a rolling-standard deviation over an x-year span makes the series persistent (Maddala, 2005), i.e. makes them non-stationary. Moreover, over-differencing of time series can lead to moving average dynamics that are not taken account of by the estimators used. So as well as lacking economic rationale, this practice is also statistically dubious. Hence, further research is needed to address the drawbacks of the reviewed studies and, in particular, i) to capture the sources of shocks onto the exchange rate; and ii) to consider the problem of the persistent series.

2.3.2. Are pegs crises-prone?

Contrary to the studies surveyed in the previous section, Klein and Marion (1997) put their emphasis on the effect of a long-lasting peg on output volatility through the possibility that a currency crisis will occur. They argue that the duration of the peg determines the probability that a currency crisis will happen, which then could transmit into output volatility and a severe recession. A peg's sustainability is heavily dependent on the current-account balance, the stock of international reserves and on the rate of appreciation of the real exchange rate. The probability of devaluation or exit increases when the level of official reserves falls, the current-account deficit widens; the inflow of foreign direct investment (FDI) is relatively small compared to the inflow of hot money; the debt burden is high and rising; and when the real exchange rate appreciates to a level that threatens international competitiveness (i.e. the currency is over-valued; see: Frankel and Rose, 1996). Aizenman and Glick (2008) argue that a severe enough shock will ultimately lead to costly pressure on the foreign-exchange market and a speculative attack on the chosen parity, causing a run on the official reserves. Defending the chosen parity will require spending reserves or raising the domestic interest-rate, or both.

Subsequently, resisting a large shock, or small, but frequent shocks over a lengthy period of time, will make the cost of sustaining the peg rise above the cost of regime change, hence leading to a collapse of the regime: either devaluation is needed, which is only a temporary solution if shocks persist; or a switch to a more flexible regime, which is a longer-term option, given the possibility that flexible rates will act as an absorber. But, at the moment of pressure, in both cases, soaring interest rates will depress real activity, while the over-valued currency will depress net-exports, hence adversely affecting the output. Devaluation might partially compensate these unfavourable developments; however, the effect depends on the timeliness of the action. Moreover, delayed action might even produce bank run and a sizeable disruption of the overall economic activity.

Many papers opt to measure currency pressures/crises and these are summarized in Bubula and Ötker-Robe (2003)[8]. Nevertheless, two prominent papers particularly assess the proneness towards currency collapses under different exchange-rate regimes. IMF (1997) utilizes the period 1975-1996 and groups currency crises according to the prevailing exchange-rate regime in the period before the crisis and defines it as a sharp change in the exchange rate. Using de-jure classification, the study found that half of currency crashes occurred under a floating regime. Two criticisms on the study are: the first, recognized by the study itself, is the "fear of floating", which is not considered in the grouping, reflecting that the crisis could have happened because of using the exchange rate as a policy instrument while officially reporting a floating rate; the second, stemming from sample-selection bias, is that the study uses only episodes of sharp exchange-rate changes. The study of Bubula and Ötker-Robe (2003) tests whether currency crises have been more associated with pegged regimes and which types of pegs were more prone to crisis; an IMF-member sample is used during the period 1990-2001. Contrary to IMF (1997), Bubula and Ötker-Robe (2003) use the actual behaviour of the exchange rate and measure the crisis as sharp movements in both exchange rates and interest rates, so that, as we argued before, to also capture those attacks which were successfully resisted by authorities. Crisis is identified when the exchange-rate pressure index (as measured by the volume of official reserves spent

[8] The tabulation in the mentioned study is useful as guidelines for the variations for constructing the exchange rate pressure index. However, at this place, no critical assessment of those measurements will be offered, since the issues of measuring exchange rate pressures are beyond the scope of this thesis.

to defend the peg per month) exceeds its mean by three standard deviations. Simple statistical tests have been employed to test various hypotheses and these provided support for the bipolar view: crises proneness is lower under hard pegs and floating rates compared to intermediate regimes. The paper finds no difference in proneness to crisis across intermediate regimes, with the firm exception of conventional pegs, which appeared significantly more crisis-prone. Hence, what is of importance for this thesis is that pegged regimes as a whole have been more prone to crises compared to floating rates. This is particularly applicable to developing markets that are more integrated in the international financial market. Albeit these findings are expected, the simplicity of the statistical approach in the study could be contested along with the claim that other factors might lead to currency crises in addition to the exchange-rate regime itself, like the durability of the peg and its consistency with the other macroeconomic policies, contagion. At present, these are not included in the analysis.

Consequently, given our earlier discussion on the way in which different shocks might affect output volatility given the exchange-rate regime, it is likely that large attack on the peg leads to a sizable disruption of the economy, first and foremost reflected in output volatility and a considerable output loss (Aizenman and Glick, 2008; Frankel and Rose, 1996). Whereas there is evidence that "normal" aggregate shocks are transmitted onto real volatility both under fixed and flexible rates, severe shocks are a threat to the peg, as they inflict reserve losses, large interest-rate increases and ultimately a currency collapse. At that point, the effects on the real economy becomes increasingly distorting, leading to severe output decline. This suggests that more conservative pegs and pegs exposed to shocks over a longer period are likely to end with severe output losses (Aizenman and Glick, 2008). Still, although the evidence seems to suggest that exchange-rate pegs are more prone to crises, this issue has not reached consensus.

2.4. Peg exit towards greater exchange-rate flexibility – further discussion

2.4.1. Can pegs plant the seed of their own demise?

Given the arguments in Section 2.3, a natural question arises if pegs can "plant the seed of their own demise" (Aizenman and Glick, 2008, p.819). Under increased capital mobility, the answer to this question tends to be positive, but still far from being overwhelming. Aizenman and Glick (2008) further argue that pegs lead to the usual trap whereby they deliver early gains in anti-inflationary credibility, but ultimately result in an exit followed by large adverse real consequences, i.e. welfare losses to the economy. Nevertheless, the peg's macroeconomic impact in the period between the "early gains" and the "crisis times" remains theoretically and empirically weakly supported (see Section 2.2). However, we cannot deny that the effect on real activity might be highly correlated to peg's duration.

For instance, Bubula and Ötker-Robe (2003) argue that majority of pegs have lasted less than five years, but Schuler (1999) emphasizes that some rigid rates existed for decades or even centuries. Klein and Marion (1997) estimated the median duration of a dollar peg to be 10 months in a sample of 16 Latin American economies (1957-1990), whereas Duttagupta and Ötker-Robe (2003) estimate four quarters for 32 economies with pegged regimes ranging from currency boards to crawling pegs (1985-2002). But, these studies do not account for the exposure of these economies to international capital flows. Hence, the notion that a long-lasting peg establishes grounds for its own downfall could be supported by a look through the history: ERM-EMS currencies crisis (1992); Mexican peso crisis (1994); East-Asian currencies crisis (1997); Russian rouble crisis (1998); Brazilian real crisis (1999); Turkish lira crisis (2001); Argentinean peso crisis (2001); and so on. The cause of all these crises was a pegged or tightly managed exchange rate at a level which, at certain point, became incompatible with the macroeconomic fundamentals and increased international capital mobility manifested through volatile capital flow reversals (i.e. external shocks). In addition, such regimes have been seen as "too costly for a government to maintain when its promises not to devalue lack credibility and when developing and maintaining credibility has become increasingly difficult" (Obstfeld and Rogoff, 1995). In may cases, the consequence was exchange-rate devaluation or, more probably, peg exit and the establishment of a flexible exchange-rate system, followed by wider financial "twin-crises", i.e. crisis in both the foreign-exchange and banking system, and an adverse effect on output. Only as an illustration, output declined by 6% in Mexico in 1995, 7% in Thailand and Korea in 1998, and by more than 11% in Argentina in 2002.

In general, peg-exits are classified as: i) exits with adjustments within the same regime (for example, devaluation); ii) exits to more flexible regimes (from conventional peg to exchange-rate band); iii) exits to less flexible regimes (from conventional peg to a currency board); iv) exits to other type of regimes not comparable with the current regime in terms of flexibility (from peg to managed or free float, probably) (Duttagupta and Ötker-Robe, 2003). Although this study makes a pioneering step to grouping peg-exits, still their classification can be questioned as to whether it is the best for purpose. For instance, the first three groups are not, in essence, peg-exits (a target is still announced, there is a change in flexibility, but not a peg-exit *per se*), while the last, which could be treated as a peg-exit, is not thoroughly explained. From the explanations by Duttagupta and Ötker-Robe (2003) and Tavlas (2003), we above listed the "famous" crises resulting in the so-called disorderly peg-exits preceded by an exchange-rate attack or pressure. However, the propensity towards greater exchange-rate flexibility has not always been preceded by severe exchange-rate attacks, resulting in financial crises. Although Duttagupta and Ötker-Robe (2003) talk about orderly peg exits as well, these still refer to those where authorities envisaged that the pressure on the forex market would expand into financial crises and prempt it by flexibilizing the rate before reserves collapsed or interest rates soared. Table A1.1 in Appendix 1 lists the exchange-rate crises that resulted in abandonment of the peg towards greater exchange-rate flexibility and the new monetary regime if the ERT was completely abandoned[9]. The table does not attempt exhaustiveness.

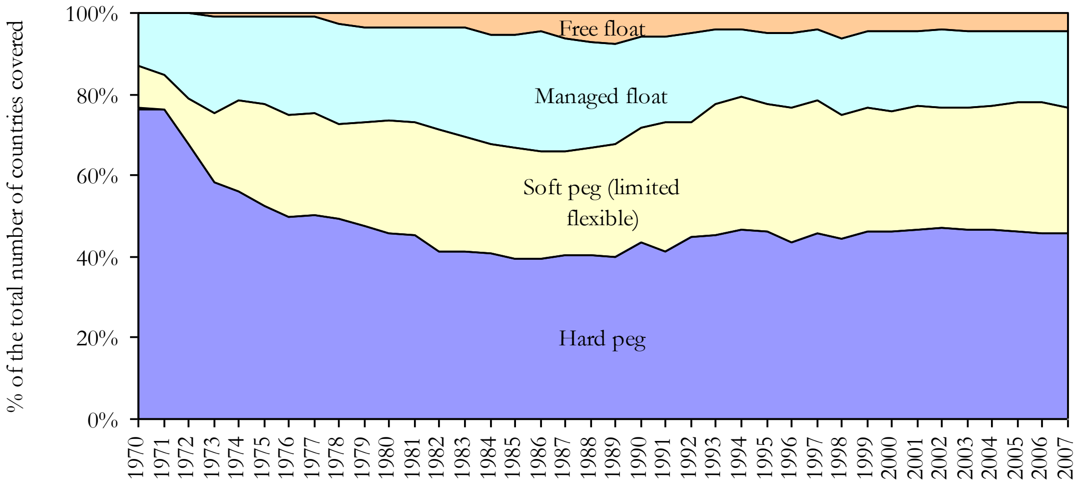
2.4.2. Toward greater exchange-rate flexibility

Taking on a historical perspective, countries recognized that a peg made their economy vulnerable to foreign disturbances and this led to the era of flexible exchange rates in the aftermath of the Bretton-Woods period. Specifically, during the Bretton Woods system, shocks hitting one economy were easily transmitted to the other economies that maintained fixed rates. However, since Breton Woods broke down, the propensity towards flexible exchange rates has been increasing. In 1972, 91% of countries had a hard pegged exchange rate; by 2007, this percent had fallen to 49% (IMF web site, 2010). A similar, but less pronounced, conclusion is derived when de-facto arrangements are observed for all IMF-member states: between 1972 and 2007, the percentage of hard fixers fell from 68% to 46%, while that of intermediate regimes (soft pegs and managed floats) doubled from 23% to 50% (Reinhart web site, 2010). Figure 2.1 gives a further detail over the period on this point. Caramazza and Aziz (1998) argue that the shift from fixed to more flexible exchange rates has been gradual, leading to complete abandoning of fixed rates in the developed world and an increasing

[9] Refer to Table 1.1. for clarification.

number of developing countries that embark on more flexible exchange rates, which is confirmed by the preceding data. An exception from this assertion is the process of monetary integration in Europe, but that is a rather different topic and beyond the scope of this study.

Figure 2.1. Evolution of de-facto exchange-rate regimes (1970-2007)



Source: Reinhart and Rogoff (2004) and Reinhart's web update (2010)

Note: The total number of countries included grows from 123 in 1970 to 157 in 2007. All countries with less than 7 annual observations excluded.

Nevertheless, these studies pass over the fact that, excepting the EMU, there is no increased propensity to establish hard pegs (Figure 2.1). Hard pegs belong to the group of irrevocable commitment (euroization, currency board) to support the peg with necessary policies and institutions. Among others, Fisher (2001) argues that the peg might become unsustainable under increased capital mobility, unless it is in the form of a hard peg. Otherwise, it must freely float. "There is little, if any, comfortable middle ground between floating rates and the adoption by countries of a common currency" (Obstfeld and Rogoff, 1995, p.2). Fisher's idea became known as the "bipolar view" or the "hollowing out" hypothesis (Eichengreen, 1994). Intermediate regimes are unsustainable under high capital mobility, especially for countries that commit to defend the peg but do not establish the firm institutional background that would require implementing policies devoted solely to the exchange-rate objective. Yet, evidence that intermediate regimes (like soft pegs and managed floats) will disappear is scarce (for instance, Masson, 2001), while there is some evidence that corner solutions also might end up with exchange-rate crises; for example, the speculative attacks on Hong Kong's and Argentina's currency board in 1997 and 1994, respectively, and the collapse of Argentina's board in 2001 (Bubula and Ötker-Robe, 2003). Moreover, the current economic crisis has shown some reversion to intermediate regimes (Frankel, 2009). Some arguments follow the line that the corner solutions are more adequate for countries that are fully or relatively open to international capital markets, whereas those with capital restrictions find intermediate regimes more feasible. Although this assertion might be logical and some attempts to test it have been made (Obstfeld and Rogoff, 1995; Levy-Yeyati and Sturzenegger, 2005), it is still not empirically verified.

Partially opposed to the "bipolar view", however, economies recognized the importance of macroeconomic policies directed towards domestic considerations, an assertion which is not compatible with fixed rates and capital mobility simultaneously. Unreservedly increased capital mobility has been the biggest factor behind the propensity towards flexible (but not floating) exchange rates in the last four decades (Obstfeld and Rogoff, 1995; Frankel, 2009). The trend towards greater exchange-rate flexibility has been associated with more open, outward-looking policies in trade and investment generally, and an increased emphasis on market-determined exchange and interest rates. Duttagupta and Ötker-Robe (2003) support the argument that shifts to more flexible regimes are associated with an increase in trade openness. Moreover, by their attitude towards more flexible rates, authorities directly affect the real economy: flexible rates are argued, but not proved to be, absorbers of real exogenous shocks and to steadily smooth output volatility (see Section 2.3.1). However, the literature and this particular study again overlook the evidence from the practice that floating rates are prone to overshooting and to unprecedented short- and long-run variations (Pugh *et al.* 1999; Pugh and Tyrrall, 2001), which might spill over into domestic output.

Not only does the greater openness lead to greater exposure to capital flows, but it might be also be a result of the economic development of the country. As the economy grows, it becomes export-oriented and thus more open. But, an aspect related to this is the idea that growing economies might not sustain their peg for some other reasons. Caramazza and Aziz (1998) explain that the real effective exchange rate of the domestic currency tends to appreciate when the economy is booming. Namely, as the economy gets involved in the foreign markets, the tradables sector experiences enhanced productivity growth, which outpaces the productivity growth of the non-tradable sector. The process is accompanied by increasing inflation, due to the higher wages requested by workers in the non-tradables sector and this particularly happens as a country converges to the level of development of other countries. If the exchange rate is pegged, then the real rate will be appreciating; and the faster the economy grows, the larger the pressure on the peg. Besides, inflation will be higher. This process, which became known as the Balassa-Samuelson (B-S) effect (due to Balassa, 1964; and Samuelson, 1964), has been largely confirmed in the literature. A review of 58 studies which were published on this topic in the period 1964-2004 can be found in Tica and Druzic (2006) and among these only six did not find support for the B-S effect. Exchange-rate flexibility would enable the exchange rate-inflation effects to be offset: exchange-rate appreciation will cancel out the effect of the increased inflation on competitiveness. For instance, between 1980 and 1996 Hong Kong, which had a type of a currency-board arrangement since 1983, experienced relatively higher inflation than Singapore which had a managed floating regime. But, the real exchange rates of both countries appreciated at roughly the same rates (Caramazza and Aziz, 1998).

Following the preceding lines of argument and those in Section 2.2, the propensity towards greater exchange-rate flexibility does not mean that the choice is to tightly fix or to freely float. The propensity towards floating rates from the beginning of the 1970s in the developed world and the limited evidence of propensity to establish hard pegs (Hong Kong, Argentina, Bulgaria, Estonia and so on) or to form currency unions later (for example, EMS/Euro zone in 1979/1999) support Fisher's (2001) bipolar view or "hollowing out" hypothesis. However, along the partial, but increasing inclusion in the world capital market, developing countries still have relatively small and thin financial markets, where a few transactions could lead to considerable exchange-rate volatility, which could not be easily hedged from being transmitted onto the real activity. Therefore, managing the exchange rate is still needed (Caramazza and Aziz, 1998). For these countries, the question is not to fix or to float, but rather a choice among a greater palette of flexible or intermediate regimes, all listed in Table 1.1. Intermediate regimes differ among each other according to the level of flexibility and part of those could appear under an ER target, whereas a managed float is freed of any target, but the central bank prevents excessive exchange-rate fluctuations. The choice of the level of flexibility is related to the concept of "fear of floating". However, while the "fear of floating" emerges when the central bank announces a de-jure float, but opts to maintain a de-facto fixed parity, which is believed to be consistent with macroeconomic fundamentals (Calvo and Reinhart, 2002), intermediate regimes are those within which the currency is neither narrowly fixed nor freely floats. In the latter case, the de-jure and de-facto regime coincides: flexibility is provided and the fear of floating is made explicit. The level of flexibility depends on the relative weight given to sustaining activity or limiting inflation and on the shocks hitting the economy or, implicitly, on real-sector effects (Masson, 2001). Along the same lines, Williamson (1999) agrees that intermediate regimes could help prevent misalignments and provide greater flexibility to cope with shocks.

Rogoff *et al.* (2004) advances the discussion by considering the greater exchange-rate flexibility due to increased credibility and maturity of the financial institutions. Albeit that financial integration affects all countries, developing countries still face institutional weaknesses (for example, instrument independence of the central bank is often contested in these economies). These in turn are an obstacle for establishing an exchange rate regime with considerable flexibility (like the managed float), except in the case when the currency is attacked and the target must be abandoned because reserves are already depleted. Consequently, institutional weaknesses could manifest themselves in higher inflation, debt sustainability problems, fragile and highly concentrated banking systems, all of which could undermine the credibility of the monetary policy. As noted earlier, credibility is accumulated by pegging; it decreases inflation and enables authorities to pursue credible macroeconomic policies. At the same time, this is a period of self-reflection, whereby pegging countries could learn to float (Rogoff *et al.* 2004). The same study introduces the concept of financial maturity, explaining that a shift to a more flexible regime must be founded on a sound financial system, which includes well-developed financial markets, institutions and instruments, including the foreign-exchange market, as well as access to international capital markets and greater trade openness. The latter in turn assumes boosted competitiveness on the global market and greater labour productivity (Salman and Shukur, 2004).

***

In summary, the debate whether to fix or to float is not ended. It is theoretically and empirically verified that a peg helps reduce inflation quickly by imposing credible macroeconomic policies on the economy. However, the history of currency crises across the world and the limited evidence have suggested that de-facto pegs are prone to exhibit crises and real-economy distortions when exogenous disturbances occur, although the latter remains without theoretical consensus or convincing empirical verification. However, the practical evidence is more in favour of the inference that long pegs are prone to failure when the economy is subject to large shocks. On the other hand, flexible rates are argued to be firm shock absorbers; they provide an adequate buffer against external shocks (Ghosh *et al.* 1997). Still, this does not reach immediate consensus in the literature. Flexible rates, although not prone to crises, are prone to overshooting and unpredictable volatility (Pugh *et al.* 1999), which could be easily transmitted to real activity. Taking into account the level of institutional and financial development of a country, this reasoning might give a priority of flexible over fixed exchange rates or vice versa. But, all these considerations require empirical verification, depend on the current macroeconomic state of the country and will probably remain a debated issue in international finance.

***

The following table (Table 2.2) is presented to summarise all the views related to exchange-rate regimes' macroeconomic performance and propensity for crises (provided in Chapters 1 and 2):

Table 2.2. Macroeconomic performance across exchange-rate regimes

	Inflation	Growth	Volatility	Collapse/Crisis
Fixed	Enhances domestic monetary policy credibility and lowers domestic inflation by tying monetary policy to that of the anchor country. Developing economies less likely to be able to import credibility without pegging. Moreover, inflation may be suppressed under weak macroeconomic management (fiscal policy) and weak institutions.	May raise trade, investment and, thus, growth by imposing certainty in the economic environment. But may also cause price misalignments and harm competitiveness by artificially appreciated the currency, thus harming growth. May also cause lower productivity growth, given the lacking liquidity when financial markets are underdeveloped.	May decrease output volatility under domestic nominal shocks, but may increase output volatility in the presence of real (and particularly exogenous) shocks and nominal rigidities.	High risk of speculative attacks against the currency, especially when exposed to volatile capital flows (which is highly realistic assumption in times of a financially integrated world). Large shocks might lead to the exchange-rate system demise. Vulnerability to financial-sector distress.
Flexible	The importance of "imported" credibility declines with stronger institutions (central-bank independence, disciplined fiscal policy) and financial sector maturity (diversified hedging instruments). In the majority of cases, price stability achieved by other monetary-policy anchor (like inflation targeting or implicit targeting).	May aid growth due to shock absorbers and fewer distortions following real shocks, but may be an obstacle to growth by imposing economic uncertainty.	Reduced output volatility due to the "shock absorber" function; but the nominal and real exchange-rate volatility may spill over into real activity, if not insulated by a developed financial sector.	Low risk of currency and banking crises, but the exchange-rate volatility might cause uncertainty in the financial system and large shocks may cause exchange-rate and output volatility.

Source: Adopted and modified by the author from Rogoff *et al. (2004), p.30, according to the discussion in Chapter 1 and Chapter 2.*

2.5. Conclusion

The debate on whether to fix or float the exchange rate is still lively. The choice of the exchange-rate regime depends on the size of the economy, macro-fundamentals, but especially on the type of shocks hitting the economy. If nominal shocks predominantly hit the economy, a peg serves better; if real external shocks predominate, a flexible rate is needed to act as a buffer. In the case of real shocks, pegs are too rigid to absorb them and hence transmit a negative disturbance onto the real economy – output must fall. As an economy becomes increasingly involved in the world financial market, real exogenous shocks become increasingly apparent, hence supporting the adoption of a flexible rate to fulfill the function of absorber of such disturbances. Moreover, the evidence favours the inference that long pegs are exposed to large shocks and are prone to failure. However, although theoretical arguments tend to support the buffer role of the flexible exchange rate, still there is argument that exchange-rate volatility under flexible rate might be also transmitted to real activity, due to flexible-rates' propensity toward overshooting and erratic volatility. Empirical evidence is unreliable though, largely owing to the limited number of studies, the measure of output volatility used and the econometric procedures applied. Still, at the empirical level, there is tendency to conclude that a peg increases output volatility, the conclusion being strong for crisis-periods, i.e. periods when the peg is under a severe attack. Given these conclusions, the issue remains an empirical problem and, along with the open issues from Chapter 1, will be further empirically investigated in Chapter 3.

CHAPTER 3

Empirical analysis of an exchange-rate regime effect on output growth and volatility

3.1. Introduction

Chapter 1 and Chapter 2 established that there is no conclusion as to whether and, if so, how the exchange-rate regime affects economic growth. Some channels were identified; however, the relationship remains unclear even at the empirical level. Albeit that some academics have worked to unveil this relationship, others have argued that the exchange-rate regime does not impinge on long-run growth at all, but might be important for short-run variations of output from its long-run level. The latter is usually put in the context of external shocks hitting the economy, whereby the exchange rate plays an important role of conveying these onto real (output) activity. Although, theoretically, more arguments support the view that a peg does not buffer against external shocks and, hence, that these are easily transmitted into real activity, this has been little researched. A few papers have tried to establish the relationship between exchange-rate regime and output variability, but the findings are not consistent across studies.

This chapter conveys the debate from Chapters 1 and 2 to the empirical level. More specifically, the chapter aims to estimate the relationship between exchange-rate regime and output (growth and volatility) by investigating data for 169 countries over the period 1976-2006. This will help in establishing whether the exchange-rate regime matters for growth at all and whether pegs more frequently cause output variations. These conclusions will be the basis for further analysis of the switch towards another monetary-policy regime and for inflation targeting itself.

For those purposes, the chapter is organized as follows. The next section reviews the major problems with the exchange-rate regime literature, on issues related to the empirical work. This section is the basis for the further empirical analysis. Section 3.3 considers the data and gives a descriptive analysis; Section 3.4 discusses the applied methodology. Section 3.5 reports the findings and offers some discussion. The last section concludes the chapter.

3.2. Background of the empirical analysis

3.2.1. Empirical issues for modelling

Chapters one and two portrayed the theoretical background of the issue to be examined in this chapter – the relationship between the exchange-rate regime and output. Although the possible channels through which the relationship may work were established, still there is no agreement on whether and, if so, how the exchange-rate regime affects output growth and volatility. Empirical research has also come to no conclusion. This section briefly reviews problems with previous research, with the objective being to resolve/account for these issues in the empirical analysis that follows in this chapter.

Firstly, the investigation of the relationship between exchange-rate regime and output depends on the growth-modelling framework employed. The growth equation needs to reflect recent advances in the literature, considering new insights from the neoclassical and endogenous-growth theories. More importantly, the growth equation should encompass macroeconomic fundamentals and institutional arrangements. Also, important concepts related to exchange-rate regime, like capital controls, need to be considered. A country with the same exchange-rate rigidity, but differences in capital controls might have different results in terms of growth. Once the theoretical background of the growth equation is justified, it can be augmented by measures of the exchange-rate regime. Robustness checks need to confirm the soundness of the growth framework.

Secondly and equally importantly, the specified modelling framework should address the Lucas critique. Specifically, it has been argued in Chapter 1 and by Domac *et al.* (2004b) that when the exchange-rate regime changes, the coefficients in the growth regression are not invariant to this switch. Addressing the Lucas critique requires capturing this change. A brief discussion of the Lucas critique is offered in Section 3.2.3.

Thirdly, control variables in the output-volatility regression need to be carefully chosen. Several studies (reviewed in Table 2.1) consider different control variables capturing conditional economic convergence, nonlinearities, trade openness, size of the economy or the share of agriculture in the economy. However, the crucial point is to capture the shocks hitting the economy and their impact upon the real activity under alternative regimes. Therefore, estimating output-volatility models with variables that represent shocks (like terms of trade, monetary/interest-rate and fiscal shocks or civil unrest) emerges as a necessity.

Fourth, two measurement issues emerge in such an analysis. The classification of exchange-rate regimes matters. Also, how output volatility is to be measured remains a debated issue. A broader discussion is offered in Section 3.2.4, but this thesis does not opt for developing its own classification of exchange-rate regimes.

Potential endogeneity is an important concern. Discussing inflation, Levy-Yeyati and Sturzenegger (2001) argued that countries with a peg constrain inflation (Section 1.3.2), but also countries with low inflation might decide to peg the exchange rate in order to maintain the macroeconomic stability achieved. Thus, the estimated coefficient in front of the exchange-rate dummy in a standard money-demand equation might suffer endogeneity bias. The same applies to the relationship between exchange-rate regime and growth, although the argument is possibly weaker. The modelling framework needs also to address this issue. Endogeneity will be treated within the methodological section below.

Some studies also report other problems when modelling this relationship. For instance, Moreno (2000) accounts for the so-called *survivor bias*; the term referring to a situation whereby, for instance, high-inflation episodes appear under a floating regime. For example, assume that high inflation caused the peg, which preceded the floating regime, to fail. However, it is inappropriate to attribute (inflation) performance during such episodes to the floating regime itself. This, though, might be corrected by excluding sharp-devaluation episodes which could have been attributed to policies pursued under the peg. Bleaney and Francisco (2007) exclude high-inflation episodes which might be also a result of incorrect policies while pegging. The latter has been more generally described as the *peso problem*, related to the episodes of severe economic stress that can lead to peg exit. Finally, *sample-selection bias* needs to be addressed. Previous studies usually fail to construct an unbiased sample given the question of interest. Some studies (Table 1.2) consider only developing countries, which more often have rigid exchange rates or face problems not related to exchange-rate policy. The hypothesised negative impact of the peg on growth in such instances is likely to be biased and the real picture obscured. Some other samples do not differentiate between countries that experienced severe exchange-rate crises and those with long-lasting stable regimes. These issues could be resolved by considering a large sample, but the distinction between developing and advanced economies must be made (Chapters 1 and 2); structural stability should not simply be assumed.

No study on the relationship between exchange-rate regime and output (growth and volatility) (reviewed in Table 1.2 and Table 2.1) treats all of the issues mentioned above. This chapter will address, or try to address, these issues in its empirical framework, which is considered to be its contribution to the existing literature.

3.2.2. Growth theory and output-volatility frameworks

Understanding what determines growth has been long disputed among academicians and policymakers. Higher growth is beneficial for the overall economic welfare of the country, so that knowing the factors that determine it becomes an imperative in order to know how to boost or contain it. The root of this concern goes back to the classical period (Hume, 1742; Tucker, 1776; Smith, 1776), which provided many of the basic ingredients that appear in modern theories of economic growth, such as competitive behaviour, equilibrium dynamics, diminishing returns and its relation to capital accumulation, the importance of population growth rate, "the effects of technological progress in the forms of increased specialization of labour and discoveries of new goods and methods of production, and the role of monopoly power as an incentive for technological advance" (Barro and Sala-i-Martin, 2004, p.9). However, there is at present no straightforward and simple answer to the specification of growth determinants, with growth theory constantly evolving. This section presents, in a condensed manner, the stream of thought about economic growth in order to build the context in which the effect of the exchange-rate regime on growth will be analysed. The objective is not an in-depth analysis of growth theory; a comprehensive and advanced reading on economic growth is Barro and Sala-i-Martin (2004).

Neo-classical economic growth

To begin with, classical economists mainly focused on capital accumulation, but disregarded the role of technology, until the revolutionary work of Solow (1956, 1957) and Swan (1956) was published. A significant development in growth theory was made by Solow who developed a formal model, in the neoclassical tradition, that describes the path of important economic variables over time, such as per capita output and capital.

Two key features of the conceptual structure of neoclassical growth theory are important. First, it is based on "the production function approach to the analysis of economic growth" (Thirlwall, 2005, p.140). That is to say, it is based on an aggregate production function, which expresses the relationship between aggregate output on the one hand and stocks of inputs and their productivity on the other. Second, the neoclassical model is designed to show the long-run equilibrium growth rate with all resource inputs fully employed and returns to capital and labour equal to their marginal productivity. The main outcome of this model is that the growth rate declines as the economy evolves toward its steady state, where income, capital and consumption per capita grow at a constant rate. This implies that countries with low levels of capital grow faster than rich countries, and so their per capita income level will converge towards the level of rich countries. Indeed, following the influential work of Barro and Sala-i-Martin (1991, 1992, 2004) and Mankiw *et al.* (1992), the conditional convergence properties of neoclassical growth models are well-known. The main assumptions behind the Solow growth model are perfect competition, homogeneous product, homogeneous capital, constant returns to scale, perfect substitutability between capital and labour, and diminishing marginal productivity of labour and capital (Barro and Sala-i-Martin, 2004). As a result of the last assumption, economies starting with lower levels of initial capital stock are expected to experience higher returns to capital and are therefore expected to grow faster than rich countries and to converge towards the leader country's level of income.

In the Solow model, the driving force of output growth in the short and medium run is physical capital accumulation determined by the saving rate. In the long run, per capita output growth is entirely determined by technological progress, which is assumed to be *exogenous* in the model. In this theory, technology is treated as a public good, i.e. it is available to everyone free of charge. The neoclassical growth model predicts that, in the long run, countries reach their steady states. Countries that own the same technology and population growth rate are expected eventually to converge to the same steady-state growth rate (as determined by a bulk of control variables, as discussed in the 'Growth theories and empirical analysis' section below), although their steady-state levels of income do not necessarily have to be same. Thus, if technology is assumed to be a public good, all countries are expected to attain the same steady-state growth rate in the long run.

Models based on Solow's ideas have been the point of departure for most empirical analysis of economic growth. Some decades later, empirical research (Mankiw *et al.* 1992) acknowledged the role of human capital (educational attainment and the health of workers) to be equally important as the role of the physical capital. This research established the so-called augmented Solow model. However, since the Solow model by construction does not explain the engine of economic growth (technological progress), it assumes away what it actually tries to explain: "we end up with a model of growth that explains everything but long-run growth, an obviously unsatisfactory situation" (Barro and Sala-i-Martin, 2004, p.11). Thus, an alternative to the neoclassical model was developed – the endogenous-growth theory, which is next discussed.

Endogenous growth

The difficulty in including endogenous technological progress in neoclassical growth theory, while at the same time preserving the perfect competition assumption, led to the modification of neoclassical growth theory by Romer (1986; 1990; 1994), Lucas (1988), Rebelo (1991) and others, who developed the 'new' endogenous growth theory by making technological progress *endogenous* to the model. In practice, the shift towards endogenous growth has been accomplished through retaining the production function approach and the general equilibrium framework, but modifying the assumptions about the nature of the production function and relaxing assumptions of perfect competition which underpin the old neoclassical model. Most critically, in endogenous-growth theory, the assumption of perfect competition was replaced by imperfect competition and increasing returns to scale, which allow for the generation of new ideas. One can view endogenous growth theory as an extension to the Solow model, combining elements of the earlier growth theory with the assumptions of increasing returns; elements of imperfect competition; and some of the microeconomic research on science, R&D, and technological change (Hands, 2001).

There are now a variety of sophisticated endogenous-growth theories in which innovation increases product variety or product quality and also considers the effects of general purpose technologies which constitute radical technological breakthroughs (see Aghion and Howitt, 1998; and Verspagen, 2004, for reviews). But these models generally make the above-mentioned assumptions to ensure a steady-state growth rate (as determined by the control variables) and although they may have a separate sector for education or R&D, they continue to work with an aggregate production function.

Although the new growth theories which seek to endogenize technological change are sometimes seen as the major alternative to the old neoclassical growth theories, there are a number of other alternatives (reviewed in Gore, 2007), which go further by rejecting the production function approach and general-equilibrium framework. These are briefly reviewed in turn.

Alternative growth approaches

These theories reject the aggregate production function approach in three different ways – focusing on, respectively, *institutions, structure* and *demand*. The first alternative theory (Nelson and Winter, 1974; 1982) relates economic growth to the institutions within which their actions are embedded and the economic capabilities of agents (firms). This approach has been developed as a critique of the micro-foundations of the neoclassical growth framework.

The second major alternative growth theory (Ocampo, 2005) rejects the production function approach through interrelating economic growth and the sectoral structure of production. Instead of "viewing the growing economy as an inflating balloon, in which added factors of production and steady flows of technological change smoothly increase aggregate GDP", growth is seen as a dynamic process in which some sectors surge ahead and others fall behind "as part of a continuous transformation of production structures" (p.8).

The third alternative growth theory (Setterfield, 2002; Blecker, 2002) rejects the production-function approach, because it explains growth solely in terms of supply factors of production and their productivity and ignores the role of demand in this process. Theories of demand-led growth recognize that, at any point in time, the level of utilization of productive resources may vary according to demand conditions. Moreover, they are founded on the view that both factor accumulation and technological progress are ultimately demand-determined.

Growth theories and empirical analysis

Relating the characteristics of the mainstream growth theories, in what follows an empirical growth model will be designed. The following generic form of a growth model is used in the literature:

$$g_{i,t} = X_{i,t}\gamma + Z_{i,t}\pi + \varepsilon_{i,t} \tag{3.1}$$

where $g_{i,t}$ is real per capita growth in economy i over period t. Barro and Sala-i-Martin (2004) suggest that real per capita GDP growth should be related to two groups of variables: initial levels of some variables, denoted $X_{i,t}$ (like the GDP itself or variables for schooling and health) and the population level or growth rate; and control variables, denoted $Z_{i,t}$, which will reflect policy actions, institutional setting or other country characteristics. The inclusion of initial values of some variables date back to the Solow-Swan models (p.88) which predict that, for a given value of these variables, an increase of initial per capita GDP or initial human capital per person, would reduce growth. That is, a richer economy tends to grow slower and vice versa. However, each economy has its own steady state, as determined by the control variables (rooted both in the neo-classical and endogenous growth theory; further refer to Table 3.2); the so-called steady-state level of output per "effective" worker (Barro and Sala-i-Martin, 2004, p.517). For given values of the state (initial) variables, a change in control variables (say, a change in government consumption) might hence impinge on growth.

A fundamental problem in growth empirics is which variables to include in the model. This is a result of what Brock and Durlauf (2001) call "the open-ended theory"; namely, a causal relationship between one variable and growth, suggested by one theory, does not exclude the relationship between another variable and growth, suggested by another theory. The literature (Durlauf and Quah, 1999) suggested over 90 variables as potential determinants of growth. However, the primary purpose of the empirical investigation in this chapter is not to make a contribution to growth theory or empirics, but rather to investigate whether and, if so, how the exchange-rate regime affects output. For that purpose, a minimally-specified growth model will be a tool for tackling this linkage, which will be sufficient to explore one-variable effects on output growth and volatility. However, the growth framework is not chosen randomly and it dovetails within the considerations specified in this section and as the text proceeds.

At an outset, the growth function is specified with the expected sign of each relationship noted in parentheses:

Per capita GDP growth = f(initial GDP(-); average years of schooling(+); 1/(life expectancy at age 1)(-); government consumption/GDP(-); trade openness(+); inflation rate(-); investment/GDP(+); fertility rate(-); democracy index(+); population growth(?); rule of law index(+); exchange-rate regime(?); regional/country specific/time dummies) (3.2)

As mentioned above and as suggested by the classical growth theory (reviewed in Barro and Sala-i-Martin; 2004), the initial level of per capita GDP should enter the regression in a log-form, so that the coefficient will represent the rate of convergence of the economy. In addition, the other initial variables are here measured as commonly in the literature as the average years of school attainment (as a proxy for the human capital – education) and the life expectancy (as a proxy for the human capital – health).

The list of control variables that ensure the achievement of the steady-state growth rate in both neoclassical and endogenous growth theory includes: trade openness; the ratio of the government consumption to GDP; the log of the total fertility rate; the ratio of real gross domestic investment to real GDP; the inflation rate; an indicator of the maintenance of the rule of law and an indicator of the democracy (the latter two as explained by the theory that relates growth to institutional factors).

One sub-group of these variables is *policy variables*. For instance, government consumption is assumed not to contribute to productivity directly, but as entailing distortion to private decisions. Moreover, such distortions can reflect the governmental activities themselves. Hence, a higher value of the government consumption leads to a lower steady-state level of output and to lower growth, ceteris paribus. Explanatory variables also include a measure of the international openness (exports plus imports to GDP) which reflects the size of the economy, but might also reflect the influence of some government policies, like tariff and trade restrictions, on international trade. The inflation rate is included as a measure of macroeconomic stability. Fiscal variables could also be included as a proxy for macro-stability. In the same line of thinking, the exchange-rate regime can be considered as a policy variable. Barro and Sala-i-Martin (2004) do not directly account for the exchange-rate regime (that is not their primary interest), but nevertheless this could be included in the list of policy variables, since altering the exchange-rate regime, or passing from ERT to IT, would be considered as a policy action aimed at certain macroeconomic goals (like preserving price stability and/or supporting the real economy and/or isolating the economy from shocks from abroad). Hence, in our model, policy variables will include the exchange-rate regime, since this is our primary concern.

In the neoclassical growth model, the fertility rate exhibits a negative effect on growth, since higher fertility entails more resources devoted to the raising of children and, hence, lowers growth. The effect of the saving rate in the neoclassical model is accounted for through the investment-GDP ratio. Barro and Sala-i-Martin (2004) attempt to isolate the effect of the saving rate on growth, rather than the reverse, by using lagged values (lagged investment ratio) as instruments in order to account for the endogeneity problem (this is further discussed in Section 3.4).

Another sub-group of variables reflects the *institutional setup*. As a measure for the institutional setting two indicators are used. One measures the rule of law, which reflects the argument that by enhanced property rights investment and growth incentives are supported. The second indicator is the democracy index in the sense of electoral rights and it is usually included along with a squared term, which suggests that democratization is expected to enhance growth for countries that are not very democratic, but to retard growth for countries that have already achieved a substantial amount of democracy. Nevertheless, the effect of democracy on growth might be ambiguous, because some models that stress the incentive of electoral majorities to use their political power to transfer resources from rich minority groups found a negative effect. Democracy, on the other hand, could be productive as a mechanism for government to commit itself not to confiscate the capital accumulated by the private sector (Barro and Sala-i-Martin, 2004).

The final variable reflects shocks hitting the economy. The terms-of-trade variable (ToT) is included through its interaction with trade openness. Changes in the ToT measure the effect of changes in international policies (including financial crises) on the income position of the domestic residents. Higher export prices will induce an increased inflow from abroad and will improve the income position at home, and vice versa. Hence, the ToT exogenously affects the position of each individual country. A positive movement of the ToT variable (higher export prices, lower import prices) would increase domestic purchasing power, consumption and hence, growth. However, following the discussion in Chapter 2, the ToT are not related to the steady-state position, and these are usually argued in relation to output volatility, as argued in the following subsection.

In conclusion, as basic ingredients of the growth function should be considered: initial level of GDP; human capital (average years of schooling and life expectancy); government consumption/GDP; domestic investment/GDP; fertility rate; population growth; inflation rate; rule of law and democracy index; trade openness; and changes in the ToT. Finally, what is of particular interest of this thesis, the growth equation would include a measure of the exchange-rate regimes, as a policy variable, in a manner that is described further in Sections 3.2.4 and 3.3.1.

Output volatility and empirical analysis

When academics examine the effect of the exchange-rate regime on growth, they apply a growth framework which dovetails the theoretical aspects considered above and empirical findings present in the literature (refer to Table 1.2). However, when the output-volatility framework is observed, then many differences appear (refer to Table 2.1). Moreover, the empirical research on the linkage between output volatility and the exchange-rate regime is very limited. This could be due to there being no consensual theory of output volatility *per se;* academics usually view this issue as merely practical. However, what is consensual in this very limited literature is that output volatility has to do with *shocks*. Changes in money demand, fiscal stance or changes in the terms of trade as a result of external factors or even civil unrest in the country would impinge on the real economy in the way elaborated in Chapter 2. "Employment and output fluctuations inevitably relate to shocks and to the manner in which the economy copes with those shocks" (Easterly *et al.* 2001, p.8). However, what is of particular importance to this thesis is how these shocks affect the real economy under alternative exchange rate regimes; namely, different regimes are argued to channel differently the various shocks to the real economy.

Following the works of Mundell (1968) and Poole (1970), many economists still believe that the relative merits of exchange-rate regimes depend on the nature of shocks that hit the economy. When shocks come from the domestic money market, fixed regimes automatically prevent them from affecting the real economy. In the event of a positive demand shock (i.e. an increased demand for money that, *ceteris paribus*, raises the interest rate), the money supply will increase as the monetary authority buys foreign reserves to prevent the appreciation of the local currency and real output is left unchanged. On the other hand, flexible regimes require income to fall (via currency appreciation effect on net export) so that real money demand is reduced back to the unchanged level of real money supply. Therefore, if nominal shocks predominate in the economy, this is an argument in favour of fixed regimes.

However, when shocks are mostly real, floats are, theoretically, the more effective choice. Indeed, one of the most important benefits commonly attributed to free-floating exchange-rate regimes is that they allow smooth adjustment to real aggregate shocks. When domestic prices are sticky and thus change at best slowly in response to shocks, a negative real shock (say, a fall in export demand or in the terms of trade) leads to a depreciation of the nominal exchange rate. This depreciation in the exchange rate, in turn, reduces the relative price of tradable goods at precisely the moment when demand for them has fallen and therefore partially offsets the effect of the negative shock. Furthermore, the nominal depreciation increases the domestic price of the export good exactly when its foreign price has fallen, also helping the economy to have a smoother adjustment. That is, the exchange rate acts as an automatic stabilizer in (managed) floating regimes. These issues were broadly discussed in Chapter 2. A second channel through which floats are able to smooth shocks is the freedom they give to pursue an independent monetary policy (refer to Chapter 1). In the presence of real negative shocks, governments would like to be able to respond to alleviate the recession. Under flexible rates, the country can respond by means of a monetary expansion. Under fixed rates, any injection of money would imply an outflow of reserves and no effect on output.

However, while almost all studies reviewed in Table 2.1 include shock variables, the differentiation between real and nominal shocks is neglected. Hence, a well-specified output-volatility regression should make this differentiation. Next, studies suggest incorporating variables representing buffers against the shocks. Easterly *et al.* (2001), for instance, suggest including trade openness, an indicator of financial deepness, price volatility and an indicator of political instability in the output-volatility regression. Mobarack (2001) suggests taking an even broader list of variables, among which are those present in the growth regression, plus, for example, the Gini coefficient, tax revenues, real-exchange-rate volatility, credit to the private sector and war participation. However, his suggestion is not backed by solid explanations of why these variables could potentially affect output volatility. Nevertheless, in general, those suggested variables could be thought of as representing certain shocks or reflecting the responsiveness of different economies to shocks, which is again in line with the preceding discussion. Focusing on the exchange-rate regimes literature, one group of academics (Levy-Yeyati and Sturzenegger, 2001; Bastourre and Carrera, 2004) uses the volatilities of the same explanatory variables as in the growth regression, though again these are not backed by rationales for their inclusion; Bleaney and Fielding (2002) use some variables to capture the country size and agriculture share, since these are important buffers when a shock hits the economy; Edwards and Levy-Yeyati (2005) estimate the growth vector and use its residual in the output-volatility regression to measure the speed of adjustment towards the long-run equilibrium, along with some variables representing shocks. However, they measure the output volatility through differencing the growth series, as in a standard autoregressive distributed lag (ARDL) model, which might be contested. They find a positive sign in front of the lagged adjustment mechanism, ranging between 0.75 and 0.80 and suggesting a relatively fast restoration of the equilibrium once a shock hits. Thus, in summary, although different studies consider different regressors in the output-volatility regression, it is generally accepted that the model must contain variables representing shocks and variables representing buffers, but there is little agreement on what else should be included. Hence, following these contemplations we include money-growth and government-consumption volatility as nominal policy shocks; TOT changes as a real shock; and civil unrest as a political shock. We also follow the suggestion of Kose *et al.* (2005) and Easterly *et al.* (2001) and we add per capita GDP growth and a measure of financial development, as these may act as buffers when a shock hits the economy.

We further include a variable for trade and financial openness, to reflect the extent of integration of the economy into global trade and capital markets. Easterly and Kraay (2000) argue that the level of financial development may matter little if firms in the country have easy access to credit abroad. Hence, a high degree of international trade and financial integration could also play a buffer role and smooth the output fluctuations. However, while high degrees of openness of the capital account could serve to smooth the adjustment of a country to a shock, it may also expose it to another adverse source of dynamic reaction and, in essence, may measure the economy's vulnerability to an external shock. Investors, observing the weakening condition of firms and financial institutions within the country in response to a shock, may decide to pull their (short-term) money out of the country and put it elsewhere, thus further weakening both firms and financial institutions (e.g. by further weakening the currency) and possibly inducing a crisis. A negative shock to the capital account will have adverse effects on the terms at which firms can get access to funds and may be exacerbated by the presence of credit rationing. The increased uncertainty about different firms' balance sheets, caused by the economic disturbance, may lead to a greater prevalence of credit rationing and to further contractions in demand, as firms attempt to increase their liquidity.

Inflation and wage growth need to be included in the regression to account for the traditional explanation of output fluctuations by downward nominal rigidities (Newbery and Stiglitz, 1982). Namely, rigid real wages provided an easy explanation of unemployment — a decrease in the demand for labour immediately turns into unemployment (lower output), because real wages are rigid and fail to equilibrate the market. The reduction in the demand for labour could be explained by the falling demand for goods, in itself explained by rigidities in intertemporal prices.

Consequently, in the regression we include: policy, external and political shock variables, variables representing buffers, openness, price rigidities and the exchange-rate regime, given the literature and the concerns of this thesis; interaction terms are also included, in order to measure whether, under real and nominal shocks respectively, output reacts differently depending on the exchange-rate regime. On that basis we proceed with the empirical investigation in this chapter. Differently from Edwards and Levy-Yeyati (2005), we carefully discuss the basis of and investigate different definitions of the output-volatility measure, include actual growth instead of a growth-residual and add more shock variables that theoretically can be considered to have a role.

The empirical model with the expected signs of the regressors is:

Output volatility = f(terms-of-trade volatility(+); money-supply volatility (+); gov't consumption volatility(+); civil unrest(+); GDP per capita growth(-); financial development(-); trade and financial openness(+); inflation(+); wage growth(+); exchange-rate regime(?); exchange-rate regime*TOT volatility; exchange-rate regime*money volatility; exchange-rate regime*government-consumption volatility; regional/country specific/time dummies) (3.3)

3.2.3. The Lucas critique – A revisit

The Lucas (1976) critique of econometric policy evaluation argues that it is inappropriate to estimate econometric models of the economy in which endogenous variables appear as unrestricted functions of exogenous or predetermined variables. In Lucas own words, "[E]ven to obtain the decision rules … we have to attribute to individuals some view of the behaviour of the future values of variables of concern to them. … To assume stability of [the exogenous or predetermined variables] under alternative policy rules is thus to assume that agents' views about the behaviour of shocks to the system are invariant under changes in the true behaviour of these shocks" (p.111). Instead, expectations about future policy actions should be considered and affect current decision-making; this view revived and brought into prominence the theory of rational expectations. He argues that expectations about the future are highly important to economic decisions made by households and firms today. But, contrary to adaptive expectations, rational expectations are genuinely forward-looking (Li, 2008). The rational expectations hypothesis means that agents exploit available information without making the systematic mistakes implied by earlier theories. Expectations are formed by constantly updating and reinterpreting this information.

The objective of this thesis is not to explore the Lucas critique *per se,* but instead to take it into consideration. As argued in the preceding chapters, changing the exchange-rate or monetary regime (rule), implies that model's parameters might change as a result of the arguments of Lucas. The econometric work pursued (Section 3.5.1) thus needs to incorporate the Lucas critique. In order to account for the Lucas critique, we use interaction terms of all independent variables with the dummies representing the exchange-rate regimes. In such a specification, the significance of the estimated coefficients in front of the interaction terms will indicate if and how parameters change when the exchange-rate regime switches.

3.2.4. Exchange-rate regimes classification and output-volatility measures

Two influential articles in the literature (Reinhart and Rogoff, 2004; Levy-Yeyati and Sturzenegger, 2005) consider an issue that has been ever since treated as trivial: *the classification of exchange-rate regimes*. Namely, the majority of studies employ the classification schemes by the IMF, which are based on what countries report and not on the actual behaviour of the exchange rate. In practice, by law, a country could pursue a pegged regime, but in practice could allow certain flexibility, in order to, say, support the real economy. This is only one example; other combinations are also possible. Reinhart and Rogoff (2004) (hereafter RR) made a pioneering inroad into this issue by measuring the actual behaviour of the nominal exchange rate. Moreover, in their study they account for the existence of dual foreign-exchange markets and for related factors, like exchange controls and currency reforms. By applying the classifying algorithm (p.14 in their study), they identify 14 options for exchange-rate regime, applied to 227 countries [10] for the period 1940-2007. This fine-tune classification is then generalized into 5 groups (fixed, limited-flexible, flexible, free-floating and free-falling). The following fine groups were identified:

Table 3.1. Classification categories of the exchange-rate regimes, according to Reinhart and Rogoff (2004)

Classification category	Number assigned to the category (fine)	Number assigned to the category (coarse)
No separate legal tender	1	1
Pre-announced peg or currency board arrangement	2	1
Pre-announced horizontal band that is narrower than or equal to ±2%	3	1
De facto peg	4	1
Pre-announced crawling peg	5	2
Pre-announced crawling band that is narrower than or equal to ±2%	6	2
De facto crawling peg	7	2
De facto crawling band that is narrower than or equal to ±2%	8	2
Pre-announced crawling band that is wider than ±2%	9	3
De facto crawling band that is narrower than or equal to ±5%	10	3
Moving band that is narrower than or equal to ±2% (i.e., allows for both appreciation and depreciation over time)	11	3
Managed floating	12	3
Freely floating	13	4
Freely falling (includes hyper-float)	OTHER	OTHER
Dual market in which parallel market data is missing	OTHER	OTHER

Source: Reinhart and Rogoff (2004)

Note: By contrast to the common crawling bands, a non-crawling band refers to the relatively few cases that allow for both a sustained appreciation and depreciation of the exchange rate over time. While the degree of exchange-rate variability in these cases is modest at higher frequencies (i.e., monthly), lower frequency symmetric adjustment is allowed for.

[10] However, some of those no longer exist.

Although very influential and prominent, this procedure does not account for the behaviour of foreign-exchange reserves, which could be considered as its main drawback. This is due to the notion that under a peg, reserves exhibit increased volatility; the lower the exchange-rate rigidity, the lower the need for foreign-exchange intervention. As such, foreign-exchange reserves interventions would signal government commitment to maintain the peg. However, the authors dispute this drawback by emphasizing the widespread switch from intervention based on reserves to intervention based on interest-rate changes; though, data on the latter are also difficult to obtain. On the other hand, although measures of capital controls have not been directly accounted for, the authors argue that the data show that the black market premium becomes insignificant with capital market integration and hence could be considered as a measure for the "size" of the capital controls imposed. Hence, the latter are implicitly taken into account when de-facto classifying the exchange-rate regimes. This also accounts for the possibility that a country with the same exchange-rate rigidity, but differences in capital controls, might have different results in terms of growth.

The other important paper, by Levy-Yeyati and Sturzenegger (2005) (hereafter LYS), utilizes cluster analysis (p.4) in order to de-facto classify regimes for 119 countries over the period 1974-2004[11]. Before forming clusters of similar regimes, the authors use three measures to define the regime: nominal exchange-rate changes; volatility of nominal exchange-rate changes; and the volatility of international reserves. The idea behind this is that countries with a volatile nominal rate and stable reserves are classified as floaters, while those with stable nominal rates and volatile reserves are fixers. Although the approach considers foreign-exchange reserves behaviour into the classification of exchange-rate regimes, it does not account for the existence of capital controls or currency reforms. The approach of LYS identifies four regimes (flexible, dirty float, crawling peg and fixed) and one "inconclusive" group, which, compared to the RR approach, is a small number of identified groups. A drawback of this method is that countries which do not exhibit considerable volatility in either variable are classified as inconclusive. While the authors present a solid theoretical argument for the inconclusive group, it decreases the sample size and the variance of the data, which might reduce its usefulness in regression. Moreover, classification is to an extent vague,

[11] However, data are missing for a lot of years. On the other hand, in the RR classification, the missing fields are related to the non-existence of the state in that period or similar reasons.

since it does not distinguish well between a dirty float and crawling peg. On the other hand, having in mind that RR account for capital controls (which might be of crucial interest when measuring the macroeconomic effect of a particular exchange-rate regime – see Chapters 1 and 2); use 14 and 5 categories of de-facto regimes; come up with an exhaustive set of data, in terms of time-span and country-coverage; and the idea that the purpose of this thesis is not to classify the exchange rate regimes; the empirical work will continue by using the RR de-facto classification, as specified in Table 3.1.

For the sake of comparison with the previous literature, the empirical part will also present the results from de-jure classification, as specified by the IMF, which classifies the exchange-rate regime on the following scale: fixed; limited flexibility; managed float; and free float.

Another, at first sight a trivial issue, is the measure of output volatility. Various measures have been proposed in the literature. Some authors (Ramey and Ramey, 1995) use the standard deviation in the annual GDP growth rate. However, Gavin and Hausman (1996) define real volatility as the standard deviation of GDP level. Some other authors (such as Pritchett, 2000) suggest taking higher order measures, like the standard deviation of the first difference in the annual GDP growth rates. Bastourre and Carrera (2004) use the rolling standard deviation of per capita GDP (level and growth) over 5-year periods as a proxy to output volatility. However, if this methodology is applied to annual-level data, then two general problems are apparent with using a rolling standard deviation: i) it will add persistence to the series, i.e. will make it an autoregressive process (Maddala, 2005); and ii) it tends to generate oscillations – the so-called Yule-Slutsky effect (Bartholomew and Bassett, 1971). More importantly for this thesis, iii) significant information regarding the switching from one exchange-rate regime to another could be lost. In consequence, the rolling standard deviation has significant drawbacks and in this thesis will be used only for the purpose of comparison. Regrettably, most of the published literature on the relationship between exchange-rate regime and output volatility (Table 2.1) uses this measure. An exception is the study of Edwards and Levy-Yeyati (2005) who define output volatility as the growth of the GDP per capita growth, which is likely to be without theoretical and econometric support.

In Chapter 2, we argued that if the exchange-rate regime is not relevant for long-run growth, then it might be relevant for its short-run departure from the potential long-run growth assumed to be determined by fundamentals, which implicitly suggests defining output volatility as the output gap. In this thesis, besides defining (for purposes of comparison) output volatility as the rolling standard deviation of the annual GDP growth over 5-year periods, we advance the issue by considering two other measures: i) output volatility defined as the difference between the actual per capita GDP growth and the long-run trend (average growth rate over the period); and ii) output volatility defined as a difference between the actual per capita GDP growth and the potential per capita GDP growth derived by Hodrick-Prescott filtering. Both measures should approximate how far the economy is pushed (heated or depressed, usually by external or policy shocks) away from its long-run level assumed to be defined by the fundamentals. However, since the first measure assumes that the long-run equilibrium growth rate is constant, we focus on the HP-based measure. The purpose of using both definitions is to investigate whether a different measure of output volatility changes the results significantly.

3.3. Data and descriptive statistics

3.3.1. Data issues

We matched the countries of the RR classification (227) with the IMF member states (185) and obtained data for 169 countries. Given that the total GDP of these countries in 2006 accounts for 95.1% of the world's GDP[12], they represent a sufficient country-set in order to offset concerns about sample-selection bias. The empirical investigation will deal with the post-Bretton-Woods monetary/exchange-rate era, hence covering the period 1976-2006. The variables used and their sources are fully described in Table 3.2 on p.120. The provider for most of the data is the IMF; educational-attainment and life-expectancy variables are obtained from the World Bank; the fertility rate is obtained from the United Nations; the democracy index and the index of civil liberties are provided by Freedom House, which, as a source, might be contested, but no comparable alternative is presently available.

For the definitions of the growth-regression variables, we follow Barro and Sala-i-Martin (2004) and Section 3.2.2. An exception is the variable measuring the rule of law; this variable could be obtained only with considerably high monetary cost and,

[12] According to IMF's World Economic Outlook.

since it is not of our primary interest, we do not include it. For the definitions of the output-volatility variables, we follow the notions in Section 3.2.2. The series on the standard deviation of the annual GDP (level and growth rate) are estimated from the GDP series as a rolling standard deviation over 5-year periods, while the series on the output gap is approximated by the absolute values of: i) the deviation of each observation from the average growth rate and ii) the deviation of each observation from the filtered growth rate obtained by the Hodrick-Prescott method.

In order to account for the Lucas critique as described in Section 3.2.3, we use interaction terms of all independent variables with the dummies representing the exchange-rate regimes. In such a specification, the significance of the estimated coefficients in front of the interaction terms will indicate if and how parameters change when the exchange-rate regime switches.

In order to account for potential survivor bias (the peso problem), as defined in Section 3.2.1, we will exclude the high-inflationary episodes. Some studies and textbooks (Fuhrer *et al.* 2009; Baumol and Blinder, 2006; Poulson, 1994) define high inflation as within the range of 30-50% per year. Hence, we will exclude all years where the inflation rate exceeds 30%. In order to account for the monetary integration in Europe (the common currency and the ERM-2 as its predecessor), we use a dummy for all 12 countries in the period 1991-2006 [13]; this is done because the common currency in Europe might follow a different pattern in terms of growth and output volatility as compared to a country that unilaterally adopted another-country's currency (such as Montenegro or Ecuador). We define regional dummies, which along with all remaining dummies are described in Table A2.1 in Appendix 2 and follow from the discussion in the preceding sections.

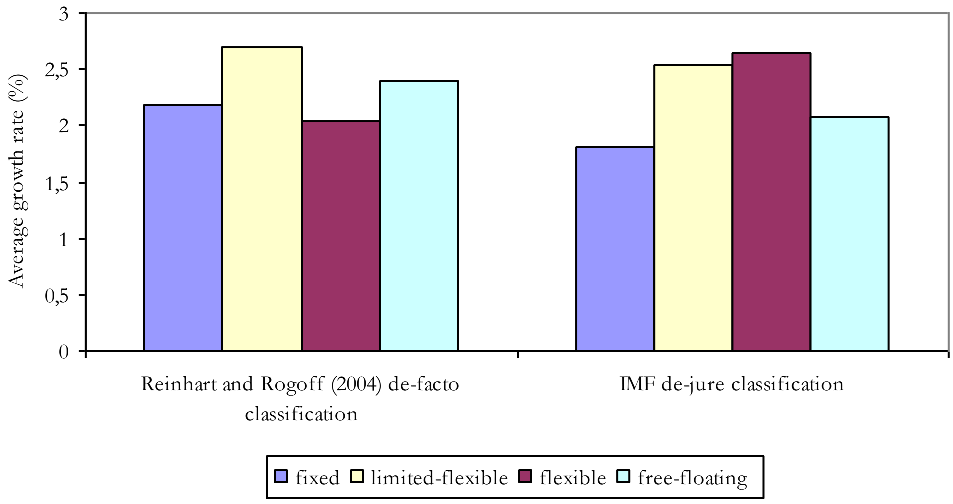
3.3.2. Descriptive analysis

This section portrays a simple descriptive analysis of output-growth and volatility performance under alternative exchange-rate regimes and classifications. We present the outcomes for the two regime classifications: de-facto (RR) and de-jure (IMF). This analysis does not discover causal relationships and its aim is not to do so, but rather to inform expectations about the issues treated herein.

[13] However, with minor adjustments in terms of when these countries joined or left ERM-2.

The growth rates by the RR classification (Table A1.2 in Appendix 1) span from 2.1% in the flexible-regime category to 2.7% in the limited-flexibility category (free-falling category excluded). While the growth rate in the IMF classification spans from 1.8% for fixers to 2.6% for flexible regimes. Table A1.2 in Appendix 1 and Figure 3.1 below suggest that, nevertheless, it could not be inferred that a certain exchange-rate regime is superior over another in terms of output growth, particularly within the de-facto classification.

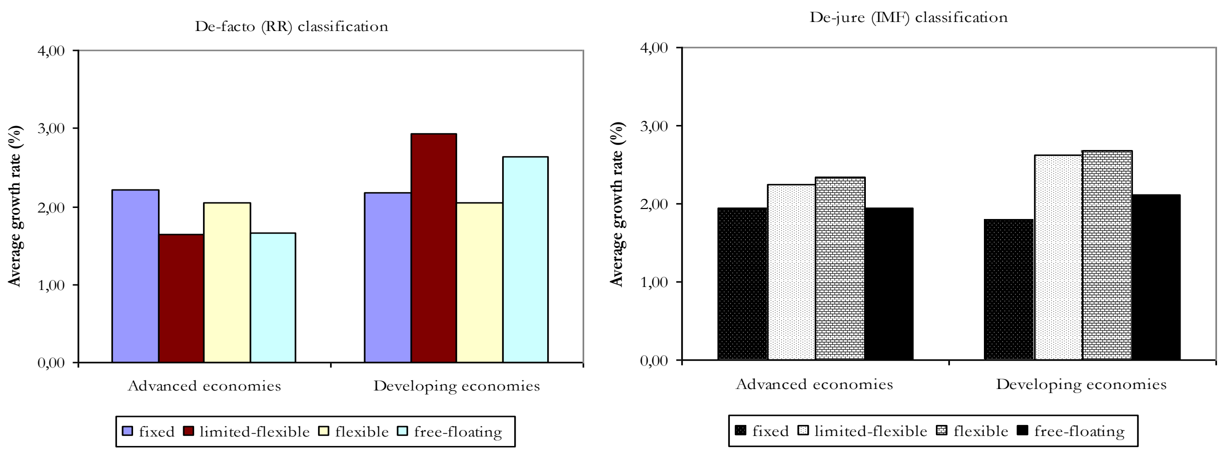
Figure 3.1. Growth performance under different exchange-rate regimes and under two classification schemes (averages 1976-2006)



Source: Calculations based on figures from International financial statistics and Reinhart and Rogoff (2004)

A different picture emerges when the exchange-rate regimes are put in the context of the level of development of the countries in the sample. The latter are observed on advanced and developing economies, according to the specification in Appendix 2. Table A1.3 and Figure 3.2 (left panel) suggest that within the de-facto (RR) classification, there are apparent differences: the growth rates of advanced economies do not much vary across exchange-rate regimes, although it is the highest under the fixed regime; for the developing economies, the variance gets larger: lower growth is experienced by flexible-rate countries, followed by fixers. The highest growth is observed with limited-flexible-regime countries. The de-jure (IMF) classification in Figure 3.2 (right panel) portrays a different picture. Growth-differences among exchange-rate regimes are again not considerable for advanced economies, as in the RR classification. However, for developing economies, fixers exhibit a considerably lower average growth, the flexible-rate countries being the best in terms of growth, but still similar to limited-flexible-rate ones. This conclusion of the comparative analysis is expected, bearing in mind that larger differences are apparent between the exchange-rate policy pursued and the one reported to the IMF within the developing-economies group. This observation strengthens the need to rely on the de-facto classification, as argued in Section 3.2.4.

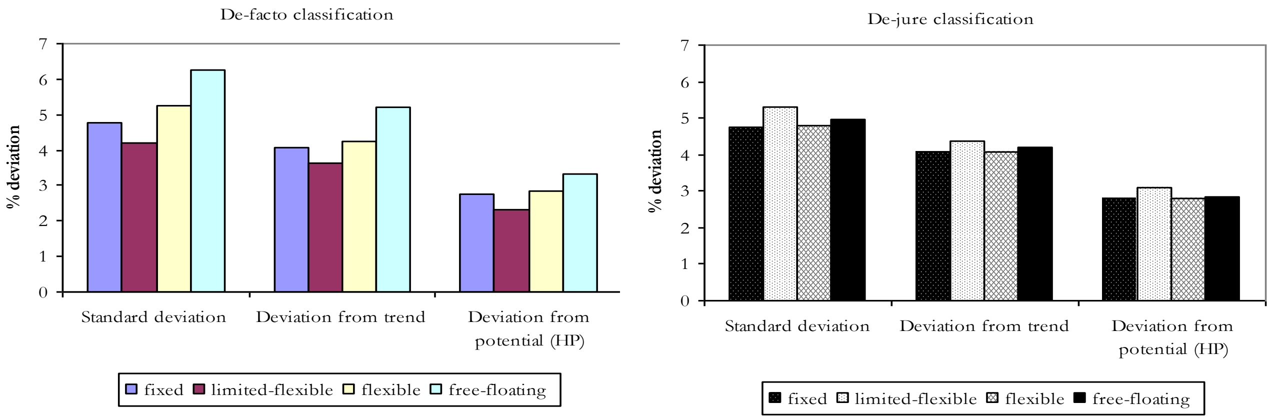
Figure 3.2. Growth performance under different exchange-rate regimes, depending on countries' level of development (averages 1976-2006)



Source: Calculations based on figures from International financial statistics and Reinhart and Rogoff (2004)

Figure 3.3 and Figure 3.4 convey the descriptive analysis on the output volatility under different exchange-rate regimes. We observe three volatility measures, according to the discussion in Section 3.2.4. However, although preference was given among these three measures, they all suggest that, within the de-facto classification, output volatility appeared the lowest under limited-flexible exchange-rate regime and the highest under the free-floating regime. Fixers are ranked second and flexible regimes third, but the discrepancy almost disappears when the output volatility is measured as the difference of the actual growth from the HP-filtered growth. The HP-output volatility is generally lower than the other two measures, and the linear-trend one is generally lower than the rolling-SD output volatility (see Table A1.4 in Appendix 1). The de-jure classification (Figure 3.3, right panel) reveals a different picture. Output volatility is negligibly different among the four categories. These discrepancies between the de-jure and the de-facto classification point to an important source of divergent results among previous studies (see Table 2.1).

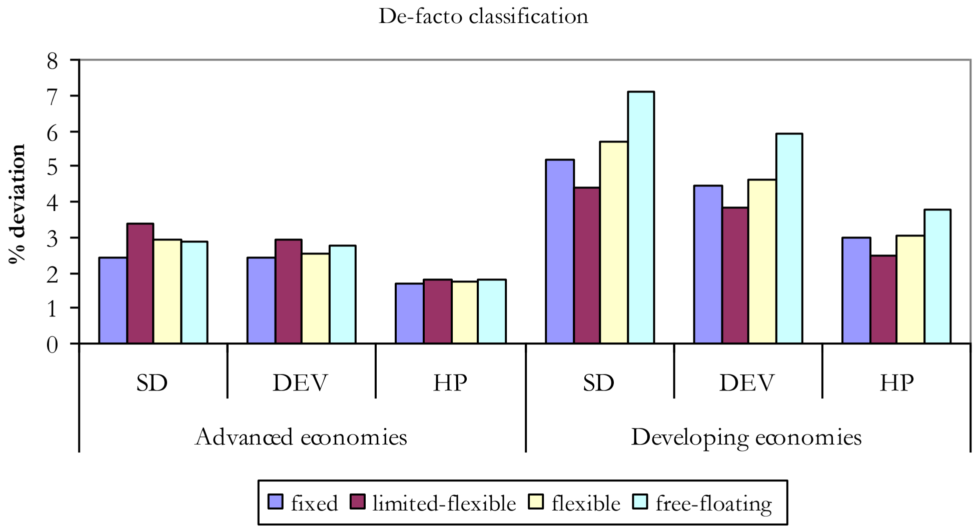
Figure 3.3. Output-volatility performance (three measures) under different exchange-rate regimes, (averages 1976-2006)

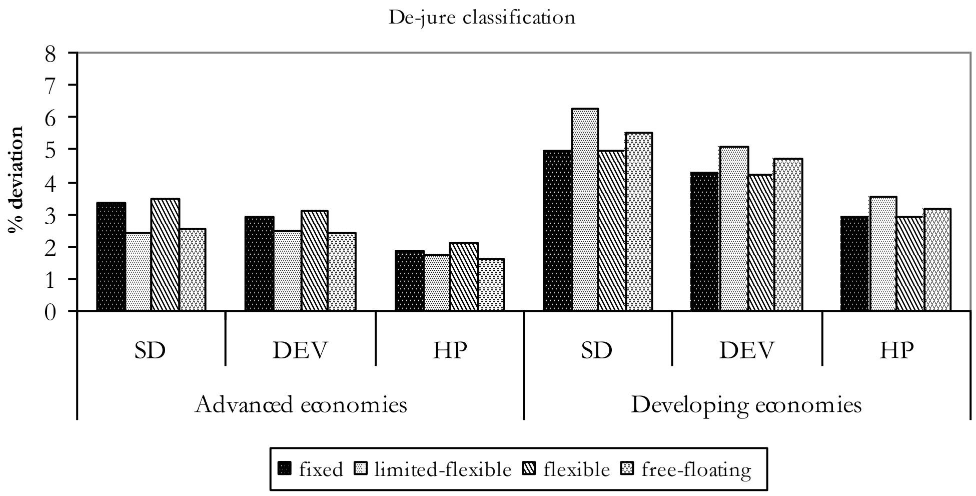


Source: Calculations based on figures from International financial statistics and Reinhart and Rogoff (2004)

Figure 3.4 below and Table A1.5 in Appendix 1 advance the analysis by differentiating countries between developing and advanced. In advanced economies, under the de-facto classification (upper panel) all three measures point to no-differences in output volatility as the regime becomes more flexible. Within the same classification, however, developing economies reveal a different picture. Firstly, the general level of output volatility is higher in developing economies, but declines going from the SD-based measure to the linear-trend-based measure to the HP-based measure. In all three measures, output volatility is the lowest under the limited-flexible regime and the highest under the floating regime. Fixers are second-ranked, but output volatility under a peg does not considerably differ from the one under a flexible regime. Observing the de-jure classification (lower panel), output volatility is generally lower and nearly the same under different exchange-rate regimes, but still lower under limited-flexible and floating regimes for the advanced economies. However, for the developing economies, contrary to the de-facto observations, the highest output volatility is noted under limited-flexible regime, and the lowest under fixed and flexible exchange-rate regime. Almost no difference is noted under fixed vis-à-vis flexible regime within the de-jure classification.

Figure 3.4. Output-volatility performance (three measures) under different exchange-rate regimes, (averages 1976-2006)





Source: Calculations based on figures from International financial statistics and Reinhart and Rogoff (2004)

In conclusion, the descriptive analysis of growth and volatility performance under alternative exchange-rate regimes points to no straightforward expectation for links between the exchange-rate regime and either output growth or output volatility. Nevertheless, the level of development of the economy and the exchange-rare-regime classification appear to make considerable differences, especially for the output-volatility considerations, and this should be investigated further in the empirical investigation.

3.4. Methodology

3.4.1. Addressing endogeneity

The preceding sections discussed how the outlined issues will be addressed within the empirical investigation in this chapter. What remains to be addressed is the endogeneity problem. An explanatory variable is said to be endogenous if it is correlated with the error term. Endogeneity bias might arise because of omitted variables, measurement error, simultaneity or the presence of a lagged dependent variable (Wooldridge, 2002). The first three of these are discussed in the current sub-section and the latter in the following sub-section.

Endogeneity because of omitted variables appears when there is a need to control for variables, but these are not included in the empirical model, either because they are unavailable or because they are unintentionally left out of the analysis. The estimates will be biased if the excluded variable is correlated with included variables. In the estimations in this chapter the variable of most concern is the exchange-rate regime. Chapter 1 suggested that the number of variables which are assumed to be highly correlated to the exchange-rate regime are very few: inflation, trade volume, investment and population. These variables are included in the growth regression and consequently, there are no theoretical grounds to expect that endogeneity bias could arise because of omitting a variable that might be correlated to the exchange-rate-regime dummies.

Endogeneity because of measurement error arises when we want to measure the effect of the exchange-rate regime over growth, but we have an imperfect measure of the exchange-rate regime. The error term would suffer endogeneity bias because it will contain the measurement error as well. Section 3.2.4 discussed the issue of the measurement of the exchange-rate regime and argued for a preferred measure, but the results using both measures are given here for comparison.

Endogeneity because of simultaneity arises when at least one of the explanatory variables is determined simultaneously along with the dependent variable. Part of the literature suggests that the relationship between exchange-rate regime and growth might be simultaneous. Thus, this type of endogeneity might be present in the overall growth regression and, hence, needs to be taken account of in estimation.

However, the exchange-rate literature is not agreed over the exchange-rate regime effect on growth nor does the growth literature associate its choice with growth performance. Hence, Levy-Yeyati and Sturzenegger (2001) believe that this problem should be relatively minor. Eichengreen and Leblang (2003), however, run a probit regression whereby they regress the choice to peg on a set of explanatory variables: trade openness; country size; inflation; GDP per capita; and some political indicators. They find that the majority of these variables are significant in terms of affecting the probability to choose a fixed exchange-rate regime. In consequence, the study suggests that the exchange-rate regime should be treated as endogenous and the failure to do that "is likely to confound efforts to identify the impact of the exchange-rate regime on growth" (p.810). Regarding the output-volatility regression, endogeneity of the exchange-rate regime might be less of an issue, albeit that deciding the exchange-rate policy based on the output fluctuations is theoretically plausible. However, other relationships would appear to dominate the policy agenda and so this issue is not pursued.

Because endogeneity, arising mainly because of simultaneity, is/might be of concern within the growth-, output-volatility and exchange-rate literature, it will be extensively treated in this thesis. The next section discusses both the final possible source of endogeneity and the estimation technique which will be used to address the problem.

3.4.2. Instrumental-variables and dynamic panel techniques

Endogeneity, as defined in Section 3.4.1, causes inconsistency of the usual OLS estimates and requires the use of instrumental variables to correct it. An instrumental variable (IV) is highly correlated with the regressor (which is assumed to be endogenous), but is not correlated with the error term (Wooldridge, 2007). Two general[14] IV estimation techniques were developed to correct the endogeneity bias: two-stage least squares (2SLS) and the generalized method of moments (GMM) techniques. In the 2SLS technique, at the first stage new variables (so-called, instruments) are created to substitute for the original endogenous ones and then, in the second stage, the regression is computed using the newly created variables, which are not correlated with the error term (i.e. are exogenous). In GMM estimation, the information contained in

[14] By "general", we mean techniques applicable in all fields of econometrics where endogeneity might be a problem, including panel econometrics.

the population moment restrictions is used to define instruments (Hall, 2005). In addition to the two general IV methods, Hausman and Taylor (1981) developed, and Amemiya and MaCurdy (1986) advanced, an IV estimator, applicable to panel data only, based on the random-effects model. Namely, in RE model, regressors are assumed to be uncorrelated with the individual-specific error; the Hausman-Taylor estimator allows some of the regressors to be correlated with the individual-country effect, but not with the idiosyncratic error. However, the former is still a source of endogeneity bias and requires an IV correction. Still, 2SLS and GMM estimates, on the one hand, and Hausman-Taylor, on the other, are not directly comparable, because they correct endogeneity arising from correlation with u_i and not ε_{it} (Greene, 2003, p.303). The three IV estimators (2SLS, GMM and Hausman-Taylor) are important in a panel context.

A large strand of the panel literature focuses on endogeneity bias stemming from the inclusion of the lagged dependent variable as a regressor. The revitalization of the interest in long-run growth, its treatment as being a dynamic process (Islam, 1995) and the availability of macroeconomic data for large panels of countries and time spans, has raised the interest in estimating dynamic panel models (See: Barro and Sala-i-Martin, 2004; Mankiw *et al.* 1992; Fisher, 1993; Levine and Renelt, 1992; and others). Judson and Owen (1996) argue that the utilization of panel data is appropriate because it allows the identification of country-specific effects that control for missing or unobserved variables. The term “dynamic”, in econometrics, refers to adding the lagged dependent variable as a regressor in the regression equation (Baltagi, 2008). Furthermore, Bond *et al.* (2001) argue that the right-hand-side variables in a standard growth regression are “typically endogenous” (p.1) and hence suggest GMM estimation of growth models within a dynamic context. A dynamic model could be specified as follows (Lokshin, 2008):

$$y_{i,t} = y_{i,t-1}\gamma + x_{i,t}\beta + \eta_i + \varepsilon_{i,t} \qquad (3.4)$$

whereby, the dependent variable, $y_{i,t}$, is determined by its one-period lag, $y_{i,t-1}$, an exogenous regressor, $x_{i,t}$, which is assumed not to be correlated with the error term

$\varepsilon_{i,t}$, an unobserved individual effect (the so-called, unobserved heterogeneity), η_i [15], and a random error, $\varepsilon_{i,t} \sim \mathrm{N}(0, \sigma_\varepsilon^2), \sigma_\varepsilon^2 > 0$. Judson and Owen argue that the fixed-effects model is preferred in macroeconomics because of two reasons: the unobserved individual effect, representing country characteristics, is highly likely to be correlated with the other regressors; and it is fairly likely that a macro-panel will not represent a *random* sample from a large number of countries, but rather the majority of countries of interest.

Since the model contains the lagged dependent variable, the least squares dummy variable (LSDV) estimator produces biased coefficients (Behr, 2003). Namely, since the dependent variable is included as a regressor with one lag, the latter will be correlated with the error term, rendering estimated coefficients biased (Sevestre and Trognon, 1985). Nickel (1981) shows, however, that when there are no exogenous regressors, the LSDV estimator's bias approaches zero as the time dimension approaches infinity. However, Judson and Owen (1996) found that even when T is as large as 30, the bias could span up to 20% of the coefficient's true value. The effort to account for this bias resulted in two classes of estimators: bias-corrected (BC) and instrumental-variables (IV) estimators (Behr, 2003).

Two practical questions arise in applied econometrics: i) which estimator/technique to proceed with; ii) how large should T be for the bias to vanish? From the viewpoint of this thesis, since we have only 31 years of data use LSDV does not seem appropriate, given the findings reported above. However, the first question asks for more attention. Before we have a look at the results of several Monte Carlo analyses, we briefly review the different estimators within the BC and IV groups, which is simultaneously the chronology of the dynamic-panel developments.

[15] It is worthwhile to make a note, at this point, on the confusion that persists in the literature of whether the unobserved individual effect is an FE or RE within a dynamic context. Pugh (2009) elaborates on this. As we will see later in this section, the confusion applies to both the difference and the system estimator. Arellano and Bond (1991), themselves, although not explicitly, defined their model with FE, but some software (e.g. Stata) implement the difference-GMM estimator as RE model. However, as the individual effect is removed by differencing, its nature is not of any useful importance within the difference-GMM estimator. However, when it comes to the system-GMM estimator, which estimates the specified equation both in levels and in first-differenced form, this issue is clearly important. Both, Arellano and Bover (1995) and Roodman (2009) clearly set out the system-GMM within an RE specification.

Following the investigation of the bias by Nickel (1981), Kiviet (1995) suggested a direct BC method, whereby a formula for the LSDV bias is subtracted from the estimated LSDV coefficients. Based on this, Hansen (2001) suggested an alternative BC method, with a two-step procedure where residuals from the first-step consistent estimator are used in the second-step calculation of the bias. Everaert and Pozzi (2007) further developed the BC approach, with an iterative bootstrap procedure. The general idea behind the correction procedures is to take advantage of the variance, which is much smaller under LSDV than with IV estimators (Behr, 2003). Because of this, it is found that BC methods perform well, i.e. produce more efficient estimates than IV estimators (Judson and Owen, 1996; Lokshin, 2008). However, they rely on the assumption of the other regressors being exogenous (Behr, 2003) and cannot be applied to unbalanced panels (Judson and Owen, 1996; Roodman, 2009). These drawbacks are directly applicable to the case of this thesis (with an unbalanced panel data set and a model with possibly endogenous regressors).

The use of instrumentation methods, mentioned at the beginning of the section, removes the endogeneity bias resulting from the correlation between the regressor and the error term (Wooldridge, 2007). Anderson and Hsiao (1981) and (1982) were the pioneers in proposing use of the GMM procedure within a dynamic context; they differenced equation 3.2 in order to remove the individual effects in the error term which, otherwise, are correlated with the lagged dependent variable; however, the difference of the lagged dependent variable will still be correlated with the error term and, hence, should be instrumented. These researchers proposed using the second lag of the dependent variable ($y_{i,t-2}$) or the lagged difference ($y_{i,t-2} - y_{i,t-3}$) as instruments of $\Delta y_{i,t-1}$, because those are expected to be uncorrelated to the error term. Arellano (1989); Arellano and Bond (1991); and Kiviet (1995) analysed the properties of the two instruments suggested by Anderson and Hsiao and found that the "level" instrument has smaller variance and is, hence, superior to the "differenced" one.

Arellano and Bond (1991) suggested exploiting an enlarged set of instruments; namely, all available lagged values of the dependent variable and the lagged values of the exogenous regressors. A possible drawback of this, so called, difference-GMM estimator, is that by enlarging the number of periods, the number of instruments gets considerably larger. Moreover, instruments could be weak, because they use information contained in differences only (Ahn and Schmidt, 1995) and because they do not account for the differenced structure of the residual disturbances (Baltagi, 2008). Ahn and Schmidt (1995), Arellano and Bover (1995), and Blundell and Bond (1998) consequently suggested using additional information contained in levels, which should result in a more efficient estimator, known as the system-GMM estimator. This augments the difference-GMM by simultaneously estimating in differences and levels, the two equations being distinctly instrumented (Roodman, 2009). In the system-GMM estimator, both predetermined and endogenous variables in first differences are instrumented with suitable lags of their own levels (used by Arellano-Bond); and predetermined and endogenous variables in levels are instrumented with suitable lags of their own first differences. As a consequence, the system-GMM estimator should produce more efficient estimates and, hence, outperform the difference-GMM estimator. All Arellano-Bond, Arellano-Bover and Blundell-Bond estimators can be estimated as one- or two-step procedures; the one-step estimator makes use of a covariance matrix that accounts for autocorrelation, while the two-step estimator uses the residuals from the first step to estimate the covariance matrix.

Nevertheless, when either difference- and system-GMM are applied, a problem arises: increasing the number of instruments can mean increasingly weak instruments which, in turn, reduces the power of the Sargan/Hansen test to reject the null of instrument validity. The problem has been acknowledged in the literature (Roodman, 2009; Tauchen, 1986; Altonji and Segal, 1996; Andersen and Sørensen, 1996; Ziliak, 1997; Bowsher, 2002; and others). However, as Roodman (2009) argues, the literature - albeit making some inroads - has not yet provided a general direction on how much bias an instrument collection of a given size generates. For instance, Windmeijer (2005) found that when the number of instruments is reduced from 28 to 13, the average bias reduces by 40%. Similar results were obtained by Ziliak (1997) and Tauchen (1986). It is inherent that the number of instruments gets larger as the number of endogenous and predetermined variables increases and as T grows. Moreover, the researcher can add external instruments. However, "the overall count [of instruments] is typically quadratic in T" and this makes asymptotic inference of the estimators and the specification tests misleading (Roodman, 2009, p.141). Moreover, the bias rises as both T and N grow (Arellano, 2003b).

The development of the dynamic-GMM panel techniques in recent years established that both difference- and system-GMM panels can generate moment conditions prolifically (Roodman, 2009). A crucial assumption for the validity of GMM is that the generated instruments are exogenous, i.e. do not correlate with the error term. Sargan and Hansen-J tests have been designed to detect violation of this assumption, but there is no formal test to check how many instruments should be cut (Ruud, 2000). Sargan and Hansen-J tests set the null as "instruments are valid", which is the assumption that we want to test. However, the Hansen-J test grows weaker with more moment conditions and a p-value of 1 is a classic sign of instrument proliferation, because it points out that the test is unable to detect the problem. Sargan/Hansen tests can be also used to test the validity of subsets of instrument, through the difference-in-Sargan specification. Roodman (2009) suggests combining two ways to cut instruments: collapsing them and/or limiting lag length. Using simulation, he found that the problem of too many instruments becomes apparent when $T>15$; also, the bias slightly increased when both collapsing and lag-limiting commands were used (from 0.03 to 0.05), but strangely lessened as T went from 5 to 20.

There are two great additional advantages of the GMM estimator in addition to those already discussed (Verbeek, 2000): i) it does not require distributional assumptions, like normality; and ii) it can allow for heteroskedasticity of unknown form. The first feature means that normality is not an assumption that should be a subject of diagnostic testing; while the potential heteroskedasticity can be allowed for by estimating "robust" parameters. However, if the errors are serially correlated, than these will not be independent of the instruments; the GMM estimator, hence, requires no (second-order) serial correlation in the error term of the differenced equation (Arellano and Bover, 1995). Moreover, the above-mentioned Sargan and Hansen-J tests (Roodman, 2009; Baltagi, 2008) test whether instruments are uncorrelated with the error term, i.e. it checks the validity of over-identifying restrictions in the model.

An early trial to evaluate the different dynamic-panel estimators was made by Judson and Owen (1996). However, the study was done when the system-GMM estimator was in its launch-phase and it is thus not included in the analysis. This Monte Carlo study shows that OLS generates significant bias, even when T gets large. The bias is lessened, but still spans up to 20% under the LSDV estimator even when $T=30$, but the estimator does not become more efficient. In any case, LSDV was acknowledged to be inappropriate in many cases, among which is this thesis. To account for the computation difficulty of including too many instruments in the difference-GMM estimator, Judson and Owen (1996) restrict the number of instruments to a maximum of eight; vary T from 10 to 30 and N from 20 to 100. The one-step difference-GMM estimator is found to outperform the two-step in terms of producing a smaller bias and a lower standard deviation of the estimates. When compared to all dynamic-panel estimators, difference-GMM again shows superiority when N is large. "[F]or a sufficiently large N and T, the differences in efficiency and bias of the different techniques become quite small" (p.12), suggesting that the estimators improve as T gets larger (up to 100 periods). Albeit, results suggest that the Anderson-Hsiao estimator produces the lowest average bias and lower bias as T gets larger. Therefore, "a reasonable strategy … for panels with larger time dimension [would be to] use the Anderson-Hsiao estimator" (p.12). On the other hand, the Monte Carlo study by Arellano and Bond (1991) (N=100, T=7) showed that the difference-GMM estimator has negligible finite sample bias and substantially smaller variance than the Anderson-Hsiao estimator. However, the estimated standard error of the two-step estimator was found to suffer downward bias, which is attributed to the estimation of the weight matrix (Windmeijer, 2005). Hence a correction has been proposed, based on a Taylor-series expansion that accounts for the estimation of the weighted matrix[16].

Behr (2003) conducted Monte Carlo analysis which includes the system-GMM Blundell-Bond estimator. When N=100, T=10, the Anderson-Hsiao estimator is found to be unbiased but rather inefficient because of the large standard deviation. The system-GMM estimator is found to be unbiased and the most efficient. The same conclusion holds, although both estimators improve, when N=1000, T=10. If predetermined endogenous variables are used, then the system-GMM is again found to be superior. A drawback of the simulation is that it does not enlarge the number of periods in order to observe how these estimators perform, but rather focuses on the cross-section dimension. Changes in the number of periods are examined in Harris and Matyas (2004) who found that both difference- and system-GMM estimator suffer bias when the sample is small and the number of instruments very large. They found that the bias is reduced as T gets larger, but they do not relate the bias to the consequent proliferation of instruments.

In summary, the evidence of the Monte Carlo studies is not overwhelming, but tends to suggest that the least biased and the most efficient estimator is system-GMM. The biasness is further lowered by increasing T, which is of particular importance in this study. The number of instruments, however, matters in terms of the trade-off between

[16] Roodman's (2008) xtabond2 command implements this correction.

biasness and efficiency: (1) limiting instruments might slightly increase bias, but negligibly as T grows; (2) efficiency increases as poor instruments are removed; and (3) computation becomes less cumbersome. Consequently, we estimate the growth and volatility regressions within the system-GMM framework.

3.5. Results and discussion

3.5.1. Exchange-rate regime and output growth

Taking into account what was proposed in Section 3.2, the growth regression is:

$$GROWTH_{i,t} = \alpha_0 + \beta\, GROWTH_{i,t-1} + \varpi_j X_i + \gamma_j Z_{i,t} + \tau_j N_{i,t} + \kappa_j INT_{i,t} + \psi_j LAG_{i,t-1} + \delta_t + (u_i + \varepsilon_{i,t}) \quad (3.5)$$

The coefficients are specified according to the groups of variables, as follows:

- α_0 is the intercept;
- β is for the lagged dependent variable;
- ϖ s for predetermined variables $X_i = (LGDP75; LIFE1)$;
- γ s for endogenous variables $Z_i = (EDUC; GCGDP; TO; INF; INVGDP; LFERTIL;\ DEM;\ RRx / IMFx)$;
- τ s for exogenous variables $N_i = (LPOPUL; EURER; SURVIVOR; LATCAR; SAHAR)$. Dummies for Sub-Saharan Africa and Latin America and the Caribbean enter as routinely suggested in the growth literature;
- κ s for interaction terms of exchange-rate regime dummies with all policy variables $INT_{i,t} = (GCGDP; TO; INF; INVGDP; DEM)$, including variables which are objects of policy actions $(EDUC; FERTIL)$. Interaction terms are added in order to address the Lucas critique (see Section 3.2.3). Following Lucas (1976), we believe that interacting policy variables may be sufficient to capture the possible parameters-change;
- ψ s for one-lag regressors $(LAG_{i,t-1})$ from the policy variables $(GCGDP; TO; INF; INVGDP)$ and from the two object-policy variables $(EDUC; FERTIL)$. This is because of Bond *et al.*'s (2001) and Roodman's (2008) argument that the right-hand-side variables in a standard growth regression are lagged as well, which means the process of adjustment to changes in these factors may depend on the passage of time;
- δ_t is a time-specific fixed effect (if applicable and reported in the print-outs in Appendix 4 only), which, according to Sarafidis *et al.* (2009) and

Roodman (2008) is always suggested as a wise strategy to remove any global time-related shocks from the errors, hence eliminating – or, at least, reducing – cross group residual correlation;

- $(u_i + \varepsilon_{i,t})$ is the composite error term, where:
    - u_i is a country-specific error term (not reported);
    - and ε_{it} is the usual i.i.d. error term.

Variables are as defined in Table 3.2. We estimate this regression for 169 countries and 31 periods. One of the exchange-rate dummies is dropped to represent the base and is indicated as the "omitted category" in Table 3.5, Table 3.6 and Table 3.8. The log of the average GDP per capita (1970-74) enters as an external instrument to correct potential measurement error in GDP per capita in 1975.

Table 3.2. Growth variables: definitions, sources and expected signs

Variable		Theory and expected sign	Source	Notes
		Dependent variable		
Real Per Capita GDP growth	GROWTH		IMF, World Economic Outlook	This variable is expressed in percentages (i.e. value of 3 refers to 3% and is not settled as 0.03).
		Independent variables		
Initial values				
Log(Initial Per Capita GDP)	LGDP75 LGDP90 (for regressions 1991-2006)	Neo-classical theory - Solow model (-)	IMF, World Economic Outlook	Observation for 1975 (1990) – a predetermined variable. Earlier values (average over 1970-1974; and value in 1989) are used in the list of instruments in order to lessen the tendency to overestimate the convergence rate because of temporary measurement error in GDP
Life expectancy at birth (reciprocal value)	LIFE1 LIFE2 (for reg. 1991-2006)	Neo-classical theory - Augmented Solow model (-)	World Bank Database	An observation in 1975 (1990)– a predetermined variable. The reciprocal value is multiplied by 100 to avoid parameter with many decimals.
Log of Population	LPOPUL	Neo-classical theory - Solow model (-) Endogenous theories (+)	IMF, WEO UNDP, Demographic statistics	Exogenous
Policy and object-to-policy variables				
Educational attainment	EDUC	Neo-classical theory - Augmented Solow model (+)	World Bank Database	Average years of secondary and higher schooling, observed as average values over 5-year periods for 1985-2006. Previous values are unavailable.
Log of Fertility rate	LFERTIL	Neo-classical theory - Solow model (-)	UNDP World Population Prospects, 2006	Total lifetime live births for the typical woman over her expected lifetime. It enters as a log of the averages 1985-1990; 1990-1995; 1995-2000 and 2000-2005. Previous and annual values are

				unavailable.
Government consumption ratio	GCGDP	Neo-classical theory - Solow model (-) Endogenous theories (-)	IMF, WEO World Bank estimated	Ratio of nominal government consumption to nominal GDP.
Trade openness	TO	Neo-classical theory - Solow model (+) Endogenous theories (+)	IMF, Trade Statistics	Ratio of export plus import over two over GDP.
Investment ratio	INVGDP	Neo-classical theory - Solow model (+)	IMF, World Economic Outlook	Ratio of gross capital formation to GDP.
Inflation rate	INF	Neo-classical theory - Solow model (-) Endogenous theories (-)	IMF, World Economic Outlook	Consumer price inflation
Exchange rate regimes	RRx IMFx	Exchange-rate regime theories (insignificant or sign mixed)	Official IMF classification De-facto classification by Reinhart and Rogoff (2004)	x represents the type of ERR: 1 – fix; 2 – limited flexibility; 3 – flexible; 4 – free float; 5 – free falling (RR only); OT –other (like dual markets; IMF only)
Institutional variables				
Democracy index	DEM	Theory of institutional factors of growth (-); squared term (+)	Freedom House	The index of political rights

We utilize system-GMM dynamic panel estimation, according to the discussion in Section 3.4.2. Bond *et al.* (2001) argue that utilizing system-GMM approach in a growth framework has at least four advantages: i) it produces estimates not biased by omitted variables (like the initial efficiency); ii) produces estimates which are consistent even in the presence of measurement error; iii) accounts for the endogenous right-hand-side variables (like investment in a growth-context); and iv) exploits an assumption about the initial conditions to obtain moment conditions that remain informative even for persistent series (i.e. series that contain a unit root, like output). In their empirical work, Bond *et al.* (2001) found that the difference-GMM in growth models is seriously biased, due to the high degree of persistence of output and the resulting weak instruments. On the other hand, they found the system-GMM to be unbiased and consistent even when some of the series contains a unit root. Hence, this study discards the earlier recommendation by Caselli *et al.* (1996) to use differenced-GMM estimator for empirical growth models.

Nevertheless, although system-GMM is found to be unbiased and consistent when some of the series are persistent, no solution has been offered when variables cointegrate, i.e. when they are all I(1), but a linear combination of those is I(0). We add this caution following the recent work of Pesaran and Smith (1995) and Pesaran *et al.* (1997, 1999) who consider the implications of the non-stationarity and cointegration properties of the underlying data-generating process. Nevertheless, the system might cointegrate only if all variables contain a unit root. Table 3.3 presents the results from two panel unit-root tests proposed by Maddala and Wu (1999) and Pesaran (2003), respectively. The first, the so-called Fisher's test, combines the p-values from N independent unit-root tests and assumes that all series are non-stationary under the null hypothesis. Pesaran's test applies to heterogeneous panels with cross-section dependence and it is based on the mean of the individual Dickey-Fuller (or Augmented DF) t-statistics of each unit in the panel. The null hypothesis also assumes that all series are non-stationary. To eliminate the cross-group dependence, the standard DF (or ADF) regressions are augmented with the cross-section averages of lagged levels and first-differences of the individual series.

Table 3.3. Panel unit-root tests (growth regression)

	Maddala and Wu (1999)		Pesaran (2003)	
	Constant	*Constant and trend*	*Constant*	*Constant and trend*
Real per capita GDP growth	1540.38***	1370.20 ***	-15.53***	-10.90***
Inflation	1410.18***	1265.26***	-13.05***	-13.14***
Trade openness	499.14***	459.84***	-0.77	-2.85***
Government consumption to GDP	617.53***	559.70***	-0.99	0.38
Investment to GDP	702.35***	742.97***	-3.84***	-4.52***
Democracy index	565.71***	527.91***	No obs	No obs
Log of population	140.79	754.03***	9.44	6.74
Δ Log of population	1156.57***	968.74***	-11.96***	-4.96***

Note: Numbers represent Chi2 statistics or t-statistics. *, ** and *** indicate that the null of a unit root is rejected at 10, 5 and 1% level of significance, respectively.
Regressions for testing for unit roots include one lag to eliminate possible autocorrelation.

The results suggest that there is little empirical basis for concern that the variables are non-stationary. As expected, the only non-stationary variable is population, where both tests indicate the presence of a unit root; hence, we use the first difference, reflecting population growth. Pesaran's test indicates a unit root in the government-consumption variable, but this is not the case with Fisher's test. Another possibility to take account of in considering the statistical generating mechanism of each variable is that there may be structural breaks in a stationary process, i.e. mean-breaks, trends and/or broken trends. For example, although in the case of the dependent variable, real per capita GDP, the unit-root tests reject its non-stationarity, what is left is likely to be stationarity with shifting means (reflecting the business cycle). A mean-shift that applies to all countries in a similar fashion is captured by the set of period dummies that is included in our model. However, structural breaks that differ in timing and magnitude between countries will not be picked up, unless these are allied with the regime shifts. Only in the latter case will an effect of the regime change be detected. Conversely, the possibly of several mean shifts in each series, and that they are idiosyncratic (i.e., different for each country) might lead to identifying a zero effect of exchange-rate regimes on growth. In this particular case, this line of argument actually supports our conclusion. Namely, if GDP growth in each country has a shifting mean then non-significance of the regime shift dummy suggests that the mean shifts do not "line up" with the shift modeled by this dummy variable. Should they exist, there will be some cause of the mean shifts; but this cause is not modeled by the regime shift dummy. More generally, however, not having modelled structural breaks distinct from exchange-rate regime dummies might complicate the estimation and, in turn, the interpretation of the results. However, there are problems in identifying the timing and type of such breaks as well as difficulties in statistically testing for them (Perron, 1989). Given this, while acknowledging that if such breaks exist then they may bias our estimation, this type of investigation is beyond the scope of this thesis and we leave it for further work (see Section C.5).

Thus, given the findings on unit roots discussed above, we proceed with the system-GMM estimation, as explained above. We use both the lag-limiting and collapse commands available under Roodman's (2008) xtabond2 command to reduce the number of instruments. These methods are important in reducing the number of instruments, whose number otherwise will be enormous because of the number of regressors and the large T. Lag-limits are set so that the number of instruments does not exceed the number of cross sections and/or to get useful Hansen's statistics. Current thinking suggests that the null of instrument validity is not rejected if the relevant p-value is above 0.25 but below values near unity[17] (Roodman, 2009).

Section A4.1 in Appendix 4 presents estimations from our specification search. We start with equation 3.5; Hansen's test for over-identification and the Arellano-Bond test for serial correlation both suggest an appropriate specification[18]. We conduct F-tests, to check if interaction terms, group-by-group, are jointly significant; these suggest that the null that the effect of the policy variables do not change when regime switches could not be rejected for all exchange-rate regimes and, in consequence, there is no evidence for the Lucas critique. Moreover, there is no particular variable among those which was individually significant, which excludes any oversight of a specific-variable effect. We remove those interactions and reestimate. The Hansen test (p=0.739) suggests the over-identifying instruments are valid, while the Arellano-Bond-AR(2) test statistic (p=0.396) suggests no evidence of serial correlation in the errors. However, observing the coefficients, the majority of these are insignificant at conventional levels. A possible explanation is that including the current and lagged value of each variable

[17] Our general principle in all specifications was to expand the number of instruments until Hansen's p-value deteriorates, i.e. approaches 0.25 or unity.

[18] The AR(2) test suggests that there is no obvious problem with heterogenous error cross-section dependence. However, to further investigate this, the procedure proposed by Sarafidis et al. (2006) is followed. The Difference-in-Hansen test for the excluded group of instruments on the lagged dependent variable (not shown, but available on request) suggests that at the 10% level of significance, there is no undue problem with cross-section dependence in our data.

might give rise to multicollinearity. The F-test for the joint significance of the lagged independent variables does not reject the null of joint insignificance (p=0.3352). The next estimation in Section A4.1 is without lagged values. The regression is well specified (p(AR2)=0.860; p(Hansen)=0.646) and this is our final specification, which is central in Table 3.5. All results in the tables do not report the time dummies, but these are reported in Section A4.1. In general, some of the dummies across the specifications appear (highly) significant, hence picking up some global developments and supporting our strategy of their inclusion.

The Wald tests (p=0.000) suggests that all the right-hand-side regressors are jointly highly significant in explaining growth. Observed individually, some of the regressors are statistically significant, some are not, but all of them have the expected sign and magnitude. The lagged dependent variable has the expected positive coefficient (0.157), which is below one and is in line with the literature (Roodman, 2008), pointing to a stable dynamic process. Before we proceed with the explanation on the other variables, a note on the issue of long-run versus short-run coefficient. Given that we have the dependent variable as lagged regressor, the coefficients reported are short-run or impact effects. We need a guidance on the magnitude and significance of the long-run effects. These are calculated as:

regressor's coefficient / (1 – coefficient of the lagged dependent variable).

Given that the coefficient in front of the lagged dependent variable in all estimations ranges between 0.12 and 0.30, obtained long-run coefficients will not be much larger than the short-run. However, their significance is more important. Though, across all specifications the exchange-rate dummies were insignificant even at the 10%, similarly as the short-run coefficients. Hence, we decided to proceed with building the argument based on the short-run effects only.

All other regressors have the expected sign and magnitude, although only inflation, fertility rate, trade openness and, in some specifications, government consumption and investment, are significant at conventional levels. Table 3.4 compares the system-GMM estimate of the lagged dependent variable with the FE one (which is, on average, downward biased) and with the OLS one (which is, on average, upward biased). Our finding is within the range given by FE and OLS estimators (Bond *et al.* 2001; Roodman, 2008) which supports its validity.

Table 3.4. Comparison statistics of System-GMM with OLS and FE in terms of the estimated coefficient on the lagged dependent variable (RR classification)

	FE	OLS	System-GMM
Growth(-1)	0.118	0.232	**0.158**
AR(1) (p-value)	0.000	0.607	**0.000**
AR(2) (p-value)	-	-	**0.860**
Hansen (p-value)	**-**	**-**	**0.646**

The variable of main interest – the de-facto *exchange-rate regime*, is statistically insignificant at conventional levels, although the signs suggest that de-facto fixers deliver the best growth performance. The insignificance of the de-facto exchange-rate regime in explaining growth is confirmed by the F-test of the joint effect of the regimes (p=0.172). Hence, the main conclusion is that the de-facto exchange-rate regime is not significant in explaining growth. The results are confirmed if the specification is applied to developing countries only, reducing the sample to 139 countries[19]. In these specifications also the de-facto exchange-rate regime did not come close to conventional significance levels. Columns (5) and (6) of Table 3.5 present the estimates for two distinct sub-periods: 1976-1990 and 1991-2006. The intuition behind this division is to capture the early post-socialism period (after 1991), when transition countries experienced accelerating inflation and nearly all of them subsequently established a form of fixed exchange rate. The de-facto regime again is insignificant at conventional levels in both periods, although coefficients in the overall regression slightly differ between the two periods. Finally, column (7) distinguishes de-facto regimes between advanced, developing and transition economies for the period 1991-2006, but finds no different results.

Table 3.6 advances the issue by considering peg duration. Some studies and findings mentioned in Chapter 1, argued that a peg delivers early benefits by curbing inflation, but long pegs strangle growth. To check for this, we make an arbitrary cut-off of peg duration at: pegs up to 5 years; pegs longer than 5 but shorter than 10 years; and pegs longer than 10 years. All specifications are diagnostically valid. However, signs, magnitudes and significance, and hence, conclusions are similar to those in Table 3.5.

[19] We do not run a regression for advanced-countries group because they comprise a sample of 30 countries, so that N=T. In this case, it could be argued that dynamic system-GMM is not the best estimator. Refer to Section 3.4.2.

The de-facto exchange-rate regime and its duration are not significant in explaining growth, irrespective of the level of development of countries or of the observed sub-periods.

It is worthwhile, though, to note that fixed exchange rate regimes and, in particular, short-to-medium-lived pegs appear to favour growth under the FE estimator. Yet, these results cannot be taken as compelling evidence, because of: (1) in a large sample, the 10% significance is indeed marginal; (2) the FE estimator is biased even with T=30 (Judson and Owen, 1996); (3) the potential endogeneity of some of the independent variables.

Table 3.5. Growth regression under RR (de-facto) classification of exchange-rate regimes

Dependent variable: *Real per capita GDP growth*	FE	OLS	System-GMM	Developing countries	Sub-periods: 1976-1990	Sub-periods: 1991-2006	1991-2006 – Lev. of devel.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Real per capita GDP growth(-1)	0.118***	0.232***	**0.157*** **	0.163**	0.167	0.295***	0.298***
Initial GDP in 1975	-	-0.192	**-2.469**	-0.455	3.875	-1.945	-1.551
Life expectancy at birth (inverse)	-	-0.422	**33.276**	14.424	10.707	-6.976	-11.084
Inflation	-0.383	0.158	**-2.649**	-3.367**	4.820	3.107	2.673
Average years of schooling	-	-0.062	**2.254**	1.925**	-2.650	0.037	-1.047
Log of fertility rate	0.119	0.00078	**-11.978** **	4.153	-6.831	-0.394	-0.544
Trade openness	4.771***	1.961***	**8.272** **	12.880***	7.384	0.210	1.327
Government consumption to GDP	-23.068***	-7.453***	**13.436**	18.389	13.807	0.561	8.085
Investment to GDP	-0.032	0.014	**0.775** *	0.870	-0.446	0.196	-0.122
Democracy index	-0.091	-0.058	**-0.786**	-1.162	-3.666	-0.229	-0.537
Democracy index squared	0.005	-0.015	**0.073**	0.155	0.492	0.028	0.023
Fixed ERR	*1.206**	*0.106*	***2.317***	*-1.564*	*0.415*	*1.160*	*3.382*
Limited flexible ERR	*0.446*	*0.312*	***-0.183***	*-3.004*	*2.572*	*-0.355*	*-0.918*
Flexible ERR	*0.022*	*0.149*	***1.134***	*-0.110*	*-1.090*	*0.025*	*0.303*
Free floating ERR	*Omitted cat*	*Omitted cat*	***Omitted cat***	*Omitted cat*	*Omitted cat*	*Omitted cat*	*Omitted cat*
Other cat. (dual market / free fal.)	*-2.073****	*-1.766****	***0.124***	*-1.543*	*-3.670*	*-2.672*	*-2.804*
Δ Log of population	-87.489***	-65.394***	**-0.075**	-117.391	-99.67	-80.729	-89.059**
Dummy for the Euro zone	-0.716	-0.782**	**-1.788**	-	-2.081	-1.865	-5.153
Dummy for survivor bias	0.580	0.931	**1.641**	1.504	-	-0.438	0.0067
Dummy for Latin A. and Caribbean	-	-0.765**	**3.698** *	-0.147	-0.102	-0.414	-0.059
Dummy for Sub-Saharan Africa	-	-0.240	**-2.704**	-5.159	-0.757	1.288	2.794
Fixed ERR in Transition countries							-0.480
Lim-flex ERR in Transition countries							3.786
Flexible ERR in Transition countries							4.079
Fixed ERR in Developing countries							-3.852
Lim-flex ERR in Developing countries							1.307
Flexible ERR in Developing countries							0.478
Constant	5.413***	6.891***	**-35.440**	-30.203	-22.530	30.027	36.717
Wald test (p-value)	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
AR(2) (p-value)	**-**	**-**	**0.860**	**0.539**	**0.565**	**0.901**	**0.838**
No instruments	**-**	**-**	**54**	**52**	**36**	**48**	**56**
Hansen (p-value)	**-**	**-**	**0.646**	**0.662**	**0.617**	**0.308**	**0.505**

Notes: *, ** and *** refer to a significance level of 10, 5 and 1%, respectively. All regressions (except the regressions of the first two columns) are two-step system GMM. The Windmeijer (2005) corrected standard errors are reported in parentheses. ● The specification for the period 1991-2006 uses the initial level of real per capita GDP in 1990. The level in 1989 is used as instrument to correct for possible measurement error. Life expectancy at birth refers to 1990.

Table 3.6. Growth regression under RR (de-facto) classification of exchange-rate regimes – by peg duration

Dependent variable: *Real per capita GDP growth*	FE	OLS	System-GMM	Developing countries	Sub-periods 1976-1990	Sub-periods 1991-2006	1991-2006 – Lev. of devel.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Real per capita GDP growth(-1)	0.118***	0.224***	0.159**	0.136**	0.119*	0.287***	0.276***
Initial GDP in 1975	-	-0.317*	-2.033	-4.603	8.889	-2.350	-1.280
Life expectancy at birth (inverse)	-	-0.537	21.952	14.598	41.597	-9.795	-11.856
Inflation	-0.373	-0.012	-1.877	-4.138*	7.036	3.219	3.302
Average years of schooling	-	-0.048	1.562*	2.491*	2.889	0.124	-0.316
Log of fertility rate	0.101	0.068	-8.247*	1.691	16.845	2.389	3.621
Trade openness	4.816***	2.049***	8.771***	13.059***	23.764	-0.644	-0.198
Government consumption to GDP	-23.198***	-7.113***	3.538	24.247	84.155	8.310	9.374
Investment to GDP	-0.03	0.016	0.601*	0.784	2.817	0.149	-0.069
Democracy index	-0.088	-0.092	-0.180	-0.2	5.125	-0.722	-0.363
Democracy index squared	0.0049	-0.01	0.017	0.023	0.604	0.073	0.001
Fixed ERR under 5 years	*1.154**	*0.975***	*1.506*	*-3.937*	*10.984*	*0.102*	*-1.878*
Fixed ERR 5 to 10 years	*1.405**	*0.557*	*1.458*	*-7.544*	*9.135*	*-1.848*	*-5.512*
Fixed ERR over 10 years	*1.312*	*-0.449*	*0.251*	*-16.384*	*9.978*	*-2.137*	*-5.956*
Limited flexible ERR	*0.461*	*0.304*	*-0.801*	*-3.410*	*9.488*	*-1.071*	*-4.856*
Flexible ERR	*0.040*	*0.131*	*0.332*	*-0.068*	*9.472*	*-0.433*	*-2.172*
Free floating ERR	*Omitted cat*	*Omitted cat*	*Omitted cat*	*Omitted cat*	*Omitted cat*	*Omitted cat*	*Omitted cat*
Other cat. (dual market / free fal.)	*-2.068****	*-1.724****	*-0.934*	*-1.074*	*10.613*	*-2.996*	*-3.995*
Δ Log of population	-87.631***	-66.026***	-31.845	-70.086	218.957	-93.556**	-92.09**
Dummy for the Euro zone	-0.768	-0.836**	-1.423	-	4.284	-0.037	1.35
Dummy for survivor bias	0.598	0.848	0.939	1.504	-	-0.714	-0.796
Dummy for Latin A. and Caribbean	-	-0.681**	2.652	3.018	6.681	-1.149	-1.427
Dummy for Sub-Saharan Africa	-	-0.128	-1.651	-1.380	5.112	1.004	1.921
Fixed ERR 5 in Transition countries							3.044
Fixed ERR (5-10) in Transition countries							7.698
Fixed ERR 10 in Transition countries							7.325
Fixed ERR 5 in Developing countries							5.338
Fixed ERR (5-10) in Developing countries							4.238
Fixed ERR 10 in Developing countries							1.621
Constant	5.427***	7.707***	-19.530	-3.427	-43.065	36.341	36.717
Wald test (p-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR(2) (p-value)	-	-	0.939	0.536	0.519	0.802	0.921
No instruments	-	-	58	50	40	52	60
Hansen (p-value)	-	-	0.693	0.740	0.439	0.440	0.637

Notes: *, ** and *** refer to a significance level of 10, 5 and 1%, respectively. Notes of Table 3.5 apply.

The above testing-down procedure is repeated with the de-jure (IMF) classification and the final specification[20] is reported in Section A4.1. The regression is well specified, according to the diagnostic statistics (p(AR2)=0.724; p(Hansen)=0.191). The coefficient on the lagged dependent variable is within the range established by FE and OLS and hence, this supports its validity.

Table 3.7. Comparison statistics of System-GMM with OLS and FE in terms of the estimated coefficient on the lagged dependent variable (IMF classification)

	FE	OLS	System-GMM
Growth(-1)	0.124	0.248	**0.219**
AR(1) (p-value)	0.0000	0.3984	**0.000**
AR(2) (p-value)	-	-	**0.724**
Hansen (p-value)	-	-	**0.191**

Table 3.8 takes the issue further. Contrary to the de-facto classification, in the overall specification, the IMF's de-jure classification of the exchange-rate regime reveals some significant effects on growth. Namely, the system-GMM estimates suggest that a de-jure peg performs better than de-jure float with a magnitude of almost 4 percentage points (hereafter p.p.), while de-jure flexible rate delivers better growth performance with a magnitude of about 2 p.p. The associated long-run coefficients are 5 p.p. and 2.8 p.p., respectively, but the former is insignificant and the latter at the 10% only. Nonetheless, studies that use de-jure classification and terminate their investigation at this point might end up with invalid conclusions. Namely, this discrepancy compared to the de-facto classification disappears when specifications for developing countries and two sub-periods are observed; in those specifications de-jure exchange-rate regimes are insignificant in explaining growth. For the same reasons specified above, column (7) in Table 3.8 differentiates transition, developing and developed economies, but finds no different results in terms of regimes' significance. All the other coefficients in the regressions are of similar magnitude and sign as when de-facto classification is used and this is a kind of robustness check of the obtained results. Considering the duration of the peg yields similar conclusions – insignificance of peg (duration) in explaining growth; hence these estimates are not reported.

[20] All the other intermediate steps towards the final specification supported the same conclusions. Hence, these are not reported, but are available upon request.

Table 3.8. Growth regression under IMF (de-jure) classification of exchange-rate regimes

Dependent variable: *Real per capita GDP growth*	FE (1)	OLS (2)	System-GMM (3)	Developing countries (4)	Sub-periods 1976-1990 (5)	Sub-periods 1991-2006 (6)	1991-2006 – Lev. of devel. (7)
Real per capita GDP growth(-1)	0.124***	0.248***	**0.219****	0.146*	0.091	0.336***	0.360***
Initial GDP in 1975	-	-0.15	**0.827**	-0.039	-3.031	-3.631	-0.069
Life expectancy at birth (inverse)	-	-0.279	**15.067**	11.321	6.532	-18.507	-5.643
Inflation	-1.277***	-0.831	**0.674**	-2.999*	-1.688	4.624	3.421
Average years of schooling	-	-0.074	**0.926**	2.328*	3.096	-0.173	-0.958
Log of fertility rate	0.428	0.077	**-3.878**	7.0	-0.165	2.426	-0.283
Trade openness	4.007***	2.468***	**5.541**	14.07***	31.196	-0.614	-5.060
Government consumption to GDP	-23.16***	-6.82***	**-34.085**	4.024	-3.680	-3.770	-26.776
Investment to GDP	-0.007	0.003	**0.054**	0.727	-0.371	-0.126	-0.013
Democracy index	-0.362	-0.229	**-0.307**	-1.873	-2.05	-0.248	-1.817
Democracy index squared	0.034	0.003	**-0.016**	0.221	0.407	-0.112	0.143
Fixed ERR	*0.435*	*0.012*	***3.884****	*3.138*	*1.412*	*2.853*	*3.381*
Limited flexible ERR	*0.329*	*0.202***	***1.128***	*-2.875*	*3.718*	*1.570*	*0.620*
Flexible ERR	*0.348*	*0.495*	***2.166****	*1.344*	*4.881*	*2.076*	*12.962*
Free floating ERR	*Omitted cat*	*Omitted cat*	***Omitted cat***	*Omitted cat*	*Omitted cat*	*Omitted cat*	*Omitted cat*
Other cat. (dual market / free fal.)	*-0.666*	*-1.776*	***-8.252***	*-3.61*	*1.079*	-	-
Δ Log of population	-94.227***	-64.77***	**-49.797**	-113.017	4.560	-99.55*	-57.152**
Dummy for the Euro zone	-0.393	-0.91***	**-1.266**		-7.513	-2.459	-4.061
Dummy for survivor bias	0.923	0.656	**0.127**	2.444		-1.301	-0.617
Dummy for Latin A. and Caribbean	-	-0.834***	**-0.693**	-1.177	-0.388	-2.505	-2.143
Dummy for Sub-Saharan Africa	-	-0.287	**-1.367**	-5.904	-4.138	2.709	0.646
Fixed ERR in Transition countries							-0.924
Lim-flex ERR in Transition countries							2.892
Flexible ERR in Transition countries							-10.599
Fixed ERR in Developing countries							-3.348
Lim-flex ERR in Developing countries							-0.790
Flexible ERR in Developing countries							-13.309
Constant	4.978***	8.839***	**-25.064**	-15.433	-16.718	28.777	13.308
Wald test (p-value)	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
AR(2) (p-value)	**-**	**-**	**0.724**	**0.460**	**0.612**	**0.415**	**0.461**
No instruments	**-**	**-**	**54**	**52**	**36**	**44**	**52**
Hansen (p-value)	**-**	**-**	**0.191**	**0.345**	**0.756**	**0.197**	**0.557**

Notes: *, ** and *** refer to a significance level of 10, 5 and 1%, respectively. Notes of Table 3.5 apply.

In general, encompassing all theoretical and modelling aspects discussed in Chapters one and two, and from the beginning of this chapter, the conclusion is that the empirical evidence suggests that *exchange-rate regime does not affect growth*, as a general rule. No empirical grounds were established that coefficients in the regression suffer the Lucas critique. Observing two sub-periods or developing countries led to the same conclusion – insignificance of the exchange-rate regime. Observation of the de-facto versus de-jure regime does not matter in that respect. Specifically, although de-facto classification accounts for the actual behaviour of the exchange rate, any capital controls and any devaluation or crisis episodes which were all apparent in the developing, including transition, economies during the 1990s and early 2000s, the conclusion is the same; namely, the exchange-rate regime does not affect economic growth, irrespective of the regimes' classification, the observed time period or the level of development of countries. The duration of the peg is not important either. The duration and developing-countries group was especially considered for the period 1991-2006, a period in which episodes of devaluation and currency crises were observed, which might have played a role in affecting growth. However, this was not the case. The empirical findings suggest, however, that there is a significant positive effect of an exchange-rate peg on growth according to the de-jure classification for the entire sample, but that this is insignificant in all other de-jure specifications. Reverting to the general findings, though, if the exchange-rate regime, as a nominal variable, is found not to affect growth, then it might be important in affecting its departure from the long-run level, i.e. the output volatility. The next sub-section proceeds to examine whether the exchange-rate regime is significant in explaining output volatility.

3.5.2. Exchange-rate regime and output volatility

Output volatility will be modelled according to the following regression:

$$VOLAT_{i,t} = \alpha_0 + \beta_j Z_{1i,t} + \gamma_j Z_{2i,t} + \varphi_j Z_{3i,t} + \eta_j Z_{4i,t} + \kappa_j INT_{i,t} + \delta_t + (u_i + \varepsilon_{i,t}) \qquad (3.6)$$

The coefficients are specified according to the groups of variables, as follows:

- α_0 is the intercept;

- β s for the variables representing shocks originating from policy measures (monetary and fiscal); real (aggregate supply) shocks, or from political sources, $Z_1 = (volTOT, volMS, volGC, CIVIL)$. The three measures defined for the output volatility (Section 3.2.4) are applied to the terms-of-trade, money-supply and government-consumption growth;

- γ s for the variables representing shock buffers or measuring the economy's vulnerability to real (external) shocks, $Z_2 = (GROWTH, FINGDP, TO, FO)$, as follows:

    - Growth - due to the empirically observed regularity between countries' economic growth and output volatility (see, for instance, Kose *et al.* 2005);

    - Financial-development variable – due to the empirically observed regularity between the level of financial development and output volatility (see, for instance, Easterly *et al.* 2001);

    - Trade- and financial-openness variables – due to Easterly and Kraay's (2000) arguments offered in Section 3.2.2. – to measure the economy's vulnerability to external shocks. We use Chinn and Ito's (2008) measure of financial openness, because besides using capital inflows and outflows, it also aims at measuring the extensity of capital controls imposed;

- φ s for inflation $Z_3 = (INF)$ – to account for the traditional explanation of output fluctuations by downward nominal rigidity (Newbery and Stiglitz, 1982). Note that we could not obtain credible series for wage growth and hence, this variable is left out of the regression;

- η s for the exchange-rate regimes

  $Z_4 = (RR1, RR2, RR3, RR4, RR5DUAL / IMF1, IMF2, IMF3, IMF4, IMFOT)$, according to the discussion in Chapter 2;

- κ s for interaction terms of exchange-rate-regime dummies with the terms-of-trade, money-supply and government-consumption volatility $INT = (RRx / IMFx * volTOT; RRx / IMFx * volMS; RRx / IMFx * volGC)$.

  Interaction terms are included in order to measure whether, under real and nominal shocks respectively, output reacts differently depending on the exchange-rate regime. Namely, in the case of supply-side shock, a peg is argued to transmit the shock directly onto real activity (output volatility), while a flexible rate is a shock absorber. On the other hand, there is at least theoretical consensus that the role of exchange-rate regimes is reversed when shocks originate from the monetary economy. These issues were broadly debated in Chapter 2 and remain to be empirically tested. This distinction is, in essence, one of the objectives of this section and its contribution to knowledge;

- δ_t is a time-specific fixed effect (if applicable and reported in the print-outs in Appendix 4 only);

- $(u_i + \varepsilon_{i,t})$ is the composite error term, where:

  - u_i is a country-specific error term (not reported);

  - and ε_{it} is the usual i.i.d. error term.

Variables are defined in Table 3.9. We estimate this regression for 169 countries and 31 periods. One of the exchange-rate dummies (floating) is the base and is indicated as the "omitted category" in Tables 3.11 - 3.12. Note that the coefficient on the TOT-volatility variable itself represents the effect of a float under a real shock.

Table 3.9. Output volatility variables

Variable		Expected sign	Source	Notes
		Dependent variable		
Output volatility	VOLATSD VOLATDEV VOLATHP		Author's estimates	Defined through 3 measures: 1. Rolling central standard deviation of the annual GDP growth rate over 5-year period; 2. Absolute value of the deviation of actual output from the linear trend; 3. Absolute value of the deviation of actual output from the Hodrick-Prescott trend (approx. of potential output).
		Independent variables		
Buffer variables				
Real Per Capita GDP growth	GROWTH	(-)	IMF, World Economic Outlook	
Financial development	FINGDP	(-)	IMF, International Financial Statistics	Total bank assets as a proportion of GDP
Financial openness	FO	(+)	Chinn and Ito (2007)	Index which includes capital flows and capital restrictions
Shocks' variables				
Volatility of Terms of trade changes	volTOT	(+)	IMF, International Financial Statistics	Defined through 3 measures as per the output volatility. Terms of trade variable is a ratio of the exports unit value index to imports unit value index
Volatility of Money supply changes	volMS	(+)	IMF, International Financial Statistics	Defined through 3 measures as per the output volatility. M2 monetary aggregate
Volatility of Government consumption changes	volGC	(+)	IMF, International Financial Statistics	Defined through 3 measures as per the output volatility.
Civil unrest	CIVIL	(+)	Freedom House	The index of civil liberties
Exchange rate regimes	RRx IMFx	(unknown sign, but more likely the more rigid regime, the higher the OV)	Official IMF classification De-facto classification by Reinhart and Rogoff (2004)	X represents the type of ERR: 1 – fix; 2 – limited flexibility; 3 – flexible; 4 – free float; 5 – free falling (RR only); OT – other (like dual markets; IMF only)

We start by checking for unit roots in the series, because of the moderately-large T dimension. The presence of unit roots might result in spurious regression. Table 3.10 presents the results from two panel unit-root tests proposed by Maddala and Wu (1999) and Pesaran (2003), respectively, as explained in the preceding section.

Table 3.10. Panel unit-root tests (output volatility regression)

	Maddala and Wu (1999)		Pesaran (2003)	
	Constant	*Constant and trend*	*Constant*	*Constant and trend*
Output volatility				
Standard deviation	530.0166***	510.6916***	-0.446	1.307
Deviation from trend	1613.5884***	1376.8509***	-14.785***	-11.171***
Hodrick-Prescott	1533.0448***	1336.9578***	-16.737***	-12.171***
Real per capita GDP growth	1281.7970***	1068.7094***	-12.773***	-9.115***
Bank assets to GDP	335.9691	368.7419*	3.985	5.817
Δ Bank assets to GDP	2082.5972***	1751.9981***	-18.755***	-13.439***
Trade openness	499.1490***	459.8479***	-0.776	-2.856***
Financial openness	446.6506***	445.4119***	-1.645	-8.162***
Inflation	1410.1860***	1265.2675***	-13.056***	-13.145***
Volatility of TOT				
Standard deviation	361.5842***	312.1579*	-0.480	4.699
Deviation from trend	1038.7767***	312.1579***	-12.995***	-8.897***
Hodrick-Prescott	1484.1000***	1107.3476***	-15.938***	-10.633***
Volatility of money supply				
Standard deviation	504.5929***	349.6309	no obs	no obs
Deviation from trend	1824.1591***	1696.0216***	-12.817***	-7.734***
Hodrick-Prescott	1554.6121***	1696.0216***	-12.027***	-7.517***
Volatility of gov't consumption				
Standard deviation	421.5621**	282.0083	no obs	no obs
Deviation from trend	1205.8077***	1009.8103***	no obs	no obs
Hodrick-Prescott	1324.5336***	1095.3444***	no obs	no obs
Civil unrest	431.2248***	432.0027***	no obs	no obs

Note: Numbers represent Chi^2 statistics or t-statistics. *, ** and *** indicate that the unit root null is rejected at the 10, 5 and 1% level of significance, respectively.
Regressions for testing for unit roots include one lag to eliminate possible autocorrelation.

Both tests suggest that the financial-development variable contains a unit root at conventional levels; however, the unit root is removed by differencing. In principle, as a bounded variable, the bank assets-to-GDP is unlikely to contain a unit root (although, it appears to have a unit root here given the relative short time series). Yet, as we decide to difference this variable, the presence of the unit root is implicitly accepted. The alternative is that the variable is a trend stationary process with structural breaks that can be difficult to distinguish from a difference stationary process (i.e., a unit-root process), as Perron (1989) highlighted. In the case that the alternative is the true statistical generating mechanism, then differencing would not be a valid approach. However, the dataset we use here is too short to pursue Perron's (1989) modified ADF to test for a unit root in the (possible) presence of a deterministic trend or a broken deterministic trend. Hence, the dataset available to the present work might be too limited to address this issue in a fuller manner and we leave this issue for the further work (see Section C.5).

The results suggest that there are some empirical grounds for concern that the variables are non-stationary when volatility is measured through a rolling-standard deviation. Our concern over these measures was raised in Chapter 2 and Section 3.2.4 is here confirmed by problems in practice. The evidence supports the view that using a rolling-standard deviation gives a variable persistence and that this could make the regression spurious and the estimates biased. All reviewed studies in Table 2.1 deal with moderately-large T, as in this thesis, but do not consider the non-stationarity of series. Non-stationarity, however, should not be a concern when volatilities are estimated based on deviations from trend (linear and HP). This is supported by the panel unit-root tests, which reject unit roots at conventional levels. Considering the issue of stationarity of panel data when T is moderately large, and considering that this may affect the significance, sign and magnitude of the estimated relationship between exchange-rate regime and output volatility, is one of the contributions to knowledge of this chapter. Hence, we proceed with estimation, as explained above.

Before specifying the estimation technique, the issue of endogeneity deserves some attention. Unlike the case for the growth regression (Section 3.5.1), the literature is not in agreement over the endogeneity issue within the output-volatility framework. Long-run growth is expected to act as a buffer and prevent the output falling/expanding too much when a shock hits the economy, but no theoretical arguments are on hand for the reverse relationship, nor do empirical growth-models include output volatility as a standard regressor. A strong argument cannot be constructed for the endogeneity of the financial-development variable either - the more a country is financially developed, the better the buffer for output volatility when a shock hits the economy; however, increased/lowered output volatility does not directly imply lower/higher financial development, albeit that it could force traders/investors to seek more hedging instruments to prevent risks or credit lines to meet their liquidity needs. Inflation, measuring nominal rigidities, could be endogenous, since rational agents could form their expectations based on developments in the real economy. The more the economy is economically open, the more exposed to external shocks and, hence, to increased output volatility. However, since trade openness is generally dependent on foreign demand and supply and trade barriers, and financial openness on foreign-investors decisions and capital-account restrictions, all of which depend on global/regional decision-makers, we treat those two variables as being exogenous. It can be argued that the exchange-rate regimes could be treated endogenous, i.e. not only is a peg expected to increase output volatility, but also countries with increased output volatility tend to choose not to peg. However, the assumption is very weak, because, as argued, the regimes effect is different depending on the shock's source. Theoretically, models do not treat the relationship between the exchange-rate regime and output volatility as potentially endogenous, nor practically has a country decided its exchange-rate policy following output-volatility developments, nor do empirical models for regime choice include output volatility as a regressor. In mainstream economics, shocks tend to be exogenous by definition (see, for instance Broda, 2002, for terms-of-trade shocks), albeit, when they come from government-policy measures they could be treated as potentially endogenous (see, for instance, Easterly *et al.* 2001), especially if these policy measures come as a response to output fluctuations and are expected by the economic agents.

Considering the difficulty in classifying financial development, exchange-rate regimes and policy shocks as being endogenous or exogenous, we start with a different modelling strategy. At the outset, assuming that all right-hand side variables are exogenous, a logical strategy would be to utilize a fixed effects model which assumes that all variables are exogenous and assumes that these are correlated with the unobserved country-specific effects. Using a fixed effects estimator is still reasonable because of the argument of Judson and Owen (1996) that a macro-panel will not represent a *random* sample from a large number of countries, but rather the majority of countries of interest. However, referring to the output-volatility regression, if right-hand side regressors are assumed exogenous, it cannot be justified that these are correlated with the unobserved-country effect. Namely, some of the variables remain correlated with the individual effect $(GROWTH, \Delta FINGDP, volMS, volGC, CIVIL, INF, RRx/IMFx)$, but some are not dependent on country characteristics, but rather on global or regional events $(volTOT, RRx/IMFx*volTOT, TO, FO)$. Hence, although not correlated with the idiosyncratic error, the former are correlated with the unobserved country effect and this could be a source of endogeneity bias. Thus, some correction for endogeneity is still needed. The Hausman-Taylor estimator explained in Section 3.4.2 best fits this situation.

The estimation strategy was to start with a wide specification that included all the interaction effects of the shocks with the exchange-rate dummies. We ran a variable deletion test for the interaction terms, group-by-group, and in all specifications we found that the interactions of the nominal shocks and the regimes were jointly insignificant. Moreover, there is no particular variable among those which was individually significant, which excludes any oversight of a specific-variable effect. This implies that, as opposed to the real shocks, the nominal shocks do not have differential effects with different exchange-rate regimes. The presented estimates here are without these insignificant interactions, because of space.

Table 3.11 and Table 3.12 below and Table A1.6; Table A1.7; Table A1.8 and Table A1.9 in Appendix 1 present the estimates. All results in the tables do not report the time dummies, but these are reported in Section A4.2. In general, some of the dummies across the specifications appear (highly) significant, hence picking up some global developments and supporting our strategy of their inclusion. Table 3.11 presents the estimates for the entire sample for the three measures of output volatility. The rolling-SD-based estimates suggest that a de-facto peg in general delivers lower output volatility compared to all other de-facto regimes, but the coefficient is significant only at 10%. However, when a TOT shock hits the economy, this has double the effect on output volatility under a de-facto peg compared to a de-facto float. In this specification, the effects of the regimes under a real shock are individually insignificant, but they are jointly highly significant. The coefficients' signs and magnitudes portray an interesting story which is consistent in all the studies published on the topic and reviewed in Table 2.1. However, as Table 3.10 reveals, when volatility is measured as a rolling-standard deviation, the series are persistent, i.e. contain a unit root. Working with variables which are I(1) can produce spurious regression in which the estimated coefficients are invalid. All published studies on the relationship between exchange-rate regime and output volatility do not treat the issue of stationarity and almost all of them use a rolling-standard deviation measure. Given the theoretical problem that argues strongly against using this definition of volatility, in practice it can give rise to very different results and this needs to be borne in mind when assessing estimates by past researchers (studies presented in Table 2.1). The results presented in the other sections of Table 3.11 using alternative (stationary) measures of volatility offer different, arguably better, estimates and are a contribution to knowledge from our investigation.

Comparison between column (1) against (2) and (3) of Table 3.11 suggests that our concerns about the effects of the non-stationarity of volatility-variables may be important and lead to incorrect conclusions if ignored. Once we measure volatilities as deviations from (linear and HP) trend, we obtain stationary variables, which when used in the output-volatility regression give different results. Although the linear-trend-based and HP-based estimates look similar in other ways, they differ considerably when we observe the coefficient on real per capita GDP growth. This may be because linear-trend-based volatility assumes constant growth. However, this assumption is practically weak. Hence, as suggested earlier in the chapter, our preferred measure of volatility is the one based on the HP filter; hence, the emphasis is on interpreting the HP-based estimates.

In what follows, we first interpret the exchange-rate effects when there is no change in the TOT (the *exchange-rate dummies*); second we interpret the additional exchange-rate effects when a real shock hits (the *interaction terms*); lastly, we derive the *overall effect*. In column (3), the estimated effects of a change in the exchange-rate regime from floating are that: a peg decreases output volatility compared to de-facto float by about 0.46 p.p., but without individual significance. Limited-flexible and flexible regimes, however, are estimated to reduce output volatility by more, 0.62 p.p. compared to de-facto float, but are only significant at the 10% level. Also, the two effects are not statistically different (p=0.9819). It is estimated that compared to a de-facto float an increase in TOT volatility by 1 p.p. will give an increase of output volatility of 0.05 p.p. more under a de-facto peg; however, the coefficient is not statistically significant. Under de-facto limited-flexible and flexible regimes, a 1 p.p. change in TOT volatility also gives greater output volatility than under a de-facto float by 0.07 and 0.08 p.p., respectively (but again not significant). The theoretical argument that a float buffers the real shock lacks support with a significant insignificance in this estimation, although the sign is as expected.

To investigate our concerns about peg duration raised in Chapter 2 and Section 3.5.1, we split the de-facto pegs into those that lasted up to 5 years, between 5 and 10 years and over 10 years (column 4). The basic intuition is that a peg is introduced to calm down the economy, usually when monetary policy lacks credibility and inflation soars. However, some argue (see Chapter 2), that the initial gains that a peg provides in terms of stabilization become exhausted as time passes and it could become a problematic strategy as the economy becomes more developed and rapidly integrated into the international financial market. Not surprisingly, there is support for this view from the estimations. The exchange-rate dummies, indicating the effect on output volatility if there is no TOT change, are significant and negative for fixed exchange rates of over 5 years. The estimates suggest a reduction in output volatility of around 0.9 to 1 p.p. Considering the interaction effects, we observe that short pegs have an insignificant additional effect on output volatility, while longer pegs (from 5 to 10 years) are significant at the 1% level, with the magnitude suggesting that if TOT changes by 1 p.p., this longer peg will, compared to a float, have an additional effect on output volatility of about 0.12 p.p. This finding might further suggest that observing all pegs (from the viewpoint of their length) in one basket might be misleading.

Lastly, the overall effect is estimated. The overall effect of going from floating to another exchange-rate regime (RRx) is estimated as follows:

*Estimated coefficient * (Volatility of TOT*RRx) + estimated coefficient * RRx*

In order to find out the value of TOT volatility above which the output volatility is boosted under the concrete exchange-rate regime, we need to set this to be higher than zero:

*Estimated coefficient * (Volatility of TOT*RRx) + estimated coefficient * RRx > 0*

E.g. In the case of going from float to peg (longer than 5 years, since this is the significant one), we have:

0.121*Volatility of TOT-0.89 > 0

0.121*Volatility of TOT > 0.89

Volatility of TOT > 7.36

This implies that a TOT shock higher than c.7 p.p. will increase output volatility.

Overall, the effect of changing from a float to a fixed exchange rate is estimated as (0.121**Volatility of TOT*-0.89). This estimate suggests that a change in TOT lower than c. 7 p.p. will decrease output volatility under a long peg, compared to a float, and vice versa. Whether this is beneficial from a policy viewpoint depends on the frequency and size of TOT shocks (and how then these are translated by a utility function). Similarly, the effects of changing from a float to limited-flexible and flexible regimes are estimated as (0.069**Volatility of TOT*-0.61) and (0.075**Volatility of TOT*-0.63), respectively, suggesting an approximate threshold of 8-9 p.p. change in TOT. The other coefficients are similar to those in column (3). Hence, the policy implication is that a TOT shock larger than 7 p.p. will increase output volatility under fixed exchange-rate regime compared to a float, while when larger than 8-9 p.p. will increase output volatility under limited-flexible and flexible regime compared to a floating regime. This is in line with the expectation that a peg increases output volatility under real shock faster than a more flexible option of the regime.

As well as the a priori preference for the volatility measures estimated with the HP filter, columns (3) and (4) in Table 3.11 largely present results that seem economically sensible. Economic growth is significant and is negatively related to output volatility, estimating that countries with a higher economic growth by 1 p.p. would have, on average, lower output volatility by 0.4 p.p. The coefficients on both trade and financial openness are positive and significant, suggesting that the more open the economy, the more it is exposed to external shocks and hence to increased output volatility. Monetary shock is insignificant, and fiscal shock is significant only at the 10% level, which suggests a 'buffer' role for government action; civil unrest positively affects output volatility as expected but is only significant at the 10% level. Financial development has the expected negative sign, but is insignificant. Also, nominal rigidities, at the centre of traditional Keynesian analysis, seem on average, to play little role in explaining output variability.

For the purpose of comparison, Columns (5)-(7) of Table 3.11 re-estimate the same regressions with the de-jure exchange-rate regime classification. At the outset, it is interesting to notice that most of the coefficients on the independent variables are similar, with the same magnitude and signs as the de-facto estimates. The exceptions are the coefficients of the exchange-rate dummies and their interactions with TOT volatility; which change their magnitude, sign and significance from specification to specification, which is as expected and supports the concern that de-jure regimes might lead to invalid conclusions (Section 3.2.4). Consequently, working with the de-jure regimes might be misleading. Accordingly, in considering the developing-countries sample, when splitting the sample into two sub-periods and when using other techniques, we do not pursue the de-jure classification.

Table 3.11. Hausman-Taylor estimates for three definitions of volatility (1976-2006) – de-facto and de-jure classifications

Dependent variable: *Output volatility*	De-facto (RR classification)				De-jure (IMF classification)		
	(1) Standard deviation	**(2) Dev. from linear tr.**	**(3) Deviation from HP trend**	**(4)**	**(5) Standard deviation**	**(6) Dev. from linear tr.**	**(7) Deviation from HP**
Real per capita GDP growth	0.016	0.013	-0.400***	-0.402***	0.017	0.02	-0.417***
Δ Financial development	-0.854*	-2.326***	-0.201	-0.261	-0.852*	-2.392***	-0.312
Trade openness	0.025***	0.008	0.012**	0.010**	3.142***	1.028	0.603
Financial openness	0.281***	0.099	0.140***	0.151***	0.237***	0.09	0.091*
Volatility of money supply	0.003	0.006*	-0.001	-0.001	0.004*	0.006*	0.000
Volatility of gov't consumption	0.110***	0.061***	-0.014*	-0.013*	0.125***	0.066***	-0.016*
Civil unrest	0.074	0.229***	0.103*	0.090	0.111*	0.282***	0.105*
Volatility of TOT	0.035	-0.011	-0.063	-0.063	-0.005	0.016	0.0097
Volatility of TOT * Fixed	*0.036*	*0.050*	*0.050*		0.042	0.016	-0.018
*Volatility of TOT * Fixed up to 5 years*				*0.045*			
*Volatility of TOT *Fixed - 5-10 years*				*0.121****			
*Volatility of TOT * Fixed over 10 years*				*0.042*			
Volatility of TOT * Lim-Flex	*-0.043*	*-0.001*	*0.070**	*0.069**	0.053	0.001	-0.078*
Volatility of TOT * Flexible	*-0.007*	*0.032*	*0.075**	*0.075**	0.019	-0.036	-0.001
Volatility of TOT * Float	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted
Volatility of TOT * Other	*-0.077***	*0.044*	*0.034*	*0.036*	0.1	0.102	
F-test (p-value) H0: ERRs under TOT shocks are jointly insignificant	**0.000**	**0.286**	**0.180**	**0.220**	**0.003**	**0.029**	**0.102**
Fixed ERR	-0.774*	-0.812*	-0.457		-0.999***	-0.291	-0.329*
Fixed ERR under 5 years				-0.131			
Fixed ERR 5 to 10 years				-0.891**			
Fixed ERR over 10 years				-0.971**			
Limited flexible ERR	0.000	-0.514	-0.621*	-0.614*	-0.632	0.249	0.141
Flexible ERR	0.197	-0.767*	-0.617*	-0.628*	-0.605**	-0.101	-0.239
Floating ERR	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted
Other category (dual market and/or free falling)	1.531***	-0.139	-0.047	-0.002	-1.08	-1.043	-
F-test (p-value) H0: ERRs are jointly insignificant	**0.000**	**0.348**	**0.170**	**0.003**	**0.005**	**0.766**	**0.347**
Inflation	0.336	0.986*	0.279	0.190	0.275	1.454***	0.430*
Dummy for Latin A. and Caribbean	-0.070	-0.129	-1.167**	-1.085*	0.012	-0.132	-1.461**
Dummy for Sub-Saharan Africa	-0.529	-0.467	-1.322***	-1.236**	-0.535	-0.362	-1.430***
Constant	2.405***	2.665***	3.894***	3.910***	2.872***	1.827***	3.881***

Notes: *, ** and *** refer to a significance level of 10, 5 and 1%, respectively.

Table 3.12 continues the analysis by: i) narrowing the sample to developing countries only[21]; and ii) differentiating two sub-periods, using the HP-based estimates only; similarly to the analysis in Section 3.5.1. Considering the estimates for the developing group, it is noticeable that they do not have dissimilar magnitudes and/or signs compared to the specifications for the entire sample, except that the significance and size of the exchange-rate variables increases (both the dummy variables and the cross-products with the terms of trade). This is as expected, because the regimes have a bigger role to play in developing countries (see Sections 1.3.2; 1.3.3; 2.2 and 2.3). Considering the estimated effect of the exchange-rate regimes, which assumes no change in TOT volatility, in columns (1) and (2) of Table 3.12, they give similar results as for the whole sample, but of greater size and individual and joint significance. A de-facto peg is estimated to give lower output volatility than a float by a magnitude of 1.2 p.p.; differentiating this effect by duration suggests that a peg over 5 years has a greater role in stabilizing output volatility. De-facto limited-flexible and flexible regimes are estimated to steady output by a little less than long pegs; in practice there seems little difference between these two and the appropriate test suggest that the effects are not statistically different (p=0.5697). The additional effects of the exchange-rate regimes under a TOT shock are individually significant. They suggest that a peg, compared to a float, amplifies a real shock, with a TOT change by 1 p.p. giving an additional increase in the volatility of about 0.12 p.p. (but only significant at 10%). Once pegs are divided by their duration, we conclude that there is no differential effect of TOT volatility on output volatility under a short peg (the variable is insignificant); however, it is estimated that longer pegs do give an increased transmission of external shocks to output volatility, with an additional increase of about 0.23 p.p., compared to a float, when the TOT change by 1 p.p. *Overall*, the effect of changing from a float to a longer-term peg is estimated as (0.23**Volatility of TOT*-1.61). This estimate suggests that a change in TOT of less than cca. 7 p.p. will decrease output volatility under fixed as compared to a floating regime, and vice versa. Similarly, the effects of changing from a float to limited-flexible and flexible are estimated as (0.13**Volatility of TOT*-1.21) and (0.14**Volatility of TOT*-1.35), respectively, suggesting an approximate threshold of 10 p.p. change in TOT. Hence, for the policy implications, under fixed compared to a floating regime, output volatility will be increased with a TOT shock larger than 7 p.p.; and larger than 10 p.p.

[21] We do not estimate regression for the advanced economies, because in that case T=N, which might cast doubt on the estimation techniques, which are generally justified when N>T.

under limited-flexible and flexible regimes. Hence, the same was concluded as for the entire sample and this can be interpreted as a robustness check of the results. Observing the estimates for two sub-periods (columns 3 and 4 of Table 3.12), the individual significance of the results vanishes, but estimates are of similar magnitude as for the entire period.

Table 3.12. Hausman-Taylor estimates for developing countries and two sub-periods (HP-based estimates)

Dependent variable:	Developing countries		1976-1990	1991-2006
Output volatility (HP-based measure)	(1)	(2)	(3)	(4)
Real per capita GDP growth	-0.420***	-0.421***	-0.319***	-0.288***
ΔFinancial development	-0.203	-0.263	-0.466	-0.345
Trade openness	0.011**	0.011*	0.030***	0.048
Financial openness	0.209***	0.210***	0.183*	0.0117
Volatility of money supply	0.001	0.001	0.002	0.010**
Volatility of gov't consumption	-0.014	-0.014	-0.053***	0.039***
Civil unrest	0.052	0.044	0.197**	0.081
Volatility of TOT	-0.129**	-0.129**	-0.019	0.042
Volatility of TOT under Fixed	*0.117**		*0.026*	*-0.008*
*Volatility of TOT * Fixed up to 5 years*		*0.114*		
*Volatility of TOT * Fixed - 5-10 years*		*0.226****		
*Volatility of TOT * Fixed over 10 years*		*0.107**		
Volatility of TOT * Lim-Flex	*0.136***	*0.135***	*0.023*	*-0.078*
Volatility of TOT * Flexible	*0.142***	*0.141***	*0.021*	*-0.041*
Volatility of TOT * Float	Omitted cat	Omitted cat	Omitted cat	Omitted cat
Volatility of TOT * Other	*0.100*	*0.102*	*0.057*	*-0.005*
F-test (p-value)	**0.214**	**0.256**	**0.904**	**0.037**
H0: ERRs under TOT shocks are jointly insignificant				
Fixed ERR	-1.217**		-0.144	-0.295
Fixed ERR under 5 years		-0.945		
Fixed ERR 5 to 10 years		-1.608***		
Fixed ERR over 10 years		-1.631***		
Limited flexible ERR	-1.217**	-1.210**	-0.434	-0.011
Flexible ERR	-1.345**	-1.350**	-0.302	-0.440
Floating ERR	Omitted cat	Omitted cat	Omitted cat	Omitted cat
Other category (dual market / free falling)	-0.685	-0.661	-0.356	-0.082
F-test (p-value)	**0.092**	**0.046**	**0.810**	**0.329**
H0: ERRs shocks are jointly significant				
Inflation	0.312	0.237	0.353	-0.098
Dummy for Latin A. and Caribbean	-1.277**	-1.195*	-0.893*	-0.871*
Dummy for Sub-Saharan Africa	-0.957*	-0.832	-0.684*	-1.095***
Constant	4.810***	4.873***	1.470*	3.392***

Notes: *, ** and *** refer to a significance level of 10, 5 and 1%, respectively.

As argued earlier in this section, however, variables in the output-volatility regression could be treated as exogenous, but still there are some arguments for treating some of them as potentially endogenous. In the following investigation and according to our discussion in Section 3.4.2, we analyse the estimates of three IV-estimation techniques which allow for potential endogeneity of the correlation between a regressor and the idiosyncratic error. These are: the two-stage least-squares (2SLS) within estimator; the generalized method of moments (GMM) within estimator; and the dynamic system-GMM estimator. All three estimators allow correction for endogeneity; and system-GMM adds dynamics in the model by including the lagged dependent variable as a regressor and also is appropriate given the persistence of the series (see Section 3.4.2).

According to the earlier discussion in this section, financial development, policy shocks (fiscal and monetary) and inflation could be treated as potentially endogenous. On the other hand, exchange-rate dummies; TOT volatility and its interaction with exchange-rate regimes, trade and financial openness will be treated as exogenous. Growth will be also treated as exogenous, for the reasons identified earlier. Finally, the civil-unrest variable will be treated as exogenous, considering that political shocks for small economies are usually related to global and regional political developments, albeit that there are some arguments that political instability could be also internally generated.

Table A1.6 and Table A1.7 in Appendix 1 present the estimates for the IV-based regressions for the HP-based volatility measures for the whole sample and for developing countries, respectively. In addition to the two IV-estimators explained in Section 3.4.2 (2SLS and GMM), we estimate here the results of continuously updated GMM estimations (CUE) proposed by Hansen *et al.* (1996) and of limited-information maximum-likelihood (LIML), since the recent research (Hahn *et al.* 2004) suggests that those might perform better than GMM and 2SLS when instruments are weak, that is if the appropriate test fails to reject the null (weak instruments), which might be the case in the estimations here[22]. Moreover, these estimators, although not more efficient than 2SLS and GMM asymptotically, might have better small sample properties (Baum *et al.* 2007). We return to the issue of 'weak identification' in Chapter 6, whereby IV estimators are our main estimation techniques and hence more attention is paid there.

Observing the diagnostics, there is insufficient evidence to reject the null hypothesis that the instruments are valid, according to the Hansen and under-identification test. The weak identification test suggests that there is a possible problem of weak identification. There is no critical values devised for more than three

[22] Critical values are not available for a number of endogenous variables exceeding three, but one can argue that the obtained values are apparently small. Hence, we perform CUE and LIML as a precautionary step.

endogenous variables (Stock and Yogo, 2005), but the obtained values are far away from the conventional 'rule of thumb' of 10 (Staiger and Stock, 1997). Columns (4) and (5) report CUE and LIML, which as explained, are argued to be robust to weak identification. Nevertheless, results' interpretation needs to be increasingly cautious. The endogeneity test, in all cases, fails to reject the null, which suggests that the specified variables cannot be treated as endogenous, given the caution about the weak identification. This is an important finding which might suggest it is unnecessary to use IV estimation. Indeed, in this situation IV estimators are less efficient (again, given the caution regarding the potential problem of weak identification). Though, we do not observe large differences compared to the Hausman-Taylor estimates. The still-exogenously treated variables preserve their coefficient signs and magnitudes, for which these estimates may be regarded as a robustness check.

In the final estimation, we conduct dynamic system-GMM estimation, since the literature is not consensual on using a non-dynamic or a dynamic model, but there are some economic arguments that may suggest treating output volatility as being a dynamic process. Table A1.8 in Appendix 1 presents the estimates when the only treated variable for potential endogeneity is the lagged dependent one, while Table A1.9 when financial development, money and government-consumption shocks and inflation are treated for potential endogeneity. The diagnostics are acceptable: the null hypotheses of no second order serial correlation and of instrument validity are not rejected. It is evident that, since system-GMM possesses the facility to account for persistent series, the rolling-SD-based estimates are considerably different from those estimated by Hausman-Taylor. That the series is highly persistent is confirmed by the estimate of the coefficient on the lagged dependent variable (0.88). Observing the HP-based estimates, the lagged dependent variable is only significant at the 10% level or insignificant and the estimated size of the effect is small, with an increase in output volatility during the previous period of 1 p.p. giving an estimated increase in output volatility of 0.05 p.p. in the current period. This only provides minimal support for a dynamic specification. Moreover, the Difference-in-Hansen test does not lend support that financial development, nominal shocks and inflation should be treated as endogenous. In other respects, similar conclusions to the Hausman-Taylor specifications can be drawn, both in Table A1.8 and Table A1.9.

Summarising aspects analyzed in this section, overall a relationship is empirically supported between the de-facto exchange-rate regime and output volatility, analyzed using three different estimators. Using rolling-SD as a measure of volatility is problematic because of non-stationarity, which then leads to potentially spurious regression. In practice estimates using this measure varied considerably from the preferred linear-trend-based and HP-based ones. Also, the rolling-SD-based estimates from the system-GMM estimator, which accounts for the persistence of the series, differed substantially from the estimates based on other measures. Furthermore, considering the estimates of linear-trend-based and HP-trend-based regressions, we argued for the latter, because the former assumes constant growth, which might be a poor assumption. Tests using the IV estimator rejected the suspected endogeneity of some regressors, given the caution as to the potentially weakly identified regression, and the likely conclusion is that all right-hand-side variables could be treated as exogenous. The system-GMM estimator gives the coefficient on the lagged dependent variable as significant at the 10% level or insignificant (depending on the model) and, more importantly, it is very small, thus giving little support for the utilization of this estimator. In the estimates with the Hausman-Taylor regressions, in all specifications, there is some evidence for the exchange-rate regime playing a role in explaining output volatility, but the magnitude and direction depends on the existence and source of shocks hitting the economy. Estimates suggest that, under a fixed exchange-rate regime output volatility will be higher, compared to a floating regime, with a TOT shock larger than 7 p.p. Whether this is beneficial from a policy view point depends, hence, on the frequency and size of TOT shocks. Similarly, the estimates for limited-flexible and flexible regimes suggest an approximate threshold of 8-11 p.p. change in the TOT.

For the policy implication, for the overall sample and for the developing group, a TOT shock (defied as the difference between the actual and the HP trend) larger than 7 p.p. will increase output volatility under a long peg; and larger than 8-11 p.p. under limited-flexible and flexible exchange-rate regimes, as compared to a floating regime. To give this finding an intuition, Table 3.13 is drafted, where the last column lists the severity of the TOT shocks in the pre-exit (from peg) year. Two thirds of the countries that exited the peg experienced a TOT shock larger than this magnitude, suggesting that it led to a demise of the exchange-rate system (and the consequences upon the real economy). Note that this figure does not encompass the TOT shocks larger than 7 p.p that were successfully resisted by authorities (i.e. the peg was sustained by interest-rate increases).

Table 3.13. The severity of a TOT shock before a peg-exit

Case	Date when the peg was abandoned	The severity of the TOT shock in the pre-exit year
Albania	Jul-92	11.6
Algeria	Apr-94	15.3
Argentina	Jul-01	19.7
Brazil	Jan-99	9.5
Bulgaria	Feb-91	6.7
Chile	Feb-99	9.3
Colombia	Sep-98	4.1
Congo, DR of	May-01	7.1
Egypt	Jul-90	15.7
El Salvador	May-90	20.6
Ethiopia	Oct-92	7.2
Finland	Sep-92	2.4
Guyana	Jun-90	9.7
Hungary	Aug-94	7.3
Iceland	Feb-01	2.2
Indonesia	Aug-97	6.2
Italy	Sep-92	3.4
Kazakhstan	Apr-99	20.2
Kenya	Mar-93	17.3
Korea	Nov-97	5.1
Madagascar	May-94	8.0
Malawi	Feb-94	20.0
Mexico	Dec-94	2.6
Nicaragua	Jan-93	38.6
Nigeria	Feb-95	9.4
Norway	Sep-92	0.9
Peru	Aug-90	8.6
Phillipines	Sep-97	8.2
	Aug-98	
Sweden	Sep-92	1.2
Thailand	Jul-97	15.0
Turkey	Feb-01	10.3
UK	Sep-92	2.0
Uruguay	Dec-01	9.8
Venezuela	Dec-95	10.2
Zimbabwe	Dec-97	13.8

Source: Estimates by the author based on IMF data.

Note: The table excludes some peg exits (about 15 cases) for which the figure for the severity of the TOT shock was not available.

3.6. Conclusion

The aim of this chapter was to investigate whether and, if so, how the exchange-rate regime affects output growth and volatility, by addressing some of the drawbacks in the existing empirical studies. For that purpose, a minimally specified growth model has been defined together with a framework for a regime's impact on output volatility, whereby shocks hitting the economy play a crucial role. The chapter addressed other important issues, which are presently - partially or entirely - missing from the exchange-rate regimes literature. Namely, the investigation contrasts use of the de-jure (IMF) versus a de-facto (Reinhart and Rogoff, 2004) exchange-rate classification; discusses the measure of output volatility; draws attention to the Lucas critique, i.e. how parameters in the equation may change when the exchange-rate regime changes; and discusses and addresses potential endogeneity bias, present in the growth, volatility and exchange-rate-regimes literature. The empirical investigation covers the post-Bretton-Woods era (1976-2006) and includes 169 countries.

We conclude first on the determinants of growth. A dynamic system-GMM panel method has been used. The main finding is that the exchange rate regime is not significant in explaining output growth. No empirical grounds were established for the coefficients in the regression as suffering from the Lucas critique. Observing two sub-periods or developing countries only led to the same conclusion – the insignificance of the exchange-rate regime. Using the de-facto versus de-jure classification of exchange rates did not matter in that respect. The duration of the peg is also not of importance. The duration and developing-countries group was especially considered for the period 1991-2006, with numbers of episodes of devaluation and currency crises, which were arguably expected to have played a role in affecting growth. However, these expectations proved incorrect.

Three estimation techniques, Hausman-Taylor, IV and dynamic system-GMM, were utilized for the output volatility regression, for two reasons: i) the literature does not agree over what technique is most appropriate; and ii) some regressors might be suspected of being potentially endogenous, although there are no firm theoretical or empirical grounds for the suspicion. We did not find sufficient evidence to reject the hypothesis that all right-hand-side variables should be treated as exogenous nor sufficient evidence to advocate treating the output volatility as a dynamic process. Secondly, we argued that the use of volatilities based on a rolling standard deviation was suspect, since we have shown that with this series there is insufficient evidence to reject the hypothesis of a unit root. Moreover, comparing the specifications with linear-trend-based and HP-trend-based regressions, we preferred the latter, because the former are based on the assumption of constant growth, which might be invalid. There is some evidence for exchange-rate regimes playing a significant role in explaining output volatility; though this is not overwhelming. Results suggest that a TOT shock larger than 7 p.p. will increase output volatility under a long peg; and larger than 8-9 p.p. under limited-flexible and flexible exchange-rate regime, as compared to a floating regime.

***

On the whole, the empirical investigation in this chapter has led to two conclusions:

1. De-facto exchange-rate regimes are *not important* in explaining output growth;
2. De-facto exchange-rate regimes are *important* in explaining output volatility and:
   i. Long fixed, limited-flexible and flexible regimes, as compared to a float, reduce output volatility in general;
   ii. A long fixed rate, compared to a float, is associated with higher output volatility under an aggregate-supply shock, but limited-flexible and flexible regimes have marginally lower output fluctuations than long pegs;
   iii. Overall, a TOT shock larger than 7 p.p. under a fixed, and larger than 8-9 p.p. under limited-flexible and flexible exchange-rate regimes, will give a higher output volatility compared to a float; and
   iv. Exchange-rate regimes are not important for channelling nominal shocks to real activity.

These findings support the initial notion that, although the exchange-rate regime as a nominal category might be not important in explaining growth, it could be important in explaining output volatility. In particular, this is an important finding in times when countries are becoming increasingly financially integrated, hence exposing their economies to external aggregate shocks, which if larger than 7 p.p., as estimated, cause output volatility to increase under a fixed exchange-rate regime. From the viewpoint of monetary policy, this implies at least two things: i) flexibilization of the exchange-rate policy is beneficial for the volatility of output, if real shocks are large enough; and ii) a nominal anchor for inflation (expectations) would be still needed. In other words, at this point the issue should be moved from exchange-rate-policy to monetary-policy. Part two of this thesis pursues this.

CHAPTER 4

The quest for a new monetary strategy. Introduction to inflation targeting

4.1. Introduction

It was argued in Chapter 2 that using exchange-rate targeting (ERT) for keeping inflation low may be problematic in the longer run. After shrinking inflation to a low level, ERT could eventually become unsustainable as the economy becomes increasingly integrated in the international capital market. The latter exposes the economy to increased exogenous shocks, which in the case of a peg directly transmits to the real economy and might cause distortions in the short run. In addition, Chapter 3 presentated evidence that although under nominal shock a peg does not affect real volatility, a peg does amplify volatility of output when a real external shock hits the economy. If the shock is large and persistent, foreign-exchange reserves might become insufficient to absorb it and the exchange-rate peg might fail. Increased pressures on the foreign-exchange market are alarming and this puts pressure on the authorities to adopt a new exchange-rate regime and/or new anchor for inflation.

This chapter deliberates on the debate on the monetary regime, including the real effects of exchange-rate pegging and, therefore, the reason to abandon it, and the reasons for adopting a particular new anchor for monetary policy. It argues that since the link between money and prices has weakened, hence making monetary targeting infeasible, and nominal-income targeting is still only a theoretical option, an alternative is to target inflation directly. Thereafter, it introduces and analyses inflation targeting (hereafter IT) as a monetary-policy regime from a technical viewpoint. This chapter largely considers the theoretical arguments related to IT while the empirical evidence and analysis will be developed in the following chapters. As such, this chapter is a point of departure for analysis of IT in this part of the thesis.

The chapter is organized as follows. Section 4.2 discusses monetary policy in the aftermath of an exit from a peg. Section 4.3 looks at the preconditions for embarking on IT, separating these into institutional and economic grounds. Section 4.4 is structured so as to provide a complete introduction into IT; it covers the definition, transmission channels and defines and differentiates between strict and flexible IT. Section 4.5 connects back to the chapter's beginning and compares IT with ERT. Section 4.6 concludes the chapter.

4.2. Monetary policy beyond the exit of an exchange rate peg

In a world with increasing global capital movements, a country with a pegged exchange rate and a low, sustainable inflation rate, appropriate for conducting economic activity, with a sufficient level of reserves and with a prudent fiscal position (without debt-sustainability problems) may experience an attack on the exchange rate as a result of an exogenous disturbance, which will further transmit to the real exchange rate and cause output volatility with consequences for the whole real economy. If the attack is strong enough, the exchange-rate might plummet. If the peg is of long standing and there is high capital mobility, this makes the foreign-exchange system prone to crises. Findings in Chapter 3 suggested a real TOT shock larger than 7 p.p. will increase output volatility under fixed exchange rate (of longer than five years) as compared to a floating regime. Consequently, if external shocks are more important for small, open economies in a world of intensified capital flows, and if pegs produce increased output volatility under external disturbances, then there is an argument for relaxation of the exchange-rate policy.

Under an exchange-rate peg, the monetary policy regime matches the exchange-rate regime – exchange-rate targeting. Hence, embarking on the option of a more flexible rate results in abandonment of this monetary-policy framework. Consequently, from the perspective of monetary policy, the decision to abandon the exchange-rate target requires another decision: the one on the monetary regime with a *nominal anchor* different from the exchange rate. In light of the earlier discussion, the monetary regime must be designed to attain the ultimate goal of monetary policy – price stability. ERT provided that. However, given the discussion in Chapter 2, the new monetary regime has to take into account variances in the real economy and, since it will function along with a flexible exchange rate, the volatility of the exchange rate as well. ERT (fixed exchange rate) theoretically is not expected to be an efficient smoother of foreign initiated disturbances and the empirical evidence supports this position. However, at this point, the extent of exchange-rate flexibility is a second-order question – the economy needs another anchor for inflation, while the exchange rate will provide the smoother when an exogenous shock hits.

The list of theoretical alternatives for the nominal anchor was introduced in Chapter 1: inflation targeting; monetary targeting; nominal-income targeting; and implicit nominal targeting. We argued there that nominal-income targeting entails central banks targeting real output and inflation at the same time. As this is difficult and frequently leads to conflicting policy responses, no country has, so far, adopted this approach. Implicit nominal targeting lacks an explicit nominal target of monetary policy, but instead it is based on a forward-looking and pre-emptive monetary-policy rule and uses a broad information-inclusive approach towards achieving the target. Within this strategy, the lack of an explicit nominal anchor is usually compensated by the credibility, skills and trustworthiness of the governor, hence making it a viable option for economies with longer central-banking traditions. Still, this strategy is a possible option for small, open developing economies, but we do not consider it in the analysis of what to adopt after peg exit, because of two reasons: i) the already identified disadvantage; and ii) its similarity to inflation targeting (see Section 4.4.1).

Monetary targeting presumes the existence of a stable relationship between one or more monetary aggregates and the general price level. When this is the case, monetary policy can be directed at a particular growth rate in the monetary aggregate compatible with low inflation. Specifically, monetary targeting requires adequate knowledge of the parameters characterizing money demand. In an economy undergoing rapid financial liberalization, however, these parameters (notably, the interest elasticity of money demand) may be highly unstable (Agénor, 2002). In such conditions money ceases to be a good predictor of future inflation; that is, the relation between the intermediate target and the final objective becomes unstable. Similarly, in a context of disinflation, money demand may be subject to large and unpredictable shifts; as a consequence, the information content of a money aggregate for future inflation will be very low. Finally, Goodhart (1975a, b) developed a thesis according to which once an economic indicator is made a target for the purpose of conducting economic policy, then it will lose the information content that would qualify it to play such a role. More precisely, "when a measure becomes a target, it ceases to be a good measure" (Strathern, 1997). This is because the financial system evolves and financial institutions can easily devise new types of financial assets, hence making the controlled aggregate a weak predictor of inflation. All these arguments suggest that relying on monetary aggregates can be potentially risky. In addition, suppose that monetary targeting is viewed as minimizing money growth volatility around the money-growth target. As shown by Svensson (1996), this policy goal may be in conflict with the objective of minimizing inflation volatility; that is, often there is a conflict between stabilizing inflation around the inflation target and stabilizing money growth around the monetary target. Monetary targeting will, in general, imply greater inflation volatility than inflation targeting. By inducing higher volatility in nominal and real interest rates, it also leads to increased volatility in output (Clarida *et al.* 1999). Because of the lost link between monetary aggregates and prices, several industrial countries have abandoned this monetary strategy (Estrella and Mishkin, 1997). Although still limited, the research on developing countries (for instance, Mishkin and Savastano (2002) for Latin America) suggests that this relationship has weakened there as well and a growing number of these countries have discarded money targets.

While monetary targeting is no longer valid, because of the reasons identified above, implicit nominal targeting is risky for a central bank without established credibility and nominal-income targeting is still only a theoretical option. The quest for a new monetary regime and, hence, a nominal anchor leads to the consideration of an *inflation-targeting regime*. Within this framework, the ultimate goal of monetary policy is attained by commitment to a numerical target for the inflation rate and the nominal anchor is found in the inflation-rate forecast. Further analysis of IT follows later in the chapter. From the perspective of exchange-rate economics, Goldstein (2002) calls for a "managed floating plus" regime, whereby the exchange rate de-facto floats with the necessary interventions (in a form of reserve intervention or interest-rate smoothing), but is accompanied by IT which provides a firm nominal anchor for inflation expectations. In other words, there is no longer an exchange-rate target; exchange-rate flexibility allows some flexibility in domestic interest rates, i.e. these are settled in conjunction with domestic objectives (mainly inflation and output). Consequently, a managed floating exchange rate, under the umbrella of IT, provides a nominal anchor under a de-facto independent monetary policy, where the exchange rate is allowed to smooth external disturbances but not allowed to interfere with the price stability objective. From Chapter 3 the findings suggest, indirectly, that managed floating provides less exposure of the real economy to external shocks, since flexible rates were found to transmit external shocks to output less forcibly than do pegs. Finally, as will be argued in Section 4.4.3, inflation targeters have output fluctuations explicitly stated in their monetary-policy functions.

In an IT framework, exchange-rate management aims to reduce excessive exchange-rate volatility and to lessen the foreign-exchange exposure of agents' balance sheets, which may suffer from currency mismatch between foreign assets and foreign liabilities. Moreover, by exerting greater control over the currency mismatch or by lessening the level of euroization, the fear of floating will be reduced. Furthermore, "[theoretically] exchange-rate flexibility instils risk into foreign-currency borrowing, thus reducing currency mismatches." (Tavlas, 2003, p.1230). The latter would, to a greater extent, support the success of an IT regime. A credible low-inflationary environment achieved by the former pegging would increase residents' eagerness to hold the domestic currency and non-resident lenders' will to conclude financial contracts in the local currency. The latter would additionally be favourable for the development of the domestic bond markets, which, in turn, further reduces the currency mismatch in the balance sheets of economic agents. "With a reduction of mismatches, the authorities can lower interest rates to counter a recession without worrying that exchange-rate depreciation will set off a free fall in the economy and a wave of bank failures" (Tavlas, 2003, p.1230). Consequently, exit from the exchange-rate peg will result in a managed floating regime under the umbrella of IT.

Conducted in the above manner, the switch from ERT to IT serves three simultaneous objectives (Corden, 2002). Monetary policy with a flexible exchange rate: i) has still a firm nominal anchor for inflation expectations; ii) can respond to a negative external shock which transmits to a real economy distortion; iii) still has the power to impede real exchange-rate volatility caused by a negative external shock, as the latter could adversely affect international trade. In terms of the latter, both Goldstein (2002) and Corden (2002) agree that under a credible monetary policy with a strong institutional commitment, prudent fiscal policy, strengthened debt management and prudential regulation, the exchange rate under an IT framework will be freed to adjust, given macroeconomic fundamentals.

The above considerations create a firm departure point towards IT. At the same time, they directly touch upon the economic environment which will be conducive for IT. In turn, the preconditions for adopting this monetary regime are reviewed in the next section.

4.3. Towards inflation targeting – preconditions for adoption

Given that IT has not been abandoned by any adopter up to the present time as it delivers satisfactory inflation performance and anchors inflation expectations, a question arises of why all countries have not adopted IT. The answer is possibly simple: not all countries fulfil the necessary conditions for pursuing this strategy. Exceptions to this answer are developed economies that pursue another monetary regime, either because they participate in a currency union (like the EMU and ERM-2 countries) or because they opt for high discretion within an implicit nominal targeting regime (like the US).

Requirements for successful IT are demanding. This conclusion stems from the view that although IT provides "constrained discretion" (Bernanke and Mishkin, 1997), a weak institutional setting for monetary policy could lead to its abuse and to the ultimate demise of the regime. Therefore, establishing an IT regime in such a setting, solely because of the authority's desire to have a flexible exchange-rate policy (to boost competitiveness, for instance) is doomed to fail. In addition, the successful IT regime is dependent on the functionality of the entire economic system. Therefore, the dichotomy of institutional and economic preconditions for IT adoption, provided in Siklos and Abel (2002) is followed in the next sections, but with the intention of making the distinction clearer.

4.3.1. Institutional requirements for adopting inflation targeting

Institutional requirements for successful IT are first and foremost related to the institutional settlement of the central bank (Hennan *et al.* 2006). First of all, the central bank must be given a clear mandate for price stability, which is often clearly stated within the central-bank law. Moreover, the credibility of the IT framework is likely to be enhanced by a high degree of central-bank independence from the government in its policy formulation. In that regard, the central bank has to have at its disposal a variety of instruments necessary for achieving the settled inflation target. This is the concept of instrument independence. However, the central bank must not be left alone in explaining to the public the chosen strategy for monetary policy. In other words, there must be a joint responsibility for setting of the inflation target. Almost in all IT economies, the ultimate numerical goal is set jointly by the central bank and the government (Ministry of Finance). That is, while the central bank must be completely instrument independent, within an IT regime, it is desirable to share the responsibility related to setting the goal (Siklos and Abel, 2002). Masson *et al.* (1997) agree that this institutional settlement, where the central bank is instrument but not goal independent, is not tailor-made for the IT regime, but it is a general precondition for formulating monetary-policy instruments separately of fiscal policy. This aspect is discussed within the economic-preconditions section below.

It follows from the preceding discussion that a central bank which opts for successful IT has to be coupled with strong accountability arrangements for policy performance. It must be prepared to answer to the public for successes, failures and remedies in case of failure to meet the settled target. Accountability, in turn, will provide incentives for the central bank to seek to meet the target. The main mechanisms to hold the IT central bank accountable for its actions usually include publishing inflation and other special reports, publishing minutes of the committee meetings, clauses for dismissal of decision makers in case of unsatisfactory performance, and so on (Hennan *et al.* 2006). It follows that a transparent central bank is simultaneously becoming more accountable and, therefore, in such an institutional setting, these two aspects reinforce each other.

Finally, concluding the central-bank setting required for successful IT, Jonas and Mishkin (2003) argue that the central bank has to be equipped with strong forecasting capabilities. As will be explained in Section 4.4.1, an IT regime uses the inflation forecast as an intermediate target of the monetary policy; hence, the inflation forecast de-facto anchors economic agents' inflation expectations, in that manner delivering optimal inflation performance. In consequence, the forecasting and modelling capacities of the central bank gain an importance greater than in any other monetary regime.

The second institutional prerequisite for adopting IT is the abandonment of other nominal targets, including exchange-rate targets. Putting it differently, the IT central bank could not adequately fulfil the accountability and transparency requirements if the determination of monetary conditions were not in domestic hands. Therefore, in light of the discussion in Chapter 1, an exchange-rate target is completely ruled out in the IT framework. However, a clarification here is desirable. While a wider exchange-rate band or a crawling peg, by definition, are forms of ERT, they are sufficiently relaxed, allowing the authorities to gear monetary policy to some other nominal objective (Masson *et al.* 1997). The same study stresses that although the optimal decision would be to abandon any ERT (including wide exchange-rate commitments), consistent with Goldstein (2002) above, still a non-fixed exchange-rate target could coexist with an inflation target, "as long as it is clear that the inflation target has priority if a conflict arises" (Leiderman and Svensson, 1995). Nevertheless, resolving such a conflict could appear costly in terms of losing control over inflation expectations, by sending confusing signals to economic agents.

Finally, the adoption of an IT regime should be made conditional upon a broad political consensus and public support, as these are crucial in guiding the monetary policy in the desired direction (Hennan *et al.* 2006). In summary, institutional preconditions are linked to the extent of central-bank independence, its transparency and accountability and the non-existence of other nominal targets for monetary policy. In this thesis, the second issue is not questioned. Quite the opposite, the issue is to design an IT regime given the abandonment of the exchange-rate target.

4.3.2. Economic conditions for successful inflation targeting

Whereas the institutional prerequisites are merely on the technical side when deciding to embark on an IT regime, the economic preconditions are more substantial, as they touch upon the interrelationship between the IT framework, other economic policies and the entire financial system. The previous section started to explore the first interrelationship. That is to say, in Masson *et al.*'s (1997) opinion, monetary policy must not be subordinated to any other economic policy, primarily fiscal policy. The concept of fiscal dominance is crucial in the IT-preconditions literature. Whereas there is no qualm that the fiscal stance should be strong (Jonas and Mishkin, 2003), implying fiscal deficits and debt levels supportive to the inflation target, the conduct of the monetary policy which targets inflation must not be dictated to or severely constrained by developments of a fiscal nature.

The case against fiscal dominance requires that the government has a sufficiently broad tax base and that, therefore, there is no incentive to systematically rely on seigniorage. In other words, under an IT regime, public sector borrowing from the central bank should be minimized or non-existent (Jonas and Mishkin, 2003). Moreover, this implies that a financial market for government securities should be developed in order to absorb the issuance of government debt. Similarly, Sargent and Wallace (1981) argue that the accumulation of debt should be at a pace that guarantees its sustainability, i.e. that it will not give rise to explosive and unpleasant dynamics. Even if the government does not borrow from the central bank, the fiscal theory of the price level suggests that such irresponsible behaviour of the government will lead to inflation with a fiscal origin. Then, the fiscally-driven inflation process will gradually undermine the effectiveness of the monetary policy to attain any nominal target, including the inflation target. In such a scenario, fiscal policy dominates, whereas the monetary policy accommodates, a situation which is inconsistent with an IT regime.

Fiscal dominance can take extreme forms. For instance, shallow capital markets are also a common manifestation of fiscal dominance. McKinnon (1991) argues that these are usually a by-product of government attempts to increase revenues by forms of financial repression, like interest-rate ceilings, high reserve requirements, sectoral credit policies and compulsory placements of public debt. If the monetary financing of budget deficits under the IT framework is dire and unsustainable, then these forms of fiscal dominance are even worse. Moreover, prolonged financial repression would cause the banking system to become fragile and would ultimately undermine the entire financial system. According to Mishkin (2004), given a weak banking system, the central bank would be unable to increase the interest rate in order to sustain the inflation target, as this will likely lead to financial-system crisis. This, in turn, will lead to demise of the monetary regime and could lead to contagious currency crisis.

Consequently, in close relation to the fiscal issue in the IT framework is the development of the financial system. Not only the government-securities market should be developed, but all segments of the financial and banking sector should be developed to a level sufficient to provide an efficient transmission mechanism for monetary policy. The development of the financial-market infrastructure is crucial for the efficient transmission of the interest rate to inflation. This implies that the market is deep enough with instruments, including government securities. Moreover, as IT is not accompanied by any target for the exchange rate, economic agents will be better off if there are hedging instruments against exchange-rate risk. Hedging gains in importance when the level of euroization of the economy is considerable. The exchange-rate risk arises because of the currency mismatch in economic agents' balance sheets in euroized economies; it follows that the level of euroization matters. Whereas a low level of euroization is not by itself a precondition for IT, it must be considered when embarking on such a strategy (Masson *et al.* 1997); in that line of argument, the flexible exchange rate under IT would create greater exchange-rate exposure to economic agents in a euroized economy. A developed foreign exchange market would mitigate this exposure. In a world of increased capital mobility, therefore, an optimal combination of the level of euroization and the development of the financial market is desirable for successful IT. Consequently, the last views involve developed foreign exchange and banking markets. The issue of euroization under IT is returned to in Chapter 5.

Mishkin (2004) argues that financial stability is a wider concept than the stability of the foreign-exchange market. Closely linked to the performance of the banking sector, the entire financial system should rely on prudential regulations and enforcement mechanisms, in order to prevent financial crises on a wider scale.

In summary, the prerequisites for successful IT range from technical to substantive instruments and policies to be in place in order to enable efficient conduct of monetary policy under IT. These are: a clear mandate to the central bank for price stability; full central-bank instrument independence and shared goal setting with the government; increased accountability and transparency of the central bank; a technical capability for forecasting inflation; absence of other nominal anchors; a strong fiscal position and absence of fiscal dominance in the economy; a well-understood transmission mechanism of monetary policy; and a well-developed financial system, including the foreign-exchange market and the banking sector.

4.4. Economics of inflation targeting

4.4.1. Inflation targeting: definition

As mentioned in Chapter 1, attaining price stability in the medium to long run emerged as a primary goal of monetary policy. The reason behind this can be sought in two directions. Firstly, a high and variable inflation rate is socially and economically costly: price distortions; lower savings and investment (and lower growth); hedging with precious metals and real estate; and capital flight. Secondly, the lure of other goals like higher output and employment ends with the known inflationary bias and without real gains in the long run (Agénor, 2002). The latter issue, known as the time-inconsistency problem, has been mentioned in the previous chapters, but remains an important issue throughout the entire thesis.

The monetary policy has long been reliant on intermediate targets, mainly monetary and exchange-rate targets. We explained in Section 4.2 that the former are no longer viable as the link between money and inflation has weakened, while the latter prevents the pursuit of independent monetary policy and exposes the economy to severe exogenous disturbances. The search for a monetary strategy to provide an independent monetary policy and greater exchange-rate flexibility, and to mitigate the problem of the weak link between money supply and inflation, resulted in the today well-known inflation-targeting regime. IT is a relatively new phenomenon dating back to the beginning of the 1990s when New Zealand was the first country to adopt it, followed by Chile, Canada and the United Kingdom. Up to the present time, 26 countries have adopted fully-fledged IT, with Serbia being the most recent inflation targeter. Inflation targeting encompasses six core elements (Mishkin, 2001; Svensson, 2007):

1. public announcement of a medium-term *numerical target* for inflation, with an increasingly explicit concern over inflation and the real economy;
2. an *institutional commitment* to price stability as the primary goal of monetary policy, to which other goals are subordinated. This implies highly instrument-independent and a considerably goal-independent central bank;
3. an *information-inclusive strategy* in which many variables, and not just the money supply or exchange rates, are included when deciding the setting of policy instruments;
4. an internal decision process – *inflation-forecast targeting*, in which projections of the target variable play a prominent role;
5. increased *transparency* of the monetary-policy strategy through communication with the public and the markets about the plans, objectives and decisions of the central bank; and
6. increased *accountability* of the central bank for attaining its inflation objectives.

In the above line of thinking, Batini *et al.* (2006) defines IT as a monetary strategy which commits to a numerical target for achieving medium-term price stability and uses an *inflation forecast* over a horizon as an intermediate target of the monetary policy. More precisely, the central bank decides upon a monetary-policy instrument, usually an interest rate, which is envisaged to meet the inflation target, through the means of intermediate targeting of the inflation forecast. This definition directly adds to the notion that price stability has to be the overriding and primary goal of monetary policy, often specified as an inflation rate that makes economic agents not take it into account in their decisions.

Defined in the above manner, the inflation commitment directly mitigates the time-inconsistency problem mentioned earlier. With an IT strategy, the central bank is freed of inflationary bias in a regime whereby it can exercise full discretion in the setting of the policy instruments. IT helps to redress the inflationary bias by making inflation, and not the output or the exchange rate, the explicit goal of monetary policy, and by providing the central bank with a forward-looking framework to undertake a pre-emptive tightening of policies before inflationary pressures become visible (Masson *et al.* 1997).

The IT operation procedure as a forward-looking regime could be illustrated by the following simple formula (Masson *et al.* 1997):

$$\Delta r_t = \gamma(\pi^e_{t+i} - \pi^*) \qquad (4.1)$$

Whereby, Δr_t is the alteration of the policy instrument (or departure from an equilibrium interest rate r^*_t) intended to achieve the inflation target π^* over horizon *i* with information given today (time *t*), superscript *e* refers to expected, and *γ* is the adjustment parameter. π^* has no time subscript as it is assumed not to change from period to period. $(\pi^e_{t+i} - \pi^*)$ is the difference between the expected rate and the target rate - i.e., the forecast deviation from the target rate – which must be reduced by interest-rate changes, where the size of the change is dictated by the adjustment parameter.

Besides expressing the IT-framework, the formula enables an analysis of some technical aspects of the regime as well. Within this regime, a clear specification of the inflation target π^* is needed; an ongoing question is whether this should be defined as a point or as a range. Inflation expectations are an ingredient of the formula, coinciding with the technical capacities of monetary authorities to forecast inflation, that is, π^e_{t+i} is settled upon empirical estimates of inflation dynamics and the effectiveness of the monetary policy to anchor these expectations. Consequently, π^e_{t+i} constitutes the intermediate target of the monetary policy within IT. That is, the objective of policymakers will be to keep the difference $(\pi^e_{t+i} - \pi^*)$ within a prescribed band, so that a value approaching zero will confirm the appropriate choice of r_t, as the target π^* becomes reachable over the chosen horizon *i*. On the contrary, r_t will have to change if the intermediate target π^e_{t+i} and the ultimate target π^* diverge.

The term π^e_{t+i} directly points to the forward-looking character of IT: the policy instrument is set based on an assessment of the expected inflation and not the past one. Note that within IT, the source of the expected inflation does not matter in the policy formulation.[23] The target horizon *i* is important for monetary policy as it corresponds to the time lag needed for the monetary decision to affect the goal. Therefore, an appropriate choice of *i* is a precondition for successful IT. Finally, which measure of inflation will be considered is an important question as well. For further analysis of the technical aspects of IT refer to Hennan *et al.* (2006).

A growing body of literature points to the following advantages of IT (see, for example Mishkin's and Svensson's work in this field). For instance, contrary to exchange-rate targeting, it enables an independent monetary policy which could be used in a direction that focuses on domestic considerations and appropriately responds to disturbances hitting the economy. Superior to money targeting, IT is not conditioned upon the relationship between broad money and inflation. The comparative analysis is further developed in Section 4.5. Finally, IT is easily understood by the public and the

[23] However, given that there are some prices in the economy which are influenced by non-market forces (such as tobacco and alcohol, which are influenced by taxes and excise duties); by geopolitical developments (the prices of energy-related products); and by the transitory seasonal developments (the prices of fresh products); some IT central banks are generally charged with targeting some measure of "core" inflation, which usually excludes the prices of these types of products, rather than "headline" inflation.

Nevertheless, given that in the major part of the discussion here we talk about small and open economies, even if they want to target the core inflation, these relative-prices changes fairly quickly become embedded in the prices of a broad-category products in the economy (a type of a second-round effect), so that a policy response will be again needed and, hence, the central bank will be concerned with these sources of inflation. Refer to Section 4.4.4.

Mainly because of these lines of thought, the IT literature does not discuss the sources of inflation under IT, i.e. whether inflation arises because of a money-goods mismatch (the example on p. 170) or because of changes in relative prices (the example on p. 176).

regularly published numerical target for inflation increases accountability and transparency.

Although, by providing monetary independence, IT is often blamed for providing too much discretion, it does not necessarily do that, since it specifies a range or specific target for inflation rate and horizon over which it should be attained. Moreover, the governor is often held highly accountable for missing the range, from the possibility of being dismissed (New Zealand) to the need to justify why the miss has happened (Australia *et al.*). Bernanke and Mishkin (1997) refer to IT as a "constrained discretion" regime, or a state which refers to point F in Figure 1.1 on p.29: discretion based on rules and an information-inclusive strategy with structural and judgmental models of the economy and appropriate policy-instrument feedback.

Another possible drawback of the IT regime is that by tight and exclusive focus on inflation performance, output variations could be exacerbated should a supply shock hit the economy. This expression is related to the often cited qualm in IT literature of credibility versus flexibility (Masson *et al.* 1997). Namely, credibility could be enhanced if IT regime tolerates the cost of losing short-run flexibility, especially in times of shocks (Svensson, 2000). Yet, this is not the case in the practical application of IT and it directly touches upon the distinction between two forms of IT: *strict* and *flexible* IT and their macroeconomic impact. These practical aspects are analysed separately in Sections 4.4.2 and 4.4.3.

4.4.2. Transmission mechanism under inflation-targeting regime

In an early study, Mishkin and Posen (1998) argue that IT delivers a superior inflation performance compared to the other strategies, by anchoring inflation expectations in the manner described above. Gosselin (2007), in that regard, found that the inflation performance of advanced countries was quite good - more than 60% of inflation deviations from targets were smaller than 1 p.p., with the bias (under/overshooting of target) almost nonexistent. On the other hand, the late 1990s and early 2000s brought new inflation targeters, mainly from emerging economies. Inflation performance was found relatively weaker and more heterogeneous in emerging market economies with the target missed by more than ±2% in one third of the cases. However, no central bank has given up IT, regardless of the magnitude, duration and frequency of inflation-target misses. Roger and Stone (2005) point out that this is due to the flexibility of the framework in handling shocks, high standards of transparency and accountability, and the lack of a credible alternative monetary regime. What is important for this thesis is that the prerequisites for embarking on IT outlined in Section 4.3 restrain the central bank from using any other anchor for monetary policy. Implicitly, this means that targeting inflation goes along with an exchange-rate strategy other than exchange-rate pegging. Taking into account that inflation could affect the short-run deviations of output from its potential levels (an aspect mentioned in Chapter 2), a clear depiction of the transmission channel of monetary policy under IT is considered necessary.

Economists in recent years have agreed that the control of inflation and the output gap should be left to monetary policy, considering that, "because of the tradeoff, unpredictable shocks, uncertainty, and unavoidably imperfect control, there will always remain some variability in both inflation and the output gap" (Svensson, 2003, p.270). Along with this, the assertion that stable prices should be the long-run overriding goal of monetary policy (Agénor, 2002) gains substantial support within an IT regime. The latter is due to the fact that almost all IT central banks declare a clear low-inflation objective and all put some weight on output stabilization besides inflation in their loss functions. In the endeavour to match the operating instruments for achieving the goal with the goal attainment, central bankers must understand the mechanisms through which monetary policy affects the economy. Mishkin (1996) argues that there are *three asset-price channels* (interest-rate, exchange-rate and equity-price channel) and *two credit channels* (bank lending and balance-sheet channel) that link monetary policy actions to the real economy and ultimately to prices. Bakradze and Billmeier (2007) add the expectations channel. In order to understand the transmission mechanism through which IT works, a brief description of the possible channels is provided next.

The traditional channel for the transmission of monetary policy is the *interest-rate channel*. Mishkin (1996) considers it as the most important, since the alteration of the interest rate directly affects the investment decisions made by firms. This was later revised by recognizing that the change in the interest rate also affects consumer spending on durable goods and housing. Consequently, change of the interest rate affects aggregate demand and, in turn, induces a change in output. Hence, when the interest rate is lowered, economic activity is increased and the economy expands, and vice versa. Taylor (1995) found strong empirical support for the interest-rate channel, i.e. evidence for substantial interest rate effects on consumer and investment spending in a few developed economies (US, Germany, Japan and others) in two distinct sub periods from the early 1970s until the mid-1990s.

With increasing international trade and global capital mobility, the exchange rate has again gained in importance in transmitting monetary policy, operating through its effects on *net exports*. It may involve the interest rate, since higher domestic interest rates attract more foreign deposits, putting appreciating pressure on the value of the domestic currency. The latter in turn reduces international competitiveness, causing net exports to decline and, hence, aggregate output.

The asset-price channel, working through the *valuation of equities,* comes in two forms: Tobin's q; and the wealth-effect channel. Tobin (1969) provided a measure of the market value of firms in relation to the replacement cost of capital, called Tobin's q; a high value for it suggests a low price for obtaining new capital (since the market value of the firm is high relative to the cost of capital). Hence, investment spending will rise and vice versa. When the monetary policy is expansionary (interest rates decrease), bonds become less attractive and equities more attractive. In turn, the latter causes the equity prices to increase giving a high Tobin's q, higher investment spending and thus higher output. The second equity channel works similarly: when prices of equities rise under expansionary monetary policy: people find themselves wealthier, leading to increased consumption and thus increased aggregate demand. Finally, housing prices could increase when monetary policy is expanding, which add to wealth and thus aggregate demand.

Distinct from the asset-price channels, Bernanke and Gertler (1995) described two credit channels: the *bank-lending* and the *balance-sheet channel.* In both channels, the effect of monetary policy is magnified due to a change in lending. The theory of the bank-lending channel is based on the Bernanke and Blinder (1988) model, where a contractionary monetary policy leads to a reduction of bank deposits which, in turn, reduces aggregate loan supply. In their model, the financial markets do not clear only through price. Loans are provided by intermediary institutions, which are specialised in screening and monitoring borrowers in the presence of asymmetric information. Market clearance can be achieved not only by changes in the interest rates, but also by the quantity of loans supplied, i.e. applying prudential measures to prevent default - credit rationing. The decrease in loans then causes investment and consumer spending to decline and thus aggregate demand as well. This alternative channel, working through the balance sheets of the firms, is described in Bernanke *et al.* (1996). There, the agency costs of lending endogenously change with monetary policy. Monetary contractions reduce the net worth of borrowers, which leads to an increase in agency costs, primarily for low-net-worth firms. In the Bernanke and Gertler (1989) model, when these agency costs increase, lenders reduce the amount of credit extended to risky firms and invest more in a safe alternative (the process of credit rationing). This happens if: i) the bank was unable to perfectly distinguish the risky borrowers from the safe ones (problem of adverse selection); ii) the loan contracts were subject to limited liability (if projects returns were less than the debt obligation, the borrower bears no responsibility to repay his part – a problem of moral hazard) (Stiglitz and Weiss, 1981). In consequence, the higher the agency costs, the lower the lending and the lower the investment spending by firms.

Finally, as explained by Bakradze and Billmeier (2007), economic agents' behaviour depends on what they *expect* that the central bank will do, or how confident they are that the central bank will stick to its long-run goal. Expectations of higher inflation than the desired level will result in expectations of higher interest rates in future; the latter will put further pressure on the central bank to reconsider its interest-rate path and thus leads to an actual increase of the nominal interest central-bank policy be.

***

Now that the possible transmission channels are depicted, their application in an IT regime will be considered. A more algebraic approach than here is provided in Section A3.1 in Appendix 3. To begin with, assume a relatively closed economy, whereby only one composite good is being produced. The two equations characterizing the economy are the following (lower-case letters refer to logarithms):

$$(y_t - y_t^*) = \beta_1(y_{t-1} - y_{t-1}^*) - \beta_2(r_{t-1} - \pi_{t-1}) + \eta_t, \beta_1 < 1 \qquad (4.2)$$

$$\pi_t - \pi_{t-1} = \alpha_1(y_{t-1} - y_{t-1}^*) + \varepsilon_t \qquad (4.3)$$

Whereby $(y_t - y_t^*)$ refers to the output gap, defined as the difference between the actual (y_t) and the potential output (y_t^*), the latter being time varying, hence subscript t; $\pi_t \equiv p_t - p_{t-1}$ is the inflation rate at time t, *p* denoting the log of the price level; r_{t-1} is the nominal interest rate in time *t-1* and η_t and ε_t are i.i.d. random shocks. $(r_{t-1} - \pi_{t-1})$

refers to the real interest rate and is important because it is the real rate, not the nominal one, that could affect output. Given that y_t^* here is time-varying, this is not fully consistent with the assumptions in Section 3.5.1, where only limited possibilities for mean-shifts were included in the model. However, it is difficult to establish the underlying data-generating processes of these variables – as we discuss on pp. 123 and 136 and in Section C.5 – in particular whether their non-stationarity is rejected against the alternative hypotheses of mean-breaks, trends and trend-breaks.

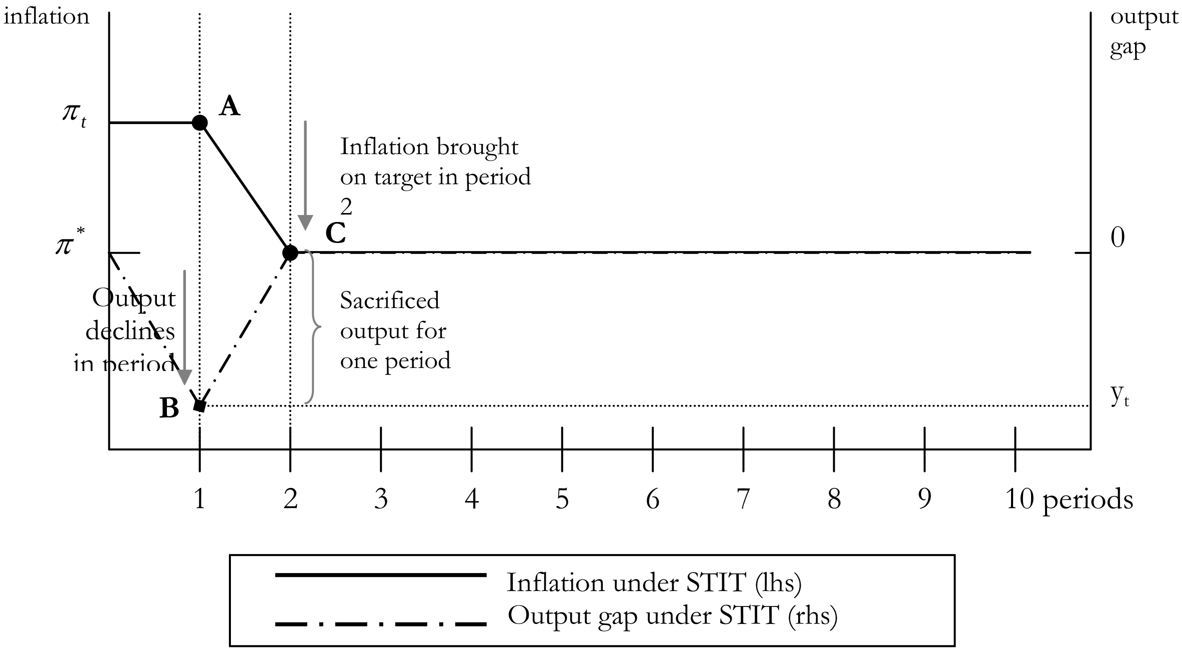
Monetary policy under IT alters the stance of the (nominal) interest rates, which then activates the interest-rate channel, i.e. affects investment. Although not formally in the model, the bank-lending channel would be expected to operate as well; i.e. changes in interest rate alter the lending rate and hence the availability of credit to consumers today. According to equation (4.2), this monetary decision will result in changes in the aggregate demand in the next period (period 1). Aggregate demand (represented through the cyclical component, i.e. the deviation of the current output from its potential level) then affects inflation with another lag (period 2; equation (4.3)) through the aggregate-supply function (Phillips curve), whereby inflation is dependent on its past value and the output gap. Increased aggregate demand caused by lower interest rates gives rise to inflationary tendencies. These issues are revisited in more detail in Section 4.4.3. As noted before, the stance of the monetary policy facilitates the creation of inflation expectations, which in turn affect inflation throughout the process of wage and price setting behaviour.

How do these transmission channels relate to IT? Opting for a fast return of the inflation rate to its target, the central bank would announce an interest rate which is consistent with equation (4.1), i.e. a rate that minimizes the difference between the inflation forecast and the inflation target over the targeting horizon. Debelle (1999) argues that this works via the interest-rate and bank-lending channels (equations (4.2) and (4.3)) and expectations channels.

Pursuing an illustration, a severe widespread drought in the country would decrease aggregate supply (assuming that temporary deficiencies emerged in production as a result of the drought), thus causing a rise in inflation (assuming that consumption does not diminish in step). Although fiscal policy might be more effective by subsidizing agriculture and stimulating the production of agricultural products in order to equilibrate the aggregate demand and supply, the response of monetary policy will be illustrated for the purposes of understanding IT in a closed economy. In King's (1996) jargon, in such situation, an "inflation nutter" central bank will immediately accommodate (raise) the interest rate so that to bring inflation pressure down and hit the target. The increased interest rate to combat inflation will have contractionary effects on domestic demand (capital becomes more expensive and reduces investment; bank lending diminishes). It can be argued that demand will contract in response to the inflationary tendencies, but if the central bank opts to bring inflation close to the target as soon as possible, then this attempt could lead to temporary depression of output below its trend-line. In the jargon of Bernanke and Mishkin (1997), a great portion of output will be forgone in order to tightly and rapidly stick to the inflation target. The sacrifice ratio, being the ratio of the cost of output forgone and the rate of inflation, hence increases (Ball, 1993); i.e. the higher the actual inflation and the shorter the desired time to bring it to target (i.e. the higher the interest rate imposed) the higher the output loss. As a consequence, the attempt to bring inflation to the target might immediately exacerbate output volatility.

Figure 4.1 is drawn to picture this monetary-policy response, called *strict inflation targeting*. The horizontal axis represents periods, the left vertical axis represents inflation, while the right one represents the output gap. Higher inflation than the target, $\pi_t > \pi^*$ (point A) will force the central bank to raise the interest rate – higher inflation deviation implies a discrete interest-rate jump. This will cause contraction of output in period 1 (point B) well below the potential level (negative output gap), but ensures that inflation reverts to target in period 2 (point C). The sacrificed output for only one period is the vertical distance between B and C.

Figure 4.1. Strict inflation targeting



Source: Drafted by the author

But in this approach IT appears so severe upon the output, so why have none of the IT central banks abandoned this strategy? This is now discussed.

4.4.3. Output considerations – flexible inflation targeting

While the empirical evidence suggested that there is no long-run trade-off between inflation and output, there is ample evidence of a short-run trade-off (Debelle, 1999). The latter, represented throughout the above-mentioned aggregate-supply function, implies a trade-off between inflation and output variability. Assume positive output gap, $y_t > y_t$. A contractionary monetary policy (increased interest rates) implies a declining output gap through the interest-rate and bank-lending channel. In the subsequent period this will lower inflation to the desired level. Thus, a policy that requires a quick return of inflation to target results in high output variability and an increasing sacrifice ratio.

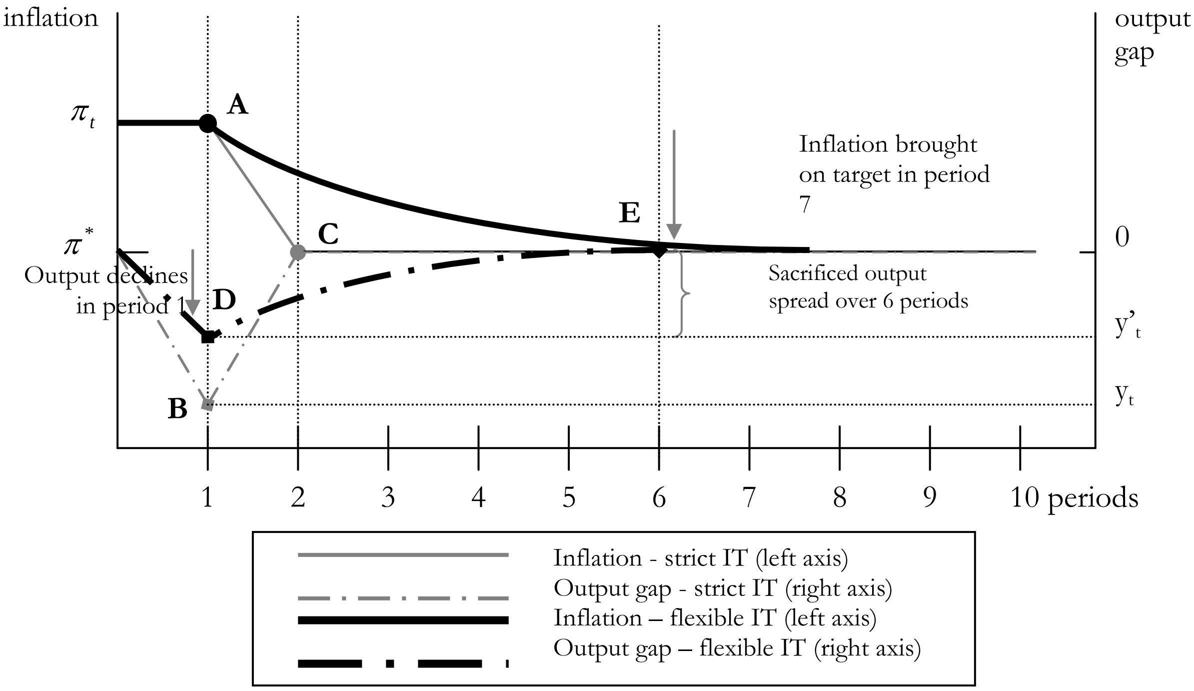
Judged according to the preceding notions, even under an IT framework, central banks would prefer gradualism in inflation reduction if aggressive policy actions are too costly in terms of output instability (Schmidt-Hebbel and Tapia, 2002). Svensson (2000) has labelled this behaviour as *flexible inflation targeting*, compared to the more stringent approach described in Section 4.4.2. This approach includes both inflation deviations from target levels and output variations around full-employment levels as arguments in central banks' objective function. In this way, inflation will be brought on target over a longer horizon, while less output is sacrificed and this loss is not felt equally strong as if it is sacrificed at once; that is, the sacrifice ratio dwindles.

The arguments of Svensson (1996, 1997, 1999a, b, 2001) lead to the conclusion that (4.1) is not an appropriate description of the policy rule. Instead, it should include output variations as well:

$$\Delta r_t = \gamma_1(\pi^e_{t+i} - \pi^*_{t+i}) + \gamma_2 \lambda (y_t - y^*_t);\ \lambda > 0 \qquad (4.4)$$

Notations are the same as before, and γ_1 and γ_2 are the adjustment parameters. Note that this is forward-looking interest-rate rule in terms of inflation. The forward-looking component of the output gap is assumed to be already included via the inflation part, as represented by the equations (4.2) and (4.3) above. $\gamma_2 \lambda$ is a compound parameter combining the policy response and the weight the central bank puts on the output, and this is the parameter estimated in the empirical specifications (see, for instance, Table 6.6, p.262). A strict inflation targeter opts for λ=0, in which case the policy rule accommodates only to deviations of the inflation forecast from the target. Any figure λ>0 would imply a form of flexible IT. Figure **4.2** is drawn to picture the flexible IT. Light lines replicate Figure 4.1 for the purpose of comparison. The starting point is again point A where the high inflation is combated with an increasing interest rate. However, although $\pi_t > \pi^*$, the central bank does not want to sacrifice a huge portion of the output (distance B-C), thus giving a positive λ in equation (4.4). Now, inflation does not immediately revert to the target (A-C), but instead the return is gradual (heavy line A-E). More importantly, the initial drop in output is lower than in the case of strict IT (B vis-à-vis D) but it also reverts to its potential level gradually (dotted line D-E). The figure is drawn so that output gap reaches zero at period 6. On the other hand, inflation is brought on target, but not in period 2, due to the desire not to severely affect the real economy. Hence, the trade-off is clear: inflation is brought to target in seven instead in two periods, but the sacrificed output in the first year is considerably less (vertical distance B-C vis-à-vis D-E; discussed below).

Figure 4.2. Flexible inflation targeting



Source: Drafted by the author

Equations (4.1) and (4.4) represent instrument rules, whereby the instrument is a prescribed function of predetermined (backward-looking) and/or expected (forward-looking) variables. However, Svensson (1996) argues that the central bank does not react to the prescribed information set in a mechanical manner, as implied by the instrument rules. Instead, the central bank uses all available information (monetary aggregates, exchange rate, output volatility and so on) in a given setting which imposes the need for re-optimization in each subsequent period.

Rather than setting an instrument rule, the IT central bank is systematically and rationally committed to following a target rule, with a relatively explicit loss function to be minimised (Svensson, 1998). In essence, the equation specifies the target variable(s) and targeted level(s). If the instrument (interest rate) affects the output gap with a one-period lag and inflation with two-period lags via the channels identified above, the appropriate loss function would be:

$$L_t = \frac{(\pi_t - \pi^*)^2}{2} + \frac{\lambda(y_t - y_t^*)^2}{2};\ \lambda > 0 \qquad (4.5)$$

Whereby, π_t refers to actual inflation, π^* is the targeted inflation rate, while $(y_t - y_t^*)$ refers to the output gap. λ, as previously, refers to the relative weight on stabilizing the output gap. In terms of the loss function, an inflation targeter will attempt to minimize deviation of actual inflation from the inflation target contained by the first term of (4.5). However the inflation targeter also takes account of the second term, which corresponds to the output volatility and it calls for the gradualist policy approach towards reducing inflation. This gradualist approach enables the sum of the losses of output in the subsequent periods to be smaller than the lump loss under strict IT in one period. It is explicit that, since the loss function is quadratic, the bigger deviation in one year gives a large loss of utility than several small ones over a number of years. Moreover, as shown in Section A3.2 in Appendix 3, the discounting factor makes the current value of losses smaller in future years, as well.

At last, reverting to the early argument in this study that IT mitigates the time-inconsistency problem by committing to an explicit numerical target, the loss function adds to this conclusion; contrary to what might be the initial impression (Debelle, 1999). That is, equation (4.5) specifies the implicit output target to be the capacity output, which is consistent with the natural-rate hypothesis, according to which, in the long-run, an expansionary monetary policy leads to higher prices but not higher employment, i.e. no changes in y_t^* (Fisher, 1996), but instead changes in the short-run deviation of the actual output from its potential level. This theory, hence, constitutes a fundamental part of the IT regime.

4.4.4. Open-economy IT: the exchange rate as core transmission channel

The preceding sections described IT in a closed economy. However, nowadays, this assumption is rather unrealistic. Svensson (2000) argues that in the real world, all inflation targeters today are small and open economies with free capital mobility. This implies at least two things:

- The exchange rate is an important element of the transmission mechanism of monetary policy; and, consequently,
- Exogenous shocks matter as these are directly transmitted to inflation and/or output volatility.

In other words, the exchange rate should be considered besides the traditional aggregate demand and expectations channel in the analysis. Abandoning any exchange-rate target, as a precondition for adopting an IT regime, does not seem to have led the central banks to attach a much lower weight to exchange-rate objectives and to stop using the exchange rate to guide their monetary policy (Masson *et al.* 1997).

How do exchange-rate considerations impact on IT? In an open economy, the exchange rate affects the relative price between foreign and domestic goods, thus aiding the aggregate-demand channel explained above. Specifically, if the interest parity condition holds, then the exchange rate is affected by the interest-rate differential and the expected future exchange rate. With sticky prices, the nominal exchange rate then affects the real exchange rate which, in turn, affects the relative price between domestic and foreign goods (Rudebusch and Svensson, 1998). Specifically, the change in the real exchange rate affects aggregate demand, typically with a lag (since consumers need time to respond to changed relative prices). Then, this affects the output gap (with a lag, equation (4.2)) and then inflation (with another lag, equation (4.3)). The exchange rate may also affect the aggregate supply, as the production costs may depend on the cost of imported intermediate inputs, while nominal wages may depend on the changes in prices generated by the exchange-rate changes (Agénor and Montiel, 1999; cited in Agénor, 2002). There is also a direct exchange-rate channel as well, that is the impact on the price of imported final and intermediate goods, which affects the inflation rate directly (Svensson, 2000). The lag of the direct channel is typically much shorter than the indirect one, with a fast inflation response.

For instance, a foreign exogenous shock will activate the exchange-rate channel, directly transmitting to increased inflation. Corsetti and Pesenti (2004) argue that two concepts are related to the exchange-rate channel: functionality (degree of pass-through) and efficiency (time lag). Namely, this channel is hypothetically assumed to be immediate, i.e. without lag, and complete, i.e. the entire shock is effectively brought onto domestic prices. As mentioned in the previous sections, the central bank will immediately increase the interest rate to bring the inflationary pressure down to hit the target. However, besides reducing output, this will lead to increased exchange-rate volatility. In order to return inflation to target immediately, a large increase in the interest rate will lead to a large movement in the exchange rate via the uncovered interest rate parity condition, as the exchange rate possesses the shortest transmission path (Svensson, 1997; Lam, 2003). The change in the relative return on assets (because of the change in interest-rate differential) will alter expectations of economic agents as to the real effective return on foreign assets compared to domestic ones. These, in turn, will affect the volatility of the exchange rate. In that way, the exchange rate initially overreacts (over-appreciates) with the increase of the interest rate, i.e. there is short-run overshooting. However, it then recovers (depreciates) to a steady level in the long run, consistent with the relative return on domestic and foreign assets[24]. In summary, the effort to bring inflation to the target immediately is likely to give exchange-rate volatility. The latter is another strong argument in favour of flexible IT. In a small, open economy, therefore, IT is described as sufficiently flexible if it brings inflation onto target, reducing the sacrifice ratio and curbs excess exchange-rate volatility. In the New Classical perspective, the exchange rate is important in determining the appropriate weighting when the optimal monetary policy is being created (Flamini, 2007).

Agénor (2002) also argues that it is not only foreign disturbances that might cause excessive exchange-rate volatility under IT. Exchange-rate movements could be instigated by domestic factors such as interest-rate differentials, expectations of future exchange rates and the risk premium caused by the size of the domestic public debt, the degree of credibility of the inflation target and considerations of political stability. Consequently, in a small, open economy, the exchange rate is arguably the most important price in both transmitting the effects of the alteration of the monetary-policy instrument (the interest rate) and in transmitting various exogenous disturbances.

***

In this section we explore the role of the exchange rate in IT, by building on equations (4.2) and (4.3). Instead of producing one good, now the assumption is that the economy is open and produces two goods: tradables and non-tradables. The price of tradables is set on the world market. Conversely, the overall demand and supply equations are valid for the non-tradables sector of the open economy whereby the exchange rate (direct quote) gains a role, due to substitution between non-traded and traded goods (the N superscript refers to the non-tradables sector; all other notations are the same as before; Agenor, 2002, is followed):

[24] An increase in the domestic interest rate causes capital inflow that appreciates the domestic currency. This appreciation stops only when the foreign exchange market judges that the appreciation has gone far enough to imply a subsequent depreciation of the domestic currency that will offset the higher domestic rate of interest, thereby maintaining the interest parity condition (equal returns on similar assets denominated in domestic and foreign currency).

$$y_t^N - y_t^* = -\beta_2(r_{t-1} - \pi_{t-1}) + \beta_3(\Delta e_{t-1} - \pi_{t-1}^N) + \eta_t; \beta_3 > 0 \qquad (4.6)$$

$$\pi_t^N = \Delta e_t + \alpha_1(y_{t-1}^N - y_{t-1}^*) + \varepsilon_t \qquad (4.7)$$

Equation (4.6) represents the aggregate-demand curve as in (4.2), but differs from (4.2) in two respects: i) it assumes that output gap does not have its own lagged effect (the parameter on $(y_{t-1}^N - y_{t-1}^*)$ is assumed to be zero, for simplification); and ii) it adds the role of the exchange rate. In the specification, changes in the real exchange rate in this period (represented by the difference between the change of the nominal exchange rate and change of prices of non-tradables, $\Delta e_t - \pi_t^N$)[25], affects aggregate demand positively in the next period. The aggregate-supply equation for non-tradables (4.7) differs from (4.3) in two respects also: i) it includes no lagged effect of the non-tradable inflation, π_{t-1}^N; and ii) the rate of depreciation of the nominal exchange rate is taken to affect inflation without a lag (the direct channel).

Now, the aggregate inflation can be written as the weighted average of non-tradable and tradable inflation:

$$\pi_t = \delta\pi_t^N + \varphi\pi_t^T + (1 - \delta - \varphi)\Delta e_t; 0 < \delta < 1; 0 < \varphi < 1 \qquad (4.8)$$

Assuming that tradable prices are determined on the foreign markets and that these are constant (hence, $\varphi\pi_t^T = 0$), the following is obtained:

$$\pi_t = \delta\pi_t^N + (1 - \delta)\Delta e_t \qquad (4.9)$$

Thus domestic inflation is determined by the movements of prices in non-tradables and the movements of the exchange rate.

The domestic interest rate r_t is related to the foreign interest rate r^* through the uncovered interest-rate parity condition; i.e. that the domestic interest rate equals

[25] This follows back from Balassa (1964) and Samuelson (1964) who make a distinction between the empirical behaviour of the tradable and non-tradable components of the real exchange rate. Long-run movements in real exchange rates are related to movements in the relative price ratio of non-tradable and tradable components. The Δe_t part is substituting the changes of fundamentals in the tradables sector. For instance, an increase in the rate of productivity growth in the tradable sector of an economy will be accompanied by an appreciation of the nominal exchange rate Δe_t. However, this assumes that the purchasing power parity condition holds even in the short run, which is only a strong assumption.

the foreign interest rate plus the expected rate of depreciation of the nominal exchange rate $(E_t e_{t+1} - e_t)$ (and a stochastic component, ξ_t):

$$r_t = r^* + (E_t e_{t+1} - e_t) + \xi_t \qquad (4.10)$$

whereby expectations of the future nominal exchange rate change as the current nominal and real exchange rate change; if non-tradable inflation (π_t^N) is rising faster than the rate at which the nominal exchange rate is depreciating (Δe_t), the current real exchange rate is appreciating. This, in turn, creates expectations of a future nominal depreciation (presses e_{t+1} downwards). this is represented by the following equation:

$$E_t e_{t+1} = e_t - \theta(\Delta e_t - \pi_t^N); \theta > 0 \qquad (4.11)$$

whereby θ is determined by the strength of the financial-market expectations and how fast those are converted into action.

The preceding system of equations highlights the relevance of the exchange-rate channel in an open economy. Agénor (2002) argues that it is also crucial for output stability; the change in the nominal exchange rate causes changes in the interest rates, which further causes output to fluctuate in the manner described in the context of the transmission channels above. Moreover, this change in the real exchange rate differently affects the tradable and the non-tradable sectors (due to the underlying Balassa-Samuelson effect), which might lead the central bank to attach different weights to the output gaps in the two sectors. This issue is further touched upon in Chapter 5.

As a summary to this section, the monetary-policy loss function given by (4.5) could be amended by the exchange-rate term, i.e. by putting an appropriate (positive) weighting on the exchange-rate fluctuations, φ. More intuitively, by targeting inflation, the central bank is interested not only in minimising the sacrifice ratio (stabilising output fluctuations), but also in minimising the competitiveness loss (stabilising exchange-rate fluctuations). In the loss function, the exchange-rate volatility is defined through the movements of the real exchange rate, i.e. through the difference between the nominal-exchange-rate changes and changes in prices of non-tradables $(\Delta e_t - \pi_t^N)$. Hence, the loss function would be:

$$L_t = \frac{(\pi_t - \pi^*)^2}{2} + \frac{\lambda(y_t - y_t^*)^2}{2} + \frac{\varphi(\Delta e_t - \pi_t^N)^2}{2}, \lambda > 0; \varphi > 0 \qquad (4.12)$$

The importance of the exchange rate is reinforced in a small, open economies according to Svensson's (2000) and Agénor's (2000) arguments. In these countries, monitoring exchange-rate developments is important for the conduct of monetary policy. The economy might not be able to bear a large depreciation as it could lead to financial crises (Mishkin and Schmidt-Hebbel, 2001). Thus, an IT central bank would be willing to smooth excessive exchange-rate fluctuations, but would not attempt to prevent the exchange rate from reaching its market-determined level over longer horizons. In other words, foreign-exchange interventions or interest-rate smoothing might be preferable when increased exchange-rate volatility is not consistent with fundamentals. This implies that under IT, exchange-rate policy should be reframed with limited flexibility, as in managed floating.

The mixture of inflation, output gap and exchange rate gains importance for policy decisions within an IT framework. Namely, while the empirical evidence suggested that there is no long-run trade-off between inflation and output, there is ample evidence of a short-run trade-off (McCaw and Morka; 2005; Arestis and Mouratidis, 2004; Arestis *et al.* 2002; Lee, 1999b; Walsh, 1999; Further, 1997; Taylor, 1994). The latter, represented throughout the above-mentioned aggregate-supply function, implies a trade-off between inflation and output volatility (Debelle, 1999). Thus, a policy that requires a quick return of inflation to target results in magnified output volatility and an increasing sacrifice ratio. Moreover, while complete flexibility of the exchange rate under IT might be intuitively expected, the literature presented in Chapter 2 and Table A1.1 support a form of managed-floating exchange rate to enable the central bank to account for exchange-rate volatility in its loss function, because of the exchange-rate transmission channel to inflation and the likelihood of exchange-rate overshooting (both discussed in Section 4.4.2 and Chapter 2, respectively).

4.5. Exchange rate targeting and inflation targeting: a summary comparison

In Chapter 1 and in this chapter (Sections 4.3 and 4.4), exchange-rate targeting and inflation targeting were respectively introduced. Given that the next chapters will further deal with IT, this section gives a brief summary comparison between those two regimes in order to summarise the debate on the different monetary regimes raised in Section 4.2.

As outlined in Chapter 1, exchange-rate pegging appeared to be a solid vehicle for achieving and maintaining price stability. The economy that targets its exchange rate imposes the monetary credibility from the anchor country at home. The curbing effect over inflation is brought about through the exchange-rate channel: money supply becomes endogenous in this framework and is directly determined by the money supply in the anchoring country (Section 1.3.2). On the other hand, IT curbs inflation by explicit announcement of a numerical target for inflation to be achieved by the available instruments of the central bank. IT highlights the need for the credibility of the central bank, which can not be imported, but instead is gained through a record of low inflation (Section 4.4.1). However, the desired ultimate outcome of both ERT and IT is low inflation, albeit the mechanism through which it is attained differs substantially.

Bearing in mind that both regimes are capable of delivering desirable inflation outcomes and firmly anchoring inflation expectations, Chapter 2, however, offered some arguments as to why pegs today are becoming increasingly unsustainable and abandoned. In times of increased capital mobility, the exchange rate anchor does not serve the function of absorber of external shocks; the latter might cause serious disturbances over the real economy as there is no shield against increased output fluctuations (Section 2.2). More specifically, the evidence advanced in Chapter 3 suggests that an external shock directly transmits into output volatility, with greater force under pegged than under flexible exchanges rates. Although the exchange rate is still an important channel under IT, the central bank considers the loss of output that will occur if it opts to quickly get back on target (Section 4.4.3) and instead puts some weight on stabilizing output and reducing exchange-rate volatility (Section 4.4.4). Consequently, whereas under ERT foreign disturbances could inflict harmful output volatility and cause outflows of foreign exchange reserves, under IT output fluctuations are a direct ingredient of the central-bank loss function – the intention being that neither will inflation tendencies result in harmful inflation nor will a large portion of output be immediately sacrificed. Moreover, within an IT regime, particularly in small, open economies, the exchange rate plays a crucial role and its volatility is also taken account of by the central bank when specifying the loss function (altering the interest rate) and when intervening on the foreign-exchange market (changing the foreign-exchange reserves). These issues are further discussed in Chapter 5.

From an operational viewpoint, IT adjusts the instrument (interest rate) so as to hit the target, and this relies on a systematic (period-by-period) assessment of future inflation. Thus, the quantification of the inflation target must be explicit and credible, and be based on a precise mechanism for attainment. Through this mechanism, the alteration of the interest rate changes monetary aggregates or the exchange rate (the intermediate targets in monetary targeting and ERT, respectively) quicker than inflation itself (due to the transmission lags discussed in 4.4.2). Given the latter, what is important under IT is the credibility of the regime, or, more intuitively, the promise to reach the inflation target in a horizon that takes into account the sacrifice ratio and the reduction of exchange-rate volatility. Thus, the reputation of the central bank plays a crucial role in curbing inflation expectations, more than in any other monetary regime. Also, as pointed out in Chapter 2, IT relies on greater transparency and accountability than any other regime.

In summary, while both ERT and IT deliver desirable inflation outcomes, ERT might inflict output volatility under increased international capital mobility. Conversely, IT pre-emptively includes output departures from its potential level in the objective function and again delivers an optimal inflation outcome, while reducing the sacrifice ratio together with exchange-rate volatility.

4.6. Conclusion

This chapter aimed to discuss the differences between ERT and IT and to give a broad, but rather technical, definition of IT. At the outset, this chapter discussed the alternative monetary regimes in the aftermath of peg exit and then the preconditions for successful IT. It described IT as a pre-emptive monetary strategy that uses an information-inclusive framework in order to achieve the pre-announced numerical target in a given time horizon. The interest-rate and bank-lending channels are crucial for transmitting the monetary policy signals onto aggregate demand and, ultimately, onto prices. Moreover, for small, open economies the exchange rate also plays a crucial role, as foreign disturbances are transmitted directly onto domestic inflation. An IT central bank would be interested in curbing inflation and bringing it immediately on target, except that this sacrifices a huge portion of output. Pragmatically, therefore, the IT central bank would opt for a not-so-fast inflation decrease, at the same time considering the reducing of output fluctuations and exchange-rate volatility. This is the concept of flexible IT, which is applied by almost all ITs.

Defined in such a way, IT appears to produce the desired inflation outcomes, as ERT does, but also takes into account the effects on the real economy in times of foreign shocks, contrary to ERT. IT is particularly important for developing economies, due to its advantages over ERT, but these countries should first build a solid financial system and implement prudent fiscal policy. Caution is needed when applying IT to emerging economies also in light of their vulnerability to capital flight and the variable degree of euroization.

This chapter forms a platform for the further analysis of IT. The next chapter further elaborates (theoretical observations and empirical evidence) on monetary regimes, in particular IT, and their relation to output volatility.

CHAPTER 5

Output-volatility and exchange-rate considerations under inflation targeting

5.1. Introduction

We have introduced inflation targeting as a monetary regime in Chapter 4. We argued there that, in the real world, inflation targeters are not "inflation nutters" (King, 1996) but, rather, demonstrate the needed flexibility in order not to sacrifice too large a proportion of output in order to quickly return inflation to target when a shock hits the economy. Furthermore, monetary authorities observe exchange-rate developments and by foreign-exchange interventions prevent large exchange-rate fluctuations, but without the aim of preventing the exchange rate reaching its market equilibrium over the longer horizon. In essence, by introducing inflation targeting, countries: i) provide an anchor for inflation expectations (Svensson, 1996; 1999a); ii) put a positive weight on output stabilization (Svensson, 1998; 2000; Debelle, 1999); and iii) introduce a managed-floating exchange rate in order to prevent large exchange-rate volatility (Goldstein, 2002; Gersl and Holub, 2006). The aim of this chapter is to evaluate and critique the theoretical arguments in Chapter 4, through further analysis and a critical literature review on the latter two aspects of the IT regime. The crucial question is if IT, in the manner in which it is defined, amends the theoretical consensus and empirical findings on the existence of a short-run trade-off between inflation volatility and output volatility.[26] Since inflation and inflation volatility dwindled after IT was introduced (Nadal-de-Simone, 2001b), and since we argued in Chapter 1 that both ERT and IT anchor inflation expectations, we aim to highlight the aspects in which these two monetary regimes are different – output volatility and exchange-rate issues. However, this does not mean that our discussion will not include issues related to inflation.

The chapter is organized as follows. Section 5.2 focuses on further theoretical analysis and a critique of the empirical literature on IT. Specifically, this section further investigates output volatility and the role of the exchange rate under IT. Section 5.3

[26] For a summary of the discussion on the inflation/output volatility trade-off, see Clarida *et al.* (1999) and the brief discussion in Chapter 4.

focuses the discussion on the developing countries and, in particular, on the relevance of the exchange rate and related issues in those countries. The last section concludes the chapter.

5.2. Theory and empirical literature on inflation targeting

5.2.1. Further theoretical analysis of output volatility and its trade-off with inflation volatility under inflation targeting

Recall from Chapter 4 that in the real world, IT is designed to bring inflation on target while reducing the sacrifice ratio. In mathematical terms, this means that the central bank's loss function - set in the quadratic form commonly found in the literature - explicitly considers the output gap and attaches to it a weight, which reflects the extent to which the central bank wants to "fight" for output[27]:

$$L_t = \frac{(\pi_t - \pi^*)^2}{2} + \frac{\lambda(y_t - y_t^*)^2}{2} \qquad (5.1)$$

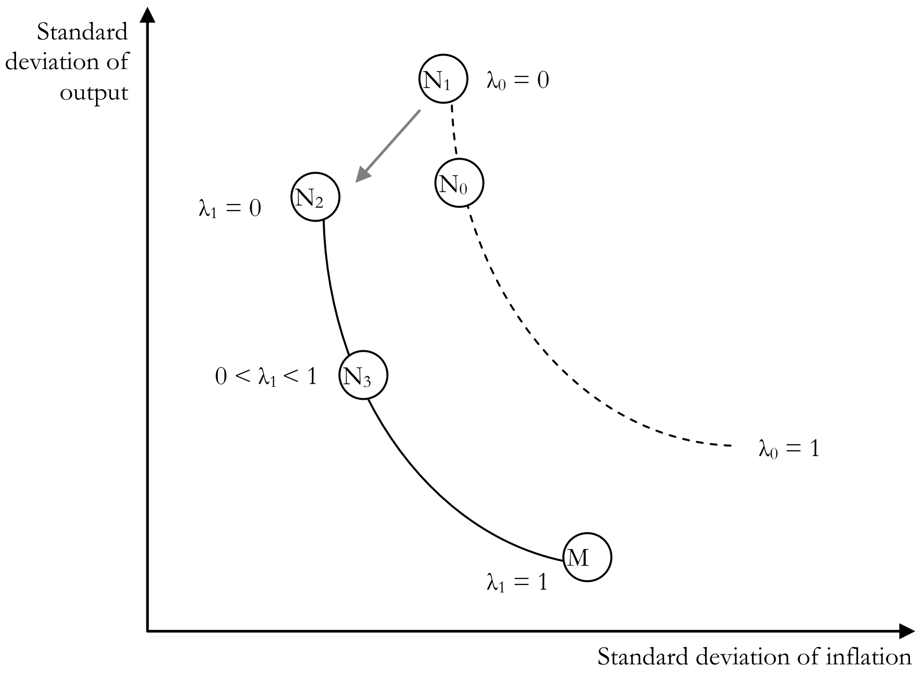
Where the notation follows that of Chapter 4 (p.174). However, while output stabilization has a clear role to play within IT, the weight put on it (noted with λ) is an empirical question (Debelle, 1999). The general approach in the literature has been to stochastically simulate an intertemporal general equilibrium model, the basis of which was established in Chapter 4. Namely, it consists of aggregate demand and supply relations derived under the intertemporal optimizing behaviour of private agents with nominal rigidities in price and wage setting. They give an explicit account of the short-term interest rate as a core instrument and of the lags in the monetary transmission mechanism (presented in equations (4.2) and (4.3), p.169). In such models, the weight put on output stabilization (λ) is changed and a variability frontier is then established for an optimal policy response.

Stevens and Debelle (1995) establish a convex relationship (Figure 5.1, solid curve) between inflation and output volatility using a model of the form described above (with inflation volatility around a given inflation target measured along the

[27] We reproduce here (4.5) and not (4.12) since we thoroughly analyze the role of the exchange rate in a separate subsection (5.2.2).

horizontal axis and output volatility measured along the vertical axis)[28]. They argue that as the weight the central bank puts on output increases, this elevates the variability of inflation and reduces the variability of output. When the central bank is an "inflation nutter" (λ=0; point N_2), the relative disregard of output will lead to a low level of inflation volatility but a high level output volatility. For values of λ different from but close to zero, a small increase of inflation volatility leads to a very large portion of output saved (upper-left part of the curve). Then, a large range of values for λ deliver very similar outcomes for inflation and output volatility and are concentrated in the middle of the curve (around point N_3). As values of λ approach unity, a large increase of inflation volatility leads to a very small portion of output saved (lower-right part of the curve). The other extreme, let us call it an "output nutter" central bank (λ=1; point M), refers to a situation when the central bank targets the output gap exclusively, there is no monetary anchor, a situation that is not observed in practice (Svensson, 2003).

Figure 5.1. Inflation and output volatility trade-off



Source: Drafted by the author based on the arguments and figures in Stevens and Debelle (1995); Debelle (1999); and Svensson (2003).

[28] Points above and to the right of the curve correspond to inefficient monetary policy, where either inflation variability or output-gap variability, or both, could be reduced by better monetary policy. Points below and to the left of the curve correspond to outcomes that are infeasible. See further details in Svensson (2003).

The curve presented on Figure 5.1 is called the Taylor curve (Taylor, 1979) and is a type of volatility trade-off frontier depicting the gains that a central bank could achieve and the cost it would pay. Namely, although Chapter 4 argued in favour of both lower inflation and output volatility under IT, and some empirical studies (Batini and Haldane, 1998; Bean, 1998 and others) found that IT is capable of smoothing both volatilities, still central banks must choose a point to position themselves on the trade-off frontier. A stable trade-off between inflation and output volatility would require that inflation volatility increases as output volatility decreases, and vice versa.

Defined in the manner to optimize the behaviour of inflation vis-à-vis output in the short run, IT is, however, criticised in the literature as being associated with increased output volatility (Arestis *et al.* 2002), especially in comparison to non-IT countries, which is important for this thesis. For instance, Ceccetti and Ehrmann (1999) observe that while inflation volatility fell more in IT countries than in non-ITers, output volatility fell by far less in the former than in the latter. The conventional view is that when prices are sticky, IT leads to slow adjustment of output to its natural level. Recall the example in Section 4.4.2: a supply shock will be combated with increasing interest rates, which will reduce inflation but will depress real activity. Such difficulty does not arise when a demand shock hits; a monetary policy that tries to offset the effect of those shocks on demand helps to stabilize both inflation and output. Policy is capable of moving output and inflation in the same direction, as the aggregate demand shock does. "It is the aggregate supply movements that create the essential dilemma for policy, because they force a choice" (Ceccetti and Ehrmann, 1999, p.9). The choice is where to position on the trade-off curve, while the extent of the policy response to a supply shock will depend on the economic structure as represented by the aggregate demand and supply curves[29] and the weight put on output stabilization.

Erceg *et al.* (1998) demonstrated the existence of an inflation-output volatility trade-off under IT, assuming optimizing agents behaviour and staggered nominal wages

---

[29] More specifically, the positioning on the trade-off frontier will depend on the slope of the aggregate supply curve (β_2) in equation (4.2) and the slope of the aggregate demand curve (α_1) in equation (4.3) (both in Chapter 4). Whereas the shape of the trade-off curve depends on the inverse of the slope of the aggregate supply curve $(1/\beta_2)$. The flatter the aggregate supply curve and, hence, the higher β_2, the more the trade-off curve looks like the solid curve on Figure 5.1. The steeper the aggregate supply curve and, hence, the lower β_2, the closer the trade-off curve to the axes.

and prices. They argue that only when prices are sticky and wages perfectly flexible does the trade-off disappear. However, this combination of assumptions is rather strong, making the case unrealistic. They show that when nominal wages are sticky, there exists a variance trade-off between price inflation and an output gap, regardless of the degree of price stickiness. In this case, the equilibrium real wage moves in response to preference and technology shocks, while the nominal wage only moves in response to changes in the output gap. Thus, if monetary policy maintains a constant price inflation rate, output must temporarily deviate from its potential to induce nominal wage adjustment, so that the real wage can move toward its new equilibrium value. Hence, in the real world, it is infeasible to simultaneously stabilize price inflation, wage inflation and an output gap. A model incorporating reasonable wage inertia produces increased output volatility when inflation volatility increases. Blanchard (1997) outlines a simple static model with predetermined nominal wages to illustrate the point that IT fails to stabilize the output gap.

Another strand of the literature (see Ceccheti and Ehrman, 1999; Clarida *et al.* 1999; and Bernanke and Mishkin, 1997), however, argues that it is possible that a shift to an IT regime acts as a commitment device, and through increasing the credibility of the central bank, facilitates the achievement of lower inflation volatility and lower output volatility. The central bank improves in anchoring inflation expectations on the inflation target by attaining credibility. Svensson (2003) argues that with an explicit inflation target, the credibility of an IT regime can be measured as the degree of proximity between private-sector inflation expectations and the inflation target. Shocks to inflation expectations are historically an important source of volatility in inflation and output, since shifts in inflation expectations have independent effects on future inflation (the direct expectations channel considered in Chapter 4). Shifts in inflation expectations also cause additional indirect disturbances to output and inflation by affecting real interest rates and exchange rates. As a result, volatility in inflation expectations shifts the curve in Figure 5.1 up and to the right and worsens the variability trade-off (dashed curve). Conversely, more stable inflation expectations, anchored on the inflation target, improve the trade-off and shift the curve down and to the left, allowing inflation volatility, or output volatility, or both to fall. This is also because inflation expectations anchored on the inflation target create a strong tendency for actual inflation to revert to the inflation target and, everything else equal, mean that monetary policy needs to be less active. Interest rates and output need to move less to counter unfavourable movements in inflation expectations. "The economy is, to some extent, put on autopilot. This situation is every IT central banker's dream" (Svensson, 2003, p.270).

Practical experience though shows that credibility cannot be granted by law but instead has to be earned over time. In most new IT regimes, especially when the initial inflation is high and a period of disinflation is required, inflation expectations are high and credibility is low (Mishkin, 2000a). Hence, the central bank should initially put more weight on reducing and stabilizing inflation in order to achieve credibility more quickly. According to the earlier discussion, the cost would be more output volatility at the beginning of the regime, while the benefit - an improved trade-off and, hence, lower volatility of both inflation and output – would occur later on, when credibility has improved and the central bank can afford to be a more flexible ITer. As an illustration using Figure 5.1, suppose, because of low initial credibility, that the economy initially is at a point to the upper-right of the efficient frontier (solid curve), i.e. on the dashed curve, implying higher volatility of both inflation and output and has some positive λ, but not too far from zero (point N_0). Suppose the central bank implements strict IT - this would correspond to a move up along the dashed trade-off curve (point N_1). If credibility improves, the trade-off curve would shift to the down-left; the more credibility is achieved, the more the curve approximates the efficient frontier (solid curve); ultimately, the solid curve is achieved, i.e. the economy will operate at point N_2. If the central bank then implements flexible IT, the economy could move to point N_3. Compared to the initial situation (N_0 vis-à-vis N_3), the economy benefits from lower volatility of both inflation and output. Hence, under an IT umbrella it has been doubted the existence of a volatility trade-off is so straightforward, suggesting that a shift can occur, making IT conducive to output volatility besides inflation volatility. This view, which in the jargon of Goodfriend and King (1997) became known as the new neoclassical synthesis, however, does not negate the thesis of vital trade-offs among the mentioned macroeconomic indicators. The models of King and Wolman (1996, 1998) and Goodfriend and King (1997), for instance, consider economies with completely flexible wages, while prices are set by monopolistically competitive firms according to a staggered price-setting rule *à la* Taylor (1979), and conclude that IT should be adopted because it smoothes inflation and output simultaneously.

5.2.2. The role of the exchange rate under inflation targeting

Several contributions within the so–called New Keynesian synthesis have shown that, under quite general conditions, a simple, inward-looking, interest rate rule can be regarded as an optimal policy response for a closed economy (Taylor, 1999). Less attention has been paid to the choice of monetary policy objectives in an open-economy context, given that an open economy is comparable to a closed economy whenever the exchange rate pass-through to import prices is complete, which is a strong assumption (Galí and Monacelli, 2005). In other words, under complete exchange-rate flexibility, policymakers in open economies should also be focused uniquely on domestic targets. Unfortunately, there is extensive evidence that, in reality, departures from the law of one price for traded-goods are large and pervasive (Rogoff, 1996; Engel, 1993; 1999; 2002). Under these circumstances, policy choices are not independent of exchange-rate dynamics and monetary conduct is liable to focus on more than just domestic stabilization. Plainly put, the question in the literature is not whether to account for exchange-rate volatility under IT, but whether to explicitly include it in the loss function. For instance, Section 4.4.4 and Agénor (2002) argued that exchange-rate-volatility management (a managed floating regime) under IT should be explicitly considered in the policy loss function. Hence, the loss function should be:

$$L_t = \frac{(\pi_t - \pi^*)^2}{2} + \frac{\lambda (y_t - y_t^*)^2}{2} + \frac{\varphi(\Delta e_t - \pi_t^N)^2}{2}, \lambda > 0; \varphi > 0 \qquad (5.2)$$

where notation is the same as in Chapter 4 (p.179), and exchange-rate volatility is defined through the movements of the real exchange rate, i.e. through the difference between the nominal-exchange-rate changes and non-tradables inflation. However, at this point, two questions arise: i) is the exchange rate an instrument towards achieving price and output gap objectives or it is an objective of the policy itself?; and ii) why, then, is the interest rate, which is the prima-facie instrument under IT, not explicitly included in the loss function? Cecchetti and Ehrmann (1999) oppose the arguments and formulation of Agénor (2002), suggesting that the exchange rate should not be a part of the loss function. The rationale for this is the belief that domestic inflation and output are the fundamental concerns of policymakers, while the exchange rate is only a vehicle to achieve these basic objectives. Namely, as long as there exists a positive pass-through from the exchange rate to prices, exchange-rate changes will affect inflation; if real exchange-rate changes reflect situations of misalignment, they will also affect the output gap (Edwards, 2006). Hence, an optimal policy would be to consider how exchange-rate developments impinge on these two components of the loss function, rather than include the exchange rate in it directly. Moreover, the decision to focus on the exchange-rate path in the formulation of policy would be a choice of an intermediate target, which, in turn, is not a desirable option under IT, according to the discussion in Section 4.3.2. Policymakers are not concerned with the behaviour of intermediate targets per se, but with the domestic inflation and output outcomes produced by their use. Ultimately, intermediate targets under direct IT would lead to conflicting policy goals and might throw bewilderment on the financial markets. This argument also gives the reason why interest rates should not be included in the loss function. However, this reasoning does not say that exchange-rate behaviour should be chaotic or left to chance but, rather, that the exchange-rate should be considered as an instrument to achieve the goals specified in (5.1).

Still, although exchange-rate management under IT emerges as possibly important, Svensson (2003) argues that it is difficult to find good reasons for stabilizing either the exchange rate or the interest rate at the expense of increased inflation and/or output-gap variability. In practice, flexible IT, with a longer horizon to meet the inflation target and concern for output volatility, will normally mean a more gradual approach and a less activist policy and, hence, reduced interest-rate volatility. Because interest-rate changes lead to exchange-rate changes, everything else equal, this also reduces exchange-rate volatility. Gersl and Holub (2006) argue that, ideally, IT would operate with a free-floating exchange-rate regime, so that the only instrument in the hands of the central bank would be the short-run interest rate. To the extent that the exchange-rate volatility affects the targeted inflation rate and the output gap, interest rates are used to respond to an exchange-rate shock. In that respect, credibility is also important because increased credibility and increasingly stable inflation expectations will reduce a major source of shocks to both interest rates and exchange rates. Thus, successful and credible flexible IT is likely to contribute to less volatility of interest rates and exchange rates. However, exchange rates are, by nature, volatile asset prices and are affected by a number of shocks beyond inflation expectations and interest-rate changes and/or a "fear of floating" (Calvo and Reinhart, 2002). Such shocks will continue to cause unavoidable exchange-rate volatility.

At that point, the central bank still has the foreign-exchange reserves to prevent large exchange-rate fluctuations and to achieve a goal as specified in equation (5.1).

Hence, exchange-rate management through foreign-exchange interventions is important under IT (Bofinger and Wollmershaeuser, 2003; Goldstain, 2002; Truman, 2003; De Mello *et al.* 2008). Though, the extent to which the central bank would be committed to prevent exchange-rate fluctuations would differ from case to case and remains an empirical question. In general, for a small, open economy, foreign-exchange interventions will reduce the harmful effect of large supply-side shocks coming from abroad (empirically supported in Chapter 3) and this will, in turn, improve the overall performance of the IT, because it will facilitate a more favourable positioning of the trade-off frontier. Some of the IT countries do use foreign-exchange interventions more or less frequently in practice (Gersl and Holub, 2006). This group includes Australia, Chile, South Korea, Sweden (in 2001), Hungary, and Slovakia, to name just a few. Most recently, the Reserve Bank of New Zealand, a pioneer of IT, has been given a formal mandate to use direct foreign-exchange interventions as a monetary-policy instrument. There is thus not a general consensus on the "fall of foreign-exchange market intervention as a policy tool" (Schwartz, 2000).

The use of foreign-exchange interventions under IT faces several challenges, though. Among these, the most important is the lack of consensus on the effectiveness of such interventions (which is closely related to the effectiveness and completeness of exchange-rate pass-through, discussed in Section 5.3). Most of the empirical analyses that were carried out during the 1980s did not support the quantitative importance of the interventions (Almekinders, 1995; Edison, 1993). On the other hand, there are some more recent econometric studies, which benefited from better data availability since the 1990s and the new methodologies applied, supporting the effectiveness of interventions (Disyatat and Galati, 2007; Dominguez and Frankel, 1993; Fatum and Hutchison, 2006; Kearns and Rigibon, 2005; Reitz, 2002). New studies focused also on the effect of intervention on exchange-rate volatility (Egert and Komarek, 2006; Ito 2003). Moreover, some authors have argued that the effectiveness of the interventions may be greater in the emerging economies compared with the advanced countries, whose data have been typically used in the empirical analyses (Canales-Kriljenko, 2003). The evidence in this respect is still rather scarce, but there are papers that do indeed find some evidence on the effectiveness of interventions in emerging economies under specific conditions (e.g., Guimaraes and Karacadag, 2004). However, the link between this policy instrument and its effects is much less clear than for the interest rates, which makes its use as a systematic monetary-policy tool challenging.

In summary, while there are some arguments that, as an instrument, the exchange rate should not be explicitly stated in the loss function, theoretical arguments and evidence are still mixed as regards the effectiveness of exchange-rate management under IT. As the exchange rate is generally considered to be of greater importance under IT in developing economies, we treat it separately in Section 5.3.

5.2.3. Empirical evidence: scope and critical analysis

Since its "invention" in the early 1990s until nowadays, IT has spurred a tremendous body of research, part of which evaluates the macroeconomic outcomes of, and/or central-bank policy responses under, this monetary regime. Some of this literature is primarily based on theoretical arguments, while empirics by and large give comparisons of macroeconomic behaviours pre- and post-IT introduction (see, for instance, Mishkin and Schmidt-Hebbel, 2001; Corbo *et al.* 2002; Neuman and von Hagen, 2002; see also Angeriz and Arestis, 2007, for a summary). In general, this part of the literature concludes that after IT was introduced inflation and its volatility fell, but that these countries did not reach better performance than non-ITers with a similar starting point (mostly taken as an equal initial level of inflation). In other words, the environment of the 1990s was, in general terms, a stable economic environment, "a period friendly to price stability" (Neumann and von Hagen, 2002, p. 129). The results on output volatility remained mixed, thus not giving support for the claim that IT is a superior strategy.[30] In that respect, the FED and the ECB continue to show scepticism

---

[30] Ćorić (2008) considers the other side of the coin, i.e. tries to establish why output has been more stable in the late 1980s and 1990s (the so-called "Great Moderation"). He reviews three strands of the literature dedicated to explaining why this happened: good luck, good policy and good practice. The first two reasons are important for the present analysis: the "good luck" hypothesis relates the lower output volatility to the absence or relative mildness of shocks during this period, while the "good policy" hypothesis refers to the economic (mainly monetary) policy pursued. The former establishes milder economic shocks, while the latter points to changes in monetary policy as the most likely reason for recent changes in the volatility pattern. However, there is no consensus among authors either on what kind of monetary policy changes happened or that these changes are related to switches between different monetary regimes, and, in particular to IT. As a consequence, this viewpoint of the literature is not helpful for our purposes. However, it does direct us towards an important issue: namely, that the analysis should control for factors other than monetary policy in order to reveal a clear picture of whether the switch to IT has an effect on volatility pattern.

towards IT adoption (Gramlich, 2000; Duisenberg, 2003). IT proponents (Bernanke *et al.* 1999; Alesina *et al.* 2001) have argued in its favour, though without empirical support. This (descriptive) part of the literature is not subject to critical analysis in this thesis, since it does not establish or reveal causal relationships. There is a need for deeper quantitative analysis, which at present still appears scarce.

Notwithstanding this general impression, a major part of the studies with systematic quantitative assessment are based upon structural models of conditional volatilities, Friedman's (1963, 1993) model of conditional and unconditional volatility, unrestricted VAR models allowing for structural breaks and others. A minor, but growing part gives sensitivity analyses within dynamic stochastic general equilibrium (DSGE) models, which is a recent innovation (see Caputo *et al.* 2007 and de Mello and Moccero, 2008). However, the analysis of IT within DSGEs in advanced economies is only marginally analysed. This could be due to these economies already possessing strengthened monetary credibility and sufficiently developed financial markets and institutions, hence, making the analysis of monetary policy more general (in terms of transmission channels and their effectiveness), rather than specifically focused on IT effects, per se. See, for instance, Liu (2006) for New Zealand; Dib (2003) for Canada; Lim *et al.* (2007) for Australia; Justiniano and Preston (2004) for Australia, New Zealand and Canada; DiCecio and Nelson (2007) for the UK; and the references therein. In addition to this, the analysis of regime switch has been almost absent. In the words of Nadal-de-Simone (2001b), this is "an issue virtually ignored in the literature" (p.4). This could be due to the previously observed evidence that developed economies embarked on IT from an implicit nominal (inflation) target, hence making the switch smooth. Only the study of Curdia and Finocchiaro (2005), for Sweden, evaluates monetary regimes within DSGE under the assumption of regime switch and, as such, is reviewed separately in Section 5.2.4. Consequently, in this section we will present some empirical studies which evaluate IT performance and policy responses. We introduce the models used, but the critical evaluation is mainly focused on the assumptions and findings. This is because one of the objectives of this thesis is to build a switching model and to evaluate monetary regimes through that prism. This will be a contribution to knowledge of this thesis and is undertaken in Chapter 6.

Nadal-de-Simone (2001b) assesses output volatility before and during IT in two models. Friedman's (1963, 1993) "plucking model" assumes that output cannot exceed a ceiling level determined by the resources and the technology available to the economy, but it is occasionally plucked down by a recession. The model assumes asymmetry in the shocks hitting the trend or cyclical component of output. Clark's (1987) model is a restricted version of the former, assuming that there is no asymmetry in output behaviour at all. Both models are a type of time-varying-parameter model, which allows for the variance of the shock to the cyclical and trend component of output to depend on the state of the economy, and are used to estimate output-conditional variance for a sample of 12 countries. The study opts to utilize a regime switch between normal and recession time by modelling a Markov process, but does not resolve how output reacts to a change of the monetary regime, or explicitly consider the role of the exchange rate. A sample of six non-ITers and six ITers in the period 1976-2000 is used, in order to compare the former with the latter and the latter before and after IT was established. However, since the study is conducted in the period when EMEs started to establish IT, the sample is restricted to developed economies. As a digression, many studies base their assessment on a comparison with non-IT economies, either neighbouring or the most successful ones (Growneveld *et al.* 1998; Almeida and Goodhart, 1998; Siklos, 1999; Rasche and Williams, 2005; Vega and Winkelried, 2005), but the concern that different economies are exposed to different (domestic or regional) shocks suggests that these should be treated with caution. In the context of our discussion in Section 5.2.1, the study finds that although inflation volatility dwindled after the introduction of IT, it was not accompanied by a significant increase in conditional output volatility, with the single exception of Canada. The results suggest that by introducing IT, these countries succeeded in delivering a combination of both lower inflation volatility and lower, or similar, output volatility. However, it is also possible that there were fewer supply shocks in the late 1980s and 1990s, so that the general reduction in the variability of inflation has not been generally accompanied by an increase in output volatility.

Contrary to the studies based on DSGE models, which consider the volatility trade-off as a long-run issue, but similarly to the previous study, Arestis *et al.* (2002) use a model of stochastic, conditional, time-varying volatilities, with the expectation of extracting more information from the short-run dynamics. First, the study compares the economic performance of six IT economies in the 1980s and 1990s, focusing on inflation and output volatility following a supply shock. However, the switch from the previous regime to IT and the IT regime itself, is not considered. The findings suggest that in the 1990s, after IT was established, there was markedly lower output volatility for an unchanged level of inflation volatility, with the exceptions of Australia and

Finland. Again, though, the sample is comprised of developed countries only, and hence the results are restrictive. Considering that the 1990s were relatively shock-free, the study, in a second stage of analysis, compares the ratio of output to inflation volatility in the 1990s, between six ITers and six non-ITers, similar to the study of Nadal-de-Simone (2001b). It was found that if IT was not adopted, a worsening of this ratio is observed, which suggests that IT regime delivers successful smoothing of inflation and output volatility. This conclusion is attributed to the acquired monetary credibility, which is a characteristic of developed economies, and to the flexibility of the monetary regime, which implicitly refers to the direct accounting for the output stabilization and exchange-rate developments within the monetary-policy loss function.

The relatively shock-free period observed in the 1990s, raised as an issue in Ceccheti and Ehrman (1999), is further advanced in Lee (1999a). He observes three IT countries: New Zealand, Canada and the UK and analyses an unrestricted VAR system of inflation, output, long-term and short-term interest rates over the period 1975-1996. Although important, the exchange-rate is omitted from the analysis, hence neglecting the discretion that the authorities (especially former exchange-rate targeters) gained with the introduction of IT. From today's viewpoint, the study is dated but it still encompasses some features in its quantitative approach not present elsewhere in the literature. First, the series are examined for containing structural breaks and, in almost all cases, particularly for the output series, a break is found to be associated with the switch to IT. Hence, in the simulation analysis, the period from 1975 until the introduction of IT is taken separately for each country and forecasts are generated. The objective of these is to provide a counterfactual for the situation without a regime switch in the economy. The comparison with the actual data reveals that, in general, inflation and output volatility under IT have been lower than compared to the simulated path (non-IT). However, Lee (1999a) argues that these findings, also present in other studies, might be deceptive, given the generally observed more stable economic environment in the time when IT was established. To check for this, in a second stage, he uses the common-trend-and-cycle approach for the three countries with three counterparts (their biggest trading non-IT partners: Australia, US and Germany). Under his framework, common stochastic trends are characterised by the existence of cointegrating vectors among the variables (long-run movements), and common cycles by serial correlation of common features among the residual stationary components of these variables (short-run movements). The possibility that the cointegration vector could be affected by a structural break (Nadal-De Simone, 2001a) is captured by estimating Sup-F and Mean-F statistics (see further in Andrews, 1993). However, no such breaks were found to be associated with the introduction of IT. Modelled in such a way, the data reveal that the volatility of inflation and output did not decrease; instead, the series became slightly more volatile. These differences in the results could be ascribed to the process of synchronisation of economic activity rather than to the monetary regime itself; and hence, depict IT as instrument ineffective, i.e. a regime whose results could have been achieved without embarking on a new regime. In general, albeit that the study is, from the econometric approach, alone in the literature, it makes a genuine approach towards assessing IT performance. Still, the regime switch is not explicitly modelled; also, the results are valid for the developed world only. The absence of the exchange rate from the analysis might appear as the main drawback of the study if a similar approach was applied to developing IT countries.

5.2.4. The study of Curdia and Finocchiaro (2005)

This is, to the best of our knowledge, the only study in the monetary-regimes literature that evaluates monetary regimes under the assumption of regime switch. It investigates the extent to which a fixed exchange rate, compared to IT, limits the central bank's reactions to inflation and output fluctuations. It builds a DSGE model and solves it in a Bayesian framework. What is of most importance from a modelling viewpoint is that it explicitly models the switch from a target-zone exchange rate[31] to a flexible exchange rate under IT. In such a context, the analysis is conducted for Sweden and the performance of its economy under the alternative monetary regimes. For the period under fixed rates (1980-1992), the model incorporates an interest-rate rule, whereby the central bank reacts to exchange-rate deviations from a central parity, while for the period under IT (1993-2003), the monetary policy is described by a Taylor rule - the policy interest rate reacts to the current and past inflation and output, but not the exchange rate. The latter is justified by the arguments of Clarida *et al.* (2001) who argue that the exchange rate does not play a quantitatively relevant role in developed ITers; however, recent policy directions (e.g. in New Zealand) and research (Leiderman *et al.*

[31] Target-zone exchange rate is a type of fixed exchange rate, characteristic of the Exchange-rate mechanism (ERM, 1970-1992/3). Some argue that it provides more flexibility in exchange-rate management than a pure peg.

2006) suggest the contrary. The results of the model suggest quite different behaviour of monetary policy: under a fixed exchange rate, the interest rate reacts to shocks originating from foreign interest rates and from expectations of exchange-rate realignment; while in the IT period, the monetary policy did have greater flexibility and reacted mainly to domestic shocks and barely to exchange-rate shocks. However, the latter conclusion could be because the policy-reaction function did not include exchange-rate behaviour, per se. Besides this, the study has significant drawbacks, mainly originating from the many simplifications used. For instance, the role of the exchange rate in the IT period is definitely neglected, not only in terms of the volatility of the exchange rate, but also in terms of its pass-through. Also, parameters are allowed to change only in the interest-rate function, which is not in line with the Lucas critique which would suggest changing parameters in general when regime switches. No acknowledement is made that the 1990s were relatively shock-free and of how this might have affected the performance of the model. Ultimately, the study does not directly answer the stated objective; instead, it answers which shocks are well responded to under different monetary regimes, but still does not consider whether monetary policy was closer to the optimal in combating macroeconomic volatility under the one regime as compared to the other.

***

Despite the fact that the work on IT in the last two decades has been immense in quality and quantity, still there is no quantitatively-credible study for the developing world, let alone a study that appropriately measures the regime switch from one monetary strategy to another. The studies for emerging markets are primarily based on theoretical arguments (Mishkin, 2000a; 2003; 2005; Debelle, 2000), while the empirical studies amount to descriptive analysis of the macroeconomic performance and/or policy responses since IT introduction, but do not model or reveal causal relationships (see Section 5.3.4). Moreover, the majority of developed countries that adopted official IT previously relied on an implicit nominal anchor, which is the closest strategy to IT, the only difference being that the target is not officially announced (see Section 1.2), which is not the case for the developing world. This could be a reason why the switch is not explicitly modelled. Hence, a logical doubt arises as to whether the same conclusions are valid for those developing countries that adopted IT at the beginning of the 2000s, and whether the regime switch matters for inflation and output. We try to address these issues in the next sections and the next chapter, and this is one of the contributions to knowledge of this thesis.

5.3. Challenges for developing economies: theory and evidence

5.3.1. Are emerging markets ready to target inflation?

The extensive literature on IT and the review of the empirical studies concludes that, in the developed world, IT delivers lower inflation and inflation volatility, provides favourable output-volatility developments and constrains excessive exchange-rate fluctuations, albeit that no systematic differences have been observed in non-IT developed countries. On the other hand, the evidence on developing economies is scarce; a few exceptions are IMF (2005); Concalves and Salles (2008); Mishkin and Schmidt-Hebbel (2002; 2006), Corbo *et al.* (2001); Edwards (2006). Moreover, this evidence is based on descriptive analysis, without a credible study that tries to establish causal relationships. This could be due to the fact that, contrary to the case of the developed ITers, the conduct of monetary policy in developing economies faces several challenges. Calvo and Mendoza (2000) highlight the weak institutional environment in the emerging economies: they did not have a strong record of low inflation and this could have been detrimental for successful inflation targeting. However, a broadened list of issues makes the analysis for developing economies more complex. Building on Calvo and Mendoza's (2000) precaution and on the preconditions listed in Section 4.3, Mishkin (2004); Fraga *et al.* (2004) and Aizenman *et al.* (2008) question: i) the capacity of fiscal, financial and monetary institutions, including the increased probability that authorities will pursue short-run objectives without regard to the long-run damage; ii) financial and fiscal dominance; iii) the exposure to shocks and cash-inflows vulnerability of those countries as small, open economies; iv) their exchange-rate pass-through to prices, as small, open economies; and v) the problem of high euroization.

Institutions in emerging markets tend to be weaker than those in developed economies. Fraga *et al.* (2004) argue that a central bank that does not enjoy confidence with economic agents cannot effectively pursue IT. Private agents have concerns about the commitment of the central bank to the target itself and to its reaction to shocks. However, the literature does not refer to the case when credibility is acquired through another monetary strategy; namely, ERT, which imposes the credibility of the economy-anchor. From that position, in normal times, the central bank may be encouraged to embark on IT. The central bank would not face the increased volatility of inflation and output nor the presence of inflation persistence, due to backward-looking behaviour in the process of price setting. In light of this, embarking on IT from ERT, without experiencing pressures on the exchange rate would be expected to be manifested through lowered inflation and output volatility, i.e. through shifting the curve on Figure 5.1 to the left. If, however, the credibility has to be earned over some time, inflation and output volatility might be increased. But in the medium to long run, it is expected that the economy would benefit from an improved trade-off and, hence, from flexible IT. The issue of credibility is closely related to the issues of dominance: fiscal, financial and external. In the case of fiscal and financial dominance, the problems that arise on the monetary policy front are quite similar: the fear that one or both regimes will break down increases the probability that the government will inflate in the future, and therefore increases expected inflation. This, in turn, increases the challenge of establishing a solid monetary anchor. The external dominance, according to Fraga *et al.* (2004), refers to the vulnerability to external shocks as a result of emerging markets' increased reliance on external trade and finances, which in turn might exacerbate increased exchange-rate volatility and macroeconomic volatility in general. The external dominance is closely related to the sudden stops of capital inflows, which is common for emerging economies. These sudden stops might reflect weak fundamentals and might generate greater instability in the economy and may jeopardize the fulfilment of the target (Mishkin, 2004). On the contrary, the objective to manage the exchange rate in order to prevent distortion of inflation expectations might signal that the exchange-rate risk is constrained, hence encourage excessive capital inflows. These in turn, might fuel the domestic lending boom and if the risk management is relaxed (either because of the cycle or because of the weak supervisory authority), this might result in financial fragility which again undermines the attainment of the inflation target. Although capital flows are heavily interlinked with the exchange rate we analyse the issues separately, to highlight their importance and/or the concern around them.

5.3.2. Exchange-rate volatility and pass-through in developing inflation targeters

As mentioned in the preceding sections, the exchange rate gains importance within emerging markets that established or opt to establish an IT framework. The literature (Amato and Gerlach, 2002; Eichengreen *et al.* 1999; Chang and Velasco, 2000) assigns such an importance to the exchange rate because of the following: i) in emerging markets, large shocks or capital flows cause significant volatility in the exchange rate, if not responded to by policy actions; ii) in economies with lessened monetary credibility, the exchange rate tends to be the core transmission channel to inflation and, hence, the focal point of inflation expectations; and iii) exchange-rate volatility affects foreign-currency borrowing and may affect firms' profitability through its balance-sheet effects. We have previously argued that developing countries are more vulnerable to external shocks, mainly because of two reasons: i) they are small and open, and hence dependent on the regional or world economy; and ii) their policies are usually less credible, which might impact on investors' incentives and lead to a withdrawal of their investments. Consequently, a large external shock or a sudden stop of cash flows would inflict increased exchange-rate volatility (Eichengreen *et al.* 1999) in an IT economy. This volatility will throw confusion onto the financial markets, distort inflation expectations, change the value of foreign-currency denominated assets and liabilities (and thus increase the exchange-rate risk and the induced risk of default) and, in consequence, complicate the achievement of the inflation target. Because of this, and as we have argued in Chapter 4, countries usually fear to float (Calvo and Reinhart, 2004) and use reserve interventions or interest-rate smoothing to prevent such a scenario (Amato and Gerlach, 2002), even when the underlying shocks are transitory (Stein *et al.* 1999). However, authorities would not opt to restrain the exchange rate from achieving its market value over longer horizons. Instead, in the short run and more frequently in the first stages of IT, such smoothing would appear necessary to prevent large fluctuations, but should not coincide with exchange-rate anchoring. The latter suggests, inter alia, that multiple monetary targets are "leaning against the wind" and could result in conflict, although Debelle (2000) and Leiderman *et al.* (2006) argue that these might coexist if hierarchically subordinated and if they do not target the trend of the real exchange rate.

The role of exchange-rate volatility in emerging markets is reinforced given the importance of the exchange-rate channel in transmitting monetary-policy actions to real activity. Standard small, open economy IT models, such as Ball (1999) and Svensson (2000) embody a central role for the exchange rate in the transmission from monetary policy to inflation. For instance, a rise in domestic interest rates to combat inflationary pressures typically leads to a short-run appreciation of the nominal and real exchange rate, which in turn helps to calm inflationary pressures through both direct and indirect channels. Namely, the appreciation will make imported goods cheaper (and, hence, prices in the tradable sector lower), hence directly contributing to offsetting inflationary pressures. The indirect effect occurs through the effect of the appreciation on aggregate demand, output and prices. Svensson (1998; 2000; 2007) argues that the direct exchange-rate channel, at the same time, has the shortest transmission path. However, the effectiveness of this channel is usually ignored in the context of IT. Edwards (2006) is among the few in the field that raises the importance of this issue and argues that, historically, the effect of exchange-rate pass-through tended to be large in emerging markets. However, Taylor (2000) argued that the 1990s saw a decline of the exchange-rate pass-through, which is considered to be a result of the decline in inflation and its volatility[32]. This might suggest that the effectiveness of the exchange-rate channel might be important in the initial IT phase until the regime gains credibility and curbs inflation (if it is at a higher level); thereafter, as IT becomes more successful, the pass-through is expected to decline due to the combined effect of lower inflation, flexible exchange rate and greater central-bank credibility under IT (Nogueira, 2006; Gulsen, 2009). Mishkin (2008) explains that in a context of a stable and predictable monetary-policy environment, nominal shocks play a vastly reduced role in driving inflation and exchange-rate volatility, which "supported by an institutional framework that allows the central bank to pursue a policy independent of fiscal considerations and political pressures, effectively remove[ing] an important potential source of high pass-through of

---

[32] Several empirical studies tried to measure the effectiveness. For instance, Borensztein and De Gregorio (1999; cited in Edwards, 2006) used a sample of 41 countries and estimated that 30% of a nominal depreciation has been passed through to inflation after one year; after two years, the pass-through was a very high 60% on average. They have also found that the degree of the pass-through has been significantly smaller in advanced economies. As for the proposition of Taylor (2000), Gagnon and Ihrig (2004) tested it on a sample of advanced countries and found that changes in the pass-through were related to the operation of the monetary policy, i.e. to IT. The same conclusion is confirmed by Edwards (2006) for an emerging group of countries.

exchange-rate changes to consumer prices" (p.4) [33]. Moreover, it suggests that the opposite also holds: increased exchange-rate volatility under a low pass-through to prices cannot threaten inflation volatility, which is in favour of the IT regime.

Along with the caveats to executing effective IT in developing economies, Leiderman *et al.* (2006) argue that the achievement of an inflation target would seem to face a further difficulty in a highly financially euroized economy. We address this issue in the following sub-section.

5.3.3. Inflation targeting in euroized/dollarized economies

The credibility of the fiscal and monetary institutions (i.e. the credibility of the central bank to achieve the target and of the fiscal authority to support it) could directly reflect on people's willingness to hold the domestic currency, thus leading to increased currency substitution if the institutions are suspect. The concern of Mishkin (2004) related to the need for credibility to target inflation should be taken seriously; however, the standing of the central bank attained by pegging the exchange rate is not included in his analysis. The majority of developing-economy ITers embarked on this strategy from ERT; the latter introduces the credibility of the central bank, as argued in Chapter 1. The level of the central-bank's credibility may be shown via the eagerness to hold the domestic currency; i.e. is reflected in the level of dollarization/euroization in the economy. A loss of confidence will result in a shift between domestic and foreign-

[33] The channels through which IT is argued to reduce the exchange-rate pass-through are lenghtly explained in Gulsen (2009) and Nogueira (2006). Within the first channel, a low inflation environment negatively affects the persistence of costs changes, which then positively correlates with the pass-through (Taylor, 2000; Fuji and Bailliu, 2004). The second channel works through the flexible exchange rate under IT: agents may view the exchange-rate movements as temporary and do not react on them systematically; also, foreign-exchange interventions reduce the correlation between inflation and exchange-rate depreciation; both effects working to weaken the pass-through (Guinigundo, 2008). The third channel works through the acquired credibility under IT: expectations formation changes under IT, since the inflation target and not the exchange rate is considered to be the anchor that affects price setting in the economy. This is likely to reduce the exchange-rate pass-through (Mishkin and Savastano, 2001; Schmidt-Hebbel *et al.* 2002). However, a critique of this strand of the literature is that it ignores the arguments that the effectiveness of the first and the third channel might have been already exhausted at the moment of establishing IT, if inflation was curbed and credibility acquired during ERT, hence making any post-switch pass-through decline possibly smaller. Moreover, it is not clear if the first channel can be ascribed to IT or to the generally shock-free period.

denominated assets, which will further complicate the central bank's task of achieving the inflation target. Moreover, in small, open economies, a portion of euroization might happen because of the need to carry out international transactions.

Notwithstanding this, let us assume that a developing country is highly euroized - its debts are denominated in euros, while firms depend on local currency receipts. Under these conditions, private sector and banks' balance sheets can be vulnerable to the type of nominal and real exchange-rate shifts that should occur for IT to work effectively. In particular, through balance-sheet effects, large real exchange-rate depreciations (for instance, due to a sudden stop), could have a contractionary effect on output and be associated with bank failures. That is, instead of real exchange-rate depreciation having a positive impact on output, as in a standard model, it would inflict a negative effect (Leiderman *et al.* 2006). However, the level of euroization is not a strict precondition for embarking on IT: quite the contrary, since IT is accompanied by a flexible exchange rate, the persistent exchange-rate risk will force agents to permanently balance their portfolios (the so-called de-euroization in the jargon of Armas and Grippa, 2006) and will induce fear of floating, forcing the government to prevent large exchange-rate fluctuations, as argued earlier (Mishkin, 2000b). The latter also supports the view that in small, open economy the exchange-rate channel is of vital importance (Section 5.3.2): in euroized economies this is reinforced (Bakradze and Billmeier, 2007). Also, IT in partially euroized economies may not be viable unless there are stringent prudential regulations on, and strict supervision of, financial institutions that ensure that the system is capable of withstanding exchange-rate shocks.

Given the theoretical observations and the empirical evidence (Leiderman *et al.* 2006; Armas and Grippa, 2006) that financial euroization does not preclude an independent monetary policy oriented at maintaining low and stable inflation rate, euroization is not of interest within the IT literature. For instance, to the best of our knowledge, only the two cited studies deal with this concept under IT. Leiderman *et al.* (2006) compare two highly dollarized IT economies, Peru and Bolivia, with two IT economies with low levels of dollarization, Chile and Colombia. They conclude that, while high dollarization does introduce significant differences in both the transmission capacity of monetary policy and its impact on the real and financial sectors, it does not seem to preclude the use of IT as an effective policy regime, per se. The same conclusion is reached in the separate study for Peru (Armas and Grippa, 2006), highlighting the importance of the exchange-rate channel and the choice of operational target and that IT contributed to reducing the level of dollarization (by the process of dollarization control, i.e. balancing portfolios because of the constant exchange-rate risk). No study currently quantifies the effect more thoroughly, which might suggest that indeed the level of euroization is not of much concern.

5.3.4. Review of empirical analyses with emphasis on exchange-rate issues

The very scarce evidence of IT performance in developing countries gives support to the relative success of this framework. This strand of the literature is generally based on a descriptive analysis of the macroeconomic performance and policy responses pre- and post-IT introduction. To begin with, Mishkin and Schmidt-Hebbel (2007) find that IT in emerging countries performs less well than in advanced countries, although reductions in inflation after IT introduction were found to be substantial. IMF (2005) presents results of a study focusing on 13 emerging ITers, compared with 29 other emerging market economies. They report that IT is associated with a significant 4.8 p.p. reduction in average inflation and a reduction of its volatility by 3.6 p.p. Conçalves and Salles (2008) apply the same methodology to 36 emerging economies. Similar to the IMF study, they find that adoption of an IT regime leads to lower average inflation rates and reduced output growth volatility compared to a control group of non-ITers. A recent edited volume published by the OECD (De Mello, 2008) on IT in emerging markets, focusing mainly on individual country case studies, also finds quite positive outcomes associated with the adoption of IT regimes. A general drawback of these studies, as said previously, is that they do not discover causal relationships as they apply neither any modelling framework nor any identification strategy.

A restricted, but growing number of studies analyse IT in developing economies through DSGE models. Caputo and Liendo (2005); Caputo *et al.* (2007) and Del Negro and Schorfheide (2008) develop standard DSGE models for Chile. They all observe the IT period only and conclude that inflation volatility mainly originated from domestic shocks, but the strong central-bank response to inflation dynamics did not result in great changes in inflation volatility. Moreover, the central bank did not respond to exchange-rate movements under IT. Strangely, no conclusion is on hand for the output volatility, which might result from the relative simplicity of their models. The study of McDermott and McMenamin (2008) developed a DSGE model for emerging ITers in

Latin America; although it makes a significant contribution to the literature as it observes IT in relative terms (pre- vs. post-IT period and ITers vs. non-ITers, which is not a case for other studies based on DSGE models), the study has significant drawbacks. It finds IT that central banks are more aggressive towards inflation volatility under IT than they were prior to IT adoption and compared to non-IT central banks; though, IT central banks in the model are treated as being pure "inflation nutters", i.e. output volatility is not considered. Also, the model does not incorporate the foreign sector and the exchange rate or the level of dollarization, issues which were highlighted as important for the developing world. Although no study explicitly explored a monetary-regime switch from ERT to IT, the DSGE model for Hungary (Jakab and Vilagi, 2008) considers two interest-rate rules given the two monetary regimes in Hungary. The finding is that indexation in consumer prices did have a lesser role in the IT regime than in the previous crawling peg regime. However, the study does not investigate the differences in terms of inflation and output volatility and exchange-rate developments. The classically-estimated DSGE-type New Keynesian model developed for Israel (Argov *et al.* 2007) highlights the importance of the exchange rate in conducting monetary policy under IT, but no special emphasis is given to volatilities.

Only one study (Edwards, 2006) has, so far, empirically modelled exchange-rate volatility under IT and only a few empirical studies have focused on the central-bank's reaction functions in emerging markets. Edwards (2006) explores monthly data for seven countries (five of which are developing), in the period 1988-2005. It employs a GARCH model of the nominal exchange rate to test if the adoption of IT has affected exchange-rate volatility, conditional on the switch to a new exchange-rate regime (given that in emerging markets the adoption of IT meant a switch to a flexible option of the exchange rate, which could have been the source of volatility). For the purpose of accounting for the latter differences, two dummies isolate those effects: one for the monetary regime and one for the exchange-rate regime, which is a step usually neglected in other studies. They find no evidence that IT increased the nominal effective exchange-rate volatility. Quite the contrary, after controlling for the exchange-rate regime, IT has tended to reduce the conditional volatility of the exchange rate. A similar conclusion is reached when the real exchange rate is considered. Although plausible, these results are not supported by other studies at present. Hence, this is a research area in a maturing process, both in terms of practical experiences and in terms of empirical investigations.

The studies that model the interest-rate function in IT economies usually employ a form of VAR (individual cases) or standard panel FE and RE models[34] (group cases) to estimate the elasticities; these estimates are important since they consider the role of the exchange rate in those countries, and hence we review some of them. Schmidt-Hebbel *et al.* (2002) apply a VAR model to compare the IT experiences of Brazil, Chile and Mexico. They estimate Taylor-rule equations for each country with the real interest rate as the dependent variable. Only for Brazil is the expected inflation gap (between actual and target inflation) statistically significant, whereas only for Chile is the output gap statistically significant. They find no evidence that the central banks have consistently reacted to exchange rate movements. One drawback of these time-series regressions is the very short sample periods, which might cast doubt on the estimated coefficients; also any restrictions derived from the theory of IT are not modelled, but variables interact in a general VAR framework. A similar approach is also followed by Cordo *et al.* (2001) for the period 1990-1999 (quarterly data) for IT countries (Chile and Israel), the then potential ITers (South Africa, Brazil, Colombia, Mexico and Korea) and one non-IT country (Indonesia). In the first two categories, four central banks appear to respond to inflation (output) deviations from target in setting interest rates, but the study does not consider the role of the exchange rate, which might be regarded as its main drawback.

Mohanty and Klau (2005) estimate modified Taylor rules for 13 emerging and transition economies over the period 1990-2002, including, as well as inflation, the output gap and lagged interest rates, current and lagged real exchange-rate changes. They find that the coefficients on the real exchange rate are statistically significant in ten countries (OLS estimates), with a significant contemporaneous effect ranging from 0.01 to 0.79 p.p. increase of interest rate when the real exchange rate depreciates by 1 p.p. (see Table 5.1 below). The policy response to exchange-rate changes is frequently larger than the response to inflation and the output gap, which might confirm our concerns that in the developing IT world the exchange rate must not be disregarded at any cost (whether for policy analysis or implementation). Mohanty and Klau (2005) do not explicitly address the IT issue in this context, but it is apparent that these countries, whether or not they profess to follow an IT regime, are attempting to stabilize real

[34] Which, in certain cases, could be certainly criticized, but this is not pursued in more detail here because of space.

exchange rates as well as control inflation and stabilize output. Building on Mohanty and Khau's (2005) study, Edwards (2006) investigates the determinants of exchange-rate response in Taylor-rule regressions. He runs cross-country regressions of the exchange-rate coefficient on several explanatory variables (each regression with 13 observations) and finds that countries with a history of high inflation, and with historically high real exchange-rate volatility, tend to have a higher coefficient on the real exchange rate in Taylor-rule equations, which supports the view that exchange-rate volatility does indeed play a strong role in the IT framework.

De Mello and Moccero (2008) estimate interest-rate policy rules within a New Keynesian structural model with equations for inflation, output and interest rates, for four Latin American emerging markets (Brazil, Chile, Colombia and Mexico), characterized by IT and flexible exchange rates in 1999. They find IT, as a post-1999 regime, is associated with stronger and persistent responses to expected inflation in Brazil and Chile. Mexico is the only country where changes in nominal exchange rates were found to be statistically significant in the central bank's reaction function during the IT period (Table 5.1). Aizenman *et al.* (2008) also use a variant of a Taylor-rule specification to test whether the interest rate responds to the developments in the real exchange rate. They use panel regression (a FE model) of 16 emerging markets over the period 1989-2006, to explore if the external vulnerability (as approximated by the exchange-rate volatility and trade openness) has a role to play in the interest-rate setting. The general finding is that the exchange rate plays a crucial role in the monetary framework of the developing economies, but is less important than in non-ITers, probably because the primary concern of ITers is inflation (Table 5.1). Moreover, the study finds that the exchange rate gains even more importance in ITers with more concentrated exports.

Table 5.1. Interest-rate response to changes in the exchange rate (elasticities from studies examining group of emerging economies)

Country	Mohanty and Klau (2005)		De Mello and Moccero (2008)		Aizenman *et al.* (2008)	
	Short term	Long term	Pre-IT	Post-IT	Non-IT	IT
India	0.18***	0.60***				
Korea	0.29***	0.67***				
Philippines	0.09**	0.13**				
Taiwan	0.03	0.18**				
Thailand	0.31***	0.74***				
Brazil	0.10**	0.36***	5.08	0.47***		
Chile	0.01***	0.03***	-0.40	-0.16		
Mexico	0.79***	1.58***	2.85***	3.75***		
Peru	0.38***	2.71***				
Colombia			-0.24	-0.13		
Czech Republic	-0.03	-0.19				
Hungary	0.15**	0.60**				
Poland	0.05	0.20**				
South Africa	0.12***	6.00***				
Panel of countries					0.07***	0.13***

Source: Mohanty and Klau (2005); De Mello and Moccero (2008); Aizenman et al. (2008)
Note: *, ** and *** refer to a significance level of 10, 5 and 1%, respectively. ● The real exchange rate is defined so that an increase means a depreciation.

In general, the majority of the studies confirm that the exchange rate has a role to play in an IT framework. The empirical studies reviewed report interest-rate increase ranging from very low, 0.01, to very high, 3.75, when the exchange rate depreciates by 1 p.p. However, Taylor (2001) and Edwards (2006) express their scepticism on the merits of adding the exchange rate into the policy-rule function, because of the indirect role of the exchange rate on inflation and output (discussed in Section 5.2.2) and because its addition could add volatility to monetary policy (refer to further discussion in Mishkin and Schmidt-Hebbel, 2001).

5.4. Conclusion

This chapter has considered further arguments on the merits of inflation targeting, with special emphasis on the exchange-rate issues in developing ITers. The general conclusion from the chapter is that although the traditionally-supported trade-off between inflation volatility and output volatility is valid under IT, the credibility that the central bank accumulates under this regime, enables the trade-off curve to "shift to the left" (in terms of Figure 5.1) and, hence, the achievement of a combination of both lower inflation volatility and lower output volatility. Moreover, while the chapter argues that a form of flexible IT is needed for viability in practice, the exchange rate is only a means to an end and as such is not suggested to be explicitly included in the policy-loss function. In empirical terms, studies concluded that IT is beneficial for inflation and its volatility; however, there is no consensus concerning the effect of IT on output volatility, although the finding is that it is beneficial for short-run output as well.

Observing the developing countries gives only a slightly different picture. However, the chapter concluded that several specifics are important for these countries, mainly those connected to the underdevelopment of the financial markets, the issues of fiscal dominance and these-countries' vulnerability to external shocks and sudden capital stops. The latter, which in such economies are more common, might exacerbate exchange-rate volatility which, under the assumption of increased pass-through to prices, might threaten the achievement of the inflation target. Thus, proper exchange-rate management appears crucial in the initial phase of IT, but this managing does not coincide with exchange-rate targeting. As monetary policy gains credibility, and as the economy institutionally strengthens, the necessity for exchange-rate interventions lessens as well as the exchange-rate pass-through. The chapter offered some consensual empirical evidence on this point. Moreover, theoretical arguments and empirical evidence suggested that financial euroization does not preclude an independent monetary policy oriented towards maintaining a low and stable inflation rate, because the persistent exchange-rate risk will force agents to permanently balance their portfolios while authorities will usually fear to float and will prevent large exchange-rate fluctuations.

The empirical evidence reviewed in the chapter reflects the variety of the ways in which IT performance and policy responses are examined in the literature. Yet the general conclusion is that the issue of the behaviour of monetary policy under the assumption of a regime switch is virtually ignored in the literature, with no study explicitly dealing with it in an appropriate manner. Only one study distinctly models the monetary policy under the two monetary regimes, but this study ignores the role of the exchange rate, which might be very important for developing economies. The analysis in this chapter provides a basis for quantifying IT performance given a regime switch and given the role of the exchange rate in developing economies, which is pursued in the next chapter.

CHAPTER 6

Empirical analysis and modelling of a monetary-policy regime switch

6.1. Introduction

"Throughout the world, monetary-policy regimes have changed dramatically over the decade of the 1990s. The biggest transformation has been the move away from focusing on intermediate objectives, such as money and exchange rates, toward the direct targeting of inflation" (Cecchetti and Ehrmann, 1999, p.1). In the first part of this thesis (Chapters 1-3) we argued and reported empirical evidence that exchange-rate targeting, albeit not important in affecting the long-term growth performance of the economy, is important in stabilizing output fluctuations. However, when large real shocks hit, it might amplify output volatility. It was argued that as the economy gets more involved in the international financial market, real shocks become likely. Further, we argued in the second part of the thesis (Chapters 4-5) that the exit from an exchange-rate peg will provide the economy with more flexibility in buffering real shocks, but the economy will still need a monetary anchor. Inflation targeting along with a managed-floating exchange rate was argued to provide a nominal anchor and to take into consideration the need to reduce output- and exchange-rate volatility; although, opinions in the literature as to the effectiveness with which such a policy affects output fluctuations remain divided. The aim of this chapter is to empirically examine whether the conduct of monetary policy has significantly changed with the switch from exchange-rate to inflation targeting in developing countries. For this purpose, a group of developing countries that have historically experienced such a switch is analysed. This is done by estimating an augmented interest-rate rule à la Taylor (1993; 2001a), through two different regime-switching methods, in order to capture a change of monetary-policy regime, along the lines discussed in Chapter 5. This will add to the current sparse literature on IT for developing countries and, to the writer's knowledge, use analysis not applied in this context elsewhere.

For those purposes, the chapter is organized as follows. The next section describes the IT waves and reviews some descriptive statistics, in order to define the sample and build intuition for later modelling. Section 6.3 discusses the data and sets out the model to be estimated. Section 6.4 establishes the panel switching-regression method as our empirical strategy. Section 6.5 examines the results, while Section 6.6 gives some discussion, robustness analysis and a critique of the applied methodology. Subsequently, Section 6.7 offers the Markov-switching regression as an alternative modelling approach. Section 6.8 reports the findings of this approach and presents further discussion. The last section concludes the chapter.

6.2. Descriptive analysis

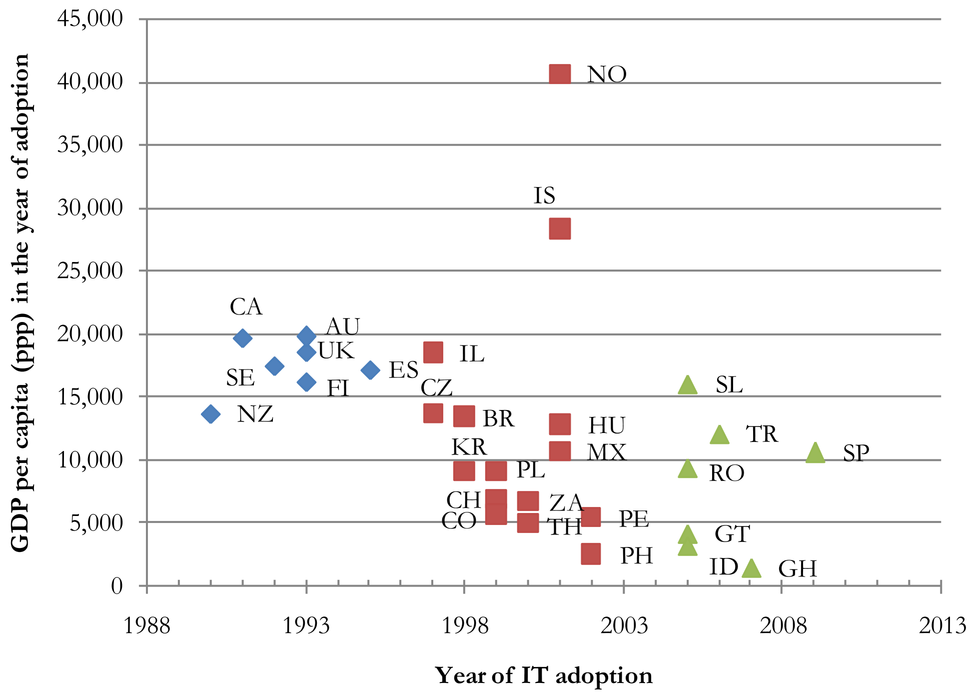
6.2.1. Waves of IT adoption and some statistics

IT as a monetary regime is relatively new, dating back to the beginning of the 1990s when New Zealand was the first to adopt an official inflation target. The first several years of the IT era were marked by adoption by advanced countries. However, many subsequent ITers either targeted inflation implicitly, i.e. only as a benchmark against which outcomes are measured, or followed several explicit targets. A further discussion of this issue is given in Sterne (1999) and Morandé and Schmidt-Hebbel (2000) and is beyond the scope of this study. The concept of IT, introduced in Chapter 4, defines this regime as a procedure based on rules and objectives that have to be achieved and which is freed of any other monetary policy target. Judging according to this specification, there are 26 inflation targeters in the world today (plus three that have left IT to join the Euro zone).

As a monetary regime, IT appeared and grew in the developed world. Figure 6.1 depicts the time of IT adoption with the income level per capita in the same year. We denote the adoption of IT by the advanced economies as the first wave, which terminated in the mid 1990s (Figure 6.1; blue points). Most quantitative studies are conducted on datasets for those countries. The initial results of the application of the new monetary regime were satisfactory: Although inflation reduction started before the introduction of IT, "inflation did not bounce back up afterwards as expected" (Mishkin and Posen, 1998, p.90). However, there is no overwhelming evidence that the new regime in the adopting countries significantly affected inflation expectations nor that it significantly reduced output volatility (refer back to Section 5.2). It is perhaps important to note that these countries enjoy previously acquired credibility of their central bank, which is important for this monetary regime.

After the positive experience of the first ITers, in terms of a low inflation level, a new wave of ITers commenced at the end of the decade: many developing economies started to target inflation, explicitly or implicitly (Figure 6.1; red points). At the same time, a growing body of studies emerged around IT in emerging economies, but our review in Chapter 5 finds that these studies are merely descriptive. Many of the implicit nominal targeters embarked on explicit IT; the majority of developing economies did that because of facing pressures on the foreign exchange market, or even a demise of the ERT regime. Chapter 2 elaborated on the challenge to sustain the peg against a background of foreign disturbances and increased capital mobility. Albeit that this section does not intend to do case-by-case analysis, a brief overview of some of the cases is used to pursue our argument.

Figure 6.1. Three waves of inflation targeters



Source: Table 6.1 on page 217 and World Economic Outlook.

Note: Countries are grouped according to the three waves outlined in the text: blue points refer to advanced countries, majority of which established IT after some years of implicit nominal targeting, but also to those which abandoned ERM I; red points refer to developing economies, some of which introduced IT after an exchange-rate turbulence; green points refer to developing economies which started accepting IT as a strategy oriented at attaining domestic objectives *per se*. Country names and codes are fully available in Table 6.1.

Among the first cases was Brazil, which after its real exchange-rate crisis in early 1999, abandoned the peg, embarked on a (managed) floating regime and officially adopted IT (Bodganski *et al.* 2000). Following the Asian financial crisis in 1997 and the demise of the Thai baht exchange-rate system, a (managed) floating rate was introduced alongside a money-base target in Thailand. The latter suffered from the weak link between money and prices and ultimately the Central Bank adopted an IT framework (Agénor, 2002). Jonas and Mishkin (2003) report the cases of the Czech Republic and Poland, which also introduced IT after exchange-rate regime turbulence, albeit the establishment of the new regime in Poland was more gradual (i.e. Poland followed an eclectic approach as of 1995, which included a crawling peg of ±2.5% and sometimes targeted numerically expressed inflation; Pruski, 2002). After the boom of capital inflows in Hungary in the late 1990s, the pressures on the foreign exchange market resulted in a widening of the exchange-rate band to ±15% in 2001 which has been retained along with the IT until early 2008. As such, Hungary makes an exception among ITers, since all the others introduced a form of managed float when introducing IT.

A third wave of IT adoption is underway with developing countries (Figure 6.1; green points) which mostly relied on alternative strategies but embark on IT persuaded by the case for improved benefits for their economies. A growing number of economies are currently examining the introduction of targets and several have already launched preparations for formally adopting them. These include the developing and emerging economies of Albania, Armenia and Kazakhstan, which already have price stability as a stated objective but have yet to adopt a formal IT. The world economic crisis might postpone any such plans; they do not dominate the agenda in these countries currently.

In general, the (quantitative) analysis of IT in developing economies has been scarce (Section 5.3.4). Not only are the datasets short and usually of lower reliability when compared to the data in advanced economies, but also several other factors make the analysis more complex, among which are: i) the institutional capacity; ii) the cash-inflows vulnerability in those countries; and iii) the problem of high euroization and exchange-rate pass-through (Mishkin, 2004). These were discussed in Section 5.3. From the viewpoint of the analysis in this thesis (Chapters 3 to 5), an important aspect of the story is the monetary regime prior to the adoption of the IT. In particular, this thesis opts to model, analyse and understand whether monetary-policy conduct changed under a regime switch from exchange-rate targeting to inflation targeting. At the outset, Table 6.1 summarizes some stylized facts for IT economies, with emphasis on the prior monetary regime and prior and posterior exchange-rate regime.

Table 6.1. Fully-fledged inflation targeters and switch

Country name and code			IT introduced	Inflation rate at the beginning of IT	Inflation target / band	Prior announced monetary regime (from which the switch has been made)	DE-FACTO (RR classification)			DE-JURE (IMF classification)		
							De-facto ERR before	Duration of ERR	De-facto ERR after	De jure ERR before	Duration of ERR	De-jure ERR after
(1)			(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1.	New Zealand	NZ	1989M12	3.3	1–3	Implicit nominal anchor	Managed floating	5 yrs	Managed floating	Free floating	6 years	Free floating
2.	Canada	CA	1991M2	6.9	1–3	Implicit nominal anchor	Limited flexible	20 yrs	Lim-flexible and flexible (2002)	Free floating	very long	Free floating
3.	UK	UK	1992M10	4.0	2	ERM I	Fixed	Less than 2 years (ERM I)	Managed floating	Fixed	7 years	Free floating
4.	Sweden	SE	1993M1	1.8	2 (±1)	ERM I	Limited flexible	15 years	Managed floating	Fixed	16 years	Managed fl. and free fl.
5.	Finland[1]	FI	1993M1	2.6		ERM I	Limited flexible	21 years	Fixed	Fixed	22 years	Free floating
6.	Australia	AU	1993M6	2.0	2–3	Implicit nominal anchor	Free float	9 years	Free float	Free floating	9 years	Free float
7.	Spain[1]	ES	1995M1	4.2		ERM I	Fixed	2 years	Fixed	Limited flexible	6 years	Limited flexible
8.	Israel	IL	1997M6	8.1	1–3	Exchange-rate targeting	Managed floating	6 years	Managed floating	Managed floating	6 years	Managed floating
9.	Czech Rep.	CZ	1997M12	6.8	3 (±1)	Exchange-rate targeting	Limited flexible	6 years	Managed fl. and lim-flexible (2002)	Fixed	6 years	Managed floating
10.	Poland	PL	1998M1	10.6	2.5 (±1)	Exchange-rate targeting	Managed floating	6 years	Managed floating	Managed floating	8 years	Free floating
11.	South Korea	KR	1998M4	2.8	3(±1)	Monetary targeting	Limited flexible	18 years	Managed floating	Managed floating	17 years	Free floating
12.	Brazil	BR	1999M6	3.3	4.5 (±2)	Exchange-rate targeting	Limited flexible	6 years	Managed floating	Managed floating	5 years	Free floating
13.	Chile	CH	1999M9	3.2	2–4	Exchange-rate targeting	Managed floating	7 years	Managed floating	Managed floating	18 years	Free floating
14.	Colombia	CO	1999M10	9.3	2-4	Exchange-rate targeting	Managed floating	16 years	Managed floating	Managed floating	20 years	Free floating
15.	South Africa	ZA	2000M2	2.6	3–6	Monetary targeting	Free floating	5 years	Free floating	Free floating	17 years	Free floating
16.	Thailand	TH	2000M5	0.8	0–3.5	Exchange-rate targeting	Fixed	24 years	Managed floating	Fixed (1997) Free float (2000)	27 years	Managed floating
17.	Mexico	MX	2001M1	9.0	3 (±1)	Monetary targeting	Managed floating	5 years	Managed floating	Free floating	6 years	Free floating
18.	Norway	NO	2001M3	3.6	2.5	Implicit nominal anchor	Managed floating	55 years	Managed floating	Managed floating	6 years	Free floating
19.	Iceland	IS	2001M3	4.1	2.5	Implicit nominal anchor	Limited flexible	14 years	Managed floating	Managed floating	4 years	Free floating
20.	Hungary	HU	2001M6	10.8	3.5 (±1)	Exchange-rate targeting	Limited flexible	7 years	Limited flexible	Managed floating	5 years	Fixed
21.	Peru	PE	2002M1	-0.1	2.5 (±1)	Monetary targeting	Limited flexible	8 years	Limited flexible	Free floating	12 years	Limited flexible
22.	Philippines	PH	2002M1	4.5	4-5	Exchange-rate targeting	Limited flexible	5 years	Limited flexible	Free floating	13 years	Free floating
23.	Slovak Rep.[1]	SL	2005M1	5.8	6 (±1)	Exchange-rate targeting	Limited flexible	6 years	Limited flexible	Fixed	2 years	Managed floating
24.	Guatemala	GT	2005M1	9.2	5.5 (±1)	Monetary targeting	Limited flexible	14 years	Limited flexible	Free floating	16 years	Managed floating
25.	Indonesia	ID	2005M7	7.4	5.5 (±1)	Monetary targeting	Managed floating	6 years	Managed floating	Managed floating	4 years	Managed floating
26.	Romania	RO	2005M8	9.3	4 (±1)	Monetary targeting	Managed floating	5 years	Managed floating	Limited flexible	3 years	Managed floating
27.	Turkey	TR	2006M1	7.7	4(±2)	Monetary targeting	Free floating	3 years	Free floating	Free floating	6 years	Free floating
28.	Ghana	GH	2007M5	10.5	0-10	Monetary targeting	Limited flexible	6 years	Limited flexible	Managed floating	6 years	Managed floating
29.	Serbia	SP	2009M1	6.5	8-12	Monetary targeting	Managed floating	6 years	Managed floating	Managed floating	6 years	Managed floating

1/ Finland, Spain and Slovakia abandoned IT upon entry into the Euro zone in 1999, 1999 and 2008, respectively.

Compiled from: Reinhart and Rogoff (2004); Pétursson (2004); Hammond (2009); Roger (2009); IMF website; Central banks' websites and Carmen Reinhart's web site.

6.2.2. Macroeconomic performance of switchers and non-switchers: developing countries

To motivate the discussion about the population used and the modelling strategy, in an intuitive way, we will portray some descriptive statistics of economic trends before-switch versus after-switch; and of ITers versus ERTers. The objective of this descriptive analysis is not to reveal definitive causal relationships. As noted in Chapter 5, the assessment of monetary-policy performance under alternative monetary regimes, especially given a switch, is a challenging task. Not only is the identification strategy important, but also problematic are the merits according to which this performance will be judged, including any external factors that might exert influence (like, say, the level of euroization and the exchange-rate pass-through).

We argue that the approach to analysing this issue should be cautious. The existing empirical literature (part of which reviewed in Chapter 5) is exposed to the identification problem: the comparison group contains a portion of countries that were not formal ITers, but did run a policy geared toward IT. In that light, the identification strategy might suffer from lack of clear distinction between the two groups and, hence, might render conclusions biased. Yet, our objective is not exposed to this problem, as we are not interested in analysing all ITers versus a potentially vague group of non-ITers. Instead, we are interested in only ITers whose former strategy was ERT, versus a control group of ERTers which, over the same period continued to target the exchange rate and did not move to IT.

The total number of countries that switched from ERT to IT is small (14 countries so far) and appropriate for further analysis (blue rows in Table 6.1). However, it is reasonable to suspect that the switch from ERT to IT in developed countries (UK, Sweden, Finland and Spain) might have been a different process, which might be ascribed to the higher credibility of the central bank than in developing countries; or to the fact that they were a part of the Exchange Rate Mechanism. Moreover, Finland and Spain no longer apply IT, as they joined the common currency in 1999; also, Slovakia joined the Euro zone shortly after the adoption of IT.

The developing-countries switchers or the "treatment" group (henceforth referred to as simply "switchers") is: Brazil, Chile, Colombia, the Czech Republic, Hungary, Israel, Philippines, Poland and Thailand. Our concerns related to the form of ERT, raised in Chapter 3, are taken into consideration: albeit that an official target has been announced, the de-facto behaviour of the exchange rate matters. Hence, the de-facto exchange-rate regime is reported to stand for the strength of the commitment to the exchange-rate target (column 6), which might appear crucial for our empirical analysis hereafter. We notice that although an official target was announced in Chile, Israel, Poland and Colombia, the de-facto behaviour of the exchange rate was considerably lax. Hence, we might need to recall this later. The rest of the group is relatively homogenous in terms of the de-facto exchange-rate regime prior to the adoption of IT - all did have a de-facto tight exchange rate, which gives grounds for comparisons of the results. However, some differences within the group would appear desirable[35], in an era whereby monetary-strategy setup might not be crucial for the policy outcomes, but rather external factors, like the Great Moderation.

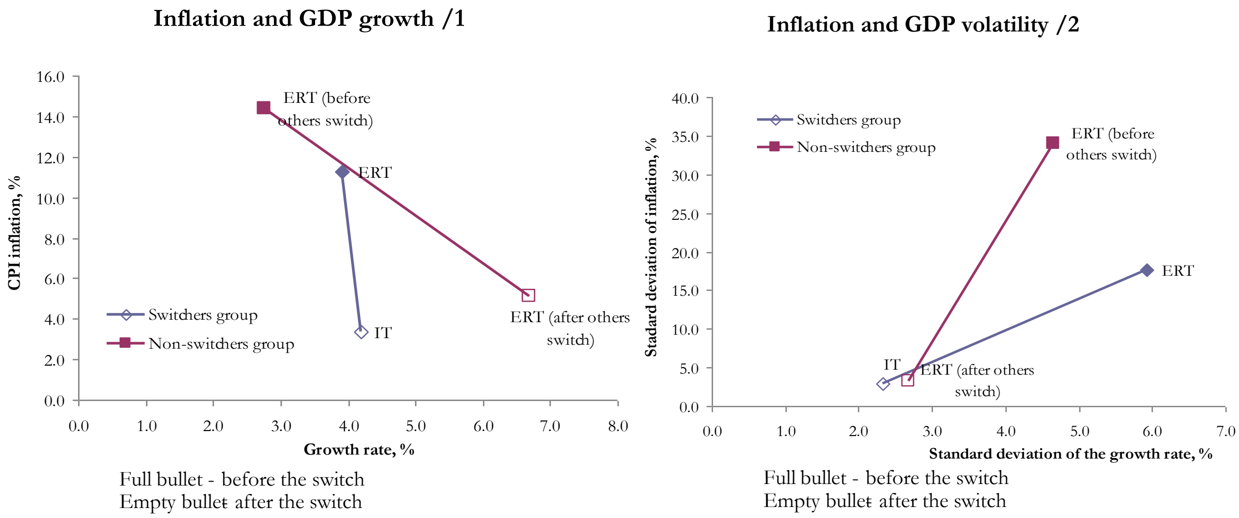
The total number of exchange-rate targeters in the world is large compared to the number of switchers. We need countries that in the same period continued to target the exchange rate and can act as a suitable comparison group (henceforth referred to as "non-switchers") that do not include implicit ITers. The comparison group for developing countries is taken from the neighbouring developing countries to the switchers and/or countries with which these have trading and financial relationships, and have had the exchange-rate strategy for a prolonged period and did not move to IT. These countries are likely to have been subject to the same common regional shocks because of the proximity and the economic relations. These are: Bulgaria, Estonia, Latvia, Lithuania, Macedonia, Argentina, Ecuador, El Salvador, Uruguay and China. In these, the first five serve as counterparts for the European switchers; the next four for the South-American switchers; China for the Phillipines and Thailand, while no straightforward counterpart could be identified for Israel, but the group of European countries might satisfactorily play this role.

Switchers versus non-switchers are graphically examined next. The numbers behind the plots are given in Table A1.10 in Appendix 1. For the switchers group, the

[35] Certainly, the most important difference for our research is the flexibility of the de-facto exchange-rate regime, which is depicted in Table 6.1. However, other differences must be born on mind when assessing the empirical results: the trade arrangements, and hence trade openness (some of the countries are a part of larger trade associations or customs unions or a part of the EU single market, but others are not); economic structures (in some the agricultural sector is more important, while in others services dominate); size and so on. Within the model we are not able to control for all these aspects, but we might want to recall them later, when we evaluate the results.

date of the switch to IT is given. For the non-switchers group, 2000 is taken as a median year when most switchers switched and, hence, the sample is divided into 1991-1999 and 2000-2008. Taking the median figures, switchers perform better in terms of inflation in the second period, but non-switching ERTs perform better in both inflation and growth. More importantly, in terms of volatilities, albeit that both groups started at high yet different levels, their median volatilities dropped to similar levels in the IT period. Hence, although some might argue that IT performs well, it still cannot be argued that those which continued to target the exchange rate perform worse. Quite the contrary, the reason for the good performance of both groups might be the relatively shock-free period (Great Moderation) of the 2000s.

Figure 6.2. Macroeconomic performance: Switchers versus non-switchers (1)

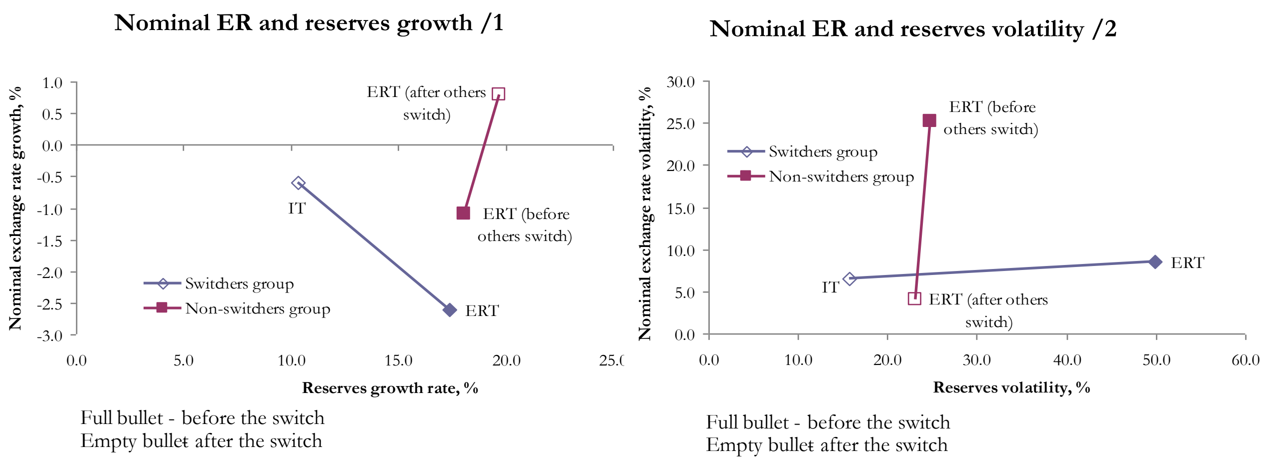


Source: Author's calculations based on World Economic Outlook data

1/ Figures based on median country values of median annual values for inflation and growth.
2/ Figures based on median country values of standard deviation of annual percentage changes.

In Figure 6.3, the median growth rate and volatilities of the nominal exchange rate and official reserves are plotted, similarly to Figure 6.2. On the left panel we observe that depreciation of the national currencies considerably slowed in the period after ITers switched to IT, but this pattern is observable in both groups. On the other hand, the average growth of the reserves declined in the switchers group, but slightly increased in the control group. This might suggest that the central bank has been less active with the sterilization on the foreign exchange market, which might be expected within an IT strategy. In the right panel, volatilities are observed. Our previous assertion might be drawn from here as well: reserve volatility fell considerably in the switchers group, which might suggest that authorities intervened less frequently under the new regime; in the control group, the volatility of reserves remained roughly the same. As for the exchange-rate volatility, the switchers group experienced a similar pattern after the switch, albeit that the volatility started low and that the control group volatility also declined considerably in the second period. Hence, the general absence of shocks in the second period might have led to this result, making nominal exchange-rate volatility non-dependent on the monetary strategy pursued.

Figure 6.3. Macroeconomic performance: Switchers versus non-switchers (2)



Source: Author's calculations based on International Financial Statistics data

Note: Nominal exchange rate is represented by the NEER. Whenever NEER was not available, we used the nominal exchange rate of the national currency per SDR. An increase means depreciation.
1/ Figures based on median country values of median values for growth rates.
2/ Figures based on median country values of standard deviation of annual percentage changes.

****

Two general conclusions from this graphical analysis can be taken. Firstly, the plots suggest that macroeconomic performance under IT improved. However, non-switchers also exhibit improved macroeconomic performance. Hence, it cannot be said that the monetary-strategy switch was the cause of the improved macroeconomic outcomes. Rather than that, the favourable economic conditions (i.e. the global Moderation, which we referred to in Chapter 5) during the period of IT in switchers and non-switchers might explain these trends. Some notable, although not clear-cut, differences (switchers versus non-switchers) are observable regarding the exchange rate and reserves. Secondly, the statistics on inflation, growth and their volatility (Figure 6.2) do not support the view that the switch was endogenous – both switchers and non-switchers did suffer a greater inflation level and volatility before the switch-year than after. However, the evidence from the exchange-rate and reserves statistics (Figure 6.3) is not supportive of this view: after the switch the depreciation rate and reserves volatility declined. Based on the implications of the descriptive analysis, the concern in the empirical work needs to take into account the possible endogeneity of the switch. We proceed with defining a model (Section 6.3) and designing a switching regression (Section 6.4).

6.3. Data and model

Since we want to investigate how the response of the monetary policy changed under alternative regimes, it is convenient to establish a monetary-policy reaction function, à la Taylor (1993; 2001a), in which the reactions of the central bank to the macro-variables (output gap and inflation) can be estimated. A large strand of the monetary-economics literature suggests the interest-rate rule as a neat way to represent monetary policy: some review papers include: Boivin and Giannoni (2006); Primiceri (2006); Lubik and Schorfheide (2004); Weerapana (2000); Svensson and Woodford (2003); King (1999); McCallum (1999a,b); Cristiano and Gust (1999); and Woodford (1999a). However, Clarida *et al.* (2000) remains probably the most cited piece of work over the preceding decade; they estimate a Taylor-type policy rule for the US, whereby the federal funds rate is a function of inflation and output gap as final targets. Clarida *et al.*'s (2000) specification is forward-looking in both inflation and the output and relates to our discussion of the IT setup in Section 4.4. They argue that the forward-looking rule nests the Taylor rule as a special case: if either lagged inflation or a linear combination of lagged inflation and the output gap is a sufficient statistic for forecasting future inflation, then the forward-looking specification collapses to the original Taylor (1993) rule (see the box on the next page for more details). However, the forward-looking specification of the rule has been emphasized both in the empirical specifications and by the central banks around the world, at least in recent years.

To design an appropriate interest-rate rule, in addition to the suggestion to use the forward-looking specification of the Taylor rule, here we recall our discussion in Chapter 5. Namely, since we do have developing countries in our sample, it is reasonable to consider their multiple-objectives setting (mainly referring to their concern over the exchange rate; see Section 5.3). The economic model is therefore as follows:

$$r_t = \alpha + \rho r_{t-1} + \beta_1 E_t \pi_{t+n} + \beta_2 (y_t - y_t^*) + \beta_3 \Delta e_t + u_t \qquad (6.1)$$

where r_t, π_{t+n}, $(y_t - y_t^*)$, and e_t denote, respectively, the nominal interest rate, expected inflation, the output gap and the nominal exchange rate (direct quote) at time t (or plus n periods into the future for expected inflation); E_t is the expectations operator conditional on information available at time t; Δ is the first difference operator; ρ is the smoothing parameter to be estimated; βs are coefficients to be estimated, measuring the central-bank response to the changes in these variables, which can partly reflect authorities' preferences in designing monetary policy; and u_t is the error term. This is a forward-looking interest-rate rule[36] explicitly only in terms of inflation, but since the output gap is a determinant of inflation (recall equations [4.2] and [4.3] on p.169), expectations of the output gap are encompassed in this. Assuming a forward-looking specification of the rule in terms of inflation only is reasonable for developing economies and especially for the former ERTs, given their only concern with inflation during ERT (ERT being introduced to curb inflation) and at least in the early phase of IT (when a process of disinflation took place). The rule is augmented with the exchange rate; some papers with this inclusion of the exchange rate in include: Ball (1999), Mishkin and Savastano (2001), Minella *et al.* (2003) Mohanty and Klau (2005) and De Mello and Moccero (2008). As argued in Section 5.3, there is some controversy over the inclusion of the exchange rate in the interest-rate rule, but this is done for three reasons, the latter two being largely present in the existing literature (see Frankel, 1979): i) our control-group countries target and our ITers formerly targeted the exchange rate, hence it is/was the main intermediate objective and might be considered as a high-frequency indicator of the external sector that guides monetary policy; ii) there may still be more complex interactions between movements in the exchange rate and macroeconomic performance in developing ITers (like their "fear of floating", discussed in Chapter 2, or the relevance of the exchange-rate pass-through, discussed in Chapter 5); and iii) financial imperfections such as a large amount of external debt or large foreign currency substitution (Section 5.3.3) might make the case for monetary intervention on exchange-rate movements stronger. Overall, the inclusion of the exchange-rate is to address our earlier concerns over the role of the exchange-rate pass-through and the euroization in the economy.

[36] Note that the forward-looking specification is used for our SR. However, when we pass onto estimating the MS-VAR, we are no longer able to estimate a forward-looking specification. More detail to follow in Section 6.8.

Forward-looking versus backward-looking interest rate rule: A note

The baseline policy rule usually considered in the literature takes a simple form. If we denote r_t to be the target interest rate in period t, then each period it is a function of expected inflation and the output and its respective target level. Specifically, we postulate the linear equation:

$$r_t = r^* + \beta E_t \{\pi_{t+k} | \Omega_t\} + \gamma \{y_{t+q} | \Omega_t\} \qquad (6.1a)$$

whereby π_{t+k} denotes the percent change in the price level between periods t and t+k (expressed in annual rates). y_{t+q} is a measure of the average output gap between period t and t+q, with the output gap being defined as the percent deviation between actual GDP and the corresponding target. However, note that in practice, the period t GDP is not known as of the time the interest rate is set in that period; i.e. $y_{t,1} \notin \Omega_t$, given the lag with which GDP is published. E_t is the expectation operator, and Ω_t is the information set at the time the interest rate is set. r^* is, by construction, the desired nominal rate when both inflation and output are at their target levels – i.e. a kind of equilibrium interest rate.

The policy rule given by (6.1a) has some appeal on both theoretical and empirical grounds. At the theoretical level, the forms that (6.1a) can take are optimal for a central bank that has a quadratic loss function in deviations of inflation, output and possibly other variables from their respective targets – as are (4.5) and (4.12) on p.169 and p.179, respectively. At the empirical level, (6.1a) well fits the manner in which many central banks reason and act nowadays, especially inflation targeters.

Nevertheless, the seminal paper of Taylor (1993) opened a strand of the literature which relies on an interest-rate rule which is backward-looking, i.e. the interest rate responds to lagged inflation and output rather than their expected future values. McCallum has, in several papers, like McCallum (1999a), argued that it is more realistic from an information point of view (Ω_t in [6.1a]), to restrict the interest rate in period t to depend on the state variables in period t-1. However, some years later, Clarida *et al.* (2000) and the strand of the literature it opened, argued that the central bank has much more information about the current state in the economy than captured by the few state variables in the backward-looking model. In order words, the lagged inflation and output do not reflect the entire information the policymaker has at time t. Hence, assuming that the state variables in quarter t+k or t+q in (6.1a), whereby k≠q, are known in quarter t is an implicit way of acknowledging the extra information. In order words, the interest-rate rule becomes forward-looking.

So, how can the reconciliation between the forward-looking and the backward-looking rule be made? Clarida *et al.* (2000) offer an intuitive explanation: the forward-looking rule nests the Taylor rule as a special case: if either lagged inflation or a linear combination of lagged inflation and the output gap is a sufficient statistic for forecasting future inflation, then equation (6.1a) collapses to the Taylor rule. In other words, if we assume that Ω_t contains information only on the previous inflation and business-cycle developments, then the rule reduces to backward-looking specification, whereby only lagged inflation and lagged output gap are observed in the policy reaction function. On the other hand, the forward-looking specification allows the central bank to consider a broad array of information (beyond lagged inflation and output) to form beliefs about the future condition of the economy. The latter is highly realistic for inflation targeters, given that they use the medium-term inflation forecast as an intermediate target toward achieving the final goal.

In addition to this, interest-rate smoothing is allowed by the specification, by adding a lagged endogenous variable (see Sack and Wieland, 2000; and Lowe and Ellis, 1997, for a documentation of this strand of the literature). Mohanty and Klau (2005) offer several reasons for smoothing: i) to reduce the risk of policy mistakes, when uncertainty about model parameters is high and when policymakers have to act on partial information; ii) the authorities' concern about the implications of their actions for the financial system (if markets have limited capacity to hedge interest-rate risk, a sudden and large change in the interest rate could expose market participants to capital losses and might raise systemic financial risks); iii) to avoid reputation risks to central banks from sudden reversals of interest-rate directions; and so on.

As a robustness check, later other variables are added that might have an importance in our analytical framework:

i) Lagged inflation, to check if monetary policy was backward- instead of forward-looking (Taylor, 1993);

ii) Reserves growth, in order to serve the same purposes as the inclusion of the nominal exchange rate, but also to reflect pressures on the foreign-exchange market more tightly. It is argued that for the periods under a pegged exchange rate, the nominal rate might not fully reflect these pressures;

iii) Net-foreign assets (NFA) of the banking system to GDP, to measure the level of euroization, hence making a separate case to address the concern of how it might have affected the conduct of monetary policy (Section 5.3.3);

iv) Monetary-aggregate growth, to capture its potential observation as an intermediate target of monetary policy (Sims and Zha, 2006). However, many studies argue that the inclusion of a monetary aggregate is contestable due to the weakened link between money and prices.

Bernanke and Gertler (2001); Bordo and Jeanne (2002) and Mohanty and Klau (2005) argue to include asset prices, in order to capture the potential role of the central bank in combating asset bubbles or as a potential source of risk to financial stability. However, several arguments lead us not to explore this aspect here: i) the asset-price role in monetary policy became of increased interest just after the crisis of 2008 emerged, i.e. only at the end of our data period; ii) the effect of asset prices on the economy was not as dramatic in the developing economies as in advanced ones; and iii) good data-series for the stock market, and particularly for the housing market, are lacking for the majority of countries of interest.

For estimation, monthly data from 1991:1 to 2009:12 are used. The use of monthly data is justified by the fact that almost all central banks decide on the interest rate at a fortnightly frequency. The data are from the IFS database; whenever a series was missing, the central-bank and statistical-office web sites have been used as the source. Data are further described in Table A2.2 in Appendix 2. The policy interest rate is represented through the money-market rate, as it best mimics the stance of the monetary policy; though where this was not available, the discount rate was used. Inflation is taken as the year-on-year monthly percentage change of the consumer price index. Based on similar literature (like Clarida *et al.* 1998), a forward–looking horizon of a year (12 months) is chosen for inflation to reflect the expected component (i.e. the 12th lead of the inflation is taken). Output volatility is defined through an HP filter, following our discussion in Chapter 3, from the industrial production index, since GDP is not available on a monthly basis. The difference in the exchange rate is approximated through the year-on-year monthly percentage change of the nominal exchange rate of the national currency to the special drawing rights, since other series, like the nominal effective exchange rate was missing for a major part of our sample. Reserves growth is taken to be the year-on-year monthly percentage growth of the official reserves minus gold. Euroization in the economy is measured through the ratio of the absolute value of the net foreign assets in the banking system to GDP. Money growth is the year-on-year monthly percentage change of the broad money aggregate M2.

We conclude this section with a note on expected inflation. We are aware that central bankers are not concerned with the month-to-month movements in inflation, but rather with its medium-term trend. Hence, the 12-month ahead horizon as expected inflation at time t seems a reasonable choice for capturing expected inflation. However, this assumes that the central bank has a complete information set in time t and does not make forecast mistakes, which is rather strong. Hence, the interpretation here requires caution from this viewpoint.

Although inflation expectations are highly relevant for both theoretical analysis and policy making, over the years measurement has remained difficult to accomplish. One approach present in the literature relies on distributed lag models of past inflation to estimate expected inflation. However, this approach assumes expectations formation in an adaptive manner (Mincer, 1969). In terms of the discussion here, such a measure would collapse the interest-rate rule into a backward-looking specification, which is close to the original Taylor specification, but not in line with the more recent literature in this area as discussed above. Alternatively, the "rational expectations" hypothesis argues that all currently available information relevant to the actual inflation process is considered when forecasts are made (Resler, 1980) – an approach which extends beyond lagged inflation. Resler argues that although such an information set would not be confined solely to past inflation, it would be likely to be dominated by it, in which case expected inflation would be again approximated by some autoregressive process. However, this has also been disputed, even in the early literature (for instance, Kane and Malkiel, 1976). Moreover, forecasts are revised as new information becomes available, which suggests that no central bank is a perfect forecaster. Other measures of expected inflation, like the information derived from qualitative data generated by surveys in which respondents are asked whether they expect prices to rise, fall or stay the same, have also been discussed in the literature (e.g. Carlson and Parkin, 1975), but are hard to obtain for developing countries. Given these considerations and cautions, here we rely on Clarida *et al.*'s (2000) suggestion to use the 12-th lead of inflation as an approximation of expected inflation.

6.4. Method I

6.4.1. Designing a switching regression

In Section 6.2 we discussed how monetary policy outcomes might have changed when the monetary regime changed by observing two time periods: before versus after the switch for our switching group and for a non-switching group. It was observed there that macroeconomic parameters behaved quite differently between the two periods, but that differences between the switchers and the comparison group were not readily apparent. This inspection lead us to design a switching regression (hereafter SR), whereby a subset of the population is subjected to an exogenous variation in variables, which may have been caused by a policy shift (Cameron and Trivedi, 2005). A traditional way to design a regime-switching regression is to incorporate a dummy variable, taking a value of zero for the one regime (pre-switching) and one for the other regime (post-switching). In this way, the policy shift will be incorporated into the estimation. Further to this, an object of interest is a comparison of the two outcomes for the same unit when exposed, and when not exposed, to the regime switch. This approach is straightforward and enables an assessment of whether the switch to a new monetary regime is significant or not.

In a SR, we would like to measure the impact of the policy-switch variable on the economic outcome of a continuous variable labelled as y_i. The policy-switch variable is discrete and observable, labelled as D, where D takes value of 1 if the switch is applied and 0 otherwise. A simple SR can be designed by writing the following:

$$y_1 = E[y_1 \mid X] + u_1 \quad \text{- for the switching group} \tag{6.2}$$

$$y_0 = E[y_0 \mid X] + u_0 \quad \text{- for the non-switching group} \tag{6.3}$$

Whereby the policy-outcome variable for each group depends on its mean conditional on a set of exogenous regressors, X, and an error term, u_i. It is crucial that both groups share the same characteristics, captured by the same regressors X. This is a SR, because switching and non-switching groups have different conditional mean functions, $\mu_i(X)$, i.e.

$$E[y_1 \mid X] = \mu_1(X) \tag{6.4}$$

$$E[y_0 \mid X] = \mu_0(X) \tag{6.5}$$

The observed outcome is written:

$$y_i = Dy_1 + (1-D)y_0 \tag{6.6}$$

D being the switching variable and i indexes countries. Substituting (6.4) and (6.5) into (6.2) and (6.3), respectively, and then the latter two in (6.6), yields:

$$\begin{aligned} y_i &= D(\mu_1(X)+u_1)+(1-D)(\mu_0(X)+u_0) \\ &= D\mu_1(X)+Du_1+\mu_0(X)+u_0-D\mu_0(X)-Du_0 \\ &= \mu_0(X)+D[\mu_1(X)-\mu_0(X)+u_1-u_0]+u_0 \end{aligned} \tag{6.7}$$

Since D can take values of 0 or 1, the term $D[\mu_1(X)-\mu_0(X)+u_1-u_0]$ switches between the switching and the non-switching group. It measures the effect of the new monetary regime; the component $\mu_1(X)-\mu_0(X)$ measures the average change to switchers with characteristics X, randomly drawn from the population (often referred to as the average treatment effect), while u_1-u_0 is the random error (often referred to as country-specific gain from treatment) (Wooldridge, 2002).

If the switching and non-switching group are observed over time, then a panel is obtained. In this way, we can make use of the increased variability of the data and along with observing switchers versus non-switchers we can exploit the 'before-switch' versus 'after-switch' variability (Blundel and MaCurdy, 2000). Now, equations (6.6) and (6.7) can be advanced in the following manner:

$$y_{it} = \beta X_{it} + \phi D_{it} + \gamma D_{it} X_{it} + \delta_t + \alpha_i + u_{it} \tag{6.8}$$

whereby y_{it} is the outcome variable for the unit (country) i in period t; D_{it} takes the value of 1 if country i switched to the new regime in period t, and 0 otherwise; X_{it} is a vector of explanatory variables; $D_{it}X_{it}$ captures the switching parameters of the explanatory variables ; δ_t is a time-specific fixed effect; α_i is a country-specific fixed effect; and u_{it} is the usual i.i.d. error term. Certainly, all or some of the explanatory variables can be allowed to switch, based on economic theory and intuition. Given that the X_{it} variables are exogenous, (6.8) can be consistently estimated by the fixed-effects estimator, given that some underlying assumptions are satisfied. Namely, as Cameron and Trivedi (2005) and Meyer (1995) explain, the extent to which a SR can give credible econometric evidence crucially depends on:

1. The mean of the non-switching group conditional on X_{it} does not depend on the value of D_{it} (the so called conditional-mean independence assumption); and
2. The decision to switch does not depend on the outcomes, after controlling for the variation in them induced by the differences in X_{it} variables (the so called exogeneity assumption).

While the decision to establish formal IT aims to be exogenous, as these assumptions require, still policymakers might be forced to, i.e. endogenously embark on a new regime. Hence, the switch-exogeneity assumption might be violated; this is discussed in the next section.

6.4.2. Endogeneity in a switching regression

It follows that despite its simplicity, the SR approach has some disadvantages. Firstly, as Imbens and Wooldridge (2009) argue, we can at most observe one of the outcomes, because the unit (country in this case) can be exposed to only one regime switch (hence, two regimes). However, this is addressed by constructing a "counterfactual" given by the comparison (control)[37] group. Secondly, Meyer (1995) argues that good natural experiments are those where there is a transparent exogenous source of variation in the explanatory variables that determine the treatment assignment, like policy changes or financial crises[38]. This can be achieved by selecting a random sample. However:

> Randomization of treatment [switch, *n.b*] is often infeasible… In most cases, individuals [countries, *n.b*] at least partly determine whether they receive treatment [whether they switch, *n.b*], and their decisions may be related to the benefits of the treatment, $y_1 - y_0$. In other words, there is **self-selection** into treatment (Wooldridge, 2002, p.606).

As an intuitive explanation, although the switch to IT might be considered as an exogenous policy shift, there might be reasons for it not being independent (i.e.

37 Strictly speaking, a control group is the one when the treatment is randomly assigned. That is why a suitable terminology would be a 'comparison group'.

38 Although many academics, including Nobel Laureates, regard financial crisis as being fully endogenous. This is, though, beyond the scope of this chapter.

exogenous) of former high levels of inflation or increased output and exchange-rate volatility under shocks. For example, ITers might have been trapped in high inflation or devaluation pressures over a prolonged period of time, which forced them to exit a peg and switch to IT (see Section 2.4). Hence, ITers might be self-selected. In econometric terms, the selection bias arises when D_{it} (the switch) is correlated with the error in the outcome equation (6.8). According to Cameron and Trivedi (2005), this can be induced by omitted variables that determine both D_{it} and y_{it}, or by some unobserved factors. To examine the former, (6.8) can be rewritten as follows:

$$E[y_{it} \mid X_{it}, D_{it}, z_{it}] = \beta X_{it} + \phi D_{it} + \gamma D_{it} X_{it} + \delta_t + \alpha_i + E[u_{it} \mid X_{it}, z_{it}] \quad (6.9)$$

Whereby z_{it} denotes a set of observable variables that determine D_{it} and may also determine the outcome y_{it} and $E[u_{it} \mid z_{it}] \neq 0$. Hence, to overcome this potential endogenous switching, we need to introduce in the equation all observable variables that could be possibly correlated with u_{it}, but also determine y_{it} i.e.:

$$y_{it} = \beta C_{it} + \phi D_{it} + \gamma D_{it} C_{it} + \delta_t + \alpha_i + u_{it} \quad (6.10)$$

whereby C_{it} includes all exogenous (X_{it}) and variables related to the switching (z_{it}) and at the same time related to y_{it}. By doing so, the observed information contained in $C_{it}^{'}$ that determines the switch will remove correlation between y_{it} and D_{it}. This so-called selection by observables will eliminate any endogeneity of the switch coming from observable information (see further in Barnow *et al.* 1980; Heckman and Hotz, 1989; and Moffitt, 1996).

However, $E[u_{it} \mid X_{it}, D_{it}] \neq 0$ may still be different from zero if there are common unobservable factors that affect both D_{it} and u_{it}, in which case D_{it} is still endogenous. If there exists a component of the z_{it} vector that only determines D_{it}, then it may be used as an instrumental variable to correct the endogeneity of D_{it} (because it is correlated with D_{it} but not with the outcome y_{it}, except through D_{it}). This means that this component of z_{it} will not appear in (6.10), because it affects y_{it} only indirectly (Wooldridge 2002, pp.621); this is the part of the identification to overcome endogeneity stemming from the selection of unobservables and it can be tested only indirectly through an over-identification test.

6.4.3. The use of Instrumental Variables techniques

The literature does not critically address the issue that the interest-rate rule (6.1) is part of larger systems of equations (like IS-LM or New Keynesian models wherein the interest rate, expected inflation and output gap, at least, are endogenously determined). Yet it simply applies IV methods, instrumenting the potentially endogenous variables. From an intuitive point of view, since intermediate and final targets of policy enter the interest rule, we cannot claim that the right-hand side variables should be treated as exogenous. Moreover, we argued above in favour of the endogeneity of the switch to a new monetary regime, but the literature on the Taylor rules has not considered a model in which a switch has been introduced, let alone the switch being treated as potentially endogenous. Hence, our model needs to be estimated using IVs from both viewpoint – simultaneity and switch endogeneity. Moreover, since our economic model (6.1) is a dynamic model, it might appear that recently popular difference and system GMM approaches to dynamic panel analysis might be appropriate. However, this type of estimation is appropriate only for panels with a short time and a wide cross-section dimension (Baltagi, 2008). Since we have a narrow but long panel of 19 countries (N=19) and monthly data over 19 years (T=228), we refer to Nickell (1981) who derived an expression for the bias of the coefficient on the lagged dependent variable (ρ in [6.1]) when there are no exogenous regressors, showing that the bias approaches zero as T approaches infinity. Judson and Owen (1996) document that the bias ranges from 3% to 20% of the true value of the coefficient when T=30. Thus, given our large time dimension, standard IV estimators should not be invalidated by undue bias of the estimator of the lagged dependent variable.

We draw attention to an issue which is ignored in the empirical literature in this area: the difference between the standard IV estimator and the GMM estimator. The difference lies in the way of addressing heteroskedasticity, which is often present in empirical work. Baum *et al.* (2003) argue that the presence of heteroskedasticity does not affect the consistency of the IV-coefficient estimates, but that the estimates of the standard errors will be inconsistent and diagnostic tests invalid. A way to partially resolve this issue is to use heteroskedasticity-consistent ("robust") standard errors. Unfortunately, the Pagan-Hall (1983) test for detecting heteroskedasticity in IV estimation has not been developed for panel data. Hence, we rely on the advice of Stock and Watson (2006, p.166) that, when using the standard IV estimator:

> Economic theory rarely gives any reason to believe that the errors are homoskedastic. It therefore is prudent to assume that the errors might be heteroskedastic unless you have compelling reasons to believe otherwise. [...] If the homoskedasticity-only and heteroskedasticity-robust standard errors are the same, nothing is lost by using the heteroskedasticity-robust standard errors; if they differ, however, then you should use the more reliable ones that allow for heteroskedasticity. The simplest thing, then, is always to use the heteroskedasticity-robust standard errors.

However, it should be noted that this applies as long as the sample is large enough, which is arguably the case here.

A more advanced way of dealing with heteroskedasticity of unknown form is to use GMM, introduced by Hansen (1982). "Efficient GMM brings with it the advantage of consistency in the presence of arbitrary heteroskedasticity, but at a cost of possibly poor finite sample performance." (Baum *et al.* 2003, p.2). If heteroskedasticity is not present, the GMM estimator is asymptotically no worse than the IV estimator. However, the optimal weighting matrix in the GMM estimation is a function of fourth moments and obtaining reasonable estimates for these requires very large sample sizes. Hence, an efficient GMM estimator can have poor small-sample properties (Hayashi, 2000).

However, as we will see in Section 6.5, our estimates might suffer from weak identification. The problem of weak identification arises, even when the sample is large, when the correlation between the endogenous regressors and the excluded instruments is nonzero but small (Baum *et al.* 2007). Unfortunately, the Stock and Yogo (2005) test has critical values devised only up to three endogenous variables, making investigation of the problem more problematic in our case. However, not all estimators are equally affected by weak instruments. Hansen *et al.* (1996) proposed the continuous updating GMM estimator (CUE), whereby estimation of the covariance matrix of orthogonality conditions and of coefficients is done simultaneously, i.e. information is "continuously updated". The limited-information likelihood estimator (LIML) dates back to Anderson and Rubin (1949), but Davidson and MacKinnon (1993, p.644-649) derived it by solving an eigenvalue problem. Both CUE and LIML are argued to perform better in the presence of weak instruments (see: Baum *et al.* 2007). Hahn *et al.* (2004) offer some evidence in favour of this. A possible drawback of CUE could be that it requires numerical optimization[39]; on the other hand, LIML requires the strong assumption of normally distributed disturbances (Baum *et al.* 2007). Given this, in our estimations, CUE is preferred.

We conclude by addressing the issue of serial correlation. In order to take into account any serial correlation in the residual, we take a conservative approach to inference by reporting standard errors that are both heteroskedasticity-robust and autocorrelation-robust (known as HAC – heteroskedasticity and autocorrelation corrected - standard errors; Newey and West, 1987b). HAC estimates are calculated with the kernel function's bandwidth, which is set to one[40].

6.5. Empirical results I

Linking our economic model in equation (6.1) and our sample defined in Section 6.2.2, with our primary objective to discover if and how the reaction of the monetary policy has changed when regime switched (Section 6.4), the following estimable form of the model can be written:

$$\begin{aligned} r_{it} &= \beta_0 + \rho r_{it-1} + \beta_1 after + \beta_2 switch + \beta_3 after\_switch + \\ &+ \sum \gamma_i COVAR_{ijt} + \sum \eta_i COVAR_{ijt} * after + \sum \kappa_i COVAR_{ijt} * switch + \\ &+ \sum \vartheta_i COVAR_{ijt} * after\_switch + \alpha_i + \delta_t + u_{it} \end{aligned} \quad (6.11)$$

Whereby, r_{it} is the nominal reference interest rate; $after$ is a dummy variable equal to unity for the period after the date of the switch for switchers and after 2000 for the non-switchers[41], and zero otherwise; $switch$ is a time-invariant dummy variable equal to unity over the whole period for the countries in the sample that switched to IT (switchers) and zero otherwise. The period-dummy $after$ captures unobserved but

[39] Even with modern computers the processing time required for CUE estimations is considerable. For some of our specifications, Stata needed about four days per regression.

[40] Unfortunately, the optimal choice of the bandwidth by using the automatic bandwidth selection criterion of Newey and West (1994) is not provided under xtivreg2. However, setting the bandwidth to one has both an economic and a technical rationale: i) the interest rate is often decided at frequent intervals of two weeks, lending support to the idea that if autocorrelation exists in the model, it would be mostly first-order; ii) estimating the model with larger bandwidth caused computational difficulties.

[41] Recall our discussion in Section 6.2, whereby we take 2000 as the median year in which most switchers established IT.

systematic influences on the interest rate during the after period in the same way for both switchers and non-switchers. The presence of $switch$ by itself captures possible differences between switchers and non-switchers that are independent of the switch. $after$ and $switch$ control for period- and group-specific level effects on the interest rate, respectively. $after\_switch$ is a dummy variable equal to unity for those observations in the switching group after these countries switched to IT, and is the variable of primary interest: it identifies the difference to the interest rate associated with switching after controlling for both group-specific variations (*switch*) and period-specific variations (*after*). $COVAR_{ijt}$ consists of our covariates explained in Section 6.3: expected inflation, π_{it+n}; output gap, gap_{it}; and changes of the nominal exchange rate, Δer_{it}. The terms $COVAR_{ijt} * after; COVAR_{ijt} * switch$; and $COVAR_{ijt} * after\_switch$ multiply those covariates with $after; switch$; and $after\_switch$, respectively. ϑ_i s are the coefficients of interest which capture differences in monetary-policy reaction in the switchers after they switched, which in the presence of controls for both group-specific and period-specific variation identifies the effects of switching. η_i and κ_i are used as coefficients to control for period- and group-specific responses, respectively. The lagged interest rate is not interacted, since there are no intuitive grounds to claim that the way in which the authorities smooth the interest-rate path has to do with the regime in operation. δ_t s are annual time dummies, which are suggested as a way to remove the common influence of any global shocks from the errors (Sarafidis *et al.* 2009; Roodman 2008). Annual and not monthly dummies are used because of the large time dimension; these are not reported in the main tables, but in Section A4.3 in Appendix 4. α_i s are country-specific dummies, and u_{it} is the usual disturbance.

With the selection of observables that might have forced a switch (expected inflation, output gap and exchange-rate changes) one part of the endogeneity of the switching dummy $after\_switch$ was addressed. Yet, many authors (the most prominent being Clarida *et al.* 1998) argue that in the interest-rule itself these three variables are suspected to be endogenous and need instrumentation. Lagged values of the endogenous variables are used as instruments given this potential endogeneity. There is no established procedure for choosing the optimal instrument set, so we rely on a trial-and-error procedure that produces acceptable diagnostics (see Roodman 2008 and 2009 for a similar discussion in a dynamic-panel context). We use lags which vary from the third until the 24th lag, at a sequence of three lags. Such a pattern considerably improved the instruments tests and has an intuitive explanation that earlier time periods become more informative, given the monthly data (i.e information derived from two subsequent months is assumed not to be as informative as from two distant months in the year). In addition to this consideration, we do not use differenced values of the endogenous variables as instruments since, in our case, variables are already in some differenced form (inflation is the price difference; the output gap is the difference between actual and potential output; and the exchange rate is conventionally differenced) and their further differencing might neither produce acceptable diagnostics nor have plausible economic meaning.

Because of potential endogeneity arising from unobservables, $after\_switch$ will be instrumented by including variable(s) that do not enter the interest-rate rule per se, but might be important for the switch. For finding suitable instruments, we refer back to Section 4.3. It was explained there that the necessary preconditions for establishing IT are: an independent, transparent, accountable and technically-capable central bank; absence of fiscal dominance; and a sufficiently developed financial system. We believe these are suitable candidates for instruments for $after\_switch$, as nowhere in the literature, to the writer's knowledge, is it argued that they enter the Taylor-rule based model directly, i.e. they affect the interest rate only through $after\_switch$. However, while a measure of the financial-system development and fiscal dominance can be easily obtained (the most frequently used measure for the first being bank assets-to-GDP and credits-to-GDP; and for the second the amount of monetary financing of the public deficit-to-GDP), measures for central-bank independence are usually calculated on an annual basis and will thus lack variability. Hence, we proceed by addressing the selection of unobservables by adding the ratio of domestic credit-to-GDP and the central-bank claims on central government-to-GDP as instruments. In addition to these, we refer back to Section 5.3.3, where we discussed the role of euroization in the IT economies. Although we did not find arguments for euroization playing an important role under IT, it may still be the case that highly-euroized ERTers might be deterred from switching to IT, because a larger amount of bank assets would become exposed to exchange-rate risk. Hence the ratio of net-foreign assets of the banking sector to GDP is used as a third instrument for the switching variable.[42]

Table 6.2. reports the results of the basic switching FE regression. Note that in all tables reporting the SR estimates, the time dummies are only reported in the Appendix 4 due to space. Also note that because an FE regression is estimated, 'switch', as a time-invariant variable is dropped. This does not mean that 'switch' was not controlled for in the specifications (it is subsumed within the FE), but we were not able to obtain a separate estimate of its value.

First, both standard IV estimators (homoskedastic-only and HAC) and GMM are reported. We firstly compare the standard errors of the homoskedasticity-only (column 1) and HAC (column 2) IV estimators and conclude that there are notable differences, which leads us to conclude that heteroskedasticity and autocorrelation should be accounted for in making statistical inferences. Then, the GMM estimator is utilized whereby estimates and standard errors are robust to arbitrary heteroskedasticity and autocorrelation (column 3). In the Stock and Yogo (2005) test the critical values are devised only up to three endogenous variables, but we do have more than three endogenous variables in all cases, and these cannot be omitted, simply because we work with interactions, which are among our variables of interest. However, in all specifications we investigated, the weak identification test did not exceed an F-value of 5. The "rule of thumb" of 10 (Staiger and Stock, 1997) is thus never attained. Yet the critical values required to interpret the F-stat depend on the number of endogenous variables and instruments and also differ between estimators, and there is a lack of studies testing for weak instruments in the presence of non-i.i.d. errors (Stock and Yogo, 2005; Baum *et al.* 2007, p.24). Given the exposition in Section 6.4.3 on how the problem of weak instruments can be addressed, CUE is reported in columns (4) and (5) and LIML in column (6). Column (4) reports CUE for homoskedasticity only, while (5) reports HAC errors. We again observe notable differences and conclude that heteroskedasticity and autocorrelation should be accounted for. LIML estimates are efficient for homoskedasticity only, while CUE estimates are efficient for arbitrary

[42] There are arguments for including this variable in the main specification to explore the role of euroization under the two monetary strategies. We do this in the robustness checking in Table 6.4. However, we find there that the NFA-to-GDP is generally insignificant in explaining the interest rate (and, hence, has no significant role in monetary policy in the investigated countries), which supports our approach in using it as an instrument for correcting 'after-switch' endogeneity due to unobservables.

heteroskedasticity. Consequently, our preferred estimator is CUE (HAC errors), and henceforth our discussion and further robustness tests are based on it.

Table 6.2. Basic switching FE regression

Dependent variable: *Interest rate*		(1) IV homoskedasticity-only s.e.	(2) IV HAC s.e.	(3) GMM HAC s.e.	(4) CUE homoskedasticity-only s.e.	(5) CUE HAC s.e.	(6) LIML HAC s.e.
Interest rate (-1)		0.834***	0.834***	0.834***	0.839***	0.938***	0.839***
A	**Expected inflation**	0.057	0.057	0.057	0.042	-0.016	0.042
A	**Output gap**	0.076	0.076	0.076	0.081	0.071*	0.081
A	**Δ Nominal exchange rate**	0.041	0.041	0.041	0.051*	-0.033	0.051
After		-0.570	-0.570	-0.570	-0.644	-0.624*	-0.644
B	**Expected inflation_after**	-0.071**	-0.071	-0.071	-0.080*	0.085*	-0.080
B	**Output gap_after**	-0.063	-0.063	-0.063	0.064	-0.043	0.064
B	**Δ Nominal exchange rate_after**	-0.060**	-0.060	-0.060*	-0.071**	0.060*	-0.071
C	**Expected inflation_switch**	0.208*	0.208*	0.208***	0.242***	0.086	0.242**
C	**Output gap_switch**	-0.012	-0.012	-0.012	-0.009	0.041	-0.009
C	**Δ Nominal exchange rate_switch**	-0.037	-0.037	-0.037	-0.050	0.018	-0.050
After-switch		2.442***	2.442*	2.442***	2.901***	1.370***	2.901**
D	**Expected inflation_after_switch**	-0.279	-0.279*	-0.279**	-0.340***	-0.183***	-0.340**
D	**Output gap_after_switch**	-0.002*	-0.002	-0.002	-0.011	-0.063	-0.011
D	**Δ Nominal exchange rate_after_switch**	0.074*	0.074	0.074*	0.090**	-0.029	0.090
F-statistics H_0: All regressors are insignificant		**287.39*** **	**372.38*** **	**287.39*** **	**282.59*** **	**1094.82*** **	**357.22*** **
Under-identification test (p-value) H_0: Model is under-identified		**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Weak identification test (F-stat) H_0: Model is weakly identified		**3.764**	**3.822**	**3.764**	**3.764**	**3.822**	**3.822**
Hansen test (p-value) H_0: Instruments are valid		**0.344**	**0.134**	**0.344**	**0.364**	**0.225**	**0.170**
Endogeneity test for the switching (p-value) H_0: After_switch may be treated exogenous		**0.000**	**0.011**	**0.000**	**0.000**	**0.011**	**0.012**

Note: *,**,*** indicate 10, 5 and 1% of significance, respectively. The potentially endogenous variables are instrumented by their lags, varying from the third until the 24th lag at a sequence of three lags, given the monthly data. The potential endogeneity of the switching variable is addressed by using as instruments the domestic credit-to-GDP; central-bank claims on central government-to-GDP and net foreign assets in the banking system-to-GDP and their first lags; and is tested through the Wu-Hausman F-test version of the endogeneity test which is robust to various violations of conditional homoskedasticity. Reported over-identification test is Hansen *J* statistic. Reported under-identification test is Kleibergen and Paap's (2006) test. Reported weak identification test is Kleibergen-Paap rk Wald F statistics.

In all regressions the null that the model is under-specified can be rejected and the null that the instruments are valid (the over-identification test) cannot be rejected. Considering the possibility of weak identification within CUE, it is observed that coefficient magnitudes are largely similar to other estimation methods. The endogeneity test for the switching variable rejects the null of it being exogenous, which supports our approach of using instrumental estimation (Section 6.4.3). Note that given our specification, estimated coefficients approximate short-run relationships. However, these are the coefficients of interest, given that the monetary-policy reactions are of a short-run nature.

Given the complexity of the estimable model, in what follows we explain each panel of Table 6.2. Because of the issues related to weak identification discussed above, attention is focused on column (5) – CUE (HAC s.e.). A note on the lagged interest rate first: it has a very plausible magnitude, suggesting on a high smoothing, and is highly significant. Hence, it is doing a lot of explanation of the significance of the other coefficients. Without observing separate groups (panel A), we find that expected inflation and the change of the nominal exchange rate are insignificant at conventional levels, while the output gap is significant only at 10%. It suggests a very mild reaction of the central bank - an increase of output gap by 1 p.p. (economy overheating) leads to an increase of the nominal interest rate by 0.07 p.p.

Panels B and C of Table 6.2 control for the period- and group-specific effects, respectively. Recall that the 'after' dummy is equal to one for all countries after their official switch (for switchers) and after 2000 (for non-switchers), and zero otherwise. The coefficient in front of the 'after' dummy (Table 6.2, Column 5) suggests that in the later period interest rates have been, on average and other things equal, lower by 0.6 p.p. It could be that this is a reflection of the characteristic of this period - an increased growth and shock-free macroeconomic environment. The latter is also reflected in the time dummies – these are generally insignificant in the period before 2001 and generally significant with a negative sign in the period afterward, suggesting that the shock-free period added to the ease of monetary-policy conduct (see Section A4.3). However, the ceteris paribus effect is very strict here, given that we know that the average macroeconomic indicators changed between periods. The results suggest that in the "after" period, countries toughen monetary policy reaction to expected inflation and exchange rate changes, but these are significant only at the 10% level.

What is of importance here is the case when the estimated monetary-policy responses in the switchers during the period under IT are considered. Recall that the 'after-switch' dummy is equal to one for switchers after they switched to IT, and zero otherwise. The coefficient on the combined intercept dummy for switchers in the period after the switch (which is the summed coefficient of 'after' and 'after-switch' dummies in Table 6.2) suggests that interest rates in switchers have been, on average and other things equal, higher by 0.75 p.p. (p=0.0237) (given the caution regarding the strictness of the ceteris paribus principle here). The policy-reaction coefficients are with negative signs and suggest that switchers, after they switched to IT, were able to moderate their reactions to macroeconomic developments. However, only expected inflation is statistically significant (at the 1% level) in affecting interest rates: an increase of expected inflation by 1 p.p. leads to a lower change in the nominal interest rate - by 0.18 p.p. - as compared to the period before and to the control group of countries. Also, the Wald test (not shown but available on request) suggests that the expected inflation coefficient in the switchers is systematically different from the period before and from the control group. Consequently, these results suggest that IT represented a real switch in the investigated countries. Under IT, the results suggest that these countries became more concerned in combating inflation (given its statistical significance), but their reaction moderated compared to the period before and to the control group (given the change in the interest rate). Still, the price they paid for this is the higher level of interest rates, as compared to the period before and to the control group (as suggested by the intercept dummy). Although the coefficients on the output gap and the change in the exchange rate seem plausible and also suggest moderation in the policy reaction, they remain neither significant nor systematically different from the period before and from the control group. This suggests that these countries were concerned with inflation and the accompanying inflation expectations only and not the output gap and exchange rate, i.e. that they ran a monetary policy geared towards strict IT. This can be reconciled with reality: many of these countries had suffered periods of high inflation in the past (and this is the primary reason why they established ERT in the former period), so that even after they switched to IT, inflation remained their primary focus. This can be also reconciled with the observation in Section 5.2.1 that inflation should remain the main focus of IT policymakers until credibility is acquired, which is particularly the case in developing economies. On the other hand, the insignificance of the exchange rate might be a result of the relaxation of the exchange rate constraint (the price of which was the higher level of interest rates, picked up by 'after-switch' dummy), but it runs counter to the discussion of the role of the exchange rate in small, open ITers (Sections 5.2 and 5.3).

Overall, the conclusion runs counter to the idea that monetary policy has not undergone any change in the 2000s. Having taken controlled for the relatively shock-free nature of this period, the estimates suggest that a switch to inflation targeting had an effect. Also, the results run counter to the usual statement in the literature that central banks under IT react strongly to inflation deviations from the target - compared to the period before and to the control group, these reactions moderate under IT. Taken together, a potential reason is that interest rates were maintained at a higher level than would otherwise have been the case. On the other hand, no statistical significance was established for the output and the exchange rate, suggesting that these countries ran policy geared toward strict IT; i.e. policy was not accounting for real-economy developments. Also, the significance of the expected inflation effect in the switchers after they switched, might suggest that the switch could be more thought of as a switch toward more independent monetary policy, which afforded a space to account for domestic objectives. However, this is yet very limited evidence, given the insignificance of the reaction to the output gap. This modelling approach, unfortunately, does not facilitate checking if the overall variability and uncertainty (i.e. the way expectations are anchored) in the economy changed with the switch to IT.

6.6. Further discussion on the switching regression

6.6.1. Robustness tests

The general conclusion of the above discussion is that the switch to IT was a real switch to a newly-designed monetary policy, focused on inflation. Here, some robustness checks are performed, to test the stability of these results; CUE (HAC s.e.) only is used. Results are presented in Table 6.3 and Table 6.4 in the same way as in Table 6.2. In Table 6.3, three kinds of robustness check are done: i) dropping the 'after' and 'switch' intercept and slope dummies; ii) allow for the switching variable to be exogenous; and iii) reducing the sample size.

Using both intercept and slope dummies is often associated with multi-collinearity and hence, unstable estimates, as the model specification and sample is changed. To investigate this, the 'after' and 'switch' slope dummies are dropped in column 1. All diagnostics seem acceptable, including the weak identification test, given our earlier discussion. The estimated coefficients in the 'quadrant' of interest again suggest moderation of the policy responses under IT, but the output gap, while having similar magnitude as in the base regression Table 6.2), now is statistically significant at the 1% level. This might lend some support to the notion that the investigated countries were not 'inflation nutters', but rather that their policymaking afforded some space for pursuing real objectives.

Columns (2) and (3) of Table 6.3 treat the switching dummy as being exogenous, the difference being that the latter column has a gap-period implemented. The gap period refers to exclusion of the period around the official switch to IT: this is done in order to avoid the potential endogeneity of the switch. We allow a gap period of three years, symmetrically shared around the switch. Arguably this gives sufficient time to capture any macro-performance that might have forced a switch (pre-switch) and/or period when IT was declared but not (fully) adhered to (post-switch). The results (column 2) are insignificant for the quadrant of interest and the exogeneity of the switching variable is rejected, which renders the specification questionable and supports our approach in dealing with the potential endogeneity of the switch followed above. When the gap-period is included (column 3), we note that the estimated response coefficients of the central bank switch sign, but are insignificant at conventional levels[43]. Also, the appropriate test cannot reject the null of exogeneity, which is expected, given that the period around the switch is ruled out of the estimation. A feature of this specification is that the 'after' dummy becomes positive, but insignificant, while the summed coefficient in front of the after-switch dummy ('after' + 'after-switch') is still positive, but its magnitude is lower than in the other specifications (0.35 p.p.) and is statistically insignificant (p=0.3253). This might suggest that the period around the switch is very important in terms of macroeconomic developments, and although this specification (column 3) supports acknowledging switch endogeneity in the other specifications, it still excludes this important period.

In column (4) the sample size is cut to 15 countries: Chile, Israel, Poland and Colombia are excluded from the switchers group, given the concern raised in Section

[43] As a further check, the gap period was shortened to two years and extended to five years, but the conclusions remained largely the same.

6.2.2 - although an official exchange-rate target was announced, the de-facto behaviour of the exchange rate remained considerably lax. Estimates are robust to reducing the sample size (compared to column 5 of Table 6.2); the output-gap effect is of similar magnitude, but in this specification is significant only at the 10% level.

Table 6.3. Robustness checks of the switching FE regression (CUE [HAC s.e.]) I

	Dependent variable: *Interest rate*	(1) Interactions with after-switch only	(2) After-switch – exogenous	(3) After-switch – gap-period	(4) Sample size
	Interest rate (-1)	0.812***	0.986***	0.997***	0.948***
A	**Expected inflation**	0.193***	0.048	0.072	0.006
A	**Output gap**	0.067***	0.107***	0.141***	0.041
A	**Δ Nominal exchange rate**	0.013	-0.031	0.043	0.006
	After	-1.404***	-0.349	0.402	-0.262*
B	**Expected inflation_after**		-0.011	-0.093	0.028
B	**Output gap_after**		-0.082*	-0.139***	-0.017
B	**Δ Nominal exchange rate_after**		0.041*	-0.057	0.016
C	**Expected inflation_switch**		-0.011	-0.08	0.075**
C	**Output gap_switch**		0.042	-0.048	0.058
C	**Δ Nominal exchange rate_switch**		0.016	-0.023	-0.035
	After-switch	2.930***	0.495	-0.053	0.598**
D	**Expected inflation_after_switch**	-0.163***	-0.038	0.084	-0.128***
D	**Output gap_after_switch**	-0.060***	-0.058	0.049	-0.077*
D	**Δ Nominal exchange rate_after_switch**	0.013	-0.013	0.050	0.029
	F-statistics	**949.68*** **	**259.68*** **	**956.48*** **	**1360.73*** **
	Under-identification test (p-value) H_0: Model is under-identified	**0.000**	**0.000**	**0.000**	**0.000**
	Weak identification test (F-stat) H_0: Model is weakly identified	**3.747**	**3.623**	**1.801**	**3.766**
	Hansen test (p-value) H_0: Instruments are valid	**0.673**	**0.288**	**0.151**	**0.115**
	Endogeneity test for the switching (p-value) H_0: After_switch may be treated exogenous	**0.003**			**0.109**
	C-statistic for the switching (p-value) H_0: After_switch may be treated exogenous		**0.001**	**0.372**	

Note: *,**,*** indicate 10, 5 and 1% of significance, respectively. See notes on diagnostic tests in Table 6.2.

The C statistic (also known as difference-in-Sargan statistic) allows a test of a subset of the orthogonality conditions; i.e. of the exogeneity of one or more instruments. It is defined as the difference of the Sargan-Hansen statistic of the equation with the smaller set of instruments and the equation with the full set of instruments, i.e. including the instruments whose validity is suspect. Under the null hypothesis, both the smaller set of instruments and the additional, suspect instruments are valid.

In Table 6.4 robustness testing is further pursued by considering possible additional variables. Firstly, we check if the interest rule has a backward-looking component; in column (1) the 12^{th} lag of inflation and the interactions are added; since these are lagged values, they enter as exogenous in the regression. Lagged inflation is insignificant in all groups, suggesting that the forward-looking specification of the interest rule might be more appropriate. The remaining coefficients remain stable. Column (2) explores the potential role of euroization in the economy. Euroization is insignificant in all groups; hence, it is in line with the discussion in Section 5.3.4 and lends justification for its usage as an excluded instrument in the previous regressions. Other coefficients remain stable.

Column (3) includes reserves. They are significant throughout the sample, suggesting that they play a strong role for these small, open economies. Estimated coefficients of other variables are of comparable magnitude as in our basic specification. An exception is the expected inflation in the 'after-switch' group, which is insignificant and has an unexpected sign, but the output gap is significant at the 10% level. Given an exchange rate peg in a major part of the sample, the pressure on the foreign exchange market cannot be fully felt on the nominal exchange rate but reserves should capture this effect. The positive sign could be unexpected, though, it is expected that growing reserves will leave more space for an easier monetary policy. However, it might be that the central bank, in such conditions, sterilizes money inflow from abroad (fearing inflation) and hence the interest rate increases. In the switchers after they switched, the response to reserve changes moderates.

Money growth is added in column (4) and is significant at 5%, except in the base group. An increase of money in the economy increases interest rates in the 'after' and switching group, but, in line with the overall conclusion above, the reaction in the 'after-switch' group moderates. Its inclusion in the regression does not change the remaining coefficients and conclusions remain largely the same.

247

Table 6.4. Robustness checks of the switching FE regression (CUE [HAC s.e.]) II

	Dependent variable: Interest rate	Added variables			
		Lagged inflation (1)	|NFA| to GDP (2)	Reserves growth (3)	Money growth (4)
	Interest rate (-1)	0.964***	0.912***	0.970***	0.962***
A	**Expected inflation**	0.052	-0.014	0.167***	0.025
A	**Output gap**	0.084**	0.054	0.089***	0.069
A	**Δ Nominal exchange rate**	-0.031	-0.058**	-0.001	-0.111**
A	***Added variable***	-1.881	-0.006	0.039***	-0.072
	After	-0.655	-0.622	-1.391	-2.567***
B	**Expected inflation_after**	0.016	0.118**	-0.151***	0.023
B	**Output gap_after**	-0.056	-0.029	-0.059**	-0.047
B	**Δ Nominal exchange rate_after**	0.049	0.106***	0.016	0.127**
B	***Added variable* _after**	2.894	0.014	0.044***	0.077**
C	**Expected inflation_switch**	0.047	0.094	-0.127*	0.003
C	**Output gap_switch**	0.038	0.045	0.130***	0.041
C	**Δ Nominal exchange rate_switch**	0.012	0.048*	0.023	0.105**
C	***Added variable* _switch**	-0.019	0.012	0.040***	0.082**
	After-switch	1.508***	1.649*	1.992***	3.242***
D	**Expected inflation_after_switch**	-0.176**	-0.211***	0.031	-0.050
D	**Output gap_after_switch**	-0.061	-0.062	-0.144***	-0.057
D	**Δ Nominal exchange rate_after_switch**	-0.015	-0.082**	-0.026	-0.104**
D	***Added variable* _after_switch**	-0.021	-0.024	-0.047***	-0.072**
	F-statistics	**932.92*** **	**752.99*** **	**1244.07*** **	**1099.59*** **
	Under-identification test (p-value) H_0: Model is under-identified	**0.000**	**0.000**	**0.000**	**0.000**
	Weak identification test (F-stat) H_0: Model is weakly identified	**3.504**	**3.344**	**3.208**	**3.599**
	Hansen test (p-value) H_0: After_switch may be treated exogenous	**0.250**	**0.103**	**0.290**	**0.440**
	Endogeneity test for the switching (p-value) H_0: After_switch may be treated exogenous	**0.013**	**0.006**	**0.009**	**0.082**

Note: *,**,*** indicate 10, 5 and 1% of significance, respectively. See notes on diagnostic tests in Table 6.2.

Overall, with the basic specification and the robustness checks, the conclusions are: i) there is supporting evidence that the switch to IT represented a real switch in the investigated countries, i.e. that monetary policy is responsible for the changing results in the 'after' period; ii) central bankers in the 'after-switch' react to expected inflation, but the reaction moderates in comparison to the control group and the period before; however, the latter happens against the background of higher interest rates, which might be a reflection of the determination to master inflation, *per se*; iii) although, in general, we concluded that these countries embarked on a policy geared towards strict IT (i.e. without considering output fluctuations), still there was limited evidence in some of the regressions that real fluctuations were taken into account and suggested that the reaction there moderated as well, but this finding is far from being robust; and iv) the exchange rate remained largely insignificant in affecting monetary-policy conduct.

6.6.2. A critique

Designed in this way, the switching regression suffers some drawbacks; three are discussed here; the last two are important for the further investigation. Firstly, some shortcomings are associated with the use of the FE estimator. Namely, it precluded the 'classic' natural experiment identification strategy, i.e. a comparison of 'before' and 'after' effects in both 'switch' and 'non-switch' groups. This cannot be done in FE estimation, because the four dummy variables, each representing one of the four 'quadrants' sum to an overall constant, as do the country fixed effects. Similar to this limitation, in our estimation, the 'switch' dummy, as time-invariant variable, cannot be included, given that it is a fixed effect. However, this does not mean that 'switch' was not controlled for in the specifications, but we were not able to obtain a separate estimate of its value. However, interactions of 'switch' with the covariates were possible.

Secondly, the technique was originally designed to capture a switch with exogenous variation. However, we argued and provided statistical evidence that the switch to IT should be treated as endogenous. This was resolved by addressing both endogeneity stemming from the selection of observables and of unobservables. The overidentifying restrictions on the switching variable were tested and suggested it being endogenous. This is not a problematic approach if countries that experienced increased inflation volatility and exchange-rate pressures ultimately abandoned the existing regime and explicitly embarked on another. However, a potential problem is that some of the countries might have started to target the medium-term inflation well before they officially introduced it (like Israel); or, the opposite, they officially introduced it but continued to tightly target the exchange rate for some intermediate period (like Hungary). The SR approach cannot capture this variety of potential developments.

Thirdly, this approach enables intercept and slope switches, but not variance switches. This cannot facilitate the need to observe if and how the monetary environment under IT changed; i.e. if, under IT, the economy achieved both lower inflation- and output variance (recall our discussion in Section 5.2.1). To address the second and the third drawback, we proceed with an alternative modelling strategy, which is described as the chapter proceeds.

6.7. Method II

6.7.1. Nonlinear switching regression

Given above drawbacks of the SR approach, other methods are available in the literature designed to capture the sources of non-linearities in the data. The last two decades marked a substantial increase in the application of non-linear methods to macroeconomic and financial data. These are largely classified into two broad areas: threshold autoregressive (hereafter TAR) and Markov-switching (hereafter MS) methods. The application of the regime-switching methods has been particularly common in analysing economic cycles (e.g. Garcia, 1998, Kim *et al,* 2008); stock markets (Ang and Bekaert, 2002b; Dai *et al.* 2007) and interest rates (Ang and Bekaert, 2002a; Garcia and Perron, 1996). However, no study, to our knowledge, uses those methods to analyse monetary policy in a context of monetary-regime switch.

The threshold autoregression models the behaviour of a variable in a relation to a threshold value (Tong, 1983; Potter, 2002). Originally, this class of methods was proposed by Tong (1978) and further developed by Tong and Lim (1980) and Tong (1983). The value that changes (the interest rate, in our case) depending on the values of an independent variable (say, inflation) is within the space of the threshold variable (which could also be inflation) but not linear in time. When the threshold variable is taken as a lagged value of the time-series itself, the method is known as a self-exciting threshold autoregressive (SETAR) method (Tong, 1993; Hansen, 1996; 1997; 2000). Designed in this way, the TAR method crucially depends on two factors: i) the choice of the threshold variable; and ii) the information about the official switch. Although some of our right-hand-side variables might be good candidates for a threshold variable, and although the official date of the switch to IT is known, our understanding is that the approach to the problem is similar to the SR approach (Section 6.4), which is not helpful given its potential drawbacks in light of our research question (as discussed in section 6.6.2).

In contrast to the TAR approach (and apparently to the SR approach), the structural break in the MS approach is the outcome of an unobserved, discrete, random variable, which is assumed to follow a Markov process[44] (Goldfeld and Quandt, 1973;

[44] A Markov process is a stochastic process in which only the present value of the variable is relevant to predict its future behaviour, i.e. its past values and the way in which the present value has emerged from the past are irrelevant. Hence, Markov processes are not path-dependent.

Cosslett and Lee, 1985; Hamilton, 1989). This strand of the literature was steered by the seminal contributions of Hamilton (1989; 1994), although the work was motivated by the earlier contribution of Goldfeld and Quandt (1973). Textbook exposition of the MS models can be found in Maddala and Kim (1998); Brooks (2002); and Doornik and Hendry (2009). Hamilton's (1989) model explores the quarterly percentage change in US real GNP from 1953 to 1984 as a function of its own lagged values in the previous four quarters and allows the conditional mean to switch between two states: expansion and recession. Since this seminal contribution, a growing literature on regime switching in applied macroeconomic time-series analysis has emerged (Cecchetti *et al.* 1990; Diebold and Rudebusch, 1996; Garcia and Perron, 1996; Ravn and Sola, 1995; Sola and Driffill, 1994; and so on). However, these applications are still largely limited to business-cycle analysis. A small part of the literature (Ang and Bekaert, 2002b; Vasquez, 2004; 2008; Sims and Zha, 2006; Valente, 2003) analyses monetary policy, but frequently tries to capture different styles of monetary policy under different central-bank governors. Also, all these studies are limited to developed countries.

What advantages would the MS approach have over the SR approach? Although we have reviewed in Chapter 5 and obtained in Section 6.6 some evidence in favour of IT, still our discussion there and in Ball and Sheridan (2003) poses the contra-argument that this evidence is still open to the identification-strategy problem (i.e. how good a comparative group is the control group; Sections 5.2.3, 5.3.4 and 6.2.2). Moreover, Creel and Hubert (2009) point out that contrary to SR and TAR methods, MS methods will circumvent the task of predefining a switch or a threshold and will simply reveal if and when different regimes occurred in the switching economies. Moreover, letting data speak freely will address our earlier concern (Section 6.6.2) that investigating the presence of distinct regimes, rather than assuming a strict break, would enable us to check if anti-inflation policies existed in the past (i.e. authorities might have started to target medium-term inflation before they officially announced a switch) or if the exchange-rate target was not fully abandoned even after the official switch to IT (i.e. authorities continued to target the exchange rate for a certain period after they officially switched). Finally, by allowing for the variance in the regression to differ in both regimes, MS methods allow for investigation of whether the stability of the economic environment changed due to monetary policy. Given that this method will potentially overcome our concerns within Section 6.6.2, we proceed with an MS framework, which is further explained in the next subsection.

6.7.2. Designing a Markov-switching regression

In an MS regression, explanatory power is assigned to the existence of a few "states" (regimes) among which the economy shifts:

$$y_t - \mu_{S_t} = \sum_{i=1}^{4} \varphi_i (y_{t-i} - \mu_{S_{t-i}}) + \varepsilon_t; \qquad (6.12)$$

where y_t is a univariate time series to be explained; s_t is a latent dummy variable taking the value of 0 or 1 and representing two states in which the economy could fit; and ε_t is Gaussian white noise ($\varepsilon_t \mid S_t \approx NID(0, \Sigma(S_t))$; Hamilton, 1989). μ is a mean term conditional upon the state in which the economy belongs; the state is assumed to be unobservable and has to be inferred from the data. In his work, Hamilton (1989) sets the autoregressive order equal to four. In cases where the null of $\mu = 0$ cannot be rejected, only one state governs the process and this could be represented by the standard AR(4) model.

To complete the description of the dynamics of (6.12), we need to define a probability rule of how y_t changes between regimes. A Markov chain is the simplest time-series method for a discrete-valued random variable, such as the regime variable s_t. s_t is assumed to follow an ergodic[45] first-order Markov process (and is, hence, serially correlated) and is characterised by the matrix Π, consisting of the transition probabilities p_{ij} from state *i* to state *j*:

$$\Pi = \begin{bmatrix} p_{11}\ p_{21} \cdots p_{N1} \\ p_{12}\ p_{22} \cdots p_{N2} \\ . \quad . \quad \ldots\ . \\ p_{1N}\ p_{2N} \cdots p_{NN} \end{bmatrix} \qquad (6.13)$$

$$p_{ij} = p(S_t = j \mid S_{t-1} = i, S_{t-2} = k, \ldots.) = p(S_t = j \mid S_{t-1} = i)$$
$$\sum_{j=1}^{N} p_{ij} = 1; i = 1,2,3 \ldots. N; 0 \le p_{ij} \le 1$$

[45] Similarly, a stochastic process is said to be ergodic if no sample helps meaningfully to predict values that are very far away in time from that sample. Another way to say that is that the time path of the stochastic process is not sensitive to initial conditions.

For a two-regime state-space, transition probabilities can be expressed as follows:

$$\begin{aligned} p[S_t = 0 \mid S_{t-1} = 0] &= p \\ p[S_t = 1 \mid S_{t-1} = 0] &= 1 - p \\ p[S_t = 1 \mid S_{t-1} = 1] &= q \\ p[S_t = 0 \mid S_{t-1} = 1] &= 1 - q \end{aligned} \tag{6.14}$$

whereby the probability that the economy has been in regime 0 and will stay in the same regime is p; the probability that it was in regime 0, but it is now in regime 1 is 1-p, and so on. With these transition probabilities the regime switch is dependent only on the state before the switch, while the expected duration of each regime is constant (Misas and Ramirez, 2007; Kim *et al.* 2008). In other words, Hamilton's (1989) approach does not require any prior information to characterize the current state of the economic series (see also in Medeiros and Sobral, 2008; Moolman, 2004). Hence, the evolution of the regime switch occurs exogenously. However, this specification appears very restrictive in the description of regime-changes.

6.7.3. Endogeneity in a Markov-switching regression

As argued above, Hamilton's (1989) model is a univariate framework that assumes regime shift being exogenous to all realizations of the regression disturbance. Since Hamilton (1989), many applications used MS models that included additional explanatory variables (see Maddala and Kim, 1998, pp.463-465, for a review). In these, though: i) independent variables, as in every other form of regression, might be endogenous; and ii) the switch might evolve endogenously. However, neither source of endogeneity in the MS regression was resolved until Krolzig (1998) developed the MS methods in the area of vector auto-regressions (hereafter MS-VAR; see Krolzig, 1998; Krolzig and Toro, 1999). These are standard VAR models, whereby some or all of the parameters are allowed to switch when regime changes. In its most general form, the MS-VAR process has the following form:

$$y_t = \nu(S_t) + \sum_{i=1}^{p} A_i(S_t) y_{t-i} + \varepsilon_t; \tag{6.15}$$

where $y_t = (y_{1t},......., y_{nt})$ is an n-dimensional transposed vector of n endogenous variables, ν is the vector of intercepts, $A_1,...., A_p$ are the matrices with the autoregressive parameters and ε_t is the white noise vector process ($\varepsilon_t \mid S_t \approx NID(0, \Sigma(S_t))$) and all can be dependant on the switching variable S_t. Hence, MS-VARs appear in a variety of specifications, whereby different facets are allowed to be regime-dependent; Krolzig (1998) gives an overview, which is reproduced here, for convenience:

Table 6.5. Types of Markov-switching models

Notation	μ	ν	Σ	A_i
	mean	***Intercept***	***variance***	***AR parameters***
MSM(M)-VAR(p)	varying	-	invariant	invariant
MSMH(M)-VAR(p)	varying	-	varying	invariant
MSI(M)-VAR(p)	-	Varying	invariant	invariant
MSIH(M)-VAR(p)	-	Varying	varying	invariant
MSIAH(M)-VAR(p)	-	Varying	varying	varying

Legend: MS-Markov-switching; M-mean; (M)-number of states/regimes; (p)-order of VAR (number of lags); I-intercept; H-heteroskedasticity; A-autoregressive terms.

Source: Krolzig (1998)

Since MS-VARs represent a system of equations whereby each potentially endogenous variable is regressed on all other potentially endogenous and exogenous variable subject to switch, the first source of endogeneity in the MS regression is addressed. In turn, the switch, the second aspect of endogeneity in an MS regression, could be endogenous to one or more of:

i) observed variables, like inflation or exchange rate;

ii) unobserved variables, like macroeconomic shocks to the VAR that correlate to the monetary regime in operation (Kim *et al.* 2008); and

iii) the duration of the regime in operation (Durland and McCurdy, 1994).

By allowing the potential determinants of the switch to interact in a dynamic framework, the issue discussed in Section 6.4.2, of endogeneity arising from the selection of observables is addressed. However, given that transition probabilities are constant, one still might be concerned about switch endogeneity stemming from unobservables. The literature approaches this issue in a similar fashion as in the SR approach: transition probabilities can be allowed to change, depending on the value of a variable that does not enter the system, but might be correlated with the latent switch. Filardo (1994) and Diebold *et al.* (1999) argue that an MS model whereby economic fundamentals are allowed to affect transition probabilities can recognize systematic changes in them before and after switching; capture more complex temporal persistence and allow expected duration to vary across time. Hence, allowing for time-varying transition probability (TVTP) will capture some of the remaining endogeneity, if any, from the switching variable. Unfortunately, at present: i) the MSVAR package does not allow for TVTP and advanced programming knowledge is needed for another program; and ii) MS-VARs with TVTP do not allow duration-dependence, which suggests that being able to account for all potential source of endogeneity in a single MS model awaits further theoretical advance(s). Given this, the possible presence of remaining switch endogeneity could be checked only indirectly, by observing whether transition probabilities change when the MS-VAR specification changes. Namely, Vázquez (2008) argues that there would be a cause for concern if estimated probabilities differ under alternative MS-VAR specifications - that is, the switching variable would be exhibiting endogeneity stemming from unobservables if the smoothed probabilities depended on the MS-VAR specification.

We need guidance on how large the bias can be if endogeneity remains in the switching variable. Kim *et al.* (2008) performed a Monte Carlo analysis to check for the bias. Their results suggest that there is a bias in the estimated coefficients under the first regime and in the obtained regimes' volatility, but that the bias is lower for larger transition probabilities and for lower correlation of the switching variable with the economic fundamentals. For illustration, we specifically refer here to Kim *et al.*'s (2008) results related to the characteristics of our case – T=200 and high persistence, p_{11}=0.9 and p_{22}=0.9. First, they obtained that allowing for TVTP when the true switching is exogenous does not yield any efficiency gain. When the true switching process is endogenous, though, the estimated coefficients in the first regime are found to be upwardly biased by 6% to 11% for the case when the correlation between the switch and the economic fundamentals is moderate, 0.5; and by 10% to 20% for the case when the correlation is high, 0.9. Estimated coefficients in the second regime are found to be unbiased. Regimes' volatilities are found to be downward biased by 3% (for moderate correlation, 0.5) and by 6% (for high correlation, 0.9).

In the empirical comparisons, these findings were roughly confirmed. Some are given here for illustration. In Turner *et al.*'s (1989) model of equity returns, volatilities' bias was found between 0% and 1.4%, but the largest bias was documented for the coefficient measuring the volatility feedback - one third smaller when endogeneity is allowed than when it is ignored. Correlation was estimated to be modest, -0.4 and different from zero only at the 10% level. Misas and Ramirez (2007) estimated a MS regression for economic growth in Colombia. Under a very high correlation of 0.98, the bias found for volatilities was again very low and ranged from 1.5% to 3.3%, but the bias for the means increased from 0.7% up to one fifth of the value when endogeneity was accounted for. However, no evidence was provided if these means were statistically different from zero or comparatives for the estimated coefficients. Cerra and Saxena (2002) evaluated the relative merits of fundamentals versus contagion in determining financial crisis in Indonesia in the late 1990s, via MS methods. They obtained a bias of 15.3% for the mean; 2.4% for the variance; and 24% for the only significant coefficient. Chen (2006) used an MS specification of the nominal exchange rate to investigate its nexus with the interest rate for six developing countries. The bias ranged from 2.7 to 8.3% for the means and from 0.5% to 12.6% for variances (although statistically insignificant). However, this paper also does not provide evidence on whether TVTP models are preferred (i.e. if the correlation mentioned above is different from zero). Overall, identified biases in the empirical investigations are in line with Kim *et al.*'s (2008) Monte Carlo simulation and, although not negligible, they are argued not to be of such a magnitude as to affect the qualitative interpretation of results or any corresponding policy implications.

In relation to the possibility that a regime's duration can itself inflict a switch and hence be a source of endogeneity, it was argued in Chapter 2 that longer pegs could be detrimental to output volatility, especially in times of large shocks. In Chapter 3, some evidence was provided suggesting that pegs longer than five years transmit real shocks larger than 7% onto output volatility and can lead to crisis and, thus, to a peg exit. Hence, the exit of a peg might be duration-dependent, i.e. it is reasonable to believe that the probability of peg exit is not the same at the very beginning of the phase as after several years. However, no such argumentation, practical or quantitative evidence exists for IT, at least not yet. Given this, the switch to a new monetary strategy might evolve endogenously because of duration.

Krolzig's models cannot possibly capture this source of endogeneity. In order to face this limitation, Durland and McCurdy (1994) introduced the duration-dependent MS autoregression, designing an alternative filter for the latent switching variable. Pelagatti (2003; 2008) generalized the model in a multivariate framework – the duration-dependent MS-VAR (DD-MS-VAR). He applied his model to the US business cycle (Pelagatti, 2002; 2008) and found it being sufficiently capable of discerning recession and expansions. Pelagatti's (2003) model has the usual MSM-VAR specification (see

Table 6.5), whereby in order the switch variable S_t to become duration dependence, a Markov chain is built for the pair $(S_t;D_t)$, D_t being regime duration, defined as follows:

$$D_t = \begin{cases} D_{t-1}+1 & \text{if } S_t = S_{t-1} \\ 1 & \text{if } S_t \neq S_{t-1} \end{cases} \quad (6.16)$$

A maximum value for the duration variable D_t must be fixed so that the Markov chain $(S_t;D_t)$ is defined in a finite state space. Then, a transition matrix of the Markov chain S_t is defined; given that it is rather sparse, a more parsimonious probit specification of S_t is used. Pelagatti's contribution consists in the introduction of the multi-move Gibbs sampler to estimate the model. However, given that we use Pelagatti's model only at the margin in this exposition, for a more technical exposition we refer to Pelagatti (2003; 2005). Moreover, the DD-MS-VAR has the shortcoming that only the mean can switch between two regimes; however, with these attributes, it has been sufficient to analyse business cycles (Durland and McCurdy, 1994; Lam, 2004); here, it will be used only as an additional indirect vehicle to check for remaining endogeneity in the switching variable due to duration.

Designed in this manner, the MS-VAR approach includes all the 'time-series' features of the switching regression (Section 6.4) and is designed to overcome the identified drawbacks (Section 6.6.2). Although powerful, Krolzig's MS-VAR suffers some potential shortcomings. First, a great disadvantage of it, at present, seems to be the apparently non-comprehensive approach to dealing with switch endogeneity. By allowing a multivariate framework and, thus, by allowing potential determinants of the switch to enter the MS regression, MS-VAR can address one part of switch endogeneity – coming from observables. However, the potential endogeneity stemming from unobservables or from regime duration is not directly addressed at present. Vázquez (2008) and Pelagatti (2003) offered indirect ways to check for these, although Pelagatti's model has its own shortcomings. Secondly, many variables (and many lags) cannot be included in the MS-VAR, because computation becomes cumbersome and frequently the system does not converge. A not-so-recent literature (Asea, 1996; Asea and Bloomberg, 1998) proposed a Markov-switching panel (MSP) model. Yet, since that time, this type of MS model has not evoked much interest nor has it been further advanced. Because of this, the current stage of MSP undergoes, at least, two main shortcomings: i) it potentially suffers from not addressing the possible cross-sectional dependence among units, which is a considerably debated issue in recent years in a panel context; and ii) it does not advance the issue for the switch being endogenous more than MS-VAR nor does it allow for endogenous regressors. These considerations render estimation of MSP inappropriate for our case. Finally, as compared to the SR approach, the MS-VAR has the disadvantage that results have only time comparability and not group comparability, which was apparently an advantage of the former.

6.7.4. Solving algorithm

To solve an MS-VAR model, an algorithm consisting of two steps is used: expectation and maximization. The expectation-maximization (EM) algorithm (Dempster *et al.* 1977) is an efficient iterative procedure to compute the Maximum Likelihood (ML) estimate of model parameters in the presence of an unobserved latent variable. In ML estimation, we wish to estimate the model parameter(s) for which the observed data are the most likely. Each iteration of the EM algorithm consists of two processes: The E-step, and the M-step. In the E-step, the latent variable is estimated given the observed variables and the current estimate of the model parameters. This is achieved using the expectation, conditional on the entire sample of observations. In the M-step, the likelihood function is maximized under the assumption that the latent variable is known. The estimate of the latent variable from the E-step is used in place of the actual latent variable. These parameter-estimates are then used to determine the distribution of the latent variables in the next E-step. Convergence is assured since the algorithm is guaranteed to increase the likelihood at each iteration.[46]

[46] A technical exposition on the EM algorithm is given in Borman (2009).

6.8. Empirical results and discussion II

6.8.1. Basic findings

In order to proceed with estimating an MS-VAR model, our economic model (6.1) needs to be defined in a reduced vector-autoregressive form, as follows:

$$y_t = \nu(S_t) + \sum_{i=1}^{p} A_i(S_t) y_{t-i} + \sum_{i=0}^{p} B_i(S_t) x_{t-i} + \varepsilon_t ; \qquad (6.17)$$

where y_t is our four-dimensional vector comprised of: nominal interest rate, r_t; inflation, π_t; output gap, gap_t; and changes of the nominal exchange rate, Δer_t; x_t is a vector of exogenous variables which could enter contemporaneously or with a lag, but is not mandatory; ν is the vector of intercepts, $A_1,....,A_p$ and $B_0,....,B_p$ are the matrices containing the autoregressive parameters and ε_t is the white noise vector process ($\varepsilon_t \mid S_t \approx NID(0, \Sigma(S_t))$). Note that since we now operate with a vector autoregressive model, all endogenous variables enter with a lag(s). Hence, inflation cannot be taken as expected, so that we can estimate only a backward-looking specification of the interest-rate rule. Some authors (for instance, Rudebusch and Svensson 1998; Rudebusch, 2002) suggest and estimate empirical Taylor-rule versions which are based on lagged variables only, which is the case with any VAR framework, including MS-VAR.

The same data for switchers as before are used, described in Table A2.2 in Appendix 2. Estimations were performed with MS-VAR in OxMetrics, which utilizes the EM algorithm, following the guidelines of Krolzig (1998) and others. The model is set as MSIAH(2)-VAR(p), allowing the intercept, autoregressive terms and the variance to switch between two regimes. Based on the statistical properties of the identified regimes, we will argue later about whether these can be reconciled with the switch to IT. No exogenous regressors are included in the basic specification. Intercept and regressors were allowed to switch within the SR approach but, additionally, by allowing the overall variance of the vectors to change here and be part of the regime switching identification, we may check whether the monetary environment changed between the two regimes (i.e. address what was identified as a drawback in SR). *p* denotes the number of lags, which is chosen by appeal to the Schwarz information criterion (SIC), after serial correlation has been eliminated.

The results for each country are reported in Table 6.6; only the vector for the interest rate is reported, because it is here representing our economic model (6.1). We note the linearity test, given in the last row in Table 6.6. This test is based on the likelihood-ratio statistic between the estimated model and the derived linear model and under the null hypothesis the linear model is preferred (Doornik and Hendry, 2009). The first p-value is based on the conventional Chi-squared distribution, while the second is derived by Davies (1987). In all cases, the linearity test suggests that the model is significantly non-linear and that parameters switch between regimes. The remaining diagnostics is available only through visual checks[47] which are given in Figure 6.4. The same plots are given for each country: the upper panel checks for serial correlation (indicated when bars exceed the band); the middle panel checks for normality (the 'distance' between the red and the blue bell-shaped curves); while the lower panel provides evidence on the structural stability of the model (the 'distance' between the red line and the blue line). The plots suggest that the errors can be considered normally and independently distributed, while the model is stable. All the remaining vectors are similarly well specified; they are available in Section A4.4 in Appendix 4, but their diagnostics only upon request.

After checking diagnostics, attention is focussed on four aspects in explicating the results in Table 6.6: i) persistence of the system in each regime; ii) volatility of innovations in each regime; iii) estimates of the model in each regime; and iv) the date of switching inferred from the data. Note that since we have not yet related the identified regimes to ERT or IT, the reporting in Table 6.6 and the explication henceforth is set so that regime 1 corresponds to the earlier regime in time and regime 2 to the later one.

Transition probabilities p_{11} and p_{22} are given in a lower panel of Table 6.6; they refer to the probability that the regime which was prevailing in the previous period will continue to operate in the current period and, in that way, are an indication of regime persistence. Reported transition probabilities suggest that regimes are highly persistent, i.e. there are no "short" and frequent switches between regimes. Brazil and Hungary might be considered as slight exceptions, since regime 1 is not as persistent as regime 2. This point is returned to. Regime persistence can be also analysed from a

[47] Note that MSVAR under OxMetrics does not report any diagnostic test except the linearity test, but offers visual diagnostics as shown on Figure 6.4.

visual inspection of Figure 6.5, which gives filtered and smoothed probabilities. The figure is reproduced for each country – the upper panel is a simple plot of the included series; the middle panel gives the filtered probability of the later regime; the lower panel gives the filtered probability of the earlier regime[48]. The occurrence and height of the blue bars is a sign of the persistence of the identified regimes and is readily apparent from visual inspection as well. Ideally, we look for two blue blocks, inferring hundred-percent persistence and one switch.

The standard error of the residuals from the interest-rate equation in each regime, approximating the overall volatility of the economic environment in the respective regime, is reported within each regime's panel in Table 6.6. The volatility of innovations is much higher in regime 1 than in regime 2. Therefore, regime 2 can be identified as the regime with lower volatility when compared to regime 1.

[48] The middle and lower panel are reversed in terms of the timing of regime 1 and regime 2, simply because MSVAR in OxMetrics reports these in this way.

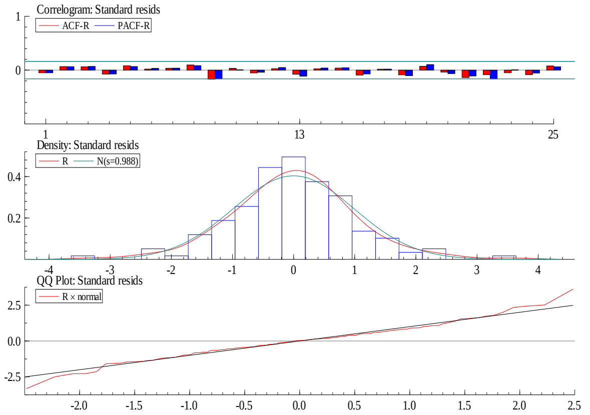
Table 6.6. Markov-switching regression results

Dependent variable: *Interest rate*	Brazil	Chile	Colombia	Czech	Hungary	Israel	Philippines	Poland	Thailand
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
REGIME 1									
Constant	14.862**	4.078***	-3.372	3.048***	7.007	0.311	10.565***	5.160***	2.580**
Σ Interest rate lags	0.599***	0.075	0.532***	0.695***	0.797***	0.947***	0.352***	0.672***	0.762***
Σ Inflation AR lags	-0.480	1.232*	0.801***	0.071*	-0.192	0.036	-0.186	0.069*	-0.111
Σ Gap AR lags	0.575*	0.791*	0.169*	0.056	0.161*	0.058	-0.089	0.204	0.062*
Σ Exchange rate AR lags	-0.011	0.050	0.148*	0.067**	0.130	0.008***	0.018	0.021	0.053*
Regime volatility	4.399	3.705	4.805	1.636	0.685	0.556	4.003	1.857	2.356
Rough regime timing	1997:3 - 1998:8***	1993:8 - 2001:8***	1995:4 - 2000:3***	1994:4 - 1999:2***	1992:7 - 1996:10***	1992:3 - 1998:4***	1992:2 - 1999:5***	1992:5 - 1998:7***	1992:2 - 1999:1***
REGIME 2									
Constant	0.033	-0.066**	-0.433	0.052***	0.090	0.012	0.359***	0.163	0.086*
Σ Interest rate lags	0.999***	0.933***	0.828***	0.960***	0.949***	0.989***	0.954***	0.931***	0.910***
Σ Inflation AR lags	0.024***	0.031***	0.258***	0.022***	0.045***	0.004***	-0.012	0.041***	0.048***
Σ Gap AR lags	0.026*	-0.006	0.009	-0.003*	-0.009	0.007*	0.002	0.018**	0.003*
Σ Exchange rate AR lags	0.000	-0.007***	-0.001	0.000	0.004	0.006	0.006*	-0.004	-0.006*
Regime volatility	0.248	0.245	0.374	0.147	0.329	0.159	0.287	0.394	0.221
Rough regime timing	1998:9 - 2009:7***	2001:9 - 2009:9***	2000:4 - 2005:9***	1999:3 - 2009:10***	1996:11 – 2009:10***	1998:5 - 2009:10***	1999:6 - 2008:12***	1998:8 - 2009:11***	1999:2 - 2009:11***
p_{11}	0.6945	0.9693	0.9640	0.9836	0.6822	0.9711	0.9266	0.9692	0.9882
p_{22}	0.9280	0.9789	0.9835	1.0000	0.9494	0.9817	0.9594	0.9810	1.0000
Lags (based on SC)	2	4	1	2	3	2	1	4	1
Inferred switch	1998:9	2001:9	2000:4	1999:3	1996:11	1998:5	1999:6	1998:8	1999:2
Official switch (Table 6.1)	1999:6	1999:9	1999:10	1997:12	2001:6	1997:6	2002:1	1998:1	2000:5
Linearity test (chi-stat)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(Davies)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ho: The linear model is preferred									

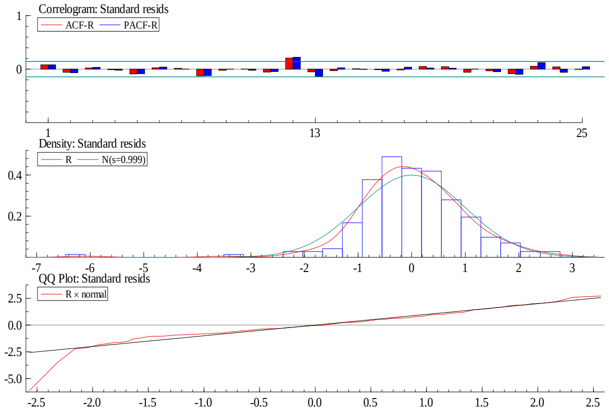
Note: *,**,*** indicate the 10, 5 and 1% levels of significance, respectively. Regime volatility is measured by the standard error of the residuals of the interest-rate vector. By "rough regime timing" it is meant that we do not present the identified short periods of a few months, but instead longer periods when the regime prevailed.
Whenever more than one lag was used, the sum of the lags for each variable is reported, along with the Wald test of their joint significance.

Figure 6.4. Diagnostics for serial correlation and normality of the interest-rate vector

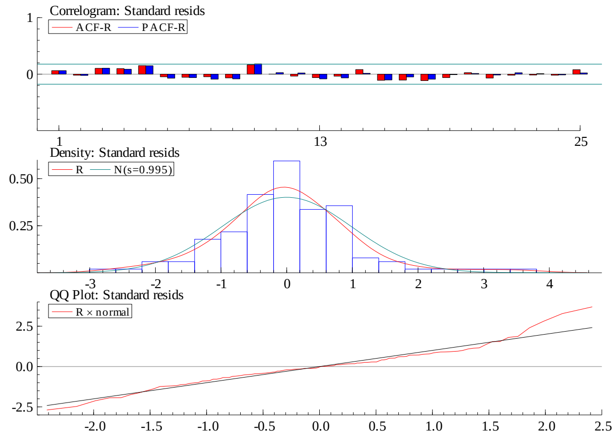
Brazil



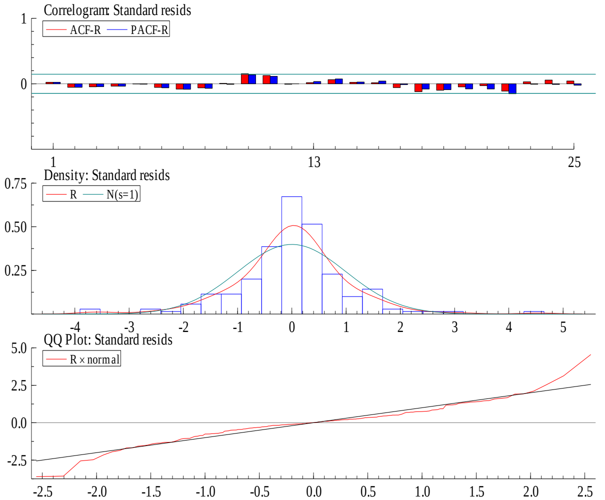
Chile



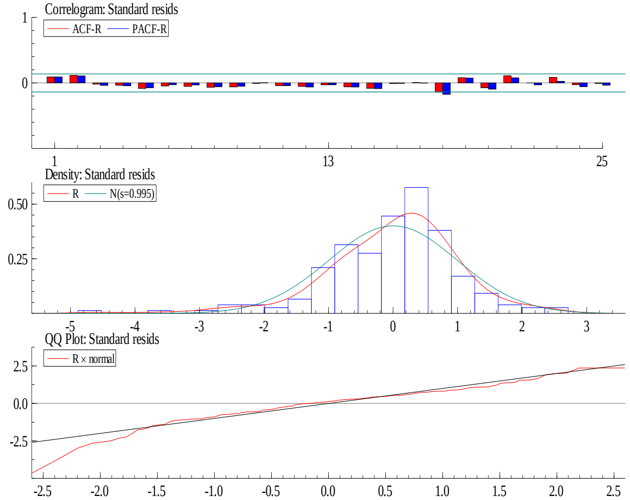
Colombia



Czech



Hungary



Israel

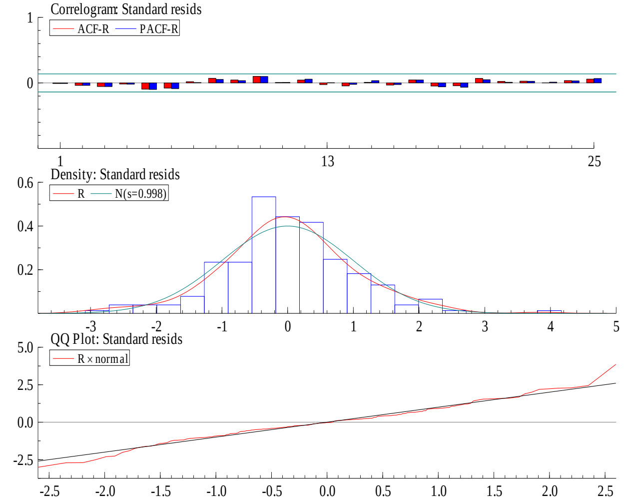
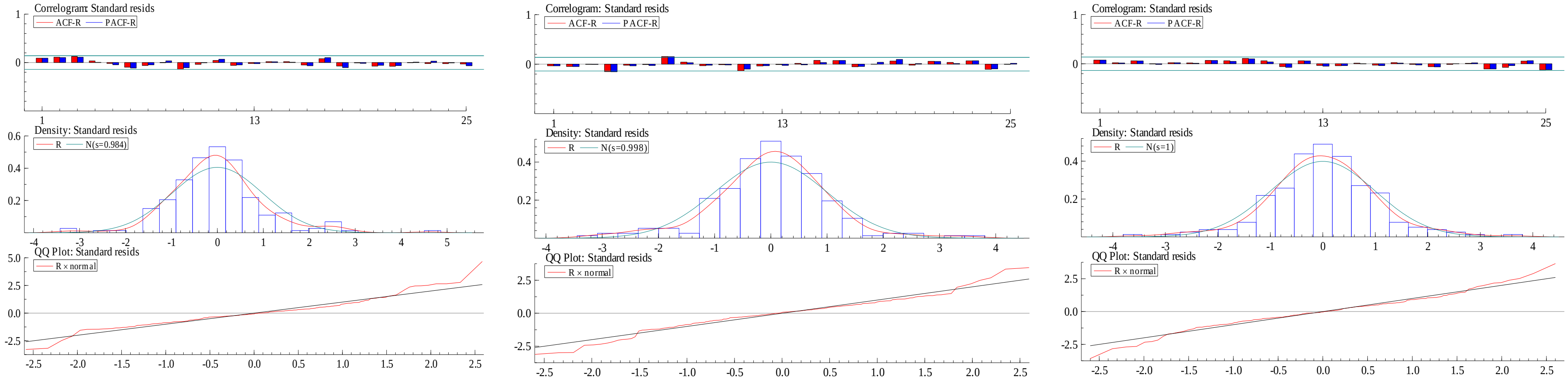


Figure 6.4. Diagnostics for serial correlation and normality of the interest-rate vector (continued)

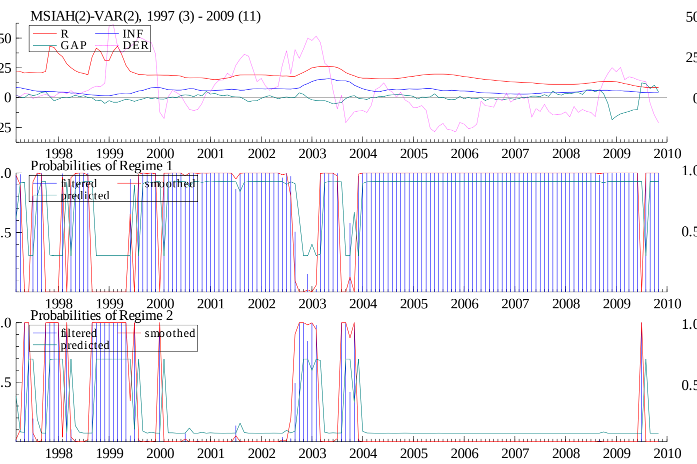
Philippines | Poland | Thailand



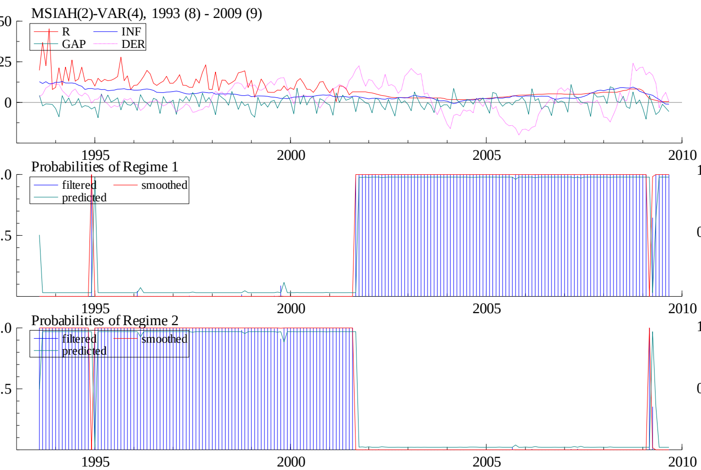
Note: R refers to the interest rate (the vector we are interested in); ACF – Auto-correlation function; PACF – Partial auto-correlation function; N(s=x) refers to the normal distribution function.

Figure 6.5. Regime probabilities

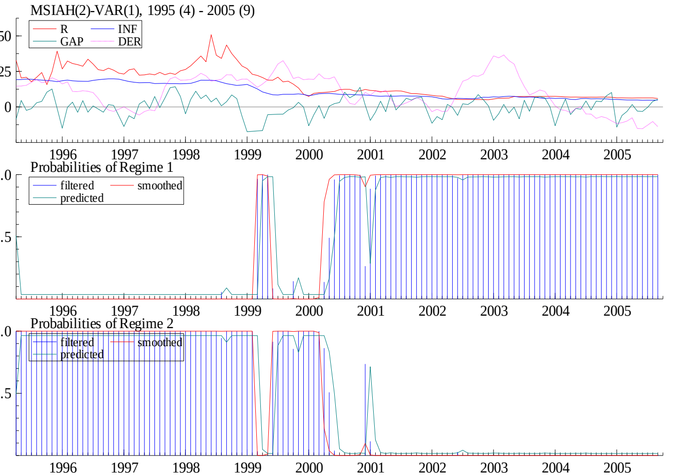
Brazil



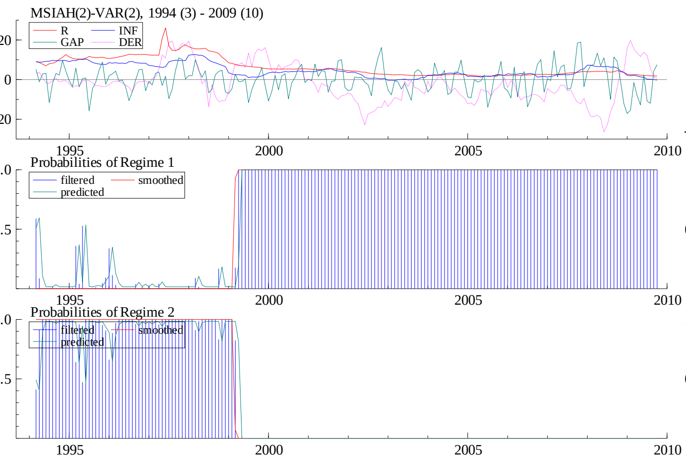
Chile



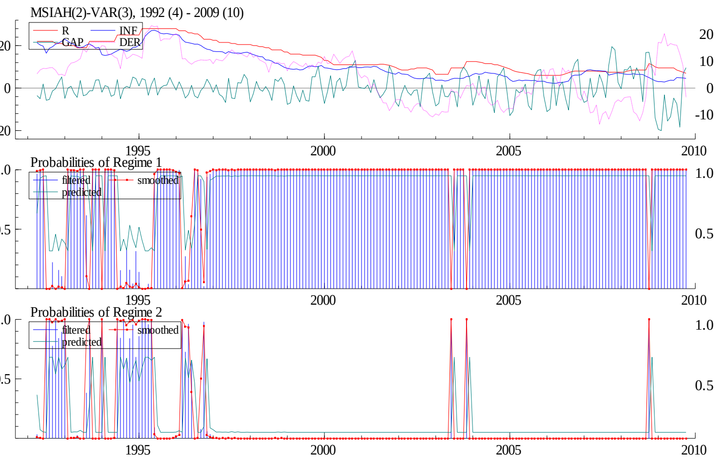
Colombia



Czech



Hungary



Israel

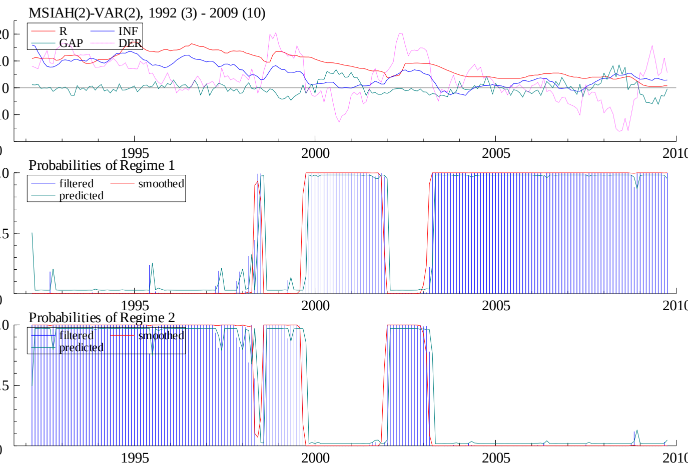
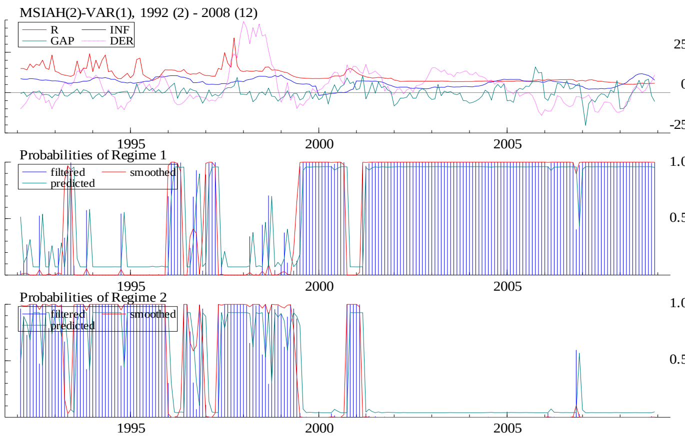
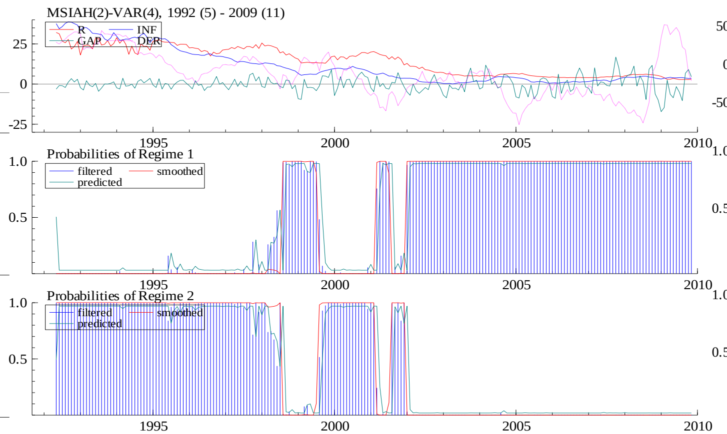


Figure 6.5. Regime probabilities (continued)

Philippines



Poland



Thailand

Note: On the figure, regimes are in reverse order compared to how they are reported in Table 6.6; hence, what is referred to as regime 1 in Table 6.6 is the lower panel of each country on

Figure 6.5. This is because of the way MSVAR in OxMetrics prints out results.

The first panel is a simple plot of the series included in the model. On the second and the third panel, the filtered, smoothed and predicted probabilities are plotted.

Estimated coefficients are given in the panels headed 'Regime 1' and 'Regime 2' in Table 6.6. Whenever more than one lag was used, the cumulative effect (the sum of the lags for each variable) is reported, along with the Wald test of their joint significance. Results suggest that the coefficient associated with the lagged interest rate generally ranges above 0.9 in the regime 2, suggesting a high degree of interest-rate smoothing. Contrary to our thought that smoothing might not be regime-dependent, here we observe considerably smaller estimated smoothing parameters of about 0.6 to 0.7 in regime 1.

The estimated coefficients suggest that central banks responded significantly to inflation in regime 2 (asterisks indicating significance are largely present in the regime-2 panel of Table 6.6 – in eight out of nine countries inflation is significant in regime 2 at the 1%), while the response in regime 1 remains insignificant in five out of nine countries. In regime 2, the central-bank response to inflation-change of 1 p.p. ranges from very mild in Israel (0.004 p.p.) to considerable in Columbia (0.26 p.p.), with the median being a 0.03 p.p. increase of the interest rate (in Chile). Still, if significant coefficients between the two regimes are compared, we observe that the reaction to inflation in regime 2 has moderated.

The output gap effect in both regimes is significant in half of the countries and frequently only at the 10% level. Estimated responses, where significant, suggest that the policy reaction to output fluctuations in regime 2 has moderated as well. Moreover, when compared to the response to inflation, the response to the output gap in regime 2 is found to be even milder. The interest-rate increase ranges from 0.003 p.p. in Thailand to 0.026 p.p. in Brazil, with the median being 0.007 p.p. in Israel, when the potential output is by an additional 1 p.p. higher than the actual. But, can this be interpreted as evidence that these central banks were less concerned with the level of economic activity than with inflation? The answer is no, because of Svensson's (1997) argument that the size of the estimated coefficient on the output gap does not necessarily reflect the importance of that variable in the central-bank loss function, but that the weight and the coefficient are related in a non-linear fashion. The objective here is not to find out the weight, because the obtained – qualitative - information that the central bank started to take into consideration, albeit partially, the movements in the real economy, besides inflation, is sufficient for our purpose.

Finally, responses to exchange-rate movements are largely insignificant under both regimes. To check for the earlier concern that this might be due to the fact that pressures on the foreign-exchange market do not fully reflect onto the nominal rate, which, at least in regime 1 was pegged, a robustness analysis with reserves is carried out in Section 6.8.2.

Given the above discussion, it is argued that regime 1 can be reconciled with ERT and regime 2 with IT. There are at least six reasons for this conclusion.

1) The volatility of regime 2 is considerably lower than the volatility of regime 1 (reported in each regime's panel in Table 6.6). It was argued in Chapter 5 that the way in which IT is designed allows moving not only along the trade-off curve, but also to the left on a new lower-volatility curve (recall Figure 5.1). Also, by allowing for a discretion constrained by a pre-set inflation target and a horizon to achieve it, the central bank is able to manage a multitude of objectives (nominal and real), which potentially gives the lowest possible macroeconomic volatility (recall the intuition behind the loss functions [4.5] and [4.12]).

2) The persistence of both regimes is high in almost all cases (reported transition probabilities in the lower panel of Table 6.6), which suggests long-lasting and continuous regimes, not regimes which appear sporadically and with frequent interchanges.

3) The macroeconomic variables are considerably more often statistically significant in regime 2, compared to in regime 1. This is as expected given the substance of the two regimes: under ERT, monetary policy is largely dependent on the monetary policy in the anchoring economy; i.e. the space for monetary policy aimed at domestic goals is restricted (and hence, the estimated effects of variables such as inflation and output gap are likely to be statistically insignificant). On the other hand, IT is a "constrained-discretion" strategy, whereby the policy can be geared toward achieving domestic objectives, *per se* (and hence, variables such as inflation and output gap are likely to be statistically significant).

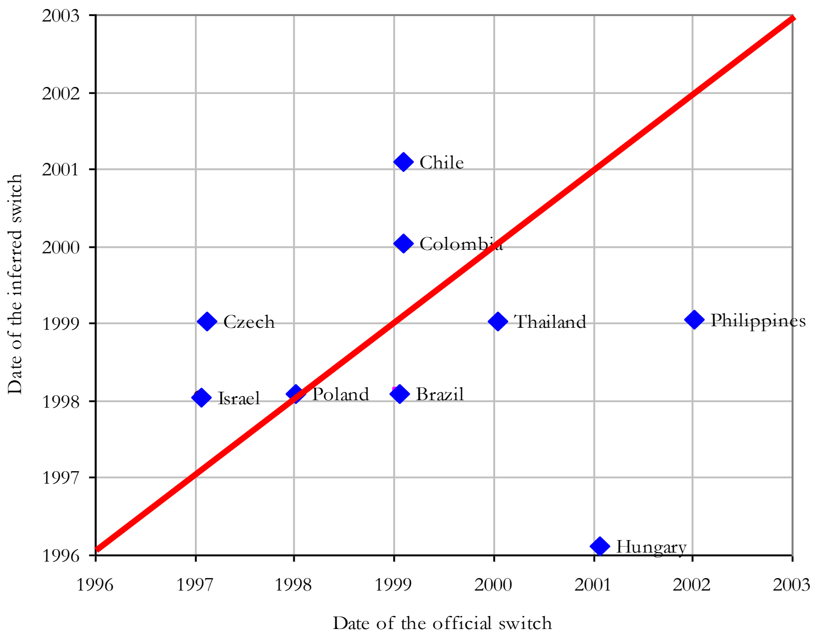
4) The significance and magnitude of the coefficient on inflation in regime 2 suggests that these countries embarked on a policy geared toward strict IT, whereby large weight is put on inflation. This is expected, given that in the early

phases of IT in developing countries credibility needs to be acquired through tight observation of inflation.

5) The sporadically-appearing significance and magnitude of the coefficient on economic activity might still suggest that although these economies geared policy towards strict IT, still they avoided being complete 'inflation nutters' and did to some extent consider short-run output movements, which is an attribute of the IT design.

6) The date of the switch inferred from the data is typically close to the official date of the switch. The inferred timing of each regime and, hence, the inferred switch date, is given last in each regime's panel in Table 6.6. Given the argument about the potential endogeneity of the switch, we expected that the real switch, if can be inferred from the data, will fall around the official switch (i.e. can be just equal to the official switch only by chance). For illustration, Figure 6.6 charts the comparison between the official- and the inferred-switch date; x and y axes measure these respectively. The red line represents the case when the official and the inferred switch are just equal. Countries above the red line are inferred to have switched later than the official switch date and opposite for the countries below. More thorough discussion on the switch date follows.

Figure 6.6. Official versus inferred switch date



Source: Table 6.1 on p.217 and Table 6.6 on p.262.

In all cases except Hungary, the inferred switch is close to the official switch to IT. In Brazil, Philippines and Thailand, it is found to precede the official switch, while in all remaining countries it followed the official switch. The distance between the official and the inferred switch ranges from as small as in Colombia and Poland (7 months) to as large as in Philippines (30 months). These findings suggest that Brazil, Philippines and Thailand embarked on a regime geared toward IT (i.e. started to target inflation forecast) before they officially announced IT, while all the others officially embarked on the new regime (as a firm way to anchor inflation expectations), but most likely continued to closely target the exchange rate for some time after the official switch. In order to pursue these suggestions, in the robustness checks section in *6.8.2.* a three-regime specification is estimated, in order to check whether some intermediate regime (between ERT and IT) governed monetary policy (which could be either a mix of both or an arrangement undertaken to constrain the excessive exchange-rate volatility that emerged in some of the countries, like the Czech Republic, Poland or Thailand).

Hungary is an exception in all considerations of the regime switch, since the inferred switch to regime 2 is too early before the official switch to IT, besides the rather sporadic appearance of regime 1. This renders the conclusion that interpreting regime 2 as IT is invalid. Some intuition behind those results is that Hungary published inflation expectations in its monetary-policy guidelines already in 1999. Moreover, the crawling peg since March 1995 served for both achieving exchange-rate targets and disinflation. The crawling peg continued besides IT until September 2001; until February 2008 a ±15% band around the central parity was still in place. This suggests that Hungary had a de-facto mixed system at least until 2008, whereby the exchange-rate targets dominated at the beginning and had only gradually been substituted by IT. This might be the reason for not identifying a clear regime switch in Hungary.

The conclusion from the above investigation is that IT represented a real switch in the investigated countries. Results suggest that monetary policy has undergone a significant change in the 2000s. The results run contrary to the usual statement in the literature that central banks under IT react strongly to inflation deviations from the target - compared to the period before, these reactions moderate under IT. On the other hand, the statistical significance for the effects of the output gap was found to be fragile, while the exchange-rate effects were found to be insignificant. The significance of the results in the regime-2 panel in Table 6.6, might suggest that the switch could be more thought of as a switch toward a monetary policy that afforded more space to account for domestic objectives. Also, regime volatility was found to be lower under IT when compared to ERT, while the inferred regimes' timing can be reconciled with the switch to IT.

What could be considered as a possible critique of these conclusions? Certainly, the most striking one is that the data might be indicating a switch that is not a result of the IT strategy but, rather, of something else. For instance, the Czech Republic and Poland exhibited a transition period during regime 1, while the 2000s was a decade oriented toward economic growth. But, this is not the case in Hungary which belongs to the same group of countries, geographically and in terms of economic developments. Secondly, Thailand and Brazil exhibited financial crises during regime 1 and subsequently have had a more stable period. Yet, as we argued earlier, a financial crisis can force the country to rethink its monetary regime. Thirdly, these nine countries originate from distinct geographic regions, so the possibility that common regional shocks and potentially strong financial ties drive results is excluded.[49] However, for strengthening confidence in the results, some robustness checks are performed in Section 6.8.2 and some checks for endogeneity in Section 6.8.3.

6.8.2. Robustness checks

Two types of robustness analysis are performed in this section: i) allowing for three regimes, instead of two, to check if an intermediate regime between ERT and IT

[49] Since this is a time-series analysis, we are limited in our ability to control for global effects (treatment-group versus control-group analysis), i.e. for trends affecting all countries at the same time. Although uncommon in the MS analysis, we still performed MS-VARs for our non-switchers (refer to Section 6.2.2): Argentina, China, Lithuania, Latvia and Macedonia. Due to the length of some of the included series - for Bulgaria, Estonia, Ecuador, El Salvador and Uruguay - these calculations were not performed for these countries. Due to space, the results are available only on request. They suggest that, in general, it cannot be established that monetary policy has been governed on a systematic basis by more than one regime over the observed period. Namely, the identified second regime, cannot be reconciled with the period of after-2000, but to other short-term 'local' events that implied different behaviour of the monetary policy; the most likely being: the currency-board crisis of 2001 in Argentina; wider exchange-rate bands (1994-1996 and possibly the wage reform in this period) in China; the easing of Latvian monetary policy in 2000-2001 and the 2008-crisis pressures on the currency board; and the easing of the Macedonian monetary policy in 2005 after the long-lasting stabilization, firstly due to the transition, then due to the internal conflict, and so on.

might have existed; and ii) adding some exogenous variables. Table 6.7 gives the transition probabilities and volatilities for the three regimes: the timing in the table is set regime 1 to correspond to the potential period of ERT; regime 2 to correspond to the potential period of IT; and regime 3 to stand for any other regime. Regime 1 and 2 persistence and timing can be reconciled with ERT and IT, respectively; also the standard errors within those regimes are similar to those in Table 6.6. In Brazil and Chile, regime 3 picks up some developments in the early 1990s but these cannot be attributed to any intermediate regime. In Hungary and Philippines, regime 3 appears only sporadically (has a low probability) and has probably no economic meaning; moreover, in Hungary even regime 1 has a relatively low probability, as found before (see Table 6.6). In Israel, regime 3 relates to the period of the mortgage crisis.

However, in Colombia, the Czech Republic, Poland and Thailand, regime 3 picks up some developments between ERT and IT (bold-typed in Table 6.7). These can be reconciled with the evidence: all these countries embarked on IT in the aftermath of exchange-rate turbulence, so that some of them observed a money target for a short period after peg exit and then started to target inflation, but this was a kind of "soft landing". Still, regime 3 is not so different from regime 2 (IT) in Colombia and the Czech Republic in terms of variance, and is likely to only reflect the intensive disinflation in the early phase of IT (Hrncir and Smidkova, 2004). In Poland and Thailand regime 3 undeniably picks up a more turbulent period than the subsequent IT period. In Thailand this is the period of the Thai baht crisis (East-Asian crisis), whereby a managed floating rate was introduced alongside a money-base target; then, the latter suffered from the weak link between money and prices and later the Central Bank adopted an IT framework (Agénor, 2002). In the Polish case, indeed the period of the eclectic approach mentioned in Section 6.2.1 is identified, when the central bank followed multiple objectives. This was a period of structural changes within the financial system and a period of constant disinflation (Pruski, 2002). However, Poland experienced slower disinflation when compared to other transition countries, which might be the cause for the intermediate regime lasting relatively long. Moreover, the volatility of the economic environment is found to be about 4 times higher than under the subsequent IT.

Table 6.7. Regimes persistence and volatility when allowed for three regimes

Country	Transition probabilities [regime volatility]			When does regime 3 ("Other") appear?
	p_{11} ERT	p_{22} IT	p_{33} Other	
Brazil	0.7677 [2167.3]	0.9461 [1.328]	0.6104 [84.636]	1992:7-1993:8
Chile	0.9083 [2.331]	0.9889 [0.151]	0.8412 [6.165]	1993:8-1994:12
Colombia	**0.9458 [2.934]**	**0.9420 [0.091]**	**0.9375 [0.700]**	**1999:4-2004:12**
Czech	**0.9825 [1.510]**	**0.9455 [0.100]**	**0.7846 [0.161]**	**1998:12-2000:4**
Hungary	0.6671 [0.553]	0.5509 [0.115]	0.1056 [1.407]	Very sporadically
Israel	0.8610 [0.892]	0.9094 [0.174]	0.8593 [0.268]	2009:1-2009:11
Philippines	0.7776 [1.070]	0.9889 [0.248]	0.6404 [4.586]	Sporadically
Poland	**0.9737 [3.154]**	**1.000 [0.295]**	**0.9888 [1.175]**	**1995:3-2002:6**
Thailand	**0.9882 [0.258]**	**0.9883 [0.143]**	**0.9458 [2.357]**	**1999:2 - 2000:10**

Note: Figures in squared brackets are regimes volatilities. Serial correlation accounted for. Bold type signifies 'other' regime that is identified between regime 1 and regime 2.

The robustness of our results is finally tested by adding some exogenous variables. Given our discussion in Section 6.3, reserves growth and NFA-to-GDP[50] are added as exogenous covariates allowed to switch. The underlying specification is again MSIAH(2)-VAR(p), whereby *p* is chosen according to the Schwarz criterion after any serial correlation is eliminated. Results are given in Table 6.8. A similar pattern is observed as before: significant variables are largely concentrated in the second panel, i.e. inflation and output become more significant under regime 2. The exchange-rate is rarely significant. Also, the coefficients largely retain the same magnitudes. Persistence is nearly the same as before; implied volatilities under both regimes are similar; and the

[50] Money growth is not included in these robustness checks since MS-VAR will become cumbersome for estimation (many iteration and possible non-convergence) and because of the support of the literature for a marginal money role in affecting monetary-policy conduct (the weakened link between money and prices).

inferred switching times are similar to those considered in Table 6.6[51]. Overall, the estimates are robust to the alternative specifications.

Surprisingly, reserves are generally insignificant under regime 1 (this regime being associated to ERT), albeit their magnitude and sign are as expected. However, the size reduces under regime 2, while they remain insignificant. Consequently, although we believed that reserves should be more important under regime 1, we do not find strong support for this. Moreover, as expected, they are insignificant under regime 2, as is the exchange rate, suggesting that in these economies the exchange rate plays a marginal role. The level of euroization is found not to be a systematically significant influence: in some countries it matters, but in others it does not. Moreover, the sign on this influence in Brazil and Chile is not as expected. In general, the limited evidence might give support to the idea that higher exposure of bank net-assets to exchange-rate risk precludes the central bank lowering the interest rate (i.e. restricts the monetary-policy manoeuvre space), but it is very feeble.

[51] Hungary behaves slightly differently in this robustness checking, although the conclusion is largely the same. Here, the technique infers the existence of two regimes (i.e. the regime that previously appeared only sporadically, now gains in persistence) and the timing of the switch comes closer to the official switch to IT. However, the two identified regimes are similar in their volatility, while in regime 2, inflation is only significant at the 10% level; the output gap is not significant, while the exchange rate is highly significant. This might suggest that the distinction in Hungary between the ERT and the consequent IT is hard to make, given the preserved exchange-rate target.

Table 6.8. Markov-switching regression results exogenous regressors added

Dependent variable: *Interest rate*	Brazil	Chile	Colombia	Czech	Hungary	Israel	Philippines	Poland	Thailand
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
REGIME 1									
Constant	18.746***	-8.504	25.586**	5.425***	2.136***	0.226	13.917***	11.974***	6.393***
Σ Interest rate	0.421***	0.119	0.420***	0.433***	0.897***	0.937***	0.28***	0.688***	0.564***
Σ Inflation AR terms	1.200	1.052***	0.207	0.131	-0.032	0.043	-0.212	-0.010	-0.190
Σ Gap AR terms	-0.027	0.603***	0.232**	0.032	0.033	0.051	-0.007	0.236	0.072**
Σ Exchange rate AR terms	-0.192	-0.127	0.261*	0.089**	0.008	0.013	-0.013	-0.013	0.052
Reserves growth	-0.191**	-0.051	0.047	-0.015*	0.000	0.003	-0.012	-0.002	-0.085***
NFA to GDP	-0.950	-0.167	-4.293**	0.064	0.027***	0.003	-0.399***	-0.382*	-0.074
Regime volatility	3.798	4.046	4.591	1.490	0.750	0.551	3.916	1.817	2.200
Rough regime timing	1997:3 - 1999:6***	1993:7 - 2001:8***	1995:4 - 2000:3***	1994:3 - 1999:2***	1992:2 - 1998:12***	1992:3 - 1999:8***	1992:2 -- 2001:2***	1992:5 - 1998:7***	1992:2 - 1999:1***
REGIME 2									
Constant	0.434***	0.236***	-0.549	0.093	0.690***	-0.265	0.246	-0.849	0.070
Σ Interest rate	0.962***	0.967***	0.825***	0.960***	0.911***	0.994***	0.978***	0.930***	0.916***
Σ Inflation AR terms	0.037**	0.024**	0.272***	0.020**	0.020*	0.009***	-0.020	0.055***	0.048***
Σ Gap AR terms	0.023***	0.004*	0.009**	-0.003*	0.000	0.010**	0.000*	0.020**	0.004***
Σ Exchange rate AR terms	0.000	-0.001	-0.002	0.000	0.014***	0.008***	0.001	0.004	-0.008**
Reserves growth	-0.001	-0.002	0.001	0.000	-0.011**	-0.001	-0.002	0.001	-0.004
NFA to GDP	-0.025***	-0.013**	0.004***	-0.001	0.010	0.015**	0.001	0.017**	0.002
Regime volatility	0.241	0.149	0.376	0.147	0.308	0.155	0.280	0.430	0.219
Rough regime timing	1999:7 - 2009:10***	2001:9 - 2009:3***	2000:4 - 2005:9***	1999:3 - 2009:10***	1999:1 - 2009:10***	1999:9 - 2009:8***	2001:3 - 2008:2***	1998:8 – 2009:11***	1999:2 - 2009:11***
p_{11}	0.7533	0.9804	0.9652	0.9836	0.9537	0.9706	0.8842	0.9681	0.9882
p_{22}	0.9371	0.9891	0.9849	1.0000	0.9757	0.9809	0.9275	0.9818	1.0000
Lags (based on BIC)	2	3	1	2	1	2	1	4	1
Official switch (Table 6.1)	1999:6	1999:9	1999:10	1997:12	2001:6	1997:6	2002:1	1998:1	2000:5
Linearity test (chi-stat)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(Davies)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Ho: The linear model is preferred

Note: *,**,*** indicate the 10, 5 and 1% levels of significance, respectively. See other notes in Table 6.6.

6.8.3. Checks for remaining endogeneity

Given our discussion on the endogeneity of the regime switch in Section 6.7.3, the main shortcoming of the MS analysis seems to be the approach towards addressing this issue. Hence, although the MS analysis does address some of the shortcoming of the SR analysis pointed out in Section 6.6.2, this is done at the cost of introducing a possible problem of not entirely addressing potential switch endogeneity. We argued that by introducing into the empirical specification the observable variables that that affect switch endogeneity, one part of it is addressed. There are intuitive grounds to believe that switch endogeneity is largely governed by the behaviour of the covariates that enter the regression: countries might be forced to switch if inflation and its volatility are threatening; if output is volatile under a peg when a large shock hits; and if the exchange-rate peg is under constant pressure, so that reserves are leaking and threaten a peg demise. However, to be on the safe side, we need to be assured that no remaining endogeneity is left in the model, stemming from: i) unobservables; and ii) regime being duration-dependent. Unfortunately, these checks can be performed only indirectly and with considerable limitations, as is considered in what follows. However, so far, the literature on MS models has not offered a complete and direct way to address entirely the potential endogeneity of the switch. Still, there are approaches that can help in building intuition about the problem.

Firstly, we rely on Vázquez's (2008) argument that if any endogeneity is left in the latent switching variable (due to unobservables, say), it will be reflected in different transition probabilities under different MS-VAR specifications (recall Table 6.5). Regime persistence under alternative MS-VAR specifications is checked in Table 6.9. The first panel is a reproduction of the persistence of Table 6.6, while the remaining three specify the MS-VAR forms MSI, MSIH and MSAH. All probabilities remain roughly the same which, given the argument of Vázquez (2008), do not suggest that substantial endogeneity remains in the switching variable and that it has, instead, been picked up by the covariates. The exception is, as expected, Hungary, whereby we were not able to reconcile regime switch with IT introduction and this is further reflected here – smoothed probabilities considerably differ between specifications.

Table 6.9. Regimes probabilities under different MS-VAR specifications

	Brazil	Chile	Colom-bia	Czech	Hun-gary	Israel	Philip-pines	Poland	Thai-land
MS(2)-VAR(p)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
MSIAH									
p11	0.6945	0.9693	0.9640	0.9836	0.6822	0.9711	0.9266	0.9692	0.9756
p22	0.9280	0.9789	0.9835	1.0000	0.9494	0.9817	0.9594	0.9810	0.9921
MSI									
p11	0.9861	0.9889	0.9108	0.9676	0.8473	0.9792	0.9588	0.9616	0.9777
p22	0.9795	1.0000	0.9411	0.9906	0.9109	0.9890	0.9477	0.9723	0.9685
MSIH									
p11	0.6624	0.9802	0.8901	0.9834	0.2055	0.9703	0.9288	0.9919	0.9906
p22	0.9146	0.9889	0.9314	1.0000	0.7852	0.9817	0.9660	1.0000	1.0000
MSAH									
p11	0.4883	0.9685	0.9836	0.7288	0.4007	0.8673	0.9323	0.9681	0.9906
p22	0.9268	0.9756	1.0000	0.9207	0.8044	0.9104	0.9636	0.9638	1.0000

Duration-dependent MS-VAR (DD-MS-VAR) is compared to conventional MS-VAR in Table 6.10. Pelagatti's (2003; 2008) DD-MS-VAR software for OxMetrics is used. As mentioned earlier, under DD-MS-VAR, only the mean can switch between regimes. From that viewpoint, this application cannot be comparable to our earlier MS-VAR specifications nor fits our argument, since it assumes that policy responses and volatilities are equal under both regimes – the latter differ only with respect to the interest-rate mean. Given that this is rather restrictive, the results need to be interpreted with caution. However, they are helpful for providing further intuition related to switch endogeneity. Given all this, Table 6.10 is drafted differently from the previous tables. In the entire tabling, regime 1 is set to associate to ERT and regime 2 to IT. In the upper panel, results of the conventional MSM-VAR are presented (only mean switches – this is needed for comparability). This panel reports the same statistical properties as before (as in Table 6.6). In the lower panel, results of the DD-MS-VAR are reported. Lag length is only based on the autocorrelation function (ACF), as other criteria were not available. Towards the bottom of the panel, transition probabilities are reported; note that these probabilities have a different interpretation from the reported probabilities in the upper panel. While in the upper panel (MSM-VAR), probabilities indicate regime persistence, in the lower panel (DD-MS-VAR), these represent the probability that a switch to the other regime will occur, given its duration. Maximal duration is set at 10 years (approximating the average duration of the regimes in our sample), but transition probabilities are available on request for any duration up to the maximum.

Once we pass from MSM-VAR to DD-MS-VAR, the coefficients largely retain their magnitudes and levels of statistical significance. Hence, the estimated coefficients do not suggest that there is remaining endogeneity in the switching variable, which suggests that the covariates that entered the regression accounted for the entire endogeneity in the switching variable. Some differences are observed in the means between the two specifications; but, in both cases, these suggest that interest rates were higher under regime 2 (the one associated to IT). This observation is consistent with the findings with the panel estimation (section 6.5). Interesting insights are obtained from the transition probabilities (p_{12} and p_{21} at the very bottom of the table). The transition probability that a switch from ERT to IT will occur (p_{12}) suggests a very high probability that, at long durations, ERT will switch to IT. This is in line with our findings in Chapter 3 that long pegs are prone to crises and exit under hard attacks. Conversely, the transition probability that a switch from IT to ERT will occur (p_{21}) ranges from 0% to 15%[52] and, as expected, suggests that even after very long duration, IT will not switch back to ERT. This is in line with the argument in Chapter 5 and could be ascribed to IT flexibility. However, the overall stability of the obtained results compared to those when duration dependence is not considered, suggest that duration dependence is not an important factor for the switch to evolve endogenously.

[52] The exception being, again, Hungary, whereby the distinction between the two regimes is negligible, which is reflected further in the p_{12} and p_{21} probabilities.

Table 6.10. Markov-switching VAR (MS-VAR) versus Duration-dependent Markov-switching VAR (DD-MS-VAR)

Dependent variable: *Interest rate*	Brazil	Chile	Colombia	Czech	Hungary	Israel	Philippines	Poland	Thailand
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
MSM-VAR									
Mean in regime 1 (ERT)	18.254**	2.938	-6.620	1.551	5.422	7.477***	12.657***	8.492**	2.183
Mean in regime 2 (IT)	18.618**	9.114**	6.241	-0.849	6.101	9.102***	8.495***	14.430***	5.704**
Σ Interest rate	0.915***	0.980***	0.814***	0.930***	0.957***	0.942***	0.468***	0.823***	0.982***
Σ Inflation AR terms	0.076	0.920***	0.309***	0.072	0.023	0.003***	0.163**	0.067	-0.002
Σ Gap AR terms	0.091	0.188	0.038	0.023	0.014**	0.046*	0.006	0.046**	0.007*
Σ Exchange rate AR terms	0.000	0.006	0.015	0.022	0.021***	0.020***	0.017	-0.002	-0.026
Regime volatility	2.444	3.809	2.042	0.834	0.601	0.482	2.658	1.187	0.873
p_{11}	0.909	0.989	0.967	0.969	0.964	0.989	0.979	0.937	0.699
p_{22}	0.942	1.000	1.000	0.978	0.978	1.000	0.991	0.942	0.925
Lags (based on BIC)	3	1	1	4	1	2	1	2	4
Linearity test (chi-stat)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(Davies)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ho: The linear model is preferred									
DD-MS-VAR									
Mean in regime 1 (ERT)	43.774	-58.712	487.69	90.128	73.69	7.137	-167.31	24.273	-1.538
Mean in regime 2 (IT)	44.638	-50.143***	9.673***	96.495**	74.52***	7.994***	8.184***	28.297***	1.813***
Σ Interest rate	0.921***	0.747***	0.815***	0.934***	0.984***	0.977***	0.944***	0.951***	1.015***
Σ Inflation AR terms	0.072	0.317*	0.296***	0.068*	0.018	0.018	0.038	0.028**	-0.005
Σ Gap AR terms	0.044	0.216***	0.086***	0.012	0.008	0.021	-0.038	0.021	0.009
Σ Exchange rate AR terms	0.014	0.008	0.025	0.010	0.000	0.010*	0.004	-0.001	-0.015
Lags (based on ACF of sigma)	3	3	1	1	1	2	3	1	1
p_{12} **at max. duration**	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
p_{21} **at max. duration**	0.150	0.020	0.000	0.040	1.000	0.060	0.000	0.000	0.000

Note: *,**,*** indicate the 10, 5 and 1% levels of significance, respectively. See other notes in Table 6.6.

6.9. Conclusion

The objective of the chapter was to empirically examine and analyse whether the conduct of monetary policy has significantly changed with the switch from exchange-rate to inflation targeting in developing countries. Put differently, we investigated whether the switch from ERT to IT represented a real switch. It was argued that the literature examining the issue for developing countries is basically descriptive. On the other hand, the available literature for the advanced economies usually suffers from the identification-strategy problem, the problem of the switch being pre-determined and largely ignores the possibility that switchers were self-selected into IT (i.e. that the switch emerged endogenously). To begin addressing these questions, a treatment group was constructed of all developing-economy switchers from ERT to IT and a comparison group of comparable countries that, in the same period, continued to target the exchange rate. The economic model used is a fairly classical Taylor rule, augmented with the exchange rate, to capture its specific role for developing countries, as small, open economies. The sample period is 1991:1-2009:12.

Firstly, a panel switching regression was designed whereby the switch is observable; all covariates in the regression were allowed to switch. By including variables in the regression that potentially affected the decision to switch, one source of possible endogeneity of the switching variable was addressed. Moreover, to overcome the potential endogeneity of the switching variable stemming from unobservables, it was instrumented with variables that might have had an influence on the decision to switch, but not directly on monetary-policy conduct. The policy-reaction coefficients suggest that switchers, after countries in the sample switched to IT, were able to moderate their reactions to macroeconomic developments, albeit against the background of higher interest rates – ceteris paribus – for the switchers. However, only expected inflation was found to be statistically significant in affecting interest rates: an increase of expected inflation by 1 p.p. leads to a reduction in the nominal interest-rate of 0.18 p.p., as compared to the period before and to the control group of countries. Consequently, these results suggest that IT represented a real switch in the conduct of monetary policy in the investigated countries. Under IT, these countries became more concerned with combating inflation, but their reaction moderated compared to the period before and to the control group, perhaps because of a more cautious monetary policy. Still, the price they paid for this is a higher level of interest rates in general. Coefficients on the output gap and the change in the exchange rate were found to be neither significant nor systematically different from the period before and the control group. This suggests that these countries were concerned with inflation only and not with the output gap and exchange rate; i.e. that they ran a monetary policy geared towards strict IT. Though, in some specifications, the output gap is marginally significant, while the coefficient suggested moderation of central-bank reaction to real fluctuations as well. However, this modelling approach could not reveal whether the overall variability and uncertainty in the economy changed with the switch to IT. Moreover, it was argued that although countries have a date where they officially switched to IT, this does not have to be necessarily reconciled with the moment of the real switch. Hence, the timing of the real switch might be obscured.

To overcome these potential drawbacks of the switching regression, another modelling approach was employed, whereby regime switching is an outcome of an unobservable random variable – the Markov-switching regression. Our economic model was utilized in a reduced-form VAR format for each of our nine switcher countries. Intercept, autoregressive terms and variance were allowed to switch between regimes. By employing a special form of VAR, the potential endogeneity of the switch stemming from observables was partly addressed, but we were able to check for any remaining endogeneity only indirectly. Hence, although the MS approach addressed some of the SR's drawbacks, it potentially performed this at the cost of dealing with switch endogeneity only partially. However, regime persistence was found to be stable under alternative MS specifications, which might lend support to the idea that the only switch endogeneity was the one stemming from observables. Moreover, estimated parameters were found to be stable when transition probabilities were allowed to depend on regime duration, which is an additional, if still indirect, confirmation that switch endogeneity might have stemmed only from observables.

In general, it was found that the inferred regimes are highly persistent; i.e. there are no "short" and frequent switches between regimes. Results suggest that regime 1 can be robustly reconciled with exchange-rate targeting and regime 2 with inflation targeting in at least eight out of the nine investigated countries. In general, the volatility of the economic environment was found to be lower under IT than under ERT. The estimation results suggest that central banks responded significantly to inflation under IT, while the response is found to be feeble or insignificant under ERT. The estimated effect of the output gap is found to be sporadically significant and only at the 10% level. The exchange rate does not have any statistically significant effects in either regime. The estimated coefficients suggest that central-bank responses moderated under IT. Finally, it was found that in all cases except Hungary, the inferred switch date is close to the official switch date. In Brazil, Philippines and Thailand, it was found to precede the official switch, while in all remaining countries it followed the official switch. Only in Hungary was monetary policy found to be governed by one regime only, which is likely to reflect the combined strategy of ERT and IT that it followed over nearly the entire investigated period.

To what extent are the conclusions from the two techniques reconcilable? The two techniques are distinct in their nature: the first is a panel technique (hence results have time and cross-section comparability) and observes the official switch; while the second is a time-series technique (hence results have time comparability only) and infers the switch from the data. Moreover, we estimated a forward-looking interest-rate rule with the SR, but we were able to only estimate a backward-looking specification with the MS-VAR approach. As such, the obtained estimates are not directly comparable. However, they can be compared in a qualitative fashion. Firstly, both methodological approaches lead to the conclusion that there has been a statistically significant shift towards different design of monetary-policy conduct, which could plausibly be attributed to inflation targeting. Overall, this conclusion from both approaches runs counter to the idea that monetary policy has not undergone any change in the 2000s. Estimates from both methods suggest that monetary policy played a role in the 2000s. The SR approach suggested that the switch to a new monetary regime explains these results, while the MS-VAR approach that IT may be inferred from the timings. Also, the results challenge the usual statement in the literature that central banks under IT react strongly to inflation deviations from the target; compared to the period before and to the control group, the estimates suggest that these reactions moderate under IT. Secondly, both conclude that the period under IT was characterized by a monetary policy (more) oriented towards domestic objectives, with a focus on inflation, which could be attributed to inflation targeting. Thirdly, the SR approach found that the policy response to short-run output movements is significant in some specifications but far from being robust, while the MS approach found significance for some of the countries – this could be attributed to inflation targeting. Fourthly, both approaches found no significant role for the exchange rate in the IT period. In addition to this, the MS method concluded that the second regime, which could be reconciled with IT, produced generally lower macroeconomic volatility; and that the probability of a peg exit increases with the peg's duration, which is not the case with IT.

Both approaches lead to the conclusion that IT represented a real switch in developing countries and that the period of IT was characterized by a more stable economic environment, by a monetary policy oriented at domestic objectives, by strict focus on inflation and higher interest rates, and, possibly, by consideration of the short-run real objectives of the economy.

CONCLUSIONS AND POLICY RECOMMENDATIONS

This chapter aims to present the main conclusions from the analysis in this thesis and to highlight the contribution to knowledge that it makes as well as the corresponding policy recommendations. It discusses some limitations of the research and then highlights areas for further research.

C.1 The main line of argument and findings

The objective of this thesis is to empirically examine and analyse whether the conduct of monetary policy has significantly changed with the switch from exchange-rate targeting (ERT) to inflation targeting (IT) in developing countries. To achieve this ultimate objective, the thesis starts by developing the argument that the exchange-rate peg, as a nominal variable, might be unimportant for long-run growth performance, but detrimental with respect to short-run output fluctuations, particularly in times of real shocks. Then, if this is true, the thesis argues that the exchange-rate target may be rethought and an inflation target may be established to anchor inflation expectations and to serve real objectives as well. Findings are presented as follows.

C.1.1. Is the exchange-rate regime important for growth?

The argument of the thesis starts around the issue of whether the exchange-rate regime is important in affecting the long-run growth performance of the economy. At the theoretical level, there are at least three channels through which the exchange-rate regime might affect growth: i) certainty imposed in the economy under a peg and its potentially positive effect on investment and trade; ii) shock adjustment under a flexible rate and its potentially positive effect on growth; and iii) the level of credit-market development and its potentially positive influence on productivity growth under a fixed exchange rate. However, the effects of these three channels remain largely contested in both the theoretical and the relatively scarce empirical literature.

The empirical work in this thesis covers the post-Bretton-Woods era (1976-2006) and includes 169 countries and addresses issues, which are - partially or entirely - missing from the literature. The investigation contrasts use of the de-jure versus a de-facto exchange-rate-regime classification; draws attention to the Lucas critique; and addresses potential endogeneity bias. A dynamic system-GMM panel method is used. The main finding is that the exchange-rate regime is not significant in explaining growth.

C.1.2. Output volatility: A role for the exchange rate?

Following the argument of Goldstein (2002), the inconclusiveness of the evidence as to how the exchange-rate regime might affect growth in theory and practice gave rise to the belief that the exchange rate, similarly to inflation, may not be important in affecting long-term output, but rather in affecting its short-run departure from a long-run trend. Hence, the argument in the thesis continued by addressing the question of whether and, if so, how the exchange-rate target affects output volatility and assigned a central role to shocks hitting the economy. The view in the economic literature is that if nominal shocks predominate then a peg serves better to offset their effects; conversely, if real external shocks predominate, a flexible rate is needed to act as a buffer. As an economy becomes increasingly involved in the global financial market, real exogenous shocks become increasingly apparent, hence supporting the adoption of a flexible rate. Moreover, the evidence suggests that long pegs are exposed to large shocks and are prone to failure. However, the empirical evidence is found unreliable, largely due to the limited number of studies and the measure of output volatility used. Still, at the empirical level, there is some support for the conclusion that a peg increases output volatility; moreover, this conclusion is stronger for crisis-periods, i.e. periods when the peg is under the most severe attack.

The Hausman-Taylor panel method is used and the same period and countries sample as in the growth model. It is argued that the use of volatilities based on a rolling standard deviation leads to persistent series and, hence, to potentially spurious regression. To overcome this potentially serious drawback of the existing studies, a new measure of output volatility is defined in the thesis - the difference between the potential and the actual output - given that this difference might arise from either economic policies or external disturbances. The empirical evidence suggests that exchange-rate regimes play a significant role in explaining output volatility; though it is not overwhelming. The policy implication, both for the overall sample and for the developing group, is that a terms-of-trade shock larger than 7 p.p. under a long peg will give a higher output volatility compared to a float.

C.1.3. The quest for new nominal anchor – is inflation targeting an answer?

If the exchange-rate peg approach is found to produce output volatility under large aggregate shocks, and if these shocks become more common as the economy integrates in the international financial system, then, the thesis argues, the exchange rate might be flexibilized. However, a more important issue will be to choose a new nominal anchor for inflation. The list of theoretical alternatives for the nominal anchor is: nominal-income target; implicit nominal target; money target and inflation target. Nominal-income targeting entails central banks targeting real output and inflation at the same time, which might lead to conflicting policy responses. Implicit nominal targeting is short of an explicit target which is usually compensated with the credibility of the governor; although the latter is a weak assumption for economies with institutional fragility. Monetary targeting presumes the existence of a stable relationship between money and the price level and requires adequate knowledge of the parameters characterizing money demand. In an economy undergoing rapid financial liberalization, however, these parameters may be unstable and, thus, the relation between the intermediate target and the final objective becomes unstable, suggesting that relying on monetary aggregates can be potentially risky. Consequently, the quest for a new monetary regime and a nominal anchor leads to the consideration of inflation targeting.

Inflation targeting is defined as a pre-emptive monetary strategy that uses an information-inclusive framework in order to achieve the pre-announced numerical target for inflation in a given time horizon and which uses the medium-term inflation forecast as an intermediate target (Mishkin, 2001; Svensson, 2007). An IT central bank would be interested in curbing inflation and bringing it immediately on target, except that this may sacrifice a huge portion of output. Today's ITers are not "inflation nutters" (King, 1997). Pragmatically, therefore, the IT central bank would opt for a not-so-fast inflation decrease, at the same time considering the reducing of output fluctuations and exchange-rate volatility. This is the concept of flexible IT, which is applied by almost all ITers. Defined in such a way, IT appears to produce the desired inflation outcomes, as ERT does, but also takes into account the effects on the real economy in times of foreign shocks, contrary to ERT. Consequently, the switch from ERT to IT may serve three simultaneous objectives (Corden, 2002): i) the regime still possesses a firm nominal anchor for inflation expectations; ii) it can more smoothly respond to negative external shocks and prevent large output volatility; and iii) it still has the power to impede real exchange-rate volatility caused by a negative external shock.

C.1.4. Has monetary-policy conduct changed under a switch from exchange-rate to inflation target in developing economies?

To investigate whether monetary-policy conduct changed with the switch from ERT to IT in developing economies, we use an augmented Taylor rule with the exchange rate to capture its specific role for developing countries. The sample period is 1991:1-2009:12. All nine developing switchers from ERT to IT are included, versus a comparison group of countries that in the same period continued to target the exchange rate. The latter circumvents the identification-strategy problem present in the respective literature. Two modelling approaches are used – a switching regression (SR) and a Markov-switching VAR (MS-VAR) – both of which allow for the special case of accounting for the potential endogeneity of the regime switch.

Results from both approaches suggest that IT represented a real switch in the developing countries, with a concern for inflation only and not the output gap and exchange rate; i.e. they ran a monetary policy geared towards strict IT. Under IT, these countries became more concerned with combating inflation, being prepared to pay for this by a higher level of interest rates. Yet their reaction to changes in inflation moderated compared to the period before and to the comparison group: an increase of expected inflation by 1 p.p. leads to a reduction in the nominal interest-rate of 0.18 p.p., as compared to the period before and to the control group of countries. In some of the specifications (in the SR approach) and for some countries (in the MS-VAR approach), the output gap is found to have exerted (marginally) significant influence on the interest rate, with the coefficient suggesting a moderation of central-bank reaction to the changes in the level of economic activity as well.

Within the MS-VAR, we conclude that the inferred regimes are highly persistent and that their volatility is found to be much higher under ERT than under IT. The latter suggests that the new monetary regime might have been responsible for the more stable macro-environment. The MS-VAR approach also finds that, in all cases except Hungary, the inferred switch date is close to the official switch date. However, although the MS-VAR approach addresses drawbacks of the SR approach it potentially performs this at the cost of only partially dealing with the switch endogeneity.

These findings that a peg inflicts increased output volatility under a real shock larger than 7 p.p. change in terms of trade, are consistent with the general argument in the thesis that exchange-rate targeting might become inappropriate under large exogenous shocks, which are argued to be more present in times of international financial integration. In turn, this raises the question of a new nominal anchor for inflation expectations and the findings support the notion that targeting inflation directly is a neat vehicle for delivering better monetary-policy responses and a more stable macroeconomic environment. Findings for developing economies and from the approaches pursued constitute contributions to knowledge which are pointed out next.

C.2. Contributions to knowledge

C.2.1. Contributions to theoretical rigour

In general, the thesis has been oriented towards empirical findings and how these can inform policymaking. However, there are a few theoretical contributions. Firstly, debates in the literature relate to either exchange-rate regimes or monetary-policy regimes. Although the distinction between these might appear trivial, it is usually lacking in the literature. Section 1.2 made a pioneering step towards their clear distinction and this taxonomy is one contribution. Secondly, the thesis contributes to the lively discussion about the trade-off between inflation- and output volatility under IT and makes a rigorous critique of the current discussion. Special emphasis is devoted to acknowledging the role of the exchange rate and its complex macroeconomic relationships (e.g. given euroization and pass-through concerns) for monetary policy under IT in developing economies. While this is a second-order issue for advanced economies, the literature for developing economies devotes little discussion on this issue, which is likely to be more important for them. Only recently have there been some studies (e.g. Stone *et al.* 2009) raising the issue at an appropriate level and such concerns are likely to be a focus for analyses in the years to come. Finally, the thesis makes a contribution to the critical analysis of the existing literature on IT. Up until recently, researchers typically used undemanding descriptive approaches to analyze the effects of IT, which for two reasons may have biased their results: the relatively shock-free environment that delivered favourable macro-outcomes; and the relative credibility of the existing IT central banks and, in turn, the favourable effect of such credibility on the monetary policy. In contrast, we offer theoretical discussion and evidence for the policy reactions under IT obtained from the more formal procedures of econometric modelling.

C.2.2. Contributions to the empirical evidence

The thesis finds that exchange-rate regime is not significant in explaining growth in general and in developing countries in particular. Contrary to the existing empirical evidence on the topic, the approach here is in line with the economic theory and it addresses neglected issues in the literature: the exchange-rate regime classification; the Lucas critique; and the issue of endogeneity. Our comprehensive approach to these issues constitutes one contribution to the empirical literature.

If the relation between the exchange-rate regime and growth has been previously analysed using rather imprecise theoretical frameworks and by neglecting potential sources of its haziness, then the relationship between regime and output volatility suffered from being unattractive for research. More attention has been attracted by the large shocks and the associated currency crises. The thesis approaches the regime-output volatility relation by designing an appropriate output-volatility framework and exploring the associated role of the exchange-rate regime. In particular, although the role of shocks in affecting output volatility under alternative regimes has been well documented in the theoretical literature, disentangling the source of shocks in empirical frameworks has been usually neglected.

Finally, the thesis makes a contribution to the existing literature in the area of monetary-policy responses under switching monetary regimes. Although a growing body of papers emerged around monetary policy and macro-performance under IT, no paper, to our knowledge, assessed IT as compared to ERT, especially for developing economies in which a peg has had a long playing, crucial role in determining inflation. Amongst the most important contributions is the finding that monetary policy had a role to play in the Great Moderation era and that these countries, because of the switch, became more oriented towards domestic objectives, including short-run output, as well as inflation, accompanied by a more stable macro-environment. The contribution is important in a time when the literature has not yet reached consensus on the issue of whether IT represents a real switch, especially in terms of its role regarding output volatility.

C.2.3. Contributions to the methodological design

On the methodological side, the the thesis makes a contribution at three points. Firstly, the discussion of exchange-rate regimes and output volatility contributes to the way in which output volatility is measured. For the first time in the literature, we argue that if output volatility is measured as a rolling standard deviation, then the series becomes persistent. Not accounting for its persistence, in turn, might exacerbate the probability of a spurious regression, especially in long panels. The empirical investigation lends some evidence in favour of this and contributes to the field by supplying a measure which is stationary.

Secondly, the thesis acknowledges and criticizes the approach to identifying a comparison group of countries for ITers. There is a so-called 'identification problem', which is discussed but not resolved in the literature: the comparison group of non-ITers usually contains countries that have monetary policy geared towards IT (like the FED's, the ECB's and Swiss monetary policy). Hence, this problem might blur and bias the clear distinction between IT and non-IT economies. Worse, it can lead to biased conclusions for the performances under both. We contribute to this, not by examining the problem of grouping in the literature *per se*, but by careful selection of a comparison group of exchange-rate targeters only, hence excluding the possibility that a country is in the comparison group, but implicitly belongs to the treatment group.

Thirdly, to the best of our knowledge, no study has so far analysed the switch between ERT and IT with a non-linear estimation method, like the Markov-switching method. Although this approach has some limitations (discussed in Section 6.7) and we further reveal a technical obstacle in Section C.3, still the pursued non-linear methodology (Section 6.7) to the research problem contributes to existing knowledge in a novel manner.

C.3. Limitations to the research

This thesis started with a broad consideration of exchange-rate and monetary regimes, but was subsequently narrowed down to investigating monetary-policy reactions under a regime switch between exchange-rate targeting and inflation targeting in developing economies. From that viewpoint, the discussion belongs to the wider argument of the pros and cons of the different monetary strategies and contributes to the heated debates about different exchange-rate regimes. However, given the limited time and space to pursue a PhD, this thesis is limited to the choice between ERT and IT in developing economies. Within these boundaries as defined by its objectives, the research did not face large obstacles. The literature has been easily accessible; the same applies to the data. An exception was the difficulty in measuring expected inflation. The usage of the 12-month lead of inflation assumes a perfect foresight model, which is a rather strong assumption, but other measures of expected inflation, like those obtained from surveys are frequently inaccessible for developing economies.

Effort has been devoted to expanding quantitative knowledge by application of MS-VARs. Still, the limited time for pursuing a PhD prevented expanding the programming knowledge on MS-VAR models that may have enabled the measurement of time-varying transition probabilities. To a lesser extent, a limitation appeared around the application of the Markov-switching panel method, mainly because this methodology is still under development: i) it potentially suffers from not addressing the possible cross-sectional dependence among units, which is a considerably debated issue in recent years in a panel context; and ii) it does not advance the issue of switch endogeneity more than MS-VAR does nor does it allow for endogenous regressors. As we argued in Section 6.7.3, some of those methods need further theoretical advancements in order to address the issue of potential endogeneity in all its aspects, rather than piecemeal. This, perforce, represents a limitation on the present work. No other major obstacles were encountered during the research.

C.4. Policy recommendations

C.4.1. Can we say "yes" to exchange-rate targeters if they want to target inflation?

Given the primary objective of the thesis, we found support for exiting a peg under large real shocks, but also support for establishing IT, suggesting that it is associated with lower macroeconomic variability, a more independent monetary policy and oriented to other domestic objectives, in particular inflation. Given these findings, the most important policy recommendation would be for developing countries that peg their exchange rate to start rethinking their monetary strategy toward IT. The thesis provides evidence on some important dimensions to support this recommendation. However, it is based on several preconditions, among which the most important are: clear knowledge of the sources and frequency with which different shocks hit the economy; financial-market development; and the role of the central bank in financing budget deficits. Moreover, the decision to embark on IT in these countries will necessitate the need to allow exchange-rate flexibility. In turn, this depends on the effectiveness of the exchange-rate channel, the level of euroization in the economy, the effectiveness of foreign-exchange intervention and the readiness to subordinate any exchange-rate objective to the inflation objective.

C.4.2. Fears

At the birth of the newest financial crisis (2008), Joseph Stiglitz stated: *"Inflation targeting is being put to the test – and it will almost certainly fail"*. Is the fear exaggerated and has IT failed the test? To our personal judgement, this statement seems far too strong, since there is no practical evidence of complete failure so far (i.e. a reversion to another monetary strategy; Spring 2011), while a strand of the literature already emerges (see, for instance de Carvalho Filho, 2010) providing some support that IT countries performed well under high commodity and fuel prices (end of 2007) and under global economic crisis (thereafter). Habermeier *et al.* (2009) finds support for IT playing a positive role in minimizing the inflationary impact of the 2007 surge in commodity prices. Also, de Carvalho Filho (2010) argues that the IT regime might have played a crucial role in fighting deflation during the crisis, by avoiding the liquidity trap and the perils of a zero interest-rate corner. In that light, Ghosh *et al.* (2009) argue that the credibility of the IT regime enables developing economies, which typically face a greater volatility and upside risks of inflation than advanced economies, to have a considerably greater scope for monetary-policy easing without compromising their inflation outlook. Finally, all this and the potential role of the exchange rate in developing economies and the argument that flexible rates under IT play a shock-absorbing role, especially in times of crises, might lend some support against Stiglitz's fear that IT will fail. Overall, the scepticism expressed by several major central banks about a recent proposal by IMF Chief Economist Olivier Blanchard to raise inflation targets, as a way to give central banks more room to lower interest rates in severe downturns, suggest that key features of IT will remain intact.

However, Buiter (2009) is right when saying that IT central banks have frequently lost sight of important determinants of financial stability, as they adopted intellectual frameworks suited to achieving narrower goals. Similarly, many (e.g. Roger, 2010) already call for designing a way to reconcile monetary-policy responsibilities and objectives with the central-bank responsibility to promote and maintain financial stability. In other words, it is certain that what the crisis suggests for monetary policy is to reassess its role in responding to potential risks to financial stability – notably, rapid increases in credit, house prices and/or stock-market values.

Ultimately, nevertheless, the global economic crisis is still unfolding, hence any premature judgement as to whether IT might not sustain this global pressure, might be naïve. We further relate this point to the proposals for future research, as the text proceeds.

C.5. Proposals for future research

The process of drafting this thesis coincided with the emergence, progression and then moderation of the 2008 Global economic crisis. It would have been distraction to try to put the issues we were treating in this thesis into the context of the crisis: firstly, because nobody knew the actual severity of the crisis until it happened nor knew the timing and durability of the recovery; secondly, because data for robust analysis will be available only a certain period after the crisis has ended (and even a longer period for developing countries); and, thirdly, this crisis was a *sui generis* phenomenon in many aspects that bars the exploitation of previous crises for extracting conclusions. However, it is certain that the crisis has changed the landscape. At a time when it seemed that the world economy has started a slow recovery, Jeffrey Frankel (2009) in the September 2009 issue of the IMF magazine F&D, highlighted five things that crisis made 'out' and five more that it made 'in'. Among them, two attracted our attention.

Firstly, the exit from the corner "hollowing-out" hypothesis (Eichengreen, 1994; Fisher, 2001), which we mentioned in Chapter 2; and the entrance of the intermediate exchange-rate regimes. However, neither the arguments in this thesis (p.77) nor in the theoretical and empirical literature (for instance, Obstfeld and Rogoff, 1995) have accepted this. In other words, the crisis has confirmed that the "middle ground" - the intermediate exchange-rate regimes - has been well populated and "it is uncommon to hear that intermediate regimes are a bad choice generically" (Frankel, 2009, p.14).

Secondly, Frankel (2009), in line of the brief discussion in Section C.4.2, argues that IT becomes 'out', while "fighting asset bubbles" becomes 'in'. He postulates: "I believe that inflation targeting - at least the narrow definition - has already seen its best days" (p.15). We are partially agreed with this observation because, a crisis lesson is that the strict observation of inflation (narrow IT) and inflation and output (flexible IT) does not necessarily deal with asset-price bubbles, as suggested by Greenspan's doctrine that it is hopeless to try to identify and prick speculative bubbles in stock markets and real-estate markets while they are in progress. The crisis challenges this observation, however. Our discussion in Chapter 5 showed that economies have progressively included the exchange rate into their decisions of the interest-rate setup to design monetary policy (p.191, 202). Nevertheless, inclusion of asset prices (like house prices, export prices, stock-market prices and so on; and accordingly, accounting for the possible asset-price cycle) currently obtrudes only as a necessity; but it is not yet pursued either for policy purposes or in the empirical research.

The objective of this short discussion was twofold: first, to show the awareness of the author of the possible questions that the crisis reveals in terms of this thesis, although these questions remain unanswered; and, second, to show that, although issues treated here have many facets to be explored in future, still the crisis has created some additional interesting directions for future research, which might change theoretical and policy thoughts on how to conduct monetary policy. A great area, consequently, is the orientation towards the inclusion of asset prices into the IT framework. This requires that issues treated in this thesis should be put together with the issues of financial (in)stability. This can be a very interesting area for further research.

An interesting area for further research from an econometric viewpoint would be to investigate further the data-generating process of the variables in this thesis (growth and the interest rate, in particular) given their potentially shifting means. The current work tests for non-stationarity in these series, but there could be possible problems if there are structural breaks within a non-stationary process or indeed structural breaks in a stationary process. Responding to this problem, the experiment in Perron (1989) suggests that if the magnitude of such a break is large, then the null of a unit root can be difficult to reject, even if the series is stationary (albeit with one or more breaks, which may refer to shifting means, changing growth or both) with i.i.d. disturbances.

However, given that we rejected the non-stationarity for our variables at conventional levels, the concern of the further work would be to test for a unit root while allowing for the presence of alternative hypotheses, i.e mean-breaks, trends and trends with structural breaks. The current research would account for shifting means if these occurred at the time of exchange-rate switch or monetary-regime switch, but not otherwise. Acknowledging and addressing this wider issue of shifting means and/or changing growth would require an investigation of the possible structural breaks in the data, which would in turn require both considering the economic intuition behind and statistical tests to reveal them. Then, if this testing revealed a problem, it would be interesting to observe how results of the empirical investigations (Section 3.5.1 and Section 6.5) might change. Namely, as Perron (1989) argues, not accounting for a potential structural breaks in the data-generating process of the variables would bias regression results. Given current statistical tests, this investigation would require longer datasets, since "when testing for the presence of a unit root ... against the hypothesis of stationary fluctuations around a deterministic trend function, the use of a long span of data has definite advantages" (Perron, 1989, p.1386). For instance, Perron (1989) uses annual data spanning over 1900-1970; 1871-1970; and quarterly data spanning over 1947:1-1986:3. Compared to the time span used in the thesis (31 years annual data, Chapter 3; 20 years monthly data, Chapter 6), Perron's study (1989) takes a much longer time span.

Other issues peripherally mentioned throughout the text remain to be explored in-depth in future as separate research problems. For instance: the debate of the extent of floating under IT (extent of foreign-exchange market interventions); the discussion of multiple targets under IT (i.e. predominantly, inflation and exchange-rate targets simultaneously); the challenges for the developing countries under IT (in particular related to their degree of currency substitution and exchange-rate pass-through); in addition to the need to take account of asset prices and financial stability. The latter is especially important, because the crisis has also highlighted the importance of financial vulnerability and, hence, of the high euroization in a significant number of developing ITers. This list is non-exhaustive and only pinpoints some interesting facets of issues acknowledged but not treated in this thesis.

References

[1] Agénor, P.R. (2002) Monetary Policy under Flexible Exchange Rates: An Introduction to Inflation Targeting. *Central Banking, Analysis, and Economic Policies Book Series*. In: Loayza, N. and Soto, R. (Editor) and Loayza, N. and Schmidt-Hebbel, K. (Editor) (eds.) *Inflation Targeting: Design, Performance, Challenges.* 1(5), chapter 3, p.79-170, Central Bank of Chile.

[2] Agénor, P.R. and Montiel, P.J. (1999) *Development Macroeconomics*. Princeton University Press.

[3] Aghion, P. and Howitt, P. (1998) *Endogenous Growth Theory*. Cambridge, MA, MIT Press.

[4] Aghion, P., Bacchetta, P., Ranciere, R. and Rogoff, K. (2009) Exchange rate volatility and productivity growth: The role of financial development. *Journal of Monetary Economics*, 56(4), p.494-513.

[5] Ahn, S. and Schmidt, P. (1995) Efficient Estimation of Models for Dynamic Panel Data. *Journal of Econometrics*, 68, p.5-28.

[6] Aizenman, J. and Glick, R. (2008) Pegged Exchange Rate Regimes – A Trap? *Journal of Money, Credit and Banking*, 40(4), p.817 – 835.

[7] Aizenman, J., Hutchison, M. And Noy, I. (2008) Inflation Targeting and Real Exchange Rates in Emerging Markets. *NBER Working Paper*, 14561.

[8] Alesina, A.F., Blanchard, O., Gali, J., Giavazzi, F. and Uhlig, H. (2001) *Defining a Macroeconomic Framework for the Euro Area: Monitoring the European Central Bank 3*. Centre for Economic Policy Research: London.

[9] Almeida, A. and Goodhart, C.A.E. (1998) Does the Adoption of Inflation Targets Affect Central Bank Behaviour? *Banca Nazionale del Lavoro Quarterly Review*, 51(4), p.19-107.

[10] Almekinders, G. J. (1995) *Foreign Exchange Intervention: Theory and Evidence.* Aldershot, UK: Edward Elgar.

[11] Altonji, J.G. and Segal, L.M. (1996) Small-sample Bias in GMM Estimation of Covariance Structures. *Journal of Business and Economic Statistics*, 14, p.353–366.

[12] Amato, J.D. and Gerlach, S. (2002) Inflation Targeting in Emerging Market and Transition Economies: Lessons after a Decade. *European Economic Review,* 46, p.781-790.

[13] Amemiya, T. and MaCurdy, T. (1986) Instrumental Variable Estimation of an Error-Components Model. *Econometrica,* 54, p.869-881.

[14] Andersen, T.W. and Sørensen, B.E. (1996) GMM Estimation of a Stochastic Volatility Model: A Monte Carlo Study. *Journal of Business and Economic Statistics*, 14, p.328–352.

[15] Anderson, T.W. and Hsiao, C. (1981) Estimation of Dynamic Models with Error Components. *Journal of the American Statistical Association*, 76, p.598–606.

[16] Anderson, T.W. and Hsiao, C. (1982) Formulation and Estimation of Dynamic Models Using Panel Data. *Journal of Econometrics*, 18, p.47–82.

[17] Anderson, T.W. and Rubin, H. (1949) Estimation of the Parameters of a Single Equation in a Complete System of Stochastic Equations. *Annals of Mathematical Statistics,* 20, p.46-63.

[18] Andrews, D. (1993) Tests for Parameter Instability and Structural Change with Unknown Change Point. *Econometrica*, 61, p.821-856.

[19] Ang, A. and Bekaert, G. (2002a) Regime Switches in Interest Rates. *Journal of Business and Economic Statistics*, 20(2), p.163-182.

[20] Ang, A. and Bekaert, G. (2002b) International Asset Allocation with Regime Shifts. *Review of Financial Studies*, 15(4), p.1137-1187.

[21] Angeriz, A. and Arestis, P. (2007) Inflation Targeting: Assessing the Evidence. Chapter in: McCombie, J.S.L. and Gonzalez, R.C. (eds.) *Issues in Finance and Monetary Policy.* Palgrave Macmillan.

[22] Arellano, M. (1989) A Note on the Anderson-Hsiao Estimator for Panel Data. *Economics Letters*, 31, p.337-341.

[23] Arellano, M. (2003a) *Panel Data Econometrics.* Oxford: Oxford University Press.

[24] Arellano, M. (2003b) Modelling Optimal Instrumental Variables for Dynamic Panel Data Models. *Working Paper 0310, Centro de Estudios Monetarios y Financieros, Madrid.*

[25] Arellano, M. and Bond, S. (1991) Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *The Review of Econometric Studies,* 58, p.277–297.

[26] Arellano, M. and Bover, O. (1995) Another Look at the Instrumental Variable Estimation of Error-Component Models. *Journal of Econometrics*, 68, p.29-51.

[27] Arestis, P. and Mouratidis, K. (2004) Is There a Trade-Off Between Inflation Variability and Output-Gap Variability in the EMU Countries? *Scottish Journal of Political Economy,* 51(5), p.691-706.

[28] Arestis, P., Caporale, G.M. and Cipollini, A. (2002) Is There a Trade-off Between Inflation and Output Gap? *The Manchester School*, 70(4), p.528-545.

[29] Argov, E., Binyamini, A., Elkayam, D. and Rozenshtrom, I. (2007) A Small Macroeconomic Model to Support Inflation Targeting in Israel. *MPRA Working Paper,* 4784.

[30] Armas, A. and Grippa, F. (2006) Targeting Inflation in a Dollarized Economy: The Peruvian Experience. In: Armas, A., Ize, A. and Levy Yeyati, E. (eds.) *Financial Dollarization: The Policy Agenda*. Palgrave Macmillan.

[31] Asea, P.K. (1996) A New Approach to the Analysis of Panel-data with Endogenous Switching Regimes. *Unpublished manuscript*. In: Asea, P.K. and Bloomberg, B. (1998) Lending Cycles. *Journal of Econometrics,* 83, p.89-128.

[32] Asea, P.K. and Bloomberg, B. (1998) Lending Cycles. *Journal of Econometrics,* 83, p.89-128.

[33] Bailliu, J., Lafrance, R. and Perrault, J.F. (2003) Does Exchange Rate Policy Matter for Growth? *International Finance,* 6(3), p.381-414.

[34] Bakradze, G. and Billmeier, A. (2007) Inflation Targeting in Georgia: Are We There Yet? *IMF Working paper,* 193.

[35] Balassa, B. (1964) The Purchasing Power Parity Doctrine: A Reappraisal. *Journal of Political Economy*, 72(2), 584-596.

[36] Ball, L. (1993) What Determines the Sacrifice Ratio? *NBER Working Paper,* 4306.

[37] Ball, L. (1999) Efficient Rules for Monetary Policy. *International Finance*, 2(1), p.63-83.

[38] Ball, L. and Sheridan, N. (2005) Does Inflation Targeting Matter? In: Bernanke, B.S. and Woodford, M. (eds.) *The Inflation Targeting Debate*. University of Chicago Press for the National Bureau of Economic Research, p.249-276.

[39] Baltagi, B.H. (2008) *Econometric Analysis of Panel Data.* 4th edition, Chichester: John Wiley and Sons Ltd.

[40] Barnow, B., Cain, G. and Goldberger, A. (1980) Issues in the Analysis of Selectivity Bias. *Evaluation Studies*, 5, p.42–59.

[41] Barro, R. and Gordon, D. (1983) Rules, Discretion and Reputation in a Model of Monetary Policy. *Journal of Monetary Economics,* 12, p.101-121.

[42] Barro, R.J. and Sala-i-Martin, X. (1991) Convergence across States and Regions. *Brookings Papers on Economic Activity*, 1, p.107-182.

[43] Barro, R.J. and Sala-i-Martin, X. (1992) Convergence. *Journal of Political Economy*, 100, p.223-251.

[44] Barro, R.J. and Sala-i-Martin, X. (2004) *Economic growth.* 2nd ed. Cambridge, MIT Press.

[45] Bartholomew, D.J. and Bassett, E.E. (1971) *Let's Look at the Figures: The Quantitative Approach to Human Affairs.* London, Penguin Books.

[46] Bastourre, D. and Carrera, J. (2004) Could the Exchange Rate Regime Reduce Macroeconomic Volatility. *Econometric Society 2004 Latin American Meetings,* 309, p.1-29.

[47] Basu, S. and Taylor, A. (1989) Business Cycles in International Historical Perspective. *Journal of Economic Perspectives.* 13(2), p.45-68.

[48] Batini, N. and Haldane, A. (1998) Forward Looking Rules for Monetary Policy. *Bank of England Discussion Paper*, 91.

[49] Batini, N., Breuer, P., Kochhar, K. and Roger, S. (2006) Inflation Targeting and the IMF. *IMF Staff Paper*, Washington DC.

[50] Baum, C. F., Schaffer, M. E. and Stillman, S. (2003) Instrumental Variables and GMM: Estimation and Testing. *Stata Journal*, 3, pp.1-31.

[51] Baum, C. F., Schaffer, M. E. and Stillman, S. (2007) Enhanced Routines for Instrumental variables/GMM estimation and testing. *Working Paper*, 667, Boston College Department of Economics.

[52] Baumol, W.J. and Blinder, A.S. (2006) *Macroeconomics: Principles and Policy*. Tenth edition. Thomson South-Western.

[53] Baxter, M. and Stockman, A.C. (1989) Business Cycle and the Exchange rate Regime: Some International Evidence. *Journal of Monetary economics,* 23, p.377-400.

[54] Bean, C. (1998) The New UK Monetary Arrangements: A View from the Literature. *Economic Journal*, 108, p.1795-1809.

[55] Behr, A. (2003) A Comparison of Dynamic Panel Data Estimators: Monte Carlo Evidence and an Application to the Investment Function. *Discussion paper of the Economic Research Centre of the Deutsche Bundesbank*, 05/03, p.1-28.

[56] Berg, A. and Borensztein, E. (2000) The Choice of Exchange Rate Regime and Monetary Target in Highly Dollarized Economies. *IMF Working Paper,* 29.

[57] Bernanke, B. and Blinder, A. (1988) Credit, Money, and Aggregate Demand. *American Economic Review*, 78, p.435-439.

[58] Bernanke, B. and Gertler, M. (1989) Agency Costs, Net Worth, and Business Fluctuations. *American Economic Review,* 79, p.14-31.

[59] Bernanke, B. and Gertler, M. (1995) Inside the Black Box: The Credit Channel of Monetary Policy Transmission. *Journal of Economic Perspectives,* 9, p.27-48.

[60] Bernanke, B. and Mishkin, F.S. (1997) Inflation Targeting: A New Framework for Monetary Policy? *Journal of Economic Perspectives,* 11(2), p.97-116.

[61] Bernanke, B., Gertler, M. and Gilchrist, S. (1996) The Financial Accelerator and the Flight to Quality. *The Review of Economics and Statistics*, 78, p.1-15.

[62] Bernanke, B.S. and Gertler, M. (2001) Should Central Banks Respond to Movements in Asset Prices? *American Economic Review*, 91(2), p.253-257.

[63] Bernanke, B.S., Laubach, T., Mishkin, F.S. and Posen, A. (1999) *Inflation Targeting: Lessons from the International Experience.* Princeton University Press: Princeton.

[64] Blanchard, O. (1997) Comment. *NBER Macroeconomics Annual 1997*, Cambridge, MA, MIT Press, p.289-295.

[65] Bleaney, M. and Fielding, D. (2002) Exchange Rate Regimes, Inflation and Output Volatility in Developing Countries. *Journal of Development Economics,* 68, p.233-245.

[66] Bleaney, M. and Francisco, M. (2007) Exchange Rate Regime, Inflation and Growth in Developing Economies – An Assessment. *The BE Journal of Macroeconomics,* 7(1), p.1-18.

[67] Blecker, R.A. (2002) *Distribution, Demand and Growth in Neo-Kaleckian Macro-Models*. In: Setterfield, M. (eds.) *The Economics of Demand-led Growth: Challenging the Supply-side Vision of the Long Run.* Cheltenham, UK and Northampton, USA: Edward Elgar.

[68] Blundel, R.W. and MaCurdy, T.E. (2000) Labour Supply: A Review of Alternative Approaches. In: Ashenfelter, O.C. and Card, D.E. (eds.) *Handbook of Labour Economics.* 3A, p.1559-1695, Amsterdam, North-Holland.

[69] Blundell, R. and Bond, S. (1998) Initial Conditions and Moment Restrictions in Dynamic Panel Data Models. *Journal of Econometrics*, 87, p.115-143.

[70] Bofinger, P. and Wollmershaeuser, T. (2003) Managed Floating as a Monetary Policy Strategy. *Economics of Planning*, 36(2), p.81-109.

[71] Bogdanski, J., Tombini, A. and Werlang, S. (2000) Implementing Inflation Targeting in Brazil. *Banco Central do Brasil Working Paper,* 1.

[72] Bohm, H. and Funke, M. (2001) Does the Nominal Exchange Rate Regime Matter for Investment? *CESifo Working Paper,* 578.

[73] Boivin, J. and Giannoni, M.P. (2006) Has Monetary Policy Become More Effective? *Review of Economics and Statistics*, 88, p.445–62.

[74] Bond, S., Hoeffler, A. and Temple, J. (2001) GMM Estimation of Empirical Growth Models. *Economics Papers: 2001-W21*, Nuffield College, University of Oxford.

[75] Bordo, M.D. and Jeanne, O. (2002) Monetary Policy and Asset Prices: Does 'Benign Neglect' Make Sense? *International Finance*, 5(2), p.139-64.

[76] Borensztein, E. and De Gregorio, J. (1999) *Devaluation and Inflation after Currency Crises*. Washington, D.C.: International Monetary Fund.

[77] Borman, S. (2009) The Expectation Maximization Algorithm - A short tutorial. *Mimeo*. Available on: http://www.isi.edu/natural-language/teaching/cs562/2009/readings/B06.pdf

[78] Bowsher, C.G. (2002) On Testing Overidentifying Restrictions in Dynamic Panel Data Models. *Economics Letters*, 77, p.211–220.

[79] Brada, J. C. and Méndez, J. A. (1988) Exchange Rate Risk, Exchange Rate Regime and the Volume of International Trade, *Kyklos,* 41(2), p.263-280.

[80] Brock, W.A. and Durlauf, S. (2001) Growth Empirics and Reality. *World Bank Economic Review,* 15(2), p.229-272.

[81] Broda, C. (2002) Terms of Trade and Exchange Rate Regimes in Developing Countries. *Journal of International Economics,* 63(1), p.31-58.

[82] Brooks, C. (2002) Switching Models. In: Brooks, C. (eds.) *Introductory Econometrics for Finance*. Cambridge: Cambridge University Press, p.533-576.

[83] Bubula, A. and Ötker-Robe, I. (2003) Are Pegged and Intermediate Exchange Rate Regimes More Crisis Prone? *IMF Working paper,* 03/223.

[84] Buiter, W. (2009) The Unfortunate Uselessness of Most 'State of the Art' Academic Monetary Economics. *Financial Times,* March 3rd, 2009. Available online: http://blogs.ft.com/maverecon/2009/03/the-unfortunate-uselessness-of-most-state-of-the-art-academic-monetary-economics/ [Access date: 25/03/2010].

[85] Calvo, G. (1978) On the Time Consistency of Optimal Policy in the Monetary Economy. *Econometrica,* 46(6), p.1411-28.

[86] Calvo, G. (2001) Capital Markets and the Exchange Rate: With Special Reference to the Dollarization Debate in Latin America. *Journal of Money, Credit and Banking,* 33(2), p.312-334.

[87] Calvo, G. and Mendoza, E. (2000) Capital-Market Crises and Economic Collapse in Emerging Markets: An Informational-Frictions Approach. *American Economic Review,* 10(2), p.29-55.

[88] Calvo, G. and Reinhart, C.M. (2002) Fear of Floating. *Quarterly Journal of Economics,* 117, p.379-408.

[89] Cameron, A.S. and Trivedi, P.K. (2005) *Microeconometrics: Methods and applications*. Cambridge: Cambridge University Press.

[90] Canales-Kriljenko, J. I. (2003) Foreign Exchange Intervention in Developing and Transition Economies: Results of a Survey. *IMF Working Paper,* 03/95.

[91] Canavan, C. and Tommasi, M. (1997) On the Credibility of Alternative Exchange Rate Regimes. *Journal of Development Economics,* 54, p.101-122.

[92] Caputo, R. and Liendo, F. (2005) Monetary Policy, Exchange Rate and Inflation Inertia in Chile: A Structural Approach. *Working Paper of the Central Bank of Chile*, 352.

[93] Caputo, R., Liendo, F. and Medina, J.P. (2007) New Keynesian Models for Chile in the Inflation-Targeting Period. In: Mishkin, F. And Schmidt-Hebbel, K. (eds.) *Monetary Policy under Inflation Targeting.* Santiago: Central Bank of Chile, p.507-546.

[94] Caramazza, F. and Aziz, J. (1998) Fixed or Flexible? Getting the Exchange Rate Right in the 1990s. *IMF Economic Issues,* 13, p.1-25.

[95] Carlson, J.A. and Parkin, M. (1975) Inflation Expectations. *Economica*, 42(166), p.123-138.

[96] Caruana, J. (2007) Review of Exchange Arrangements, Restrictions, and Controls. *IMF Staff report.* Washington DC.

[97] Caselli, F., Esquivel, G. and Lefort, F. (1996) Reopening the Convergence Debate: A New Look at Cross-country Growth Empirics. *Journal of Economic Growth,* 1, p.363-389.

[98] Cavalho, M. (2005) To Float or Not to Float? Exchange Rate Regimes and Shocks, *FRBSF Economic Letter*, 2005(1), p.1-3.

[99] Cecchetti, S. C. and Ehrmann, M. (1999) Does Inflation Targeting Increase Output Volatility? An International Comparison of Policymakers' Preferences and Outcomes. *NBER Working Paper*, 7426.

[100] Cecchetti, S.G., Lam, P.S. and Mark, N.C. (1990) Mean Reversion in Equilibrium Asset Prices. *American Economic Review,* 80, p.398-418.

[101] Cerra, V. and Saxena, S.C. (2002) Contagion, Monsoons, and Domestic Turmoil in Indonesia's Currency Crisis. *Review of International Economics*, 10(1), p.36 - 44.

[102] Chang, R. and Velasco, A. (2000), Exchange Rate Policy for Developing Countries, *American Economic Review,* 90(2), p.71-75.

[103] Chen, S.S. (2006) Revisiting the Interest Rate-Exchange Rate Nexus: A Markov Switching Approach. *Journal of Development Economics*, 79(1), p.208-224.

[104] Chinn, M.D. and Ito, H. (2008) A New Measure of Financial Openness. *Journal of Comparative Policy Analysis,* 10(3), p.309-322

[105] Christiano, L.J. and Gust, C.J. (1999) Taylor Rules in a Limited Participation Model. *De Economist*, 147(4), p.437-460.

[106] Clarida, R., Galí, J. and Gertler, M. (1998) Monetary Policy in Practice: Some International Evidence. *European Economic Review*, 42, p.1033–1067.

[107] Clarida, R., Galí, J. and Gertler, M. (1999) The Science of Monetary Policy: A New Keynesian Perspective. *Journal of Economic Literature,* 37, p.1661-1707.

[108] Clarida R, Galí, J. and Gertler, M. (2000) Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory. *Quarterly Journal of Economics*, 115, p.147–180.

[109] Clarida, R., Galí, J. and Gertler, M. (2001) Optimal Monetary Policy in Open Versus Closed Economies: An Integrated Approach. *The American Economic Review*, 91(2), p.248-252.

[110] Clark, P.K. (1987) The Cyclical Component of US Economic Activity. *Quarterly Journal of Economics,* 102, p.797-814.

[111] Collins, M.S. (1996) On Becoming More Flexible: Exchange Rate Regime in Latin America and the Caribbean. *Journal of Development Economics,* 51(1996), p.117-138.

[112] Conçalves, C.E.S. and Salles, J.M. (2008) Inflation Targeting in Emerging Economies: What do the Data Say? *Journal of Development Economics*, 85, p.312-318.

[113] Cooper, R. (1999) Exchange Rate Choices. *Harvard Institute of Economic Research Working Papers*, 1877.

[114] Cooper, R. (2000) Towards a Common Currency. *International Finance*, 3(2), p.287-308.

[115] Corbo, V., Landerretche, M.O. and Schmidt-Hebbel, K. (2001) Assessing Inflation Targeting After a Decade of World Experience. *International Journal of Finance and Economics,* 6, p.343-368.

[116] Corbo,V., Landerrretche, M.O. and Schmidt-Hebbel, K. (2002) Does Inflation Targeting Make A Difference? In: N. Loayza and R. Saito (eds.) *Inflation Targeting: Design, Performance, Challenges.* Central Bank of Chile: Santiago, Chile.

[117] Corden, W.M. (2002) *Too Sensational: On the Choice of Exchange Rate Regimes.* Cambridge, MA: MIT Press.

[118] Ćorić B. (2008) Globalization, Capital Market Imperfections and Decline in Short-run Output Volatility of World Economies. *Unpublished PhD dissertation, Staffordshire University.*

[119] Ćorić B. and Pugh, G. (2010) The effects of exchange rate variability on international trade: a meta-regression analysis. *Applied Economics*, 42(20), p.2631-2644.

[120] Coricelli, F., Jazbec, B. and Masten, I. (2006) Exchange Rate Pass-through in EMU Acceding Countries: Empirical Analysis and Policy Implications. Journal of Banking and Finance, 30(5), p.1375-1391.

[121] Corsetti, G. and Pesenti, P. (2004) International Dimensions of Optimal Monetary Policy. *Journal of Monetary Economics,* 52(2), p.281-330.

[122] Cosslett, S.R. and Lee, L.F. (1985) Serial Correlation in Discrete Variable Models. *Journal of Econometrics*, 27, p.79-97.

[123] Creedy, J., Lye, J. and Martin, V. (1994) Non-linearities and the Long-run Real Exchange Rate Distribution. In: Creedy, J. and Martin, V. (eds.) *Chaos and Non-linear Models in Economics.* Cheltenham: Edward Elgar, Chapter 13.

[124] Creel, J. and Hubert, P. (2009) Has the Adoption of Inflation Targeting Represented a Regime Switch? Empirical evidence from Canada, Sweden and the UK. *Documents de Travail de l'OFCE*, 2008-25.

[125] Crowley, P. and Lee, J. (2003) Exchange Rate Volatility and Foreign Investment: International Evidence. *International Trade Journal*, 17(3), p.227-52.

[126] Curdia, V. and Finocchiaro, D. (2005) An Estimated DSGE Model for Sweden with a Monetary Regime Change. *Seminar Papers,* 740, Stockholm University, Institute for International Economic Studies.

[127] Dai, Q., Singleton, K.J. and Yang, W. (2007) Regime Shifts in a Dynamic Term Structure Model of U.S. Treasury Bond yields. *Review of Financial Studies*, 20(5), p.1669-1706.

[128] Davidson, R. and MacKinnon, J.G. (1993) *Estimation and Inference in Econometrics.* 2nd ed. New York: Oxford University Press.

[129] Davies, R.B. (1987) Hypothesis testing when a nuisance parameter is present only under the alternative. *Biometrika,* 74, p.33–43.

[130] De Carvalho Filho, I. (2010) Inflation Targeting and the Crisis: An Empirical Assessment. *IMF Working paper,* 10/45.

[131] De Grauwe, P. (1989; 2nd ed., 1996) *International Money*. Oxford: Oxford University Press.

[132] De Grauwe, P. and Schnabl, G. (2005) Exchange Rates Regimes and Macroeconomic Stability in Central and Eastern Europe. In: Schadler, S. (eds.) *Euro adoption in Central and Eastern Europe: opportunities and challenges*. Washington DC: International Monetary Fund.

[133] De Mello, L. and Moccero, D. (2008) Monetary Policy and Macroeconomic Stability in Latin America: The Cases of Brazil, Chile, Colombia and Mexico. In: De Mello, L. (eds.), *Monetary Policies and Inflation Targeting in Emerging Economies* (edited volume). OECD (Paris).

[134] De Mello, L., Editor, (2008) *Monetary Policies and Inflation Targeting in Emerging Economies* (edited volume). OECD (Paris).

[135] De Mello, L., Moccero, D. and Gnabo, J. (2008) Interdependencies between Monetary Policy and Foreign-Exchange Intervention under Inflation Targeting: The case of Brazil and the Czech Republic. *OECD Economics Department Working Papers*, 593.

[136] Debelle, G. (1999) Inflation Targeting and Output Stabilization. *Research Discussion paper,* 1999-08, Reserve Bank of Australia, p.1-25.

[137] Debelle, G. (2000) The Viability of Inflation Targeting for Emerging Market Economies. *Paper prepared for the conference on "Financial Markets and Policies in East Asia",* Australian National University, September.

[138] Del Negro, M. and Schorfheide, F. (2008) Inflation Dynamics in a Small Open-Economy Model under Inflation Targeting: Some Evidence from Chile. *Federal Reserve Bank of New York Staff Report*, 329.

[139] Dellas, H. and Zilberfarb, B. (1995) Real Exchange Rate Volatility and International Trade: A Re-examination of the Theory. *Southern Economic Journal,* p.641-647.

[140] Dempster, A. P., Laird, N. M. and Rubin, D. B. (1977) Maximum likelihood from in-complete data via the EM algorithm. *Journal of the Royal Statistical Society: Series B*, 39(1), p.1–38.

[141] Dib, A. (2003) An Estimated Canadian DSGE Model with Nominal and Real Rigidities. *The Canadian Journal of Economics*, 36(4), p.949-972.

[142] DiCecio, R. and Nelson, E. (2007) An Estimated DSGE Model for the United Kingdom. *Working Paper, Federal Reserve Bank of St. Louis*, No. 2007-006A.

[143] Diebold, F. X., and Rudebusch, G. D. (1996) Measuring Business Cycles: A Modern Perspective. *Review of Economics and Statistics*, 78, p.67–77.

[144] Diebold, F., Lee J-H, and Weinbach G.C. (1999) Regime switching with time-varying transition probabilities. In: Diebold, F. and Rudebusch, G.D. (eds.) *Business cycles: durations, dynamics and forecasting.* Princeton University Press.

[145] Disyatat, P. and Galati, G. (2007) The Effectiveness of Foreign Exchange Intervention in Emerging Market Countries: Evidence from the Czech Koruna. *Journal of International Money and Finance*, 26(3), p.383-402.

[146] Dixit, A. (1989) Hysteresis, Import Penetration and Exchange Rate Pass-Through. *Quarterly Journal of Economics,* 26, p.309-325.

[147] Domac, I., Peters, K. and Yuzefovich, Y. (2004a) Does the Exchange Rate Regime Matter for Inflation? Evidence from Transition Economies. *Policy Research Working Paper,* 2641.

[148] Domac, I., Peters, K. and Yuzefovich, Y. (2004b) Does the Exchange Rate Regime Affect Macroeconomic Performance? Evidence from Transition Economies. *Policy Research Working Paper,* 2642.

[149] Dominguez, K. M. and Frankel, J. A. (1993) Does Foreign Exchange Intervention Matter? The Portfolio Effect. *American Economic Review,* 83, p.1356-1369.

[150] Doornik, J. A. and Hendry, D.F. (2009) Part VI: Regime Switching Models (Switching). In: Doornik, J. A. and Hendry, D.F. (eds.) *PcGive 13: Volume III.* London: Timberlake Consultants Ltd., p.129-156.

[151] Du, H. and Zhu, Z. (2001) The Effect of Exchange-rate Risk on Exports: Some Additional Empirical Evidence. *Journal of Economic Studies,* 28(2), p.106-123.

[152] Dubas, J.M., Lee, B.J. and Mark, N.C. (2005) Effective Exchange Rate Classifications and Growth. *NBER Working paper,* 11272.

[153] Duisenberg, W. (2003) Introductory Statement, and Questions and Answers. *ECB Press Conference*, 8 May, Frankfurt: Germany.

[154] Durland, J. and McCurdy, T. (1994) Duration-dependent Transitions in a Markov Model of US GNP Growth. *Journal of Business and Economic Statistics,* 12(3), p.279-288.

[155] Durlauf, S. and Quah, D. (1999) The New Empirics of Economic Growth. In: Taylor, J. and Woodford, M. (eds.) *Handbook of Macroeconomics.* Amsterdam, North Holland.

[156] Duttagupta, R. and Ötker-Robe, I. (2003) Exits From Pegged Regimes: An Empirical Analysis. *IMF Working Paper*, 03/147.

[157] Easterly, W. and Kraay, A. (2000) Small States, Small Problems? Income, Growth, and Volatility in Small States. *World Development*, 28(11), p.2013-2027.

[158] Easterly, W., Islam, R. and Stiglitz, J.E. (2001) Shaken and Stirred: Explaining Growth Volatility. *Proceedings of the Annual World Bank Conference on Development Economics*, p.191-222.

[159] Edison, H. J. (1993) The Effectiveness of Central Bank Intervention: A Survey of the Literature after 1982. *Special Papers in International Economics*, 18, Princeton University. Princeton.

[160] Edwards, S. (1996) Economic Policy and the Dynamics of Growth. *Estudios de Economia*, 23(2), p.137-55.

[161] Edwards, S. (2006) The Relationship Between Exchange Rates and Inflation Targeting Revisited. *NBER Working Paper,* 12163.

[162] Edwards, S. and Levy-Yeyati, E. (2005) Flexible Exchange Rates as Shock Absorbers. *European Economic Review,* 49(8), p.2079-2105.

[163] Edwards, S. and Magendzo, I. (2003) A Currency of One's Own? An Empirical Investigation on Dollarization and Independent Currency Unions. *NBER Working Paper*, 9514.

[164] Egert, B. and Komarek, L. (2006) Foreign Exchange Interventions and Interest Rate Policy in the Czech Republic: Hand in Glove? *Economic Systems*, 30(2), p.121-140.

[165] Eichengreen, B. (1994) *International Monetary Arrangements for the 21st Century.* Washington DC: Brookings Institution.

[166] Eichengreen, B. and Leblang, D. (2003) Exchange Rates and Cohesion: Historical Perspectives and Political-Economy Considerations. *Journal of Common Market Studies,* 41(5), p.797-822.

[167] Eichengreen, B., Masson, P., Savastano, M. and Sharma, S. (1999) Transition Strategies and Nominal Anchors on the Road to Greater Exchange Rate Flexibility. *Essays in International Finance*, 213, Princeton University.

[168] Engel, C. (1993) Real exchange rates and relative prices: An empirical investigation. *Journal of Monetary Economics*, 32(1), p.35-50.

[169] Engel, C. (1999) On the Foreign Exchange Risk Premium in Sticky-Price General Equilibrium Models. *International Tax and Public Finance*, 6(4), p.491-505.

[170] Engel, C. (2002) The Responsiveness of Consumer Prices to Exchange Rates: A Synthesis of Some New Open Economy Macro Models. *Manchester School*, 70(0), p.1-15.

[171] Erceg, C., Henderson, D. W. and Levin, A. T. (1998) Trade-offs between Inflation and Output Gap Variances in an Optimizing Agent Model. *International Finance,* 627, Washington, DC, Board of Governors of the Federal Reserve System.

[172] Estrella, A. and Mishkin, F.S. (1997) Is There a Role for Monetary Aggregates in the Conduct of Monetary Policy. *Journal of Monetary Economics*, 40(2), p.279-304.

[173] Everaert, G. and Pozzi, L. (2007) Bootstrap-based Bias Correction for Dynamic Panels. *Journal of Economic Dynamics and Control.* 31, p.1160-1184.

[174] Fatum, R. and Hutchison, M. M. (2006) Effectiveness of Official Daily Foreign Exchange Market Intervention Operations in Japan. *Journal of International Money and Finance*, 25(2), p.199-219.

[175] Filardo, A. (1994) Business-cycle Phases and Their Transitional Dynamics. *Journal of business and economics.* 12(3), p.299-308.

[176] Fischer, S. (1993) The Role of Macroeconomic Factors in Growth. *Journal of Monetary Economic*s, p.485-512.

[177] Fisher, S. (2001) Exchange Rate Regimes: Is the Bipolar View Correct? *Journal of Economic Perspectives,* 15, p.3-24.

[178] Fisher, S., Sahay, R. and Vegh, C. (1996) Stabilization and Growth in Transition Economies: The Early Experience. *Journal of Economic Perspectives,* p.45-66.

[179] Flamini, A. (2007) Inflation Targeting and Exchange Rate Pass-Through. *Journal of International Money and Finance,* 26(7), p.1113-1150.

[180] Flood, R. and Rose, A. (1995) Fixing Exchange Rates: A Virtual Quest for Fundamentals. *Journal of Monetary Economics,* 36, p.3-37.

[181] Fraga, A., Goldfajn, I. and Minella, A. (2004) Inflation Targeting in Emerging Market Economies. *Paper presented at the NBER Eighteenth Annual Conference on Macroeconomics, Washington,* p.365-400.

[182] Frankel, J.A. (1979) On the Mark: A Theory of Floating Exchange Rates Based on Real Interest Differentials. *American Economic Review,* 69(4), p.610-22.

[183] Frankel, J.A. (2009) What's In and Out in Global Money. *Finance and development,* September 2009, p.13-17.

[184] Frankel, J.A. and Rose, A.K. (1996) Currency crashes in emerging markets: An empirical treatment. *Journal of International Economics*, 41(3-4), p.351-366.

[185] Friedman, M. (1963) Monetary Studies of the National Bureau. *The National Bureau Enters its 45th Year,* 44th Annual Report. Reprinted in: Friedman, M. (1969) *The Optimum Quantity of Money and Other Essays*. Chicago: Aldine, Chap.12, p.261-284.

[186] Friedman, M. (1993) The 'Plucking Model' of Business Fluctuations Revisited. *Economic Inquiry,* p.171-177.

[187] Friedman, Milton (1953) The Case for Flexible Exchange Rates. In: *Essays in Positive Economics.* University of Chicago Press, Chicago.

[188] Fuhrer, J., Sneddon Little, J., Kodrzycki, Y.K. and Olivei, G.P. (2009) *Understanding Inflation and the Implications for Monetary Policy: A Phillips Curve Retrospective*. The MIT Press, Chatham, Massachusetts.

[189] Fuji, E. and Bailliu, J. (2004) Exchange Rate Pass-Through and the Inflation Environment in Industrialized Countries: An Empirical Investigation. *Computing in Economics and Finance Series*, 135.

[190] Further, J.C. (1997) Inflation Output Variance Trade-off and Optimal Monetary Policy. *Journal of Money Credit and Banking*, 29, p.214-234.

[191] Gagnon, J.E. and Ihrig, J. (2004) Monetary Policy and Exchange Rate Pass-Through. *International Journal of Finance and Economics*, 9(4), p.315-338.

[192] Galí, J. and Monacelli, T. (2005) Monetary Policy and Exchange Rate Volatility in a Small Open Economy. *Review of Economic Studies*, 72(3), p.707 - 734.

[193] Garcia, R. (1998) Asymptotic Null Distribution of the Likelihood Ratio Test in Markov Switching Models. *International Economic Review,* 39, p.763-788.

[194] Garcia, R. and Perron, P. (1996) An Analysis of the Real Interest Rate under Regime Shifts. *Review of Economics and Statistics*, 78, p.111–125.

[195] Garofalo, P. (2005) Exchange Rate Regimes and Economic Performance: The Italian Experience. *Banca D'Italia Quaderni dell'Úfficio Ricerche Storiche,* 10.

[196] Gavin, M. and Hausman, R. (1996) *Securing Stability and Growth in a Shock Prone Region: The Policy Challenges for Latin America.* In: Hausman, R. and Reisen, H. (eds.) Securing Stability and Growth in Latin America. OECD Paris.

[197] Gersl, A. and Holub, T. (2006) Foreign Exchange Interventions under Inflation Targeting: The Czech Experience. *Contemporary Economic Policy,* 24(4), p.475-491.

[198] Ghosh, A.R. and Ostry, J.D. (2009) Choosing an Exchange Rate Regime. *Finance and development,* December 2009, p.38-40.

[199] Ghosh, A.R., Chamon, M., Crowe, C., Kim, J.I. and Ostry, J.D. (2009) Coping with the Crisis: Policy Options for Emerging Market Countries. *IMF Staff Position Note*, 09/08.

[200] Ghosh, A.R., Ostry, J.D., Gulde, A.M. and Wolf, H.C. (1997) Does the Exchange Rate Regime Matter for Inflation and Growth? *IMF Economic Issues,* 2, p.1-19.

[201] Goldfeld, S.M. and Quandt, R.E. (1973) A Markov Model for Switching Regressions. *Journal of Econometrics*. 1, p.3-16.

[202] Goldstein, M. (2002) *Managed Floating Plus*. Washington DC: Institute for International Economics, Policy Analyses in International Economics.

[203] Goodfriend, M. and King, R. (1997) The New Neoclassical Synthesis and the Role of Monetary Policy. *NBER Macroeconomics Annual 1997*, Cambridge, MA, MIT Press, p.233-283.

[204] Goodhart, C.A.E. (1975a) Monetary Relationships: A View from Thread needle Street. In: *Papers in Monetary Economics*, Volume I, Reserve Bank of Australia.

[205] Goodhart, C.A.E. (1975b) Problems of Monetary Management: The UK Experience. In: *Papers in Monetary Economics*, Volume I, Reserve Bank of Australia.

[206] Gore, C. (2007) Which Growth Theory is Good for the Poor? *The European Journal of Development Research,* 19(1), p.30-48.

[207] Gosselin, M.A. (2007) Central Bank Performance under Inflation Targeting. *Working paper,* 2007-18, Bank of Canada.

[208] Gramlich, E.M. (2000) *Inflation Targeting. Remarks before the Charlotte Economics Club*, Charlotte: North Carolina.

[209] Greene, W. (2003) *Econometric Analysis*, 5th Ed., New Jersey: Prentice Hall.

[210] Groenevald, H.M.; Koedijk, K.G. and Kool, C.J.M. (1998) Inflation Dynamics and Monetary Strategies: Evidence from Six Industrialized Countries. *Open Economies Review*, 9(1), p.21-38.

[211] Grubel, H.G. (2000) The Merit of a Canada-US Monetary Union. *North American Journal of Economics and Finance,* 11, p.19-40.

[212] Guimaraes, R. F. and Karacadag, C. (2004) The Empirics of Foreign Exchange Intervention in Emerging Market Countries: The Cases of Mexico and Turkey. *IMF Working Paper*, 123.

[213] Guinigundo, D. (2008) Transmission mechanism of monetary policy in the Philippines. In: "*Transmission mechanisms for monetary policy in emerging market economies*", *BIS Papers*, 35, p.413-426.

[214] Gulsen, E. (2009) Exchange Rate Pass-through and Inflation Targeting. *Unpublished Master's thesis. Middle East Technical University.*

[215] Gylfason, T. (2000) Fix or Flex? Alternative Exchange Rate Regimes in an Era of Global Capital Mobility. *North American Journal of Economics and Finance,* 11(2), p.173-89.

[216] Habermeier, K, Ötker-Robe, İ., Jacome, L., Giustiniani, A., Ishi, K., Vávra, D., Kışınbay, T. and Vazquez, F. (2009) Inflation Pressures and Monetary Policy Options in Emerging and Developing countries: A Cross Regional Perspective. *IMF Working paper,* 09/1.

[217] Hahn, J., Hausman, J. and Kuersteiner, G. (2004) Estimation with Weak Instruments: Accuracy of Higher-order Bias and MSE Approximations. *Econometrics Journal*, 7(1), p.272-306.

[218] Hall, A.R. (2005) *Generalized Method of Moments.* Oxford: Oxford University Press.

[219] Hamilton, J.D. (1989) A New Approach to the Economic Analysis of Nonstationary Time Series and the Business Cycle. *Econometrica*, 57(2), p.357–384.

[220] Hamilton, J.D. (1994) *Time Series Analysis.* Princeton: Princeton University Press.

[221] Hammond, G. (2009) State of the Art of Inflation Targeting. *CCBS Handbook,* 29.

[222] Hands, D.W. (2001) *Reflection without Rules: Economic Methodology and Contemporary Science Theory*. Cambridge: Cambridge University Press.

[223] Hansen, B.E. (1996) Inference when a Nuisance Parameter is not under the Null Hypothesis. *Econometrica*, 64: 413-430.

[224] Hansen, B.E. (1997) Inference in TAR Models. *Studies in Nonlinear Dynamics and Econometrics*, 2, p.1-14.

[225] Hansen, B.E. (2000) Sample Splitting and Threshold Estimation. *Econometrica*, 68, p.575-603.

[226] Hansen, G. (2001) A Bias-corrected Least Squares Estimator of Dynamic Panel Models. *Allgemeines Statistisches Archiv*, 85, p.127-140.

[227] Hansen, L., Heaton, J. and Yaron, A. (1996) Finite Sample Properties of Some Alternative GMM Estimators. *Journal of Business and Economic Statistics*, 14(3), p.262-280.

[228] Hansen, P.L. (1982) Large Sample Properties of Generalized Method of Moments Estimators. *Econometrica,* 50(4), p.1029-1054.

[229] Harris, M.N. and Matyas, L. (2004) A comparative analysis of different IV and GMM estimators of dynamic panel data models. *International Statistical Review,* 72(3), p.397-408

[230] Hausman, J. and Taylor, W. (1981) Panel Data and Unobservable Individual Effects. *Econometrica,* 49(6), p.1377-1398.

[231] Hayashi, F. (2000) *Econometrics.* 1st ed. Princeton, NJ: Princeton University Press.

[232] Heckman, J. and Hotz, V. (1989) Choosing among Alternative Non-experimental Methods for Evaluating the Impact of Social Programs. *Journal of the American Statistical Association,* 85, p.862-880.

[233] Hennan, G., Peter, M. and Roger, S. (2006) Implementing Inflation Targeting: Institutional Arrangements, Target Design and Communications. *IMF Working paper,* 06/278.

[234] Hrncir, M. and Smidkova, K. (2004) Inflation targeting in the Czech Republic. *Mimeo.*

[235] Huang, H. and Malhotra, P. (2005) Exchange Rate Regimes and Economic Growth: Evidence from developing Asian and Advanced European Economies. *China Economic Quarterly,* 2(1), p.1-23.

[236] Hume, D. (1742) *Essays: Moral, Political and Literary.* Ed. E. Miller Indianapolis: Liberty Classics.

[237] Husain, A., Mody, A. and Rogoff, K.S. (2005) Exchange Rate Regime Durability and Performance in Developing Versus Advanced Economies. *Journal of Monetary Economics*, 52(1), p.35-64.

[238] Imbens, G.W. and Wooldridge, J. (2009) Recent Developments in the Econometrics of Program Evaluation. *Journal of Economic Literature*, 47(1), p.5-86(82).

[239] IMF (1997) *World Economic Outlook*, Chapter IV, p.78–97. World Economic and Financial Surveys, Washington: International Monetary Fund.

[240] IMF (2005) *World Economic Outlook*. Washington: International Monetary Fund.

[241] Islam, N. (1995) Growth Empirics: A Panel Data Approach. *Quarterly Journal of Economics*, 110(4), p.1127-70.

[242] Ito, T. (2003) Is Foreign Exchange Intervention Effective? The Japanese Experiences in the 1990s. In: Mizen, P. (eds.) *Monetary History. Exchange Rates and Financial Markets.* Cheltenham. UK: Edward Elgar, p.126-153.

[243] Jakab, Z.M. and Vilagi, B. (2008) An Estimated DSGE Model of the Hungarian Economy. *MNB Working papers*, 2008/09.

[244] Jonas, J. and Mishkin, F.S. (2003) Inflation Targeting in Transition Countries: Experience and Prospects. In: Woodford, M. (eds.) *Inflation Targeting.* University of Chicago Press: Chicago.

[245] Judson, R. A. and Owen, A. L. (1996) Estimating Dynamic Panel Data Models: A Guide for Macroeconomics. *Economics Letters*, 65, p.9-15.

[246] Justiniano, A. and Preston, B. (2004) Small Open Economy DSGE Models: Specification, Estimation and Model Fit. *IMF Working paper,* 125.

[247] Kane, E.J. and Malkiel, B.G. (1976) Autoregressive and Nonautoregressive Elements in Cross-Section Forecasts of Inflation. *Econometrica,* 44, p.1-12.

[248] Kearns, J. and Rigibon, R. (2005) Identifying the Efficacy of Central Bank Interventions: Evidence from Australia and Japan. *Journal of International Economics,* 66, p.31-48.

[249] Kim, C.J., Piger, J. and Startz, R. (2008) Estimation of Markov Regime-Switching Regression Models with Endogenous Switching. *Journal of Econometrics,* 143, p.263–273.

[250] King, M. (1996) How Should Central Banks Reduce Inflation? Conceptual Issues. In: *Achieving Price Stability*, Federal Reserve Bank of Kansas City, Kansas City, p.53-91.

[251] King, M. (1999) Challenges for Monetary Policy: New and Old. *New Challenges for Monetary Policy: A Symposium Sponsored by the Federal Reserve Bank of Kansas City*, p.11-58.

[252] King, R.G. and Wolman, A.L. (1996) Inflation Targeting in a St. Louis Model of the 21st Century. *Federal reserve bank of St. Louis Quarterly Review,* p.83-107.

[253] King, R.G. and Wolman, A.L. (1998) What Should Monetary Authority Do When Prices are Sticky? In: Taylor, J. (eds.) *Monetary Policy Rules.* Chicago, IL, University of Chicago Press.

[254] Kiviet, J. (1995) On Bias, Inconsistency, and Efficiency of Various Estimators in Dynamic Panel Data Models. *Journal of Econometrics*, 68, p.53-78.

[255] Kleibergen, F. and Paap, R. (2006) Generalized Reduced Rank Tests using the Singular Value Decomposition. *Journal of Econometrics*, 133(1), p.97-126.

[256] Klein, M.W. and Marion, N.P. (1997) Explaining the Duration of Exchange-Rate Pegs. *Journal of Development Economics*, 54(2), p.387-404.

[257] Kose, M.A., Prasad, E.S. and Terrones, M.E. (2005) Growth and Volatility in an Era of Globalization. *IMF Staff Papers,* 52(Special issue), p.31-63.

[258] Krolzig, H.M. (1998) Econometric Modelling of Markov-Switching Vector Autoregressions using MSVAR for Ox. *Working paper of the Institute of Economics and Statistics and Nuffield College, Oxford.*

[259] Krolzig, H.-M. and Toro, J. (1999) A New Approach to the Analysis of Shocks and the Cycle in a Model of Output and Employment. *European University Institute Working Paper ECO*, 99/30.

[260] Krueger, A. O. (1997) Nominal Anchor Exchange Rate Policies as a Domestic Distortion. *NBER Working paper,* 5968.

[261] Krugman, P. (1991) Target Zones and Exchange Rate Dynamics. *Quarterly Journal of Economics,* 56, p.669-682.

[262] Kydland, F. and Prescott, E. (1977) Rules Rather than Discretion: The Inconsistency of Optimal Plans. *Journal of Political Economy,* 85(3), p.473-92.

[263] Lam, J.P. (2003) Alternative Targeting Regimes, Transmission Lags and the Exchange Rate Channel. *Bank of Canada Working Paper,* 2003-39.

[264] Lam, P.S. (2004) A Markov-switching Model of GNP Growth with Duration Dependence. *International Economic Review,* 45(1), p.175-205.

[265] Lee, J. (1999a) Inflation Targeting in Practice: Further Evidence. *Contemporary Economic Policy,* 17(3), p.332-347.

[266] Lee, J. (1999b) The Inflation and Output Volatility Trade-Off: Evidence from a GARCH Model. *Economic Letters,* 62, p.63-67.

[267] Leiderman, L., and Svensson, L.E.O. eds. (1995) *Inflation Targets*. London: Centre for Economic Policy Research.

[268] Leiderman, L., Maino, R. and Parrado, E. (2006) Inflation Targeting in Dollarized Economies. *IMF Working paper*, 157.

[269] Levine, R. and Renelt, D. (1992) A Sensitivity Analysis of Cross-Country Growth Regressions. *American Economic Review*, p.942-63.

[270] Levy-Yeyati, E. and Sturzenegger, F. (2001) Exchange Rate Regimes and Economic Performance. *Journal of International Money and Finance,* 47(special issue), p.62-95.

[271] Levy-Yeyati, E. and Sturzenegger, F. (2002) To Float or to Fix: Evidence on the Impact of Exchange Rate Regimes on Growth. *American Economic Review,* 12(2), p.1-49.

[272] Levy-Yeyati, E. and Sturzenegger, F. (2005) Classifying Exchange Rate Regimes: Deeds vs. Words. *European Economic Review*, 49(6), p.1603-1635.

[273] Li, H. (2007) Small sample inference in rational expectations models with persistent data. *Economics letters*, 95(2), p.203-210.

[274] Liederman, L. and Svensson, L. (1995) *Inflation Targets.* CEPR, London.

[275] Lim, G., Li, S. and Bao, Y. (2007) An Estimated Small DSGE Model for Australia: Insights from Alternative Monetary Policy Rules. *Working paper, The University of Melbourne.*

[276] Lindsey, D. (1986) The Monetary Regime of the Federal Reserve System. In: Campbell, C. and Dougan, W. (eds.) *Alternative Monetary Regimes.* Baltimore and London: The Johns Hopkins University Press.

[277] Liu, P. (2006) A Small New Keynesian Model of the New Zealand Economy. *Working paper, Research School of Pacific and Asian Studies.*

[278] Lokshin, B. (2008) A Monte-Carlo Comparison of Alternative Estimators for Dynamic Panel Data Models. *Applied Economics Letters,* 15, p.15–18.

[279] Lowe, P. and Ellis, L. (1997) The Smoothing of Official Interest Rates. *Monetary policy and inflation targeting*, Reserve Bank of Australia, p.287-312.

[280] Lubik, T.A. and Schorfheide, F. (2004) Testing for Indeterminacy: An Application to U.S. Monetary Policy. *American Economic Review*, 94, p.190–217.

[281] Lucas, R. (1976) Econometric Policy Evaluation: A Critique. In: Brunner, K. and Meltzer, A. (eds.) The Phillips Curve and Labour Markets. *Carnegie-Rochester Conference Series on Public Policy,* 1.

[282] Lucas, R. (1988) On the Mechanisms of Development Planning. *Journal of Monetary Economics,* 22(1), p.3–42.

[283] Maddala, G.S. (2005) *Introduction to Econometrics*. Third ed. John Wiley and Sons. Chichester.

[284] Maddala, G.S. and Kim, I.M. (1998) Regime Switching Models and Structural Time-series Models. In: Maddala, G.S. and Kim, I.M. (eds.) *Unit roots, Cointegration and Structural Change.* Cambridge: Cambridge University Press, p.454-485.

[285] Maddala, G.S. and 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, p.631-652.

[286] Mankiw, G., Romer, D. and Weil, D. (1992) A Contribution to the Empirics of Economic Growth. *Quarterly Journal of Economics,* 407–437.

[287] Mankiw, G.N. (2006) *Macroeconomics.* Thompson Learning, 6-th Edition.

[288] Masson, P. (2001) Exchange Rate Regime Transition. *Journal of Development Economics*,
64(2), p.571-586.

[289] Masson, P.R., Savastano, M.A. and Sharma, S. (1997) The Scope for Inflation Targeting in developing Countries. *IMF Working paper,* 130.

[290] McCallum, B.T. (1999a) Issues in the design of monetary policy rules. *Handbook of Macroeconomics*. In: Taylor, J.B. and Woodford, M. (eds.) *Handbook of Macroeconomics.* 1(1), Chapter 23, p.1483-1530.

[291] McCallum, B.T. (1999b) Recent Developments in Monetary Policy Analysis: The Roles of Theory and Evidence. *Journal of Economic Methodology*, 6(2), p.171-98.

[292] McCaw, S. and Morka, K.H. (2005) Monetary Policy and the Trade-off between Inflation and Output Variability. *Economic Bulletin,* p.1-24.

[293] McDermott, J. and McMenamin, P. (2008) Assessing Inflation Targeting in Latin America with a DSGE Model. *Working Papers Central Bank of Chile*, 469.

[294] McKenzie, M. (1999) The Impact of Exchange Rate Volatility on International Trade Flows. *Journal of Economic Surveys*, 13(1), p.71-106.

[295] McKinnon, R. and Schnabl, G. (2004) The East Asian Dollar Standard, Fear of Floating and Original Sin. *Review of Development Economics*, 8(3), p.331 - 360.

[296] McKinnon, R.I. (1991) Financial Control in the Transition from Classical Socialism to a Market Economy. *The Journal of Economic Perspectives*, 5(4), p.107-122.

[297] Medeiros, O. R. and Sobral, Y.D. (2008) A Markov Switching Regime Model of the Brazilian Business Cycle. *Programa de Pos-Graduacao em Administracao – PPGA,* 1, p.1-22.

[298] Meyer, B.D. (1995) Natural and Quasi-Experiments in Economics. *Journal of Business and Economic Statistics,* 13(2), p.151-195.

[299] Mincer, J. (1969) Models of Adaptive Forecasting. In: *Economic Forecasts and Expectations*. Ed. New York: National Bureau of Economic Research.

[300] Minella, A., de Freitas, P.S., Goldfajn, I. and Muinhos, M.K. (2003) Inflation Targeting in Brazil: Constructing Credibility Under Exchange Rate Volatility. *Journal of International Money and Finance*, 22, p.1015-40.

[301] Misas, M. and Ramirez, M.T. (2007) Colombian Economic Growth under Markov Switching Regimes with Endogenous Transition Probabilities. *Working paper of the Banco de la Republica.*

[302] Mishkin, F.S. (1996) The Channels of Monetary Transmission: Lessons for Monetary Policy. *Banque de France Bulletin Digest,* 27, p.33-44.

[303] Mishkin, F.S. (1999) International Experiences with Different Monetary Policy Regimes. *Journal of Monetary Economics*, 43(3), p.579-606.

[304] Mishkin, F.S. (2000a) Inflation Targeting in Emerging Market Countries. *American Economic Review*, 90(2), p.105-109.

[305] Mishkin, F.S. (2000b) What Should Central Banks Do? *Federal Reserve Bank of St. Louis Review*, 82(6), p.1-13.

[306] Mishkin, F.S. (2001) Issues in Inflation Targeting. In: *Price Stability and the Long-Run Target for Monetary Policy.* Bank of Canada: Ottawa, Canada, p.203-222.

[307] Mishkin, F.S. (2002a) From Monetary Targeting to Inflation Targeting: Lessons from the Industrialized Countries. In: *Banco de Mexico, Stabilization and Monetary Policy: The International Experience.* Bank of Mexico: Mexico City, p.99-139.

[308] Mishkin, F.S. (2002b) Inflation Targeting. In: Vane, H. and Snowdon, B. (eds.) *Encyclopaedia of Macroeconomics.* Edward Elgar: Cheltenham U.K., p.361-65.

[309] Mishkin, F.S. (2002c) The Role of Output Stabilization in the Conduct of Monetary Policy. *International Finance*, 5(2), p.213-227.

[310] Mishkin, F.S. (2003) Comments on 'Inflation Targeting in Emerging Market Economies'. *NBER Macro Annual*, p.403-413.

[311] Mishkin, F.S. (2004) Why the Fed Should Adopt Inflation Targeting. *International Finance*, 7(1), p.117-27.

[312] Mishkin, F.S. (2005) Can Inflation Targeting Work in Emerging Market Countries? In: Reinhart, C., Vegh, C. and Velasco, A. (eds.) *A Festschrift for Guillermo Calvo*.

[313] Mishkin, F.S. (2008) Exchange Rate Pass-Through and Monetary Policy. *NBER Working Paper, 13889*.

[314] Mishkin, F.S. and Calvo, G. (2003) The Mirage of Exchange Rate Regimes for Emerging Market Countries. *Journal of Economic Perspectives*, 17(4), p.99-118.

[315] Mishkin, F.S. and Posen, A.S. (1998) Inflation Targeting: Lessons from Four Countries. *Economic Policy Review*, 3(3), p.9-110.

[316] Mishkin, F.S. and Savastano, M. (2002) Monetary Policy Strategies for Emerging Market Countries: Lessons from Latin America. *Comparative Economic Studies,* 44(2), p.45-83.

[317] Mishkin, F.S. and Schmidt-Hebbel K.D. (2006) Monetary Policy Under Inflation Targeting: An Introduction. *Journal Economía Chilena (The Chilean Economy)*, 9(3), p.5-17.

[318] Mishkin, F.S. and Schmidt-Hebbel K.D. (2007) Does Inflation Targeting Make a Difference? *NBER Working Paper*, 12876.

[319] Mishkin, F.S. and Schmidt-Hebbel, K. (2001) One Decade of Inflation Targeting in the World: What Do We Know and What Do We Need to Know? *NBER Working paper,* 8397.

[320] Mobarack, A. (2001) The Causes of Volatility and Implications for Economic Development. *Mimeo*, University of Maryland.

[321] Moffitt, R. A. (1996) Identification of Causal Effects Using Instrumental Variables: Comment. *Journal of the American Statistical Association*, 91, p.462–465.

[322] Mohanty, M.S. and Klau, M. (2005) Monetary Policy Rules in Emerging Market Economies: Issues and Evidence. In: Laughammer, R.J. and Vinhas de Souza, L. (eds.) *Monetary Policy and Macroeconomic Stabilization in Latin America*, Berlin: Springer Berlin Heidelberg.

[323] Mohsin, K.S. (2003) Current Issues in the Design and Conduct of Monetary Policy. *IMF Working paper,* 03/56.

[324] Moolman, E.A. (2204) A Markov Switching Regime Model of the South African Business Cycle. *Economic modelling,* 21, p.631-646.

[325] Morandé, F.L. and Schmidt-Hebbel, C.D. (2000) Alternative Monetary Schemes: A Positive Evaluation for the Chilean Peso. *Journal Economía Chilena (The Chilean Economy), Central Bank of Chile*, 3(1), p.57-84.

[326] Moreno, R. (2000) Pegging and Macroeconomic Performance in East Asia. *ASEAN Economic Bulletin*, 18(1), p.48-63.

[327] Moreno, R. (2001) Pegging and Stabilization Policy in Developing Countries. *Economic Review of the Federal Reserve Bank of San Francisco*, 12(99), p.17-29.

[328] Mundell, R.A. (1961) A Theory of Optimum Currency Areas. *The American Economic Review*, 51(4), p.657-665

[329] Mundell, R.A. (1968) *International economics.* New York: Macmillan.

[330] Mundell, R.A. (1995) Exchange Rate Systems and Economic Growth. In: Marcuzzo, M.C., Officer, L.H. and Rosselli, A. (1996) *Monetary Standards and Exchange Rates*, p.13-37.

[331] Mussa, M. (1986) Nominal Exchange Rate Regimes and the Behaviour of Real Exchange Rates: Evidence and Implications. *Carnegie-Rochester Conference Series on Public Policy.*

[332] Mussa, M., Masson, P., Swoboda, A., Jadresic, E., Mauro, P. and Berg, A. (2000) Exchange Rate Regimes in an Increasingly Integrated World Economy. *IMF Occasional Paper*, 193.

[333] Nadal-De Simone, F. (2001a) Inflation Targeting and Monetary Targeting in a Small Open Economy: The Behaviour of Price Variables. *New Zealand Economic Papers*, 35(1), p.101 - 142.

[334] Nadal-De Simone, F. (2001b) An Investigation of Output Variance before and during Inflation Targeting. *IMF Working paper,* 215.

[335] Nelson, R.R. and Winter, S.G. (1974) Neoclassical vs. Evolutionary Theories of Economic Growth: Critique and Prospectus. *The Economic Journal*, 84(36), p.886–905.

[336] Nelson, R.R. and Winter, S.G. (1982) *An Evolutionary Theory of Economic Change.* Cambridge, MA: Harvard University Press.

[337] Neumann, M.J.M. and von Hagen, J. (2002) Does Inflation Targeting Matter? *Federal Reserve Bank of St. Louis Review*, 84(4), p.127-148.

[338] Newbery, D.M. and Stiglitz, J.E. (1982) Risk Aversion, Supply Response, and the Optimality of Random Prices: A Diagrammatic Analysis. *Quarterly Journal of Economics*, 97(1), p.1-26.

[339] Newey, W.K. and West, K.D. (1987a) Hypothesis Testing with Efficient Method of Moments Estimation. *International Economic Review,* 28, p.777–787.

[340] Newey, W.K. and West, K.D. (1987b) A Simple, Positive Semi-definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix. *Econometrica,* 55, p.703–708.

[341] Newey, W.K. and West, K.D. (1994) Automatic Lag Selection in Covariance Matrix Estimation. *Review of Economic Studies,* 61, p.631–653.

[342] Nickell, S. (1981) Biases in Dynamic Models with Fixed Effects. *Econometrica*, 49, p.1417-1426.

[343] Nilsson, K. and Nilsson, L. (2000) Exchange Rate Regimes and Export Performance of Developing Countries. *World Economy*, 23(3), p.331 – 349.

[344] Nogueira, R.P., Jr. (2006) Inflation Targeting and the Role of Exchange Rate Pass-Through. *University of Kent Discussion Paper* 0602.

[345] Obstfeld, M. and Rogoff, K. (1995) The Mirage of Fixed Exchange Rates. *Journal of Economic Perspectives,* 9(4), p.73-96.

[346] Ocampo, J.A. (2005) *The Quest for Dynamic Efficiency: Structural Dynamics and Economic Growth in Developing Countries.* In: Ocampo, J.A. (eds.) *Beyond Reforms: Structural Dynamics and Macroeconomic Vulnerability*. Stanford Economics and Finance, Stanford University Press and Washington DC: World Bank.

[347] Pagan, A.R. and Hall, D. (1983) Diagnostic Tests as Residual Analysis. *Econometric Reviews,* 2(2), p.159-218.

[348] Pelagatti M. (2002) Duration-Dependent Markov-Switching VAR models with Application to the U.S. Business Cycle Analysis. *Proceedings of the XLI Scientific Meeting of the Italian Statistics Society*.

[349] Pelagatti M. (2003) DDMSVAR for Ox: a Software for Time Series Modeling with Duration Dependent Markov-Switching Autoregressions. *1st OxMetrics User Conference, London*, September 1-2, 2003.

[350] Pelagatti M. (2008) Duration Dependent Markov-Switching Vector Autoregression: Properties, Bayesian Inference, Software and Application. In: Nagakawa, T. (eds.) *Business Fluctuations and Cycles*. Nova Science Publishers, Hauppauge NY, p.43-46.

[351] Pelagatti, M.M. (2005) Time Series Modeling with Duration Dependent Markov-Switching Vector Autoregressions: MCMC Inference, Software and Applications. *Econometrics*, 0503008.

[352] Pentecost, E. (1993) *Exchange Rate Dynamics.* Aldershot: Edward Elgar.

[353] Perron, P. (1989) The Great Crash, the Oli Price Shocs, and the Unit Root Hypothesis. *Econometrica,* 57(6), p.1361-1401.

[354] Pesaran, H.M. (2003) Estimation and Inference in Large Heterogeneous Panels with Cross Section Dependence. *Cambridge Working Papers in Economics,* 0305.

[355] Pesaran, M. H., and Smith, R. P. (1995) Estimating Long-run Relationships from Dynamic Heterogeneous Panels. *Journal of Econometrics,* 68(1), p.79-113.

[356] Pesaran, M. H., Shin, Y. and Smith, R. P. (1997) Pooled Estimation of Long-run Relationships in Dynamic Heterogeneous Panels. *Cambridge Working Papers in Economics*, 9721.

[357] Pesaran, M. H., Shin, Y. and Smith, R. P. (1999) Pooled Mean Group Estimation of Dynamic Heterogeneous Panels. *Journal of the American Statistical Association,* 94, p.621-634.

[358] Pétursson, T.G. (2004) Formulation of Inflation Targeting around the World. *Monetary Bulletin*, 2004/1, p.57-84.

[359] Piragic, S. and Jameson, K. P. (2005) The Determinants of Latin American Exchange Rate Regimes, *Applied Economics,* 37(13), p.1465-1474.

[360] Poirson, H. (2001) How Do Countries Choose Their Exchange Rate Regime? *IMF Working Paper,* 46.

[361] Poole, W. (1970) Optimal Choice of Monetary Policy Instruments in a Simple Stochastic Model. *Quarterly Journal of Economics, 84*(2), p.197–216.

[362] Potter, S.M. (2002) Nonlinear Time Series Modelling: An Introduction. *Journal of Economic Surveys*, 13(5), p.505 - 528.

[363] Poulson, B.W. (1994) *Economic Development: Private and Public Choice.* New York, West Publishing Company.

[364] Primiceri, G.E. (2006) Why Inflation Rose and Fell: Policymakers' Beliefs and US Postwar Stabilization Policy. *Quarterly Journal of Economics,* 121, p.867–901.

[365] Pritchett, L. (2000) Understanding Patterns of Economic Growth: Searching for Hills among Plateaus, Mountains, and Plains. *World Bank Economic Review,* 14(2), p.221-250.

[366] Pruski, J. (2002) Poland as an Example of Successful Transition From Inflation Targeting Lite to Fully Fledged Inflation Targeting. *Conference at the IMF "Challenges to Central Banking from Globalized Financial Systems",* Washington, D.C., September 16–17, 2002 .

[367] Pugh, G. (2009) The GMM Estimation of Dynamic Panel Models: An Intuitive Explanation of the Principles. *Mimeo, Staffordshire University.*

[368] Pugh, G. and Tyrrall, D. (2001) Will the Single Currency Promote intra-European trade? *European Business Journal*, 14, p.150-157.

[369] Pugh, G., Tyrrall, D. and Tarnawa, L. (1999) Exchange Rate Variability, International Trade and the Single Currency Debate: A Survey. In: Meeusen, W. (eds.) *Current Issues in European Economic Policy.* Aldershot: Edward Elgar.

[370] Ramey, G. and Ramey, V. (1995) Cross-Country Evidence on the Link between Volatility and Growth. *American Economic Review,* 85, p.1138-1151.

[371] Rasche, R.H. and Williams, M.M. (2005) The Effectiveness of Monetary Policy. *Federal Reserve Bank* of *St. Louis Working Paper,* 2005-048B.

[372] Ravn, M. O. and Sola, M. (1995) Stylized Facts and Regime Changes: Are Prices Procyclical? *Journal of Monetary Economics*, 36, p.497–526.

[373] Rebelo, S. (1991) Long-run Policy Analysis and Long-run Growth. *Journal of Political Economy,* 99(3), p.500–21.

[374] Reinhart, C. and Rogoff, K.S. (2004) The Modern History of Exchange Rate Arrangements: A Reinterpretation. *Quarterly Journal of Economics,* 119(1), p.1-48.

[375] Reitz, S. (2002) Central Bank Intervention and Exchange Rate Expectations—Evidence from Daily DM/US-Dollar Exchange Rate. *Deutsche Bundesbank Discussion Paper,* 17.

[376] Resler, D.H. (1980) The formation of inflation expectations. *Review of Federal Reserve Bank of St Louis.* April issue, p.2-12.

[377] Roger, S. (2009) Inflation Targeting at 20: Achievements and Challenges. *IMF Working paper,* 09/236.

[378] Roger, S. (2010) Inflation Targeting Turns 20. *Finance and development,* March 2010, p.46-49.

[379] Roger, S. and Stone, M. (2005) On Target? The International Experience with Achieving Inflation Targets. *IMF Working Paper*, 05/163.

[380] Rogoff, K. (1996) The Purchasing Power Parity Puzzle. *Journal of Economic Literature*, 34(2), p.647-668.

[381] Rogoff, K. (1999) International Institutions for Reducing Global Financial Instability. *The Journal of Economic Perspectives*, 13(4), p.21-42.

[382] Rogoff, K.S., Husain, A.M., Mody, A., Robin, B. and Oomes, N. (2004) Evolution and Performance of Exchange Rate Regimes. *IMF Occassional paper,* 229.

[383] Romer, P. (1986) Increasing Returns and Long-run Growth. *Journal of Political Economy,* 94, p.1002–37.

[384] Romer, P. (1990) Endogenous Technological Change. *Journal of Political Economy*, 98, p.S71–S102.

[385] Romer, P. (1994) The Origins of Endogenous Growth. *Journal of Economic Perspectives*, 8, p.3–22.

[386] Roodman, D. (2008) How to Do xtabond2: An Introduction to Difference and System GMM in Stata. *Working paper of Center for Global Development*, 103.

[387] Roodman, D. (2009) A Note on the Theme of Too Many Instruments. *Oxford Bulletin of Economics and Statistics*, 71(1), p.135 – 158.

[388] Rudebusch, G. (2002) Term Structure Evidence on Interest Rate Smoothing and Monetary Policy Inertia. *Journal of Monetary Economics*, 49, p.1161–1187.

[389] Rudebusch, G.D. and Svensson, L.O. (1998) Policy Rules for Inflation Targeting. *NBER Working Paper*, 6512.

[390] Ruud, P.A. (2000) *Classical Econometrics.* New York: Oxford University Press.

[391] Sack, B. and Wieland, V. (2000) Interest-rate Smoothing and Optimal Monetary Policy: A Review of Recent Empirical Evidence. *Journal of Economics and Business*, 52(1-2), p.205-228.

[392] Salman, A.K. and Shukur, G. (2004) Testing for Granger Causality Between Industrial Output and CPI in the Presence of Regime Shift. *Journal of Economic Studies,* 31(6), p.492-499.

[393] Samuelson, P. A. (1964) Theoretical Notes on Trade Problems. *The Review of Economics and Statistics*, 46, 145-154.

[394] Sarafidis, V., Yamagata, T. and Robertson, D. (2009) A Test of Cross Section Dependence for a Linear Dynamic Panel Model with Regressors. *Journal of*

Econometrics,
148(2), p.149-161.

[395] Sargent, T.J. and Wallace, N. (1981) The Real Bills Doctrine vs. The Quantity Theory: A Reconsideration. *Federal Reserve Bank of Minneapolis, Staff Report,* 64.

[396] Schmidt-Hebbel, K. and Tapia, M. (2002) Monetary Policy Implementation and Results in Twenty Inflation-Targeting Countries. *Central Bank of Chile Working Paper,* 166.

[397] Schmidt-Hebbel, K., Werner, A., Hausmann, R. and Chang, R. (2002) Inflation Targeting in Brazil, Chile, and Mexico: Performance, Credibility, and the Exchange Rate. *Economía*, 2(2), p.31-89.

[398] Schuler, K. (1999) The Problem with Pegged Exchange Rates. *Kyklos*, 52(1), p.83-102.

[399] Schwartz, A. J. (2000) The Rise and Fall of Foreign Exchange Market Intervention. *Journal of Financial Services Research*, 18(2-3), p.319-339.

[400] Setterfield, M. (2002) *The Economics of Demand-led Growth: Challenging the Supply-side Vision of the Long Run*. Cheltenham, UK and Northampton, USA: Edward Elgar.

[401] Sevestre, P. and Trognon, A. (1985) A Note on Autoregressive Error Component Models. *Journal of Econometrics*, 28, 231–245.

[402] Siklos, P.L. (1999) Inflation Target Design: Changing Performance and Persistence in Industrial Countries. *Federal Reserve Bank of St. Louis Review*, 81(2), p.47-58.

[403] Siklos, P.L. and Abel, I. (2002) Is Hungary Ready for Inflation Targeting? *Economic Systems,* 26, p.309-333.

[404] Sims, C.A. and Zha, T. (2006) Were there Regime Switches in US Monetary Policy? *American Economic Review,* 36(1), p.54–81.

[405] Smith, A. (1776) *An Inquiry into the Nature and Causes of the Wealth of Nations*. New York: Modern Library.

[406] Sola, M., and Driffill, E. J. (1994) Testing the Term Structure of Interest Rates from a Stationary Markov-Switching VAR. *Journal of Economic Dynamics and Control*, 18, p.601–628.

[407] Solow, R. (1956) A Contribution to the Theory of Economic Growth. *Quarterly Journal of Economics*, 70, p.65–94.

[408] Solow, R. (1957) Technical Change and the Aggregate Production Function. *Review of Economics and Statistics*, 39(3), p.312–20.

[409] Staiger, D. and Stock, J.H. (1997) Instrumental Variables Regression with Weak Instruments. *Econometrica*, 65(3), p. 557-586.

[410] Stein, E., Hausmann, R., Gavin, M. and Pagés-Serra, C. (1999) Financial Turmoil and Choice of Exchange Rate Regime. *IADB Working Paper (Washington: Inter-American Development Bank).*

[411] Sterne, G. (1999) The Use of Explicit Targets for Monetary Policy: Practical Experiences of 91 Economies in the 1990s. *Bank of England Quarterly Bulletin*, August 1999.

[412] Stevens, G. and Debelle, G. (1995) Monetary Policy Goals for Inflation in Australia. In: Haldane, A. (eds.) *Targeting Inflation*. Bank of England, p.81–100.

[413] Stiglitz, J. and Weiss, A. (1981) Credit Rationing in Markets with Imperfect Information. *American Economic Review*, 71, p.393-410.

[414] Stock, J. H. and Yogo, M. (2005) Testing for Weak Instruments in Linear IV Regression. In: Andrews, D. W. and Stock, J. H. (eds.) *Identification and Inference for Econometric Models: Essays in Honour of Thomas Rothenberg*. Cambridge University Press, Cambridge, p.80-108.

[415] Stock, J.H. And Watson, M.W. (2006) *Introduction to econometrics*. 2nd ed. Prentice Hall.

[416] Stone, M., Roger, S., Shimizu, S., Nordstrom, A., Kisinbay, T. and Restrepo, J. (2009) The Role of the Exchange Rate in Inflation-targeting Emerging Economies. *IMF Occasional paper,* 267.

[417] Strathern, M. (1997) 'Improving Ratings': Audit in the British University System. *European Review,* 5, 305-321.

[418] Svensson, L.O. (1996) Inflation Forecast Targeting: Implementing and Monitoring Inflation Targets. *European Economic Review*, 41, p.1111-1146.

[419] Svensson, L.O. (1997) Monetary Policy and Inflation Targeting. Research Summary. *NBER Reporter,* p.5-8.

[420] Svensson, L.O. (1998) Inflation Targeting in an Open Economy: Strict or Flexible Inflation Targeting? Public Lecture held at Victoria University of Wellington, New Zealand, November 18, 1997. *Victoria Economic Commentaries,* 15-1.

[421] Svensson, L.O. (1999a) Inflation Targeting as a Monetary Policy Rule. *Journal of Monetary Economics,* 43, p.607-654.

[422] Svensson, L.O. (1999b) Inflation Targeting: Some Extensions. *Scandinavian Journal of Economics,* 101(3), p.337-361.

[423] Svensson, L.O. (2000) Open-Economy Inflation Targeting, *Journal of International Economics* 50, p.155-183.

[424] Svensson, L.O. (2003) Monetary Policy and Real Stabilization. *NBER Working Papers,* 9486.

[425] Svensson, L.O. (2007) Optimal Inflation Targeting: Further Developments of Inflation Targeting. *Central Bank of Chile Working Paper,* p.187-225.

[426] Svensson, L.O. and Woodford, M. (2003) Indicator variables for optimal policy. *Journal of Monetary Economics*, 50(3), p.691-720.

[427] Swan, T.W. (1956) Economic Growth and Capital Accumulation. *Economic Record*, 32(2), p.334–61.

[428] Tauchen, G. (1986) Statistical Properties of Generalized Method-of-moments Estimators of Structural Parameters Obtained from Financial Market Data. *Journal of Business and Economic Statistics*, 4, p.397–416.

[429] Tavlas, G.S. (2003) The Economics of Exchange-Rate Regimes: A Review Essay. *World Economy,* 26(8), p.1215-1246.

[430] Taylor, J.B. (1979) Estimation and control of a macroeconomic model with rational expectations. *Econometrica,* 47(5), p.1267-86.

[431] Taylor, J.B. (1993) Discretion Versus Policy Rules in Practice. *Carnegie–Rochester Conference Series on Public Policy,* 39, p.195–214.

[432] Taylor, J.B. (1994) The Inflation/Output Variability Trade-off Revisited. In: Fuhrer, J.C. (eds.) Goals, Guidelines, and Constraints Facing Monetary Policymakers. *The Federal Reserve Bank of Boston Conference Series*, 38, p.21-38.

[433] Taylor, J.B. (1995) The Monetary Transmission Mechanism: An Empirical Framework. *Journal of Economic Perspectives.* 9, p.11-26.

[434] Taylor, J.B. (1999) The Robustness and Efficiency of Monetary Policy Rules as Guidelines for Interest Rate Setting by the European Central Bank. *Journal of Monetary Economics*, 43, p.655-679.

[435] Taylor, J.B. (2000) Low Inflation, Pass-Through, and the Pricing Power of Firms. *European Economic Review*, 44 (7), p.1389-1408.

[436] Taylor, J.B. (2001) *Monetary Policy Rules*. National Bureau of Economic Research Studies in Income and Wealth.

[437] Taylor, J.B. (2001a) The Role of the Exchange Rate in Monetary-policy Rules. *American Economic Review Papers and Proceedings*, 91, p.263-67.

[438] Thirlwall, A.P. (2005) *Growth and Development with Special Reference to Developing Countries.* Basingstoke: Palgave Macmillan.

[439] Tica, J. and Družić, I. (2006) The Harrod-Balassa-Samuelson Effect: A Survey of Empirical Evidence. University of Zagreb, Faculty of Economics and Business, Zagreb, *FEB - Working Paper,* 06-07.

[440] Tobin, J. (1969) A General Equilibrium Approach to Monetary Theory. *Journal of Money, Credit, and Banking.* 1, p.15-29.

[441] Tong, H. (1978) On a Threshold Model. In: Chen, C.H. (eds.) *Pattern Recognition and Signal Processing.* Kluwer: Amsterdam.

[442] Tong, H. (1983) *Threshold models in non-linear time series analysis,* Springer: New York.

[443] Tong, H. (1993) *Non-linear Time Series: A Dynamical System Approach.* Oxford University Press: Oxford.

[444] Tong, H. and Lim, K. S. (1980) Threshold Autoregressions, Limit Cycles and Data. *Journal of the Royal Statistical Society B,* 42, p.245-295.

[445] Tornell, A. and Velasco, A. (2000) Fixed Versus Flexible Exchange Rates: Which Provides More Fiscal Discipline? *European Economic Review*, 46(6), p.1111-1123.

[446] Truman, E. M. (2003) *Inflation Targeting in the World Economy.* Washington. DC: Institute for International Economics.

[447] Tucker, J. (1776) *Four Facts on Political and Commercial Subject.* 3rd ed. reprint, Clifton, NJ: Augustus M. Kelley Publishers.

[448] Turner, C.M., Startz, R. and Nelson, C.R. (1989) A Markov Model of Heteroskedasticity, Risk, and Learning in the Stock Market. *Journal of Financial Economics*, 25, p.3–22.

[449] Valente, G. (2003) Monetary Policy Rules and Regime Shifts. *Applied Financial Economics*, 13(7), p.525-535.

[450] Vázquez, J. (2008) Does the Term Spread Play a Role in the Fed Funds Rate Reaction Function? An Empirical Investigation. *Empirical Economics*, 36, p.175–199.

[451] Vega, M. and Winkelried, D. (2005) Inflation Targeting and Inflation Behaviour: A Successful Story? *International Journal of Central Banking,* 1(3), p.153-175.

[452] Velickovski, I. and Pugh, G.T. (forthcoming) Constraints on exchange rate flexibility in transition economies: a meta-regression analysis of exchange rate pass-through. Forthcoming in *Applied Economics*.

[453] Verbeek, M. (2000) *A Guide to Modern Econometrics*, Chichester: John Wiley.

[454] Verspagen, B. (2004) *Innovation and Economic Growth*. In: Fagerberg, J., Mowery, D.C. and Nelson, R.R. (eds.) *The Oxford Handbook of Innovation*. Oxford: Oxford University Press.

[455] Viaene, V.M. and de Vries, C.G. (1992) International Trade and Exchange Rate Volatility. *European Economic Review,* p.1311-1321.

[456] Walsh, C.E. (1999) Monetary Policy Trade-offs in the Open Economy. *Mimeo*, University of California, Santa Cruz.

[457] Weerapana, A. (2000) The Performance of Simple Monetary Policy Rules in A Large Open Economy. *Wellesley College Working Paper,* 2000-05.

[458] Willett, T. (1998) Credibility and Discipline Effects of Exchange Rate as Nominal Anchors: The Need to Distinguish Temporary from Permanent Pegs. *World Economy,* 21(6), p.803-827.

[459] Williamson, J. (1999) Are Intermediate Regimes Vanishing? *Speech Given at the International Conference on Exchange Rate Regimes in Emerging Market Economies*, Tokyo, Japan (December 17–18).

[460] Windmeijer, F. (2005) A Finite Sample Correction for the Variance of Linear Efficient Two-step GMM Estimators. *Journal of Econometrics,* 126, p.25-51.

[461] Woodford, M. (1999a) Optimal Monetary Policy Inertia. *The Manchester School.* 67(1), p.1 - 35.

[462] Woodford, M. (1999b) Commentary: How Should Monetary Policy Be Conducted in an Era of Price Stability? *Federal Reserve Bank of Kansas City, New Challenges for Monetary Policy.*

[463] Wooldridge, J.M. (2002) *Econometric Analysis of Cross Section and Panel Data.* London: The MIT Press.

[464] Wooldridge, J.M. (2007) *Introductory Econometrics: A Modern Approach.* 3rd edition, London: The MIT Press.

[465] Xu, X. (2004) Exchange Rate Regime Choices for China. *The Journal of American Academy of Business, Cambridge,* 4(1/2), p.218-222.

[466] Ziliak, J.P. (1997) Efficient Estimation with Panel Data when Instruments are Predetermined: An Empirical Comparison of Moment-condition Estimators. *Journal of Business and Economic Statistics*, 16, p.419–431.

APPENDICES

APPENDIX 1 – Additional tables

Table A1.1. Peg-exits and new monetary regimes

Case	Date	Type of peg/ER target before the exit	New exchange-rate regime (de jure)	New monetary regime (if ERT completely exited)
Albania	Jul-92	Conventional peg	Free float	Monetary targeting
Algeria	Apr-94	Conventional peg (to basket)	Managed float	Implicit nominal targeting
Angola	May-99	Conventional peg	Free float	Implicit nominal targeting
Argentina	Jul-01	Currency board	Managed float	Monetary targeting
Brazil	Jan-99	Crawling peg	Free float	Inflation targeting
Bulgaria	Feb-91	Conventional peg (to basket)	Free float	Monetary targeting
Burundi	Aug-99	Conventional peg (to basket)	Managed float	Implicit anchor
Chile	Feb-99	Crawling band	Managed float	Inflation targeting
Colombia	Sep-98	Crawling band	Managed float	Inflation targeting
Congo, DR of	May-01	Conventional peg	Free float	Monetary targeting
Cyprus	Sep-92	Conventional peg (to basket)	ER band	-
Czech R.	May-97	ER band	Managed float	Inflation targeting
Egypt	Jul-90	Conventional peg	ER band	-
El Salvador	May-90	Conventional peg	Managed float	Managed float
Ethiopia	Oct-92	Conventional peg	Managed float	Monetary targeting
Finland	Sep-92	ER band	Free float	Inflation targeting
Guyana	Jun-90	Conventional peg	Managed float	Monetary targeting
Hungary	Aug-94	Conventional peg (to basket)	Crawling band	Inflation targeting[53]
Iceland	Feb-01	ER band	Free float	Inflation targeting
Indonesia	Aug-97	Crawling band	Free float	Implicit nominal targeting (1997) and Inflation targeting (2005)
Israel	Mar-91	ER band	Crawling band	Implicit nominal targeting (1991) and Inflation targeting (1997)
Italy	Sep-92	ER band	Free float	Implicit nominal targeting
Kazakhstan	Apr-99	Crawling peg	Free float	Implicit nominal anchor
Kenya	Mar-93	Conventional peg (to basket)	Managed float	IMF supported implicit nominal targeting
Korea	Nov-97	Crawling band	Free float	Implicit nominal targeting (1997) and Inflation targeting (2001)
Laos	Dec-97	Conventional peg	Managed float	Monetary targeting
Madagascar	May-94	Conventional peg (to basket)	Managed float	Monetary targeting
Malawi	Feb-94	Conventional peg (to basket)	Managed float	Monetary targeting
Mexico	Dec-94	Crawling band	Free float	Implicit nominal targeting (1994) and Inflation targeting (2001)
Mongolia	Jan-93	Conventional peg	Free float	Monetary targeting
Myanmar	Dec-95	Conventional peg (to	Managed float	Implicit nominal target

[53] Hungary is the exception that runs simultaneously ERT and IT, the ERT being under the most flexible option. Hungary is returned to in Chapter 6.

		basket)		
Nicaragua	Jan-93	Conventional peg	Crawling peg	-
Nigeria	Feb-95	Conventional peg	Managed float	Monetary targeting
Norway	Sep-92	ER band	Free float	Inflation targeting
Peru	Aug-90	Crawling peg	Managed float	Monetary targeting (1990) and Inflation targeting (2002)
Phillipines	Sep-97	Conventional peg	Free float	Implicit nominal targeting (1997) and Inflation targeting (2002)
Poland	Feb-92	Conventional peg (to	Crawling peg	-
	Oct-98	Crawling peg	Managed float	Inflation targeting
Sao Tome and	Sep-91	Conventional peg (to	Crawling peg	-
Principe	Dec-94	Crawling peg	Managed float	Implicit nominal targeting
Sierra Leone	May-90	Conventional peg	Free float	Monetary targeting
Slovakia	Jul-93	Conventional peg	ER band	Implicit nominal targeting
	Aug-98	ER band	Managed float	Implicit nominal targeting (1998) and Inflation targeting (2005)
Sweden	Sep-92	ER band	Free float	Inflation targeting
Thailand	Jul-97	Conventional peg (to basket)	Managed float	Monetary targeting (1997) and Inflation targeting (2000)
Tonga	Aug-98	Conventional peg (to basket)	ER band	-
Trinidad and Tobago	Apr-93	Conventional peg	Free float	Monetary targeting
Turkey	Feb-01	Crawling peg	Free float	Monetary targeting (2001) and Inflation targeting (2006)
Ukraine	Oct-94	Conventional peg	Managed float	
UK	Sep-92	ER band	Free float	Inflation targeting
Uruguay	Dec-01	Crawling band	Free float	Monetary targeting
Venezuela	Dec-95	Conventional peg	Crawling band	-
Vietnam	Jan-96	Conventional peg	Free float	Monetary targeting
Zimbabwe	Dec-97	Crawling band	Managed float	Monetary targeting

Source: Babula and Ötker-Robe, 2003; Caruana, 2007

Note: The table consists of ERT exits only and switches on IT regime. Some of the new regimes are today abandoned.

Table A1.2. Growth under alternative regimes and classifications (whole sample)

	Average growth rate	
	RR (2004) de-facto classification	**IMF de-jure classification**
fixed	2.18	1.81
limited-flexible	2.69	2.53
flexible	2.05	2.64
free-floating	2.39	2.08
free falling	0.52	n.a.

Source: Calculated by the author, based on figures by the IMF

Table A1.3. Growth under alternative regimes and classifications (countries' development level)

	Average growth rate			
	Reinhart and Rogoff (2004) de-facto classification		**IMF de-jure classification**	
	Advanced economies	**Developing economies**	**Advanced economies**	**Developing economies**
fixed	2.21	2.17	1.95	1.79
limited-flexible	1.64	2.94	2.24	2.62
flexible	2.04	2.05	2.34	2.68
free-floating	1.65	2.64	1.94	2.11
free falling	-0.26	0.55	n.a.	n.a.

Source: Calculated by the author, based on figures by the IMF

Table A1.4. Average output-volatility under alternative regimes and classifications (whole sample; figures in percentage points)

	RR classification			IMF classification		
	Standard deviation	Linear trend	HP trend	Standard deviation	Linear trend	HP trend
fixed	4.75	4.08	2.75	4.75	4.06	2.78
limited-flexible	4.19	3.64	2.33	5.32	4.37	3.09
flexible	5.27	4.23	2.83	4.79	4.08	2.81
free-floating	6.27	5.21	3.34	4.96	4.2	2.83
free falling	6.33	5.84	4.01	na	na	na

Source: Calculated by the author, based on figures by the IMF

Table A1.5. Average output-volatility under alternative regimes and classifications (countries' development level; figures in percentage points)

	Reinhart and Rogoff (2004) de-facto classification					
	Advanced economies			Developing economies		
	SD	DEV	HP	SD	DEV	HP
fixed	2.41	2.4	1.67	5.18	4.45	2.97
limited-flexible	3.39	2.93	1.79	4.39	3.81	2.46
flexible	2.92	2.55	1.77	5.69	4.6	3.05
free-floating	2.9	2.78	1.79	7.09	5.92	3.76
free falling	7.14	5.24	3.77	6.3	5.8	4.02

Source: Calculated by the author, based on figures by the IMF

	IMF de-jure classification					
	Advanced economies			Developing economies		
	SD	DEV	HP	SD	DEV	HP
fixed	3.35	2.89	1.87	4.95	4.25	2.9
limited-flexible	2.41	2.46	1.74	6.26	5.09	3.56
flexible	3.47	3.12	2.1	4.95	4.22	2.89
free-floating	2.55	2.42	1.63	5.51	4.69	3.14

Source: Calculated by the author, based on figures by the IMF

Table A1.6. IV estimates of output volatility regression – whole sample

Dependent variable: **HP-based output volatility**	(1)	(2)	(3)	(4)	(5)
	2SLS		GMM	LIML	CUE
Real per capita GDP growth	-0.379***	-0.383***	-0.3734**	-0.377***	-0.372***
ΔFinancial development	0.244	1.236	-0.245	0.451	-0.379
Trade openness	0.011	0.009	0.011	0.011	1.163
Financial openness	0.133*	0.156**	0.141*	0.129	0.149*
Volatility of money supply	-0.024	-0.024	-0.019	-0.030	-0.022
Volatility of gov't consumption	-0.305**	-0.263*	-0.257*	-0.363*	-0.332**
Civil unrest	0.277**	0.248*	0.261*	0.314*	0.297**
Volatility of TOT	-0.112**	-0.108**	-0.103*	-0.122**	-0.115**
Volatility of TOT under Fixed	*0.106**		*0.098*	*0.118**	*0.112**
Volatility of TOT under Fixed up to 5 years		*0.063*			
Volatility of TOT under Fixed - 5-10 years		*0.130***			
Volatility of TOT under Fixed over 10 years		*0.099*			
Volatility of TOT under Lim-Flex	*0.170***	*0.158***	*0.153***	*0.191***	*0.176***
Volatility of TOT under Flexible	*0.119***	*0.116***	*0.110***	*0.129***	*0.122***
Volatility of TOT under Float	Omitted cat	Omitted cat	Omitted cat	Omitted cat	Omitted cat
Volatility of TOT under Other (dual market and/or free falling)	*0.013*	*0.027*	*0.025*	*0.011*	*0.022*
F-test (p-value) H$_0$: ERRs under TOT shocks are jointly insignificant	**0.290**	**0.306**	**0.399**	**0.367**	**0.329**
Fixed ERR	-0.620		-0.727	-0.631	-0.773
Fixed ERR under 5 years		-0.128			
Fixed ERR 5 to 10 years		-1.166**			
Fixed ERR over 10 years		-1.219**			
Limited flexible ERR	-0.797	-0.773	-0.843	-0.837	-0.918
Flexible ERR	-0.869	-0.877*	-0.898	-0.907	-0.968*
Floating ERR	Omitted cat	Omitted cat	Omitted cat	Omitted cat	Omitted cat
Other category (dual market and/or free falling)	-0.494	-0.423	-0.383	-0.561	-0.464
F-test (p-value) H$_0$: ERRs are jointly insignificant	**0.588**	**0.086**	**0.548**	**0.648**	**0.595**
Inflation	1.803	1.347	1.207	2.075	1.539
F-test H$_0$: All regressors are insignificant	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Under-identification test (p-value) H$_0$: Model is under-identified	**0.040**	**0.043**	**0.040**	**0.040**	**0.040**
Weak identification test (F-stat) H$_0$: Instruments are weak	**1.464**	**1.419**	**1.464**	**1.464**	**1.464**
Hansen test (p-value) H$_0$: Instruments are valid	**0.638**	**0.647**	**0.638**	**0.706**	**0.626**
Endogeneity test (p-value) H$_0$: Regressors are exogenous	**0.347**	**0.372**	**0.347**	**0.347**	**0.347**

Note: *,**,*** indicate 10, 5 and 1% of significance. Standard errors corrected for heteroskedasticity and autocorrelation. Heteroskedasticity and autocorrelation robust standard errors are reported in parentheses.
The potentially endogenous variables (financial development, monetary and fiscal volatility, and inflation) are instrumented by: their first and second lags, terms of trade, inflation and growth and their first lags; and population. For the developing-group and sub-periods specifications, adjustment in the group of instrument could have been made (changing how many lags to include) in order to improve the instrument-identification tests.
The reported test for endogenous regressors is the Wu-Hausman F-test version of the endogeneity test which is robust to various violations of conditional homoskedasticity.
The reported over-identification test is Hansen *J* statistic. Reported under-identification test is Kleibergen and Paap's (2006) test. Reported weak identification test is Kleibergen-Paap rk Wald F statistics.
Dummies for Latin America and Caribbean and Sub-Saharan Africa were dropped because of collinearity. Time dummies are not reported due to space, but are available on request.
-xtivreg2- does not report an estimated constant. The reason is that it can cause problems when combining two-step GMM and cluster-robust option.

Table A1.7. IV estimates of output volatility regression – developing countries

Dependent variable:	(1)	(2)	(3)	(4)	(5)
HP-based output volatility	2SLS		GMM	CUE	LIML
Real per capita GDP growth	-0.404***	-0.388***	-0.388***	-0.383***	-0.383***
ΔFinancial development	0.182	1.025	1.861	0.227	0.227
Trade openness	0.009	0.008	0.010	0.009	0.009
Financial openness	0.171**	0.186***	0.156**	0.175**	0.175**
Volatility of money supply	-0.019	-0.022	-0.021	-0.027	-0.027
Volatility of gov't consumption	-0.294**	-0.271**	-0.255**	-0.386**	-0.386**
Civil unrest	0.596**	0.247**	0.266**	0.313*	0.313*
Volatility of TOT	-0.109**	-0.107**	-0.104**	-0.123*	-0.123*
Volatility of TOT under Fixed	*0.108**		*0.106**	*0.127**	*0.127**
Volatility of TOT under Fixed up to 5 years		*0.075*			
Volatility of TOT under Fixed - 5-10 years		*0.136***			
Volatility of TOT under Fixed over 10 years		*0.103**			
Volatility of TOT under Lim-Flex	*0.167***	*0.161***	*0.158***	*0.198**	*0.198**
Volatility of TOT under Flexible	*0.117***	*0.116***	*0.112***	*0.130***	*0.130***
Volatility of TOT under Float	Omitted cat	Omitted cat	Omitted cat	Omitted cat	Omitted cat
Volatility of TOT under Other (dual market and/or free falling)	*0.012*	*0.022*	*0.023*	*0.009*	*0.009*
F-test (p-value) H$_0$: ERRs under TOT shocks are jointly insignif.	**0.082**	**0.098**	**0.098**	**0.100**	**0.123**
Fixed ERR	-0.707		-0.725	-0.736	-0.736
Fixed ERR under 5 years		-0.266			
Fixed ERR 5 to 10 years		-1.220**			
Fixed ERR over 10 years		-1.193**			
Limited flexible ERR	-0.853	-0.834	-0.828	-0.913	-0.913
Flexible ERR	-0.934*	-0.946*	-0.910*	-0.990	-0.995
Floating ERR	Omitted cat	Omitted cat	Omitted cat	Omitted cat	Omitted cat
Other category (dual market and/or free falling)	-0.643	-0.600	-0.547	-0.739	-0.739
F-test (p-value) H$_0$: ERRs are jointly insignificant	**0.086**	**0.055**	**0.090**	**0.098**	**0.127**
Inflation	1.780	1.528	1.271	2.055	2.191
F-test H$_0$: All regressors are insignificant	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Under-identification test (p-value) H$_0$: Model is under-identified	0.059	0.069	0.059	0.059	0.059
Weak identification test (F-stat) H$_0$: Instruments are weak	1.350	1.300	1.350	1.350	1.350
Hansen test (p-value) H$_0$: Instruments are valid	0.695	0.802	0.695	0.695	0.828
Endogeneity test (p-value) H$_0$: Regressors are exogenous	0.174	0.125	0.174	0.174	0.174

Note: *,**,*** indicate 10, 5 and 1% of significance. Standard errors corrected for heteroskedasticity and autocorrelation. See notes in Table A1.6.

Table A1.8. Dynamic system-GMM estimates of output volatility regression (only lagged dependent variable is assumed endogenous)

Dependent variable: *Output volatility*	**(1)** Standard deviation	**(2)** Dev. from linear trend	**(3)** Deviation from HP trend Whole sample		**(4)** Deviation from HP trend Developing economies	
Output volatility (-1)	0.812***	0.093**	0.054*	0.053*	0.050	0.025
Real per capita GDP growth	-0.001	-0.064	-0.377***	-0.377***	-0.393***	-0.375***
ΔFinancial development	0.566**	-1.623*	-0.455*	-0.476**	-0.388	-4.451
Trade openness	-0.001	0.010	0.018***	0.018***	0.014**	0.016**
Financial openness	0.020	-0.003	-0.014	-0.003	0.123*	0.102
Volatility of money supply	0.001	0.007	-0.001	-0.001	-0.001	-0.001
Volatility of gov't consumption	0.028***	0.045***	0.005	0.005	0.005	0.009
Civil unrest	0.033	0.182***	0.032	0.037	-0.028	-0.102
Volatility of TOT	0.010	-0.011	-0.046*	-0.047*	-0.083	-0.034
Volatility of TOT * Fixed	*-0.013*	*0.037*	*0.039*		*0.076*	
*Volatility of TOT * Fixed up to 5 years*				*0.063*		*0.054*
*Volatility of TOT *Fixed - 5-10 years*				*0.026*		*0.025*
*Volatility of TOT * Fixed over 10 years*				*0.041*		*0.026*
Volatility of TOT * Lim-Flex	*-0.022*	*0.035*	*0.013**	*0.047**	*0.084*	*0.035*
Volatility of TOT * Flexible	*-0.001*	*0.021*	*0.058***	*0.058***	*0.096**	*0.043*
Volatility of TOT * Float	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted
Volatility of TOT * Other	*-0.005*	*0.017*				*-0.016*
category			*0.017*	*0.017*	*0.044*	
F-test (p-value)	**0.980**	**0.184**	**0.200**	**0.200**	**0.200**	**0.410**
H_0: ERRs under TOT shocks are jointly insignificant						
Fixed ERR	-0.005	-0.365	-0.269		-0.640	
Fixed ERR under 5 years				-0.399		-0.614
Fixed ERR 5 to 10 years				-0.161		-0.155
Fixed ERR over 10 years				-0.240		-0.128
Limited flexible ERR	-0.059	-0.464	-0.531*	-0.509*	-1.168	-0.541
Flexible ERR	-0.021	-0.567	-0.602**	-0.582**	-1.105	-0.478
Floating ERR	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted
Other category (dual market /	0.399	0.691				1.251
free fal.)			0.911	0.911	0.247	
F-test (p-value)	**0.906**	**0.408**	**0.026**	**0.026**	**0.026**	**0.075**
H_0: ERRs are jointly insignificant						
Inflation	-0.751	-0.837	-0.743	-0.729	-0.329	-0.578
Dummy for Latin A. and	0.144					
Caribbean		0.227	-0.433	-0.440	-0.508	-0.795*
Dummy for Sub-Saharan Africa	-0.006	-0.336	-0.776***	-0.770**	-0.723*	-0.673*
Constant	0.476**	2.037***	2.505***	2.467***	3.576***	2.968
Wald test (p-value)	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Number of instruments	**139**	**71**	**70**	**74**	**73**	**77**
Hansen test (p-value)	**0.434**	**0.688**	**0.787**	**0.779**	**0.659**	**0.891**
H_0: Instruments are valid – no over-identification						
Difference in Hansen (p-value)	**0.739**	**0.816**	**0.951**	**0.956**	**0.994**	**1.000**
H_0: Instruments are valid – regressor (lagged dependent variable) is endogenous						
Arellano-Bond AR(2) (p-value)	**0.571**	**0.612**	**0.434**	**0.402**	**0.334**	**0.475**
H_0: No second-order serial correlation						

Notes: *, ** and *** refer to a significance level of 10, 5 and 1%, respectively. All regressions are two-step system GMM. The Windmeijer (2005) corrected standard errors reported. Time dummies are not reported due to space, but are available on request.

Table A1.9. Dynamic system-GMM estimates of output volatility regression (lagged dependent and other variables assumed endogenous)

Dependent variable:	**(1)**	**(2)**	**(3)**		**(4)**	
Output volatility	**Standard deviation**	**Dev. from linear trend**	**Deviation from HP trend Whole sample**		**Deviation from HP trend Developing economies**	
Output volatility (-1)	0.805***	0.129***	0.062*	0.064*	0.047	0.070**
Real per capita GDP growth	-0.004	0.006	-0.369***	-0.371***	-0.369***	-0.408***
ΔFinancial development	0.656*	-0.025	0.085	-0.063	-3.635	-0.364
Trade openness	-0.004	0.751	0.017**	0.017**	0.015**	0.011
Financial openness	0.106**	0.030	0.024	-0.030	0.135*	0.097
Volatility of money supply	-0.005	0.003	-0.003	-0.003	-0.010	-0.001
Volatility of gov't consumption	0.091***	0.071***	-0.003	-0.003	0.006	0.004
Civil unrest	0.005	0.205***	0.058	0.059	-0.116	-0.112
Volatility of TOT	-0.023	-0.108	-0.033	-0.033	-0.068	-0.099
Volatility of TOT * Fixed	*0.013*	*14.933*	*2.799*		*6.334*	
*Volatility of TOT * Fixed up to 5 years*				*0.049*		*0.090*
*Volatility of TOT *Fixed - 5-10 years*				*0.021*		*0.098*
*Volatility of TOT * Fixed over 10 years*				*0.029*		*0.086*
Volatility of TOT * Lim-Flex	*-0.006*	*0.120*	*0.031*	*0.032*	*0.067*	*0.098*
Volatility of TOT * Flexible	*0.025*	*0.130*	*0.046***	*0.046*	*0.080*	*0.111*
Volatility of TOT * Float	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted
Volatility of TOT * Other category	*-0.014*	*0.109*	*-0.002*	*-0.000*	*0.014*	*0.073*
F-test (p-value) H0: ERRs under TOT shocks are jointly insignificant	**0.354**	**0.540**	**0.345**	**0.633**	**0.268**	**0.793**
Fixed ERR	-0.118	-0.915	-0.074		-0.969	
Fixed ERR under 5 years				-0.115		-0.830
Fixed ERR 5 to 10 years				-0.018		-0.593
Fixed ERR over 10 years				-0.087		-0.767
Limited flexible ERR	0.015	-1.138*	-0.364	-0.353	-1.283	-1.178
Flexible ERR	-0.099	-1.190*	-0.574**	-0.558*	-1.270	-1.166
Floating ERR	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted
Other category (dual market / free fal.)	0.389	0.212	1.192	1.173	0.696	-0.158
F-test (p-value) H0: ERRs are jointly insignificant	**0.423**	**0.181**	**0.020**	**0.086**	**0.124**	**0.549**
Inflation	0.181	1.078	-0.773**	-0.766**	-0.749**	-0.555*
Dummy for Latin A. and Caribbean	0.038	0.084	-0.151	-0.135	-0.589	-0.729*
Dummy for Sub-Saharan Africa	-0.123	-0.315	-0.600*	-0.583*	-0.544	-0.637
Constant	0.458*	2.062**	2.336***	2.282***	3.876*	4.325***
Wald test (p-value)	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Number of instruments	**121**	**130**	**75**	**79**	**78**	**59**
Hansen test (p-value) H0: Instruments are valid – no over-identification	**0.204**	**0.318**	**0.423**	**0.408**	**0.806**	**0.234**
Difference in Hansen (p-value) H0: Instruments are valid (lagged dependent variable)	**0.297**	**0.515**	**0.573**	**0.550**	**0.853**	**0.295**
Difference in Hansen (p-value) H0: Instruments are valid (other potentially endogenous variables)	**0.804**	**0.261**	**0.166**	**0.202**	**0.885**	**0.234**
Arellano-Bond AR(2) (p-value) H0: No second-order serial correlation	**0.610**	**0.800**	**0.528**	**0.525**	**0.558**	**0.382**

Notes: *, ** and *** refer to a significance level of 10, 5 and 1%, respectively. All regressions are two-step system GMM. The Windmeijer (2005) corrected standard errors reported.

Table A1.10. Macroeconomic statistics of switchers and non-switchers

MEDIANS	**Switchers group**		**Control (non-switchers) group**	
	ERT	**IT**	**ERT (before others switch)**	**ERT (after others switch)**
Inflation rate	11.3	3.4	14.4	5.1
Growth rate	3.9	4.2	2.8	6.7
Inflation volatility	17.6	2.9	33.9	3.3
Output volatility	5.9	2.3	4.7	2.7
Reserves growth	17.4	10.3	18.1	19.7
Exchange-rate changes	-2.6	-0.6	-1.1	0.8
Reserves volatility	49.9	15.8	24.8	23.2
Exchange-rate volatility	8.5	6.5	25.2	4.0

Note: Volatility is measured through the standard deviation of the series over the observed period

Source: Author's calculations based on data from World Economic Outlook

APPENDIX 2 – Additional variables

Table A2.1. Full specification of dummy variables

Notation	Value 1	Value 0	Source
Exchange-rate regimes			
RR1	If fixed	Otherwise	De-facto RR classification
RR2	If limited-flexible	Otherwise	De-facto RR classification
RR3	If flexible	Otherwise	De-facto RR classification
RR4	If free float	Otherwise	De-facto RR classification
RR5DUAL	If free falling or dual market	Otherwise	De-facto RR classification
IMF1	If fixed	Otherwise	IMF web
IMF2	If limited-flexible	Otherwise	IMF web
IMF3	If flexible	Otherwise	IMF web
IMF4	If free float	Otherwise	IMF web
IMFOT	If dual market exists	Otherwise	IMF web
Other dummies related to the exchange-rate regime			
EURERM	If a country belongs to the Euro zone and the ERM II - 12 (mainly the period 1991-2006) + UK in 1991 and 1992	Otherwise	Eurostat
Survivor bias			
SURVIVOR	If in the particular year inflation rate exceeds 30%	Otherwise	Based on CPI measure; IMF, World Economic Outlook
Geographic groupings			
LATCAR	If the country belongs to the region **Latin America and the Caribbean:** Argentina; Belize; Bolivia; Brazil; Chile; Colombia; Costa Rica; Dominica; Dominican Republic; Ecuador; El Salvador; Grenada; Guatemala; Guyana; Haiti; Honduras; Jamaica; Mexico; Nicaragua; Panama; Paraguay; Peru; St. Kitts and Nevis; St. Lucia; St. Vincent and the Grenadines; Suriname; Uruguay; Venezuela.	Otherwise	World Bank groupings
SAHAR	If the country belongs to the region **Sub-Saharan Africa:** Angola; Benin; Botswana; Burkina Faso; Burundi; Cameroon; Cape Verde; Central African Republic; Chad; Congo, Rep; Côte d'Ivoire; Ethiopia; Gabon; Gambia, The; Ghana; Guinea; Guinea-Bissau; Kenya; Lesotho; Liberia; Madagascar; Malawi; Mali; Mauritania; Mauritius; Mozambique; Namibia; Niger; Nigeria; Rwanda; São Tomé and Principe; Senegal; Seychelles; Sierra Leone; South Africa; Sudan; Swaziland; Tanzania; Togo; Uganda; Zambia; Zimbabwe.	Otherwise	World Bank groupings
Development groupings			
ADVAN	**Developed (advanced) market economies** Australia; Austria; Belgium; Bermuda; Brunei Darussalam; Canada; Cyprus; Denmark; Finland; France; Germany; Greece; Hong Kong, Iceland; Ireland ; Italy; Japan; Rep.; Kuwait; Luxembourg;	Otherwise	World Bank groupings, Group high-income countries

	Netherlands; New Zealand; Norway; Portugal; Qatar; Singapore; Slovenia; Spain; Sweden; Switzerland; United Arab Emirates; United Kingdom; United States.		
TRANS	**Transition markets** Albania; Armenia; Azerbaijan; Belarus; Bosnia-Herzegovina; Bulgaria; China; Croatia; Czech Republic; Estonia; Georgia; Hungary; Kazakhstan; Kyrgyzstan; Latvia; Lithuania; Macedonia; Moldova; Mongolia; Poland; Romania; Russian Federation; Serbia/Montenegro; Slovakia; Slovenia; Tajikistan; Ukraine; Uzbekistan; Vietnam	Otherwise	SSRN
DEVEL	**Developing economies (includes transition countries)** Albania; Armenia; Azerbaijan; Belarus; Bosnia-Herzegovina; Bulgaria; China; Croatia; Czech Republic; Estonia; Georgia; Hungary; Kazakhstan; Kyrgyzstan; Latvia; Lithuania; Macedonia; Moldova; Mongolia; Poland; Romania; Russian Federation; Serbia/Montenegro; Slovakia; Slovenia; Tajikistan; Ukraine; Uzbekistan; Vietnam + All the remaining in the sample	Otherwise	Residual

Table A2.2. Interest-rule variables: definition and sources

Label	Description	Unit	Source	Notes
R	Money market interest rate	y-o-y % per month	IFS and national central banks	Wherever not available, the discount rate used.
CPI	Consumer prices	Index number	IFS	
INF	Inflation	y-o-y % per month	Calculated	Inflation= log(cpi)-log(cpi[-12])
IND	Industrial production	Index number	IFS and national statistics offices	
GAP	Output gap	Percentage points	Calculated	The residual series between the actual and the potential output estimated from the industrial production by HP filtering.
ER	Exchange rate	Units of national currency per SDR	IFS	
DER	Change in the exchange rate	y-o-y % per month	Calculated	DER= log(ER)-log(ER[-12])
RES	Reserves minus gold	Million of USD	IFS	
DRES	Change in the reserves	y-o-y % per month	Calculated	DRES= log(RES)-log(RES[-12])
DC	Domestic credit to nominal GDP	%	IFS	The annual GDP used for each month.
M2	Money aggregate M2	Millions/billions of national currency	IFS and national central banks	
NFA	|Net foreign assets| to GDP	Millions/billions of national currency	IFS	NFA refers to the difference between foreign assets and foreign liabilities of the banking system, taken as an absolute value. The annual GDP used for each month.

APPENDIX 3 – IT algebra

Building on the analysis in the main text of Chapter 4 (Section 4.4.2 and 4.4.3), the appendix deepens the analysis of IT as a monetary-policy regime, by presenting simple algebraic approach. The algebraic approach is taken from the literature, mainly from Agénor (2002) and as cited in the text. Derivations are made clearer, to fully understand how IT works. Both types of IT regime are represented by a set of equations, representing how the alteration of the monetary-policy stance is brought onto prices.

A3.1. Strict inflation targeting

Equations (4.2) and (4.3) in Section 4.4.2 represent a closed economy producing one good; the former relates output gap positively to its value in period *t-1,* and negatively with the real interest rate in period *t-1;* the latter relates inflation positively to the output gap in period *t-1*. The central bank's loss function represented by (4.5), for the moment, is taken to be a function only of inflation (thus, λ=0). According to the previous discussion, the monetary policy objective in period *t* is to choose a sequence of current and future interest rates, $\{r_h\}_{h=t}^{\infty}$, so as to minimize the intertemporal loss function at period t (ℓ_t), i.e. the expected sum of discounted squared deviations of the actual inflation from its targeted level (i.e. the loss function given by (4.5)), subject to the length of the transmission channels, represented by (4.2) and (4.3), i.e.:

$$\ell_t = \min\,(E_t \sum_{h=t}^{\infty} \delta^{h-t} L_h) = E_t \left\{ \sum_{h=t}^{\infty} \delta^{h-t} \frac{(\pi_h - \pi^*)^2}{2} \right\}, 0 < \delta < 1 \qquad \text{(A3.1)}$$

Whereby, δ denotes a discount factor and E_t the expectations operator of future interest rates conditional upon the information disposable at period *t*. This is the optimisation problem to be solved.

However, the problem could be given more intuition. Since the nominal interest rate affects the output gap with one-period lag (equation 4.2) and inflation with a two-period lag (equation 4.3), inflation in period *t+2* could be expressed in terms of period *t* variables and the shocks occurring at periods *t+1* and *t+2*. Thus, equations (4.2) and (4.3) could be rearranged in the following manner. Equation (4.2):

$$(y_{t+1} - y^*_{t+1}) = \beta_1(y_t - y^*_t) - \beta_2(r_t - \pi_t) + \eta_{t+1}, \beta_1 < 1 \quad \text{(A3.2)}$$

Equation (4.3) for period *t+1*:

$$\pi_{t+1} - \pi_t = \alpha_1(y_t - y^*_t) + \varepsilon_{t+1}$$

$$\pi_{t+1} = \pi_t + \alpha_1(y_t - y^*_t) + \varepsilon_{t+1} \quad \text{(A3.3)}$$

And similarly for period *t+2*:

$$\pi_{t+2} = \pi_{t+1} + \alpha_1(y_{t+1} - y^*_{t+1}) + \varepsilon_{t+2} \quad \text{(A3.4)}$$

Substituting (A3.2) and (A3.3) into (A3.4), the following is obtained:

$$\pi_{t+2} = (\pi_t + \alpha_1(y_t - y^*_t) + \varepsilon_{t+1}) + \alpha_1(\beta_1(y_t - y^*_t) - \beta_2(r_t - \pi_t) + \eta_{t+1}) + \varepsilon_{t+2}$$

$$\pi_{t+2} = (1 + \beta_2)\pi_t + \alpha_1(1 + \beta_1)(y_t - y^*_t) - \alpha_1\beta_2 r_t + (\varepsilon_{t+1} + \alpha_1\eta_{t+1} + \varepsilon_{t+2})$$

(A3.5)

Now, we define new notations for the coefficients in front of variables, as follows:

$$\mu_1 = 1 + \alpha_1\beta_2;$$

$$\mu_2 = \alpha_1(1 + \beta_1);$$

$$\mu_3 = \alpha_1\beta_2;$$

$$\xi_{t+2} = \varepsilon_{t+1} + \alpha_1\eta_{t+1} + \varepsilon_{t+2} \quad \text{(A3.6)}$$

Substitution of those in (A3.5), we obtain:

$$\pi_{t+2} = \mu_1\pi_t + \mu_2(y_t - y^*_t) - \mu_3 r_t + \xi_{t+2} \quad \text{(A3.7)}$$

Now it is clear that the nominal interest rate (r_t) set by the central bank today (period *t*) will affect inflation (π_{t+2}) after two periods (*t+2*) and afterwards, but not in periods *t* and *t+1;* the nominal interest rate set by the central bank in the next period *t+1* will affect inflation in period *t+3* and afterwards, but not in periods *t+1* and *t+2,* and so on.

Consequently, the solution of the optimisation problem (A3.1) could be perceived as setting the interest rate (r_t) today, *t,* and the periods afterwards (*t+1, t+2,* and so on) so that the expected inflation in period *t+2* and afterwards (periods *t+3, t+4,* and so on) will be equal to the target rate. In other words, since today's interest rate and not the future one affects inflation in two periods from now, the minimization of the objective function defined by (A3.1) becomes a sequence of one-period problems:

$$\ell_t = \min_{i_h} \frac{\delta^2}{2} E_t(\pi_{t+2} - \pi^*)^2 + E_t \left\{ \sum_{h=t+1}^{\infty} \min_{i_h} \delta^{h-t} \frac{(\pi_{h+2} - \pi^*)^2}{2} \right\} \tag{A3.8}$$

Whereby the first part of (A3.8) refers to inflation affected by the alteration of today's interest rate (see equation A3.7), while the second part is affected by the interest-rate alteration afterwards (r_{t+1}, r_{t+2} and so on; the reconsideration and updated decisions, mentioned earlier). Since, the problem in period *t* is being optimised, it consists of minimizing the expected, discounted square value of inflation in period *t+2* from the target, $\min_{i_h} \frac{\delta^2}{2} E_t(\pi_{t+2} - \pi^*)^2$, by altering today's interest rate in accordance to (A3.7).

Taking from statistical theory that the expected square value of a random variable equals the square of the bias plus the conditional variance (Agénor, 2002), the following is obtained:

$$E_t(\pi_{t+2} - \pi^*)^2 = (\pi_{t+2|t} - \pi^*)^2 + V_t(\pi_{t+2}) \tag{A3.9}$$

Equation (A3.9) indicates that the optimisation problem could be equivalently viewed as minimizing the sum of expected future squared deviations of the inflation from the target and the variability of future inflation, conditional on the information set disposable at time *t*. As $V_t(\pi_{t+2})$ is not affected by the policy choice, the optimisation problem consists of minimizing the first part of (A3.8). Hence, the first order condition of $\min_{i_h} \frac{\delta^2}{2} E_t(\pi_{t+2} - \pi^*)^2$ would be to differentiate it according to inflation in period *t+2,* π_{t+2}, but conditional upon today's interest rate r_t:

$$\begin{aligned} &\delta^2 E_t \left\{ (\pi_{t+2} - \pi^*)^2 \frac{\partial \pi_{t+2}}{\partial r_t} \right\} = 0 \\ &-\delta^2 \mu_3 (\pi_{t+2|t} - \pi^*) = 0 \\ &\pi_{t+2|t} - \pi^* = 0 \\ &\pi_{t+2|t} = \pi^* \end{aligned} \tag{A3.10}$$

The last equation in (A3.10) suggests that, given the two-period lag, the optimal monetary policy would be to set the nominal interest rate today so that the expected inflation after two periods be equal to the inflation target, $\pi_{t+2|t} = \pi^*$, subject to information available today.

We have set the transmission mechanism by (4.2) and (4.3) and further explained it by (A3.7). Now, we will derive the interest rate rule. In (A3.7), the expected value of the random shock is zero, $\xi_{t+2} = 0$. Accounting for this, we rearrange this equation and solve for r_t:

$$\begin{aligned} \pi_{t+2|t} &= \mu_1\pi_t + \mu_2(y_t - y_t^*) - \mu_3 r_t \\ \mu_3 r_t &= \mu_1\pi_t + \mu_2(y_t - y_t^*) - \pi_{t+2|t} \\ r_t &= \frac{\mu_1\pi_t + \mu_2(y_t - y_t^*) - \pi_{t+2|t}}{\mu_3} \end{aligned} \tag{A3.11}$$

Given the definition of $\mu_1 = 1 + \alpha_1\beta_2$ in (A3.6), the following is rearranged:

$$\begin{aligned} r_t &= \frac{(1+\alpha_1\beta_2)\pi_t + \mu_2(y_t - y_t^*) - \pi_{t+2|t}}{\mu_3} \\ r_t &= \frac{\pi_t + \alpha_1\beta_2\pi_t + \mu_2(y_t - y_t^*) - \pi_{t+2|t}}{\mu_3} \\ r_t &= \frac{(\pi_t - \pi_{t+2|t}) + \alpha_1\beta_2\pi_t + \mu_2(y_t - y_t^*)}{\mu_3} \end{aligned} \tag{A3.12}$$

Since we set today's interest rate to affect inflation after two periods (A3.7), in the final derivation of (A3.12) we observe that the higher the excess of the current inflation rate over the forecast for period *t+2*, the higher the interest rate needed to satisfy the condition $\pi_{t+2|t} = \pi^*$ derived in (A3.10):

$$r_t \uparrow = \frac{(\pi_t - \pi_{t+2|t}^f)\uparrow + \alpha_1\beta_2\pi_t + \mu_2(y_t - y_t^*)}{\mu_3} \tag{A3.13}$$

Since we want $\pi_{t+2|t} = \pi^*$ and since $\pi_{t+2|t}$ must be forecasted and we want to minimize the difference between the actual and the forecast inflation for *t+2,* we implicitly need to target $\pi_{t+2|t}$, i.e. to target inflation forecast for period *t+2*. Hence, now it is clear how the inflation forecast serves as an intermediate target within the IT framework (Svensson, 1999). If we substitute $\pi_{t+2|t} = \pi^*$ in the last row of (A3.11) we obtain:

$$r_t = \frac{\mu_1 \pi_t + \mu_2 (y_t - y_t^*) - \pi^*}{\mu_3} \qquad \text{(A3.14)}$$

And given the definitions of the μ's in (A3.6), the rewritten form of (A3.14) is:

$$\begin{aligned}
r_t &= \frac{(1+\alpha_1\beta_2)\pi_t + \alpha_1(1+\beta_1)(y_t - y_t^*) - \pi^*}{\alpha_1\beta_2} \\
r_t &= \frac{(1+\alpha_1\beta_2)\pi_t}{\alpha_1\beta_2} + \frac{\alpha_1(1+\beta_1)(y_t - y_t^*)}{\alpha_1\beta_2} - \frac{\pi^*}{\alpha_1\beta_2} \\
r_t &= \frac{\pi_t}{\alpha_1\beta_2} + \frac{\alpha_1\beta_2\pi_t}{\alpha_1\beta_2} + \frac{\alpha_1 + \alpha_1\beta_1(y_t - y_t^*)}{\alpha_1\beta_2} - \frac{\pi^*}{\alpha_1\beta_2} \\
r_t &= \frac{\pi_t}{\alpha_1\beta_2} - \frac{\pi^*}{\alpha_1\beta_2} + \pi_t + \frac{1+\beta_1(y_t - y_t^*)}{\beta_2} \\
r_t &= \pi_t + \frac{1}{\alpha_1\beta_2}(\pi_t - \pi^*) + \frac{1+\beta_1}{\beta_2}(y_t - y_t^*)
\end{aligned} \qquad \text{(A3.15)}$$

The last equation in (A3.15) could be rewritten as:

$$r_t = \pi_t + \rho_1(\pi_t - \pi^*) + \rho_2(y_t - y_t^*) \qquad \text{(A3.16)}$$

Where, $\rho_1 = \frac{1}{\alpha_1\beta_2}; \rho_2 = \frac{1+\beta_1}{\beta_2}$. From (A3.16) it follows that it is optimal for the central bank to adjust the nominal interest rate upward to reflect current inflation (coefficient in front of current inflation is equal to one, thus the reflection will be to a full extent), the difference between the current inflation and the target, as well as the increase in the output gap. Svensson (1997) argues that the inclusion of the current inflation rate and the current output gap in (A3.16) helps in predicting future inflation. (A3.16) is also what Agénor (2002) calls certainty-equivalent: the same interest-rate rule would be optimal in the absence of shocks. If a shock occurs, (A3.16), however, ensures that it will not persist over time. In equilibrium, shocks occur within the specified lag, once the interest rate has been set. Thus, the actual deviation in *t+2* will deviate from the forecast by the scale of the forecasting error, $\xi_{t+2} = \varepsilon_{t+1} + \alpha_1\eta_{t+1} + \varepsilon_{t+2}$:

$$\begin{aligned}
\pi_{t+2} &= \pi_{t+2|t} + \xi_{t+2} \\
\xi_{t+2} &= \pi_{t+2} - \pi^*
\end{aligned} \qquad \text{(A3.17)}$$

Precisely because following an optimal interest-rate rule, as defined by (A3.16), the central bank cannot prevent deviations of the inflation from the target due to shocks, is important in evaluating the performance of IT in practice.

A3.2. Flexible inflation targeting

As mentioned above, central banks are not "inflation nutters" and their loss function is not solely dependent on inflation, but also on the output gap as well. Hence, the loss function is represented by equation (4.5) while the objective of the central bank becomes minimizing the following intertemporal loss function:

$$\ell_t = \min E_t \sum_{h=t}^{\infty} \delta^{h-t} L_h = E_t \left\{ \sum_{h=t}^{\infty} \delta^{h-t} \frac{(\pi_h - \pi^*)^2 + \lambda (y_h - y_h^*)^2}{2} \right\}, 0 < \delta < 1; \lambda > 0 \quad \text{(A3.18)}$$

Where λ represents the weight that the central bank puts on stabilizing output and the other symbols as in (A3.1). The discount factor δ is, for all practical purposes, likely to be very close to one, especially when the period is a quarter (Svensson, 2003). Interestingly, when the discount factor is close to unity, the intertemporal loss function is approximately equal to the weighted sum of the unconditional volatilities of inflation and the output gap (when the unconditional means of inflation and the output gap equal the inflation target and zero, respectively: $E[\pi_t] = \pi^*$ and $E[y_t - y_t^*] = 0$):

$$\lim_{\delta \to 1} \ell_t = Var[\pi_t] + \lambda * Var[y_t - y_t^*] \quad \text{(A3.18a)}$$

Equation (A3.18a) points to the substance of the flexible inflation targeting which opts to stabilize inflation around the inflation target and output around the potential output. However, observing (A3.18), the issue is more intricate and this equation could not be split into sequential one-period problems, because current inflation depends on lagged output and the current output on lagged inflation. Svensson (1997) showed that the first order condition for minimizing (A3.18) with respect to the nominal interest rate can be written as:

$$\pi_{t+2|t} = \pi^* - \frac{\lambda}{\delta \alpha_1 \kappa} (y_{t+1|t} - y_{t+1}^*); \kappa > 0 \quad \text{(A3.19)}$$

Where, $\kappa = \frac{1}{2} \left\{ 1 - \mu + \sqrt{(1+\mu)^2 + 4\lambda / \alpha_1^2} \right\}$ and $\mu = \frac{\lambda(1-\delta)}{\delta \alpha_1^2}$. Equation (A3.19) proves that, given the two-period lag, the optimal monetary policy would be to set the nominal interest rate today so that the expected inflation after two periods be equal to the inflation target and the weighted output in period *t+1*, subject to the information available today. Implicitly, this means that the central bank would not opt for fast convergence of inflation to the target, because it will have to sacrifice a big portion of output. Instead, current inflation will converge to the target in a later period, but less output will be forgone (refer to Figure **4.2**). Equation (A3.19) shows exactly this: convergence will not be achieved in *t+2,* because the central bank puts some weight on output $(\frac{\lambda}{\delta\alpha_1\kappa})$. The higher λ, the slower inflation convergence, but less output sacrificed. In other words, from (A3.19) it is evident that the two-year ahead inflation $\pi_{t+2|t}$ will coincide with the target π^* only if the one-period ahead output gap equals zero $(y_{t+1|t} - y^*_{t+1} = 0)$. As long as the central bank considers output fluctuations and opts for minimizing the sacrifice ratio $(\lambda > 0)$, $\pi_{t+2|t}$ will exceed π^* if the output gap is negative, and vice versa. Namely, if the current output is expected to be below the trend-line in period *t+1,* then the central bank will ease the monetary policy stance by lowering the interest rate and hence support the economic activity. This policy will lead to higher inflation at *t+2* than otherwise, thus raising the inflation forecast for *t+2* made today. Consequently, if the central bank takes into account the output-gap movements, than it is optimal to gradually adjust the inflation forecast to the inflation target and hence reduce output fluctuations or minimize the sacrifice ratio. The higher the λ, the higher the influence of the expected output gap on the inflation forecast and the more gradual the adjustment process will be.

Now, we want to derive the interest-rate rule. We start by reproducing (A3.5):

$$\pi_{t+2} = (1+\beta_2)\pi_t + \alpha_1(1+\beta_1)(y_t - y^*_t) - \alpha_1\beta_2 r_t + (\varepsilon_{t+1} + \alpha_1\eta_{t+1} + \varepsilon_{t+2})$$

Whereby the expected value of $(\varepsilon_{t+1} + \alpha_1\eta_{t+1} + \varepsilon_{t+2})$ is zero. Further rearrangement gives:

$$\pi_{t+2|t} = \pi_t + \alpha_1(1+\beta_1)(y_t - y^*_t) - \alpha_1\beta_2(r_t - \pi_t) \qquad \text{(A3.20)}$$

From (4.3): $\pi_t - \pi_{t-1} = \alpha_1(y_{t-1} - y^*_{t-1}) + \varepsilon_t$, the output gap could be set as:

$$y_{t+1|t} - y^*_{t+1} = \frac{\pi_{t+2|t} - \pi_{t+1|t}}{\alpha_1} \qquad \text{(A3.21)}$$

Which, if substituted in (A3.19), yields:

$$\pi_{t+2|t} = \pi^* - \frac{\lambda}{\delta\alpha_1\kappa}\frac{\pi_{t+2|t} - \pi_{t+1|t}}{\alpha_1}$$
$$\pi_{t+2|t} = \pi^* - \frac{\lambda}{\delta\alpha_1^2\kappa}(\pi_{t+2|t} - \pi_{t+1|t}) \quad \text{(A3.22)}$$

Multiplying from both sides by $\delta\alpha_1^2\kappa$ and rearranging yields:

$$\delta\alpha_1^2\kappa\pi_{t+2|t} = \delta\alpha_1^2\kappa\,\pi^* - \lambda(\pi_{t+2|t} - \pi_{t+1|t})$$
$$\delta\alpha_1^2\kappa\pi_{t+2|t} = \delta\alpha_1^2\kappa\,\pi^* - \lambda\pi_{t+2|t} + \lambda\pi_{t+1|t}$$
$$\delta\alpha_1^2\kappa\pi_{t+2|t} + \lambda\pi_{t+2|t} = \delta\alpha_1^2\kappa\,\pi^* + \lambda\pi_{t+1|t}$$
$$(\delta\alpha_1^2\kappa + \lambda)\pi_{t+2|t} = \delta\alpha_1^2\kappa\,\pi^* + \lambda\pi_{t+1|t}$$

To both sides a term $-\lambda\pi^*$ is added and then rearranging gives:

$$(\delta\alpha_1^2\kappa + \lambda)\pi_{t+2|t} - \lambda\pi^* = \delta\alpha_1^2\kappa\,\pi^* + \lambda\pi_{t+1|t} - \lambda\pi^*$$
$$(\delta\alpha_1^2\kappa + \lambda)\pi_{t+2|t} - \delta\alpha_1^2\kappa\,\pi^* - \lambda\pi^* = \lambda\pi_{t+1|t} - \lambda\pi^*$$
$$(\delta\alpha_1^2\kappa + \lambda)\pi_{t+2|t} - (\delta\alpha_1^2\kappa + \lambda)\pi^* = \lambda(\pi_{t+1|t} - \pi^*)$$
$$(\delta\alpha_1^2\kappa + \lambda)(\pi_{t+2|t} - \pi^*) = \lambda(\pi_{t+1|t} - \pi^*)$$

For the purpose of deriving the interest-rate rule under flexible IT, further rearrangement gives:

$$(\delta\alpha_1^2\kappa + \lambda)\pi_{t+2|t} - \lambda\pi^* = \delta\alpha_1^2\kappa\,\pi^* + \lambda\pi_{t+1|t} - \lambda\pi^*$$
$$(\delta\alpha_1^2\kappa + \lambda)\pi_{t+2|t} - \delta\alpha_1^2\kappa\,\pi^* - \lambda\pi^* = \lambda\pi_{t+1|t} - \lambda\pi^*$$
$$(\delta\alpha_1^2\kappa + \lambda)\pi_{t+2|t} - (\delta\alpha_1^2\kappa + \lambda)\pi^* = \lambda(\pi_{t+1|t} - \pi^*)$$
$$(\delta\alpha_1^2\kappa + \lambda)(\pi_{t+2|t} - \pi^*) = \lambda(\pi_{t+1|t} - \pi^*)$$

From the last-row equation, it follows:

$$\pi_{t+2|t} - \pi^* = \frac{\lambda}{\delta\alpha_1^2\kappa + \lambda}(\pi_{t+1|t} - \pi^*)$$

$$\pi_{t+2|t} - \pi^* = c(\pi_{t+1|t} - \pi^*)$$

$$\pi_{t+2|t} = \pi^* + c(\pi_{t+1|t} - \pi^*) \quad \text{(A3.23)}$$

Where $c = \frac{\lambda}{\delta\alpha_1^2\kappa + \lambda}$ and $0 \le c < 1$, since under flexible IT, $\lambda > 0$ and hence, *c* must be positive but less than unity.

Now, equating (A3.20) and (A3.23) yields:

$$\pi^* + c(\pi_{t+1|t} - \pi^*) = \pi_t + \alpha_1(1+\beta_1)(y_t - y_t^*) - \alpha_1\beta_2(r_t - \pi_t) \qquad \text{(A3.24)}$$

Which rearranged and given (4.3): $\pi_{t+1|t} = \pi_t + \alpha_1(y_t - y_t^*)$, yields:

$$\pi^* + c\pi_t + \alpha_1 c(y_t - y_t^*) - c\pi^* = \pi_t + \alpha_1(y_t - y_t^*) + \alpha_1\beta_1(y_t - y_t^*) - \alpha_1\beta_2 r_t + \alpha_1\beta_2\pi_t$$
$$\alpha_1\beta_2 r_t = (c-1)\pi^* + \pi_t - c\pi_t + \alpha_1\beta_2\pi_t + (\alpha_1 + \alpha_1\beta_1 - \alpha_1 c)(y_t - y_t^*)$$
$$\alpha_1\beta_2 r_t = (c-1)\pi^* - (c-1)\pi_t + \alpha_1\beta_2\pi_t + (\alpha_1 + \alpha_1\beta_1 - \alpha_1 c)(y_t - y_t^*)$$
$$\alpha_1\beta_2 r_t = (1-c)(\pi_t - \pi^*) + \alpha_1\beta_2\pi_t + (\alpha_1 + \alpha_1\beta_1 - \alpha_1 c)(y_t - y_t^*)$$
$$r_t = \frac{(1-c)}{\alpha_1\beta_2}(\pi_t - \pi^*) + \frac{\alpha_1\beta_2}{\alpha_1\beta_2}\pi_t + \frac{\alpha_1 + \alpha_1\beta_1 - \alpha_1 c}{\alpha_1\beta_2}(y_t - y_t^*)$$
$$r_t = \frac{(1-c)}{\alpha_1\beta_2}(\pi_t - \pi^*) + \pi_t + \frac{1+\beta_1 - c}{\beta_2}(y_t - y_t^*)$$

And, from the last-row equation, it follows:

$$r_t = \rho_1^*(\pi_t - \pi^*) + \pi_t + \rho_2^*(y_t - y_t^*) \qquad \text{(A3.25)}$$

Where, $\rho_1^* = \frac{1-c}{\alpha_1\beta_2}; \rho_2^* = \frac{1+\beta_1-c}{\beta_2}$. From (A3.25) it follows that it is optimal for the flexible ITs, similarly to strict ITs, to adjust the nominal interest rate upward to reflect current inflation (the coefficient in front is equal to one, thus the adjustment will be to a full extent), the difference between the current inflation and the target, as well as the increase in the output gap. Svensson (1997) argues that the inclusion of the current inflation rate and the current output gap in (A3.25) helps in predicting future inflation. However, the extent to which those will shape the interest rates, differently from the case of strict IT, now depends on the weight attached to stabilizing output λ, because it defines c and it is an ingredient of $\rho_1^* = \frac{1-c}{\alpha_1\beta_2}; \rho_2^* = \frac{1+\beta_1-c}{\beta_2}$. Comparing these to $\rho_1 = \frac{1}{\alpha_1\beta_2}; \rho_2 = \frac{1+\beta_1}{\beta_2}$ in (A3.16), it is evident that $\rho_1 = \rho_1^*$ and $\rho_2 = \rho_2^*$ when $c = 0$ (i.e. when $\lambda = 0$, with the bank as a strict inflation targeter). Accordingly, when the current inflation exceeds the target or the current output exceeds the potential (overheating of the economy), the instrument must respond positively (an increase of the interest rate).

If equation (A3.25) is compared to (A3.16): $r_t = \pi_t + \rho_1(\pi_t - \pi^*) + \rho_2(y_t - y_t^*)$, the ρ^* s are smaller than ρ s, for some proportion of *c*, and this is due to the positive weight attached on the output gap in the loss function. The higher the weight on output, the longer the period required to bring inflation on target. Consequently, the length of the target horizon depends not only on the magnitude and persistence of the shock, but also on the relative weight attached on the output gap. In times of shocks, flexible IT provides a trade-off between inflation volatility and output-gap volatility. Fuhrer (1997a, cited in Agénor, 2002) states that by varying the relative weight that the central bank puts on the output gap in the loss function, an optimal policy frontier is designed, which comprises the set of efficient combinations of inflation volatility and output-gap volatility attainable by policymakers.

APPENDIX 4 – Printouts

A4.1. Growth regression printouts

<u>Specification with time dummies and interaction terms</u>

```
xtabond2 growth l.growth lgdp75 life1 inf l.inf educ l.educ lfertil l.lfertil to l.to
gccugdp l.gccugdp invgdp l.invgdp dem l.dem dem2 rr1 rr2 rr3 rr5 d.lpopul eurer
survivor latcar sahar r1inf r1to r1gc r1inv r1educ r1fertil r1dem r2inf r2to r2gc
r2inv r2educ r2fertil r2dem r3inf r3to r3gc r3inv r3educ r3fertil r3dem r5inf r5to
r5gc r5inv r5educ r5fertil r5dem _Iyear_*, gmm(l.growth lgdp75 life1 l.inf l.educ
l.lfertil l.to l.gccugdp l.invgdp l.dem l.dem2 l.rr1 l.rr2 l.rr3 l.rr5 l.r1inf l.r1to
l.r1gc l.r1inv l.r1educ l.r1fertil l.r1dem l.r2inf l.r2to l.r2gc l.r2inv l.r2educ
l.r2fertil l.r2dem l.r3inf l.r3to l.r3gc l.r3inv l.r3educ l.r3fertil l.r3dem l.r5inf
l.r5to l.r5gc l.r5inv l.r5educ l.r5fertil l.r5dem , eq(diff) laglimits(1 1) collapse)
gmm(l.growth lgdp75 life1 inf educ lfertil to gccugdp invgdp dem dem2 rr2 rr3 rr1
rr5, eq(level) laglimits(1 1) collapse) iv(d.lpopul lavgdp70 eurer survivor latcar
sahar _Iyear_*) twostep robust

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: country                         Number of obs      =      1551
Time variable : year                            Number of groups   =        87
Number of instruments = 81                      Obs per group: min =         0
Wald chi2(72) =   1616.10                                      avg =     17.83
Prob > chi2   =     0.000                                      max =        21
------------------------------------------------------------------------------
             |              Corrected
      growth |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      growth |
         L1. |   .0204268   .1213502     0.17   0.866    -.2174152    .2582688
      lgdp75 |  -4.465656   7.857754    -0.57   0.570    -19.86657    10.93526
       life1 |   13.20673     26.116     0.51   0.613    -37.97969    64.39314
         inf |
         --. |  -92.89865   184.6196    -0.50   0.615    -454.7465    268.9492
         L1. |   10.79553   11.84017     0.91   0.362    -12.41078    34.00185
        educ |   -6.42222   9.894161    -0.65   0.516    -25.81442    12.96998
     lfertil |
         --. |  -63.81266     73.171    -0.87   0.383    -207.2252    79.59986
         L1. |   35.59316   68.17779     0.52   0.602    -98.03285    169.2192
          to |
         --. |  -140.8733   134.1978    -1.05   0.294    -403.8962    122.1497
         L1. |   16.61851   25.88024     0.64   0.521    -34.10583    67.34285
     gccugdp |
         --. |  -374.6865      369.3    -1.01   0.310    -1098.501    349.1282
         L1. |   17.46299    78.6266     0.22   0.824    -136.6423    171.5683
      invgdp |
         --. |  -104.9467   201.6556    -0.52   0.603    -500.1845     290.291
         L1. |  -4.093005   16.00626    -0.26   0.798    -35.46471     27.2787
         dem |
         --. |  -11.37066   9.148401    -1.24   0.214     -29.3012    6.559876
         L1. |   4.242734   4.656541     0.91   0.362    -4.883918    13.36939
        dem2 |   -.526038    .805318    -0.65   0.514    -2.104432    1.052356
         rr1 |  -184.1669   159.6873    -1.15   0.249    -497.1483    128.8144
         rr2 |  -209.8411   171.2775    -1.23   0.221    -545.5388    125.8567
         rr3 |   -207.834   179.8857    -1.16   0.248    -560.4034    144.7355
     rr5dual |   -214.493   157.8882    -1.36   0.174    -523.9482    94.96229
      lpopul |
         D1. |  -14.67682    75.8417    -0.19   0.847    -163.3238    133.9702
      eurerm |  -.0213094   5.160612    -0.00   0.997    -10.13592     10.0933
    survivor |   2.476342   6.118129     0.40   0.686    -9.514971    14.46765
      latcar |   2.862662   2.477502     1.16   0.248    -1.993152    7.718476
       sahar |  -.8353853   5.234332    -0.16   0.873    -11.09449    9.423716
       r1inf |   64.63787   156.4418     0.41   0.679    -241.9824    371.2581
        r1to |   141.2791   155.6891     0.91   0.364    -163.8659     446.424
        r1gc |    258.116   329.1026     0.78   0.433    -386.9132    903.1451
       r1inv |   112.5153   215.0188     0.52   0.601    -308.9138    533.9445
      r1educ |   9.195518   11.44236     0.80   0.422     -13.2311    31.62214
    r1fertil |   14.41324    32.1017     0.45   0.653    -48.50492    77.33141
       r1dem |   12.12052    10.6185     1.14   0.254    -8.691354     32.9324
       r2inf |   71.70851   165.2431     0.43   0.664     -252.162     395.579
        r2to |   152.9376   162.4393     0.94   0.346    -165.4376    471.3129
        r2gc |   348.7935   348.9397     1.00   0.318    -335.1157    1032.703
       r2inv |   109.3529   203.1247     0.54   0.590    -288.7642    507.4699
      r2educ |   9.083781   10.59779     0.86   0.391    -11.68751    29.85508
    r2fertil |   23.25287    30.5509     0.76   0.447    -36.62579    83.13154
       r2dem |   10.98389    10.5144     1.04   0.296    -9.623957    31.59173
       r3inf |   56.24166   151.6192     0.37   0.711    -240.9264    353.4097
        r3to |   136.2669   143.8417     0.95   0.343    -145.6576    418.1915
        r3gc |   376.5448   359.6336     1.05   0.295    -328.3242    1081.414
       r3inv |   109.6923    203.102     0.54   0.589    -288.3803     507.765
```

```
     r3educ |   8.878792   11.52905     0.77   0.441    -13.71772    31.47531
   r3fertil |   25.96557   40.82479     0.64   0.525    -54.04956    105.9807
      r3dem |   10.00239   9.269315     1.08   0.281    -8.165131    28.16992
      r5inf |   72.35263    170.221     0.43   0.671    -261.2744    405.9796
       r5to |   158.0861   192.1082     0.82   0.411    -218.4391    534.6113
       r5gc |   324.6476   318.8463     1.02   0.309    -300.2796    949.5748
      r5inv |   180.4118   180.7891     1.00   0.318    -173.9283    534.7519
     r5educ |   6.890094   8.552162     0.81   0.420    -9.871835    23.65202
   r5fertil |   18.36015    24.0717     0.76   0.446    -28.81951    65.53981
      r5dem |   12.63984   11.77288     1.07   0.283    -10.43458    35.71426
_Iyear_1986 |   3.083226    3.19916     0.96   0.335    -3.187013    9.353465
_Iyear_1987 |   4.865101   3.224863     1.51   0.131    -1.455514    11.18572
_Iyear_1988 |   5.172513   3.667326     1.41   0.158    -2.015314    12.36034
_Iyear_1989 |   4.560782   3.231844     1.41   0.158    -1.773516    10.89508
_Iyear_1990 |  -.2633832   5.102673    -0.05   0.959    -10.26444    9.737672
_Iyear_1991 |   1.647697   3.649218     0.45   0.652     -5.50464    8.800034
_Iyear_1992 |   1.447226   2.540581     0.57   0.569    -3.532221    6.426674
_Iyear_1993 |   1.495559   2.411159     0.62   0.535    -3.230225    6.221343
_Iyear_1994 |   2.841962   2.707124     1.05   0.294    -2.463904    8.147827
_Iyear_1995 |  -2.858247   5.960762    -0.48   0.632    -14.54113    8.824632
_Iyear_1996 |   .1332359   2.012694     0.07   0.947    -3.811572    4.078044
_Iyear_1997 |   .3946018   1.894589     0.21   0.835    -3.318724    4.107928
_Iyear_1998 |   .5992573   2.416609     0.25   0.804     -4.13721    5.335725
_Iyear_1999 |  -.2734299    1.48858    -0.18   0.854    -3.190994    2.644134
_Iyear_2000 |  -3.156475   5.289748    -0.60   0.551    -13.52419     7.21124
_Iyear_2001 |  -1.841228   1.490806    -1.24   0.217    -4.763154    1.080697
_Iyear_2002 |  -1.487039   1.586289    -0.94   0.349    -4.596109    1.622031
_Iyear_2003 |  -.7343514   1.366409    -0.54   0.591    -3.412463     1.94376
      _cons |   204.4602   176.4763     1.16   0.247    -141.4269    550.3474
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(D.lpopul lavgdp70 eurerm survivor latcar sahar _Iyear_1980 _Iyear_1981
    _Iyear_1982 _Iyear_1983 _Iyear_1984 _Iyear_1985 _Iyear_1986 _Iyear_1987
    _Iyear_1988 _Iyear_1989 _Iyear_1990 _Iyear_1991 _Iyear_1992 _Iyear_1993
    _Iyear_1994 _Iyear_1995 _Iyear_1996 _Iyear_1997 _Iyear_1998 _Iyear_1999
    _Iyear_2000 _Iyear_2001 _Iyear_2002 _Iyear_2003 _Iyear_2004)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L.(L.growth lgdp75 life1 L.inf L.educ L.lfertil L.to L.gccugdp L.invgdp
    L.dem L.dem2 L.rr1 L.rr2 L.rr3 L.rr5dual L.r1inf L.r1to L.r1gc L.r1inv
    L.r1educ L.r1fertil L.r1dem L.r2inf L.r2to L.r2gc L.r2inv L.r2educ
    L.r2fertil L.r2dem L.r3inf L.r3to L.r3gc L.r3inv L.r3educ L.r3fertil
    L.r3dem L.r5inf L.r5to L.r5gc L.r5inv L.r5educ L.r5fertil L.r5dem)
    collapsed
Instruments for levels equation
  Standard
    _cons
    D.lpopul lavgdp70 eurerm survivor latcar sahar _Iyear_1980 _Iyear_1981
    _Iyear_1982 _Iyear_1983 _Iyear_1984 _Iyear_1985 _Iyear_1986 _Iyear_1987
    _Iyear_1988 _Iyear_1989 _Iyear_1990 _Iyear_1991 _Iyear_1992 _Iyear_1993
    _Iyear_1994 _Iyear_1995 _Iyear_1996 _Iyear_1997 _Iyear_1998 _Iyear_1999
    _Iyear_2000 _Iyear_2001 _Iyear_2002 _Iyear_2003 _Iyear_2004
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.(L.growth lgdp75 life1 inf educ lfertil to gccugdp invgdp dem dem2 rr2
    rr3 rr1 rr5dual) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z = -1.81  Pr > z =  0.071
Arellano-Bond test for AR(2) in first differences: z =  0.88  Pr > z =  0.380
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(8)  = 11.70 Prob > chi2 =  0.165
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(8)  =  9.59 Prob > chi2 =  0.295
  (Robust, but can be weakened by many instruments.)
```

<u>F-test for interaction terms</u>

```
test r1inf= r1to= r1gc= r1inv= r1educ=r1fertil=r1dem=0

           chi2(  7) =    2.94
         Prob > chi2 =    0.8908

. test r2inf= r2to= r2gc= r2inv= r2educ=r2fertil=r2dem=0

           chi2(  7) =    1.93
         Prob > chi2 =    0.9634

. test r3inf= r3to= r3gc= r3inv= r3educ=r3fertil=r3dem=0

           chi2(  7) =    2.54
         Prob > chi2 =    0.9239

. test r5inf= r5to= r5gc= r5inv= r5educ=r5fertil=r5dem=0
```

```
          chi2(  7) =    2.35
        Prob > chi2 =    0.9378

. test inf= to= gccugdp= invgdp= educ=lfertil=dem=0

          chi2(  7) =    2.56
        Prob > chi2 =    0.9223
```

Specification without interaction terms (de-facto RR classification)

```
xtabond2 growth l.growth  lgdp75 life1 inf l.inf educ l.educ lfertil l.lfertil to
l.to gccugdp l.gccugdp invgdp l.invgdp dem l.dem dem2 rr1 rr2 rr3 rr5 d.lpopul eurer
survivor latcar sahar _Iyear_*, gmm(l.growth  lgdp75 life1 l.inf l.educ l.lfertil
l.to l.gccugdp l.invgdp l.dem l.dem2 l.rr1  l.rr2 l.rr3 l.rr5 , eq(diff) laglimits(1
1) collapse) gmm(l.growth  lgdp75 life1  inf educ lfertil to gccugdp invgdp dem dem2
rr2 rr3 rr1 rr5, eq(level) laglimits(1 1) collapse) iv(d.lpopul lavgdp70 eurer
survivor latcar sahar _Iyear_*)  twostep  robust

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: country                         Number of obs      =      1551
Time variable : year                            Number of groups   =        87
Number of instruments = 53                      Obs per group: min =         0
Wald chi2(44) =    295.01                                      avg =     17.83
Prob > chi2   =     0.000                                      max =        21
------------------------------------------------------------------------------
             |              Corrected
      growth |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      growth |
         L1. |   .0850736    .070237     1.21   0.226    -.0525885    .2227356
      lgdp75 |   2.791713   2.450683     1.14   0.255    -2.011537    7.594963
       life1 |   27.30191   13.10951     2.08   0.037     1.607739    52.99609
         inf |
         --. |  -12.22831   12.11183    -1.01   0.313    -35.96705    11.51043
         L1. |    6.30297   4.006636     1.57   0.116    -1.549892    14.15583
        educ |   1.174668   1.287328     0.91   0.362    -1.348449    3.697785
     lfertil |
         --. |  -43.56409   78.56853    -0.55   0.579    -197.5556    110.4274
         L1. |   37.91972   76.24811     0.50   0.619    -111.5238    187.3633
          to |
         --. |   5.970802   20.83483     0.29   0.774    -34.86472    46.80632
         L1. |   3.881833   23.44902     0.17   0.869    -42.07739    49.84106
     gccugdp |
         --. |  -51.25583   51.84778    -0.99   0.323    -152.8756    50.36394
         L1. |   12.20547   57.55679     0.21   0.832    -100.6038    125.0147
      invgdp |
         --. |   3.019572   3.952988     0.76   0.445    -4.728141    10.76729
         L1. |   -2.83827   4.017825    -0.71   0.480    -10.71306    5.036522
         dem |
         --. |  -3.860626   4.294121    -0.90   0.369    -12.27695    4.555696
         L1. |   4.496814   3.041513     1.48   0.139    -1.464443    10.45807
        dem2 |  -.1659347   .2413933    -0.69   0.492    -.6390568    .3071874
         rr1 |   5.843016   3.323309     1.76   0.079    -.6705494    12.35658
         rr2 |    1.42875   2.919395     0.49   0.625    -4.293159    7.150658
         rr3 |    2.59103    3.72789     0.70   0.487    -4.715499     9.89756
    rr5dual |   1.833908   4.050956     0.45   0.651    -6.105821    9.773636
      lpopul |
         D1. |  -65.59398   50.45261    -1.30   0.194    -164.4793    33.29132
      eurerm |  -2.195756   2.131029    -1.03   0.303    -6.372497    1.980984
    survivor |   .5414071   1.962011     0.28   0.783    -3.304064    4.386878
      latcar |  -.2256889   2.127854    -0.11   0.916    -4.396205    3.944828
       sahar |   -3.51957   3.987861    -0.88   0.377    -11.33564    4.296494
 _Iyear_1986 |    2.01008   1.137122     1.77   0.077     -.218638    4.238798
 _Iyear_1987 |   2.406846   1.213432     1.98   0.047     .0285618    4.785129
 _Iyear_1988 |    3.54987   1.158776     3.06   0.002     1.278711     5.82103
 _Iyear_1989 |   3.058588   1.250282     2.45   0.014     .6080793    5.509096
 _Iyear_1990 |  -1.784663   5.288525    -0.34   0.736    -12.14998    8.580655
 _Iyear_1991 |   1.023119   1.110616     0.92   0.357    -1.153648    3.199887
 _Iyear_1992 |   .5016838   1.002173     0.50   0.617    -1.462539    2.465907
 _Iyear_1993 |   .9558411   1.024726     0.93   0.351    -1.052585    2.964267
 _Iyear_1994 |    1.51945   1.050971     1.45   0.148    -.5404149    3.579314
 _Iyear_1995 |   -2.91591   7.626334    -0.38   0.702    -17.86325    12.03143
 _Iyear_1996 |   .4369994   .8534914     0.51   0.609    -1.235813    2.109812
 _Iyear_1997 |   .8750481   .7283663     1.20   0.230    -.5525237     2.30262
 _Iyear_1998 |  -.8130091   .8599013    -0.95   0.344    -2.498385    .8723665
 _Iyear_1999 |  -.4458285    .749215    -0.60   0.552    -1.914263    1.022606
 _Iyear_2000 |  -4.140452   6.431053    -0.64   0.520    -16.74509     8.46418
 _Iyear_2001 |   -1.57208   .7843578    -2.00   0.045    -3.109393   -.0347675
 _Iyear_2002 |  -1.893396   .7687484    -2.46   0.014    -3.400115   -.3866767
 _Iyear_2003 |  -.8745451   .6112307    -1.43   0.152    -2.072535     .323445
       _cons |  -59.29174    35.0665    -1.69   0.091    -128.0208    9.437348
------------------------------------------------------------------------------
```

```
Instruments for first differences equation
  Standard
    D.(D.lpopul lavgdp70 eurerm survivor latcar sahar _Iyear_1980 _Iyear_1981
    _Iyear_1982 _Iyear_1983 _Iyear_1984 _Iyear_1985 _Iyear_1986 _Iyear_1987
    _Iyear_1988 _Iyear_1989 _Iyear_1990 _Iyear_1991 _Iyear_1992 _Iyear_1993
    _Iyear_1994 _Iyear_1995 _Iyear_1996 _Iyear_1997 _Iyear_1998 _Iyear_1999
    _Iyear_2000 _Iyear_2001 _Iyear_2002 _Iyear_2003 _Iyear_2004)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L.(L.growth lgdp75 life1 L.inf L.educ L.lfertil L.to L.gccugdp L.invgdp
    L.dem L.dem2 L.rr1 L.rr2 L.rr3 L.rr5dual) collapsed
Instruments for levels equation
  Standard
    _cons
    D.lpopul lavgdp70 eurerm survivor latcar sahar _Iyear_1980 _Iyear_1981
    _Iyear_1982 _Iyear_1983 _Iyear_1984 _Iyear_1985 _Iyear_1986 _Iyear_1987
    _Iyear_1988 _Iyear_1989 _Iyear_1990 _Iyear_1991 _Iyear_1992 _Iyear_1993
    _Iyear_1994 _Iyear_1995 _Iyear_1996 _Iyear_1997 _Iyear_1998 _Iyear_1999
    _Iyear_2000 _Iyear_2001 _Iyear_2002 _Iyear_2003 _Iyear_2004
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.(L.growth lgdp75 life1 inf educ lfertil to gccugdp invgdp dem dem2 rr2
    rr3 rr1 rr5dual) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -3.45  Pr > z =  0.001
Arellano-Bond test for AR(2) in first differences: z =   0.85  Pr > z =  0.396
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(8)    =   9.55  Prob > chi2 =  0.298
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(8)    =   5.17  Prob > chi2 =  0.739
  (Robust, but can be weakened by many instruments.)


test l.inf=l.lfertil=l.to=l.gccugdp=l.invgdp=0

           chi2(  5) =    5.71
         Prob > chi2 =    0.3352
```

Specification without lags – final specification (de-facto RR classification)

```
xtabond2 growth l.growth  lgdp75 life1 inf educ lfertil  to  gccugdp invgdp dem dem2
rr1 rr2 rr3 rr5 d.lpopul eurer survivor latcar sahar   _Iyear_*, gmm(l.growth  lgdp75
life1 l.inf l.educ l.lfertil l.to l.gccugdp l.invgdp l.dem l.dem2 l.rr1 l.rr2 l.rr3
l.rr5, eq(diff) laglimits(1 1) collapse) gmm(l.growth  lgdp75 life1  inf educ lfertil
to gccugdp invgdp dem dem2 rr2 rr3 rr1 rr5, eq(level) laglimits(1 1) collapse)
iv(d.lpopul lavgdp70 eurer survivor latcar sahar _Iyear_*)  twostep  robust

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: country                         Number of obs      =      1638
Time variable : year                            Number of groups   =        87
Number of instruments = 54                      Obs per group: min =         0
Wald chi2(40) =    530.99                                      avg =     18.83
Prob > chi2   =     0.000                                      max =        22
------------------------------------------------------------------------------
             |              Corrected
      growth |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      growth |
         L1. |   .1576417   .0646995     2.44   0.015     .0308329    .2844504
      lgdp75 |  -2.469407   2.932618    -0.84   0.400    -8.217233    3.278419
       life1 |   33.27618   22.37026     1.49   0.137    -10.56873    77.12109
         inf |  -2.649208   2.523829    -1.05   0.294    -7.595822    2.297407
        educ |   2.254954   1.541335     1.46   0.143    -.7660083    5.275915
     lfertil |  -11.97876   5.813957    -2.06   0.039    -23.37391   -.5836185
          to |   8.272352   3.477286     2.38   0.017     1.456996    15.08771
     gccugdp |    13.4368    22.1126     0.61   0.543    -29.90309     56.7767
      invgdp |   .7757353     .47501     1.63   0.102    -.1552673    1.706738
         dem |  -.7859954   1.866554    -0.42   0.674    -4.444373    2.872382
        dem2 |    .073584   .2236193     0.33   0.742    -.3647018    .5118698
         rr1 |   2.317676   2.358146     0.98   0.326    -2.304204    6.939557
         rr2 |  -.1834732   2.211403    -0.08   0.934    -4.517744    4.150797
         rr3 |   1.134327   2.384588     0.48   0.634    -3.539379    5.808033
     rr5dual |   .1246945   2.667043     0.05   0.963    -5.102613    5.352002
      lpopul |
         D1. |  -.0750599    57.6579    -0.00   0.999    -113.0825    112.9323
      eurerm |  -1.788558   2.212495    -0.81   0.419    -6.124969    2.547852
    survivor |   1.641992   1.544854     1.06   0.288    -1.385865     4.66985
      latcar |    3.69878   2.176253     1.70   0.089    -.5665972    7.964158
       sahar |  -2.704982   3.590996    -0.75   0.451    -9.743204     4.33324
 _Iyear_1985 |   3.183549   1.617514     1.97   0.049     .0132787    6.353819
 _Iyear_1986 |   2.896078   1.459794     1.98   0.047     .0349347    5.757221
 _Iyear_1987 |   3.456481   1.447029     2.39   0.017     .6203557    6.292606
 _Iyear_1988 |   4.360919    1.45204     3.00   0.003     1.514972    7.206865
 _Iyear_1989 |   3.808642   1.490599     2.56   0.011     .8871212    6.730163
```

```
  _Iyear_1990 |   2.022084   1.146014     1.76   0.078    -.2240615    4.268229
  _Iyear_1991 |   1.683368   1.052354     1.60   0.110    -.3792073    3.745944
  _Iyear_1992 |   1.070778   .8593248     1.25   0.213    -.6134676    2.755024
  _Iyear_1993 |   1.406502    .918046     1.53   0.126    -.3928347    3.205839
  _Iyear_1994 |   2.260815   .9816273     2.30   0.021     .3368612    4.184769
  _Iyear_1995 |   1.590724   .6783359     2.35   0.019     .2612105    2.920238
  _Iyear_1996 |     1.4373   .7689297     1.87   0.062    -.0697742    2.944375
  _Iyear_1997 |   1.636294   .8357944     1.96   0.050    -.0018328    3.274421
  _Iyear_1998 |   .0106262   .7889931     0.01   0.989    -1.535772    1.557024
  _Iyear_1999 |   .4869201   .6408507     0.76   0.447    -.7691243    1.742964
  _Iyear_2000 |  -.2444096   .5185544    -0.47   0.637    -1.260758    .7719383
  _Iyear_2001 |  -1.751747   .5457568    -3.21   0.001    -2.821411   -.6820836
  _Iyear_2002 |  -1.486249   .5482959    -2.71   0.007    -2.560889   -.4116084
  _Iyear_2003 |  -.5366942   .4311561    -1.24   0.213    -1.381745    .3083562
  _Iyear_2004 |    .408314   .4157776     0.98   0.326    -.4065952    1.223223
        _cons |  -35.44042   49.26198    -0.72   0.472    -131.9921     61.1113
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(D.lpopul lavgdp70 eurerm survivor latcar sahar _Iyear_1980 _Iyear_1981
    _Iyear_1982 _Iyear_1983 _Iyear_1984 _Iyear_1985 _Iyear_1986 _Iyear_1987
    _Iyear_1988 _Iyear_1989 _Iyear_1990 _Iyear_1991 _Iyear_1992 _Iyear_1993
    _Iyear_1994 _Iyear_1995 _Iyear_1996 _Iyear_1997 _Iyear_1998 _Iyear_1999
    _Iyear_2000 _Iyear_2001 _Iyear_2002 _Iyear_2003 _Iyear_2004)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L.(L.growth lgdp75 life1 L.inf L.educ L.lfertil L.to L.gccugdp L.invgdp
    L.dem L.dem2 L.rr1 L.rr2 L.rr3 L.rr5dual) collapsed
Instruments for levels equation
  Standard
    _cons
    D.lpopul lavgdp70 eurerm survivor latcar sahar _Iyear_1980 _Iyear_1981
    _Iyear_1982 _Iyear_1983 _Iyear_1984 _Iyear_1985 _Iyear_1986 _Iyear_1987
    _Iyear_1988 _Iyear_1989 _Iyear_1990 _Iyear_1991 _Iyear_1992 _Iyear_1993
    _Iyear_1994 _Iyear_1995 _Iyear_1996 _Iyear_1997 _Iyear_1998 _Iyear_1999
    _Iyear_2000 _Iyear_2001 _Iyear_2002 _Iyear_2003 _Iyear_2004
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.(L.growth lgdp75 life1 inf educ lfertil to gccugdp invgdp dem dem2 rr2
    rr3 rr1 rr5dual) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -4.24  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   0.18  Pr > z =  0.860
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(13)   =  27.21  Prob > chi2 =  0.012
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(13)   =  10.58  Prob > chi2 =  0.646
  (Robust, but can be weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(1)    =   0.07  Prob > chi2 =  0.789
    Difference (null H = exogenous): chi2(12)   =  10.51  Prob > chi2 =  0.572
  gmm(L.growth lgdp75 life1 inf educ lfertil to gccugdp invgdp dem dem2 rr2 rr3 rr1
rr5dual, collapse eq(level) lag(1 1
> ))
    Hansen test excluding group:     chi2(1)    =   0.07  Prob > chi2 =  0.789
    Difference (null H = exogenous): chi2(12)   =  10.51  Prob > chi2 =  0.572


test rr1=rr2=rr3=rr5dual=0

           chi2(  4) =    6.39
         Prob > chi2 =    0.1720
```

<u>Developing (including transition) countries</u>

```
xtabond2 growth l.growth  lgdp75 life1 inf educ lfertil  to  gccugdp invgdp dem dem2
rr1 rr2 rr3 rr5 d.lpopul eurer survivor latcar sahar   _Iyear_*, gmm(l.growth  lgdp75
life1 l.inf l.educ l.lfertil l.to l.gccugdp l.invgdp l.dem l.dem2 l.rr1 l.rr2 l.rr3
l.rr5, eq(diff) laglimits(1 1) collapse) gmm(l.growth  lgdp75 life1  inf educ lfertil
to gccugdp invgdp dem dem2 rr1 rr2 rr3 rr5, eq(level) laglimits(1 1) collapse)
iv(d.lpopul lavgdp70 eurer survivor latcar sahar _Iyear_*)  twostep  robust

------------------------------------------------------------------------------
Group variable: country                         Number of obs      =      1189
Time variable : year                            Number of groups   =        64
Number of instruments = 52                      Obs per group: min =         3
Wald chi2(38) =    782.53                                      avg =     18.58
Prob > chi2   =     0.000                                      max =        22
------------------------------------------------------------------------------
             |              Corrected
      growth |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      growth |
```

```
         L1. |   .1638806   .0680192     2.41   0.016     .0305654    .2971958
      lgdp75 |  -.4554574   2.095039    -0.22   0.828    -4.561659    3.650744
       life1 |   14.42425   12.43096     1.16   0.246    -9.939978    38.78848
         inf |  -3.367305   1.741387    -1.93   0.053    -6.780362    .0457513
        educ |    1.92597   .9186728     2.10   0.036      .125404    3.726535
     lfertil |   4.153891   9.812219     0.42   0.672     -15.0777    23.38549
          to |   12.88066   3.044816     4.23   0.000      6.91293    18.84839
     gccugdp |   18.38933   20.16548     0.91   0.362    -21.13428    57.91295
      invgdp |   .8708282   .6064255     1.44   0.151     -.317744      2.0594
         dem |  -1.162889   1.939909    -0.60   0.549    -4.965042    2.639263
        dem2 |   .1551581   .2485625     0.62   0.532    -.3320155    .6423316
         rr1 |   -1.56471   2.171514    -0.72   0.471    -5.820798    2.691379
         rr2 |  -3.004516   2.527935    -1.19   0.235    -7.959177    1.950145
         rr3 |  -.1107522   2.305268    -0.05   0.962    -4.628994     4.40749
     rr5dual |  -1.543039   1.891917    -0.82   0.415    -5.251129    2.165051
      lpopul |
         D1. |  -117.3905   93.20553    -1.26   0.208      -300.07    65.28896
    survivor |   1.504545   1.311923     1.15   0.251    -1.066777    4.075868
      latcar |  -.1478497   2.327732    -0.06   0.949    -4.710121    4.414422
       sahar |  -5.159645   3.507965    -1.47   0.141    -12.03513    1.715839
 _Iyear_1985 |  -.5427019   2.509579    -0.22   0.829    -5.461386    4.375982
 _Iyear_1986 |  -.7748481   2.224223    -0.35   0.728    -5.134245    3.584549
 _Iyear_1987 |   -.723306   2.392194    -0.30   0.762    -5.411921    3.965309
 _Iyear_1988 |   .2919206   2.315002     0.13   0.900    -4.245401    4.829242
 _Iyear_1989 |  -.0814047   2.605293    -0.03   0.975    -5.187686    5.024876
 _Iyear_1990 |   .1362924   1.542524     0.09   0.930       -2.887    3.159585
 _Iyear_1991 |   .1053363   1.514031     0.07   0.945     -2.86211    3.072783
 _Iyear_1992 |  -.6844128   1.444169    -0.47   0.636    -3.514931    2.146106
 _Iyear_1993 |  -.2406934   1.356676    -0.18   0.859     -2.89973    2.418343
 _Iyear_1994 |   .4458894   1.456505     0.31   0.760    -2.408808    3.300587
 _Iyear_1995 |   1.295651   .6473045     2.00   0.045     .0269577    2.564345
 _Iyear_1996 |   1.492531   .6678492     2.23   0.025     .1835703    2.801491
 _Iyear_1997 |   1.474256   .6538632     2.25   0.024     .1927074    2.755804
 _Iyear_1999 |  -.2820741   .6952377    -0.41   0.685    -1.644715    1.080567
 _Iyear_2000 |   .3045961   .8539075     0.36   0.721    -1.369032    1.978224
 _Iyear_2001 |  -.9824817   .7012765    -1.40   0.161    -2.356958    .3919951
 _Iyear_2002 |  -.9574084   .9192766    -1.04   0.298    -2.759158    .8443406
 _Iyear_2003 |   .1696565   .6627793     0.26   0.798    -1.129367     1.46868
 _Iyear_2004 |    .899055    .661299     1.36   0.174    -.3970673    2.195177
       _cons |  -30.20294   28.88464    -1.05   0.296     -86.8158    26.40992
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(D.lpopul lavgdp70 eurerm survivor latcar sahar _Iyear_1978 _Iyear_1979
    _Iyear_1980 _Iyear_1981 _Iyear_1982 _Iyear_1983 _Iyear_1984 _Iyear_1985
    _Iyear_1986 _Iyear_1987 _Iyear_1988 _Iyear_1989 _Iyear_1990 _Iyear_1991
    _Iyear_1992 _Iyear_1993 _Iyear_1994 _Iyear_1995 _Iyear_1996 _Iyear_1997
    _Iyear_1999 _Iyear_2000 _Iyear_2001 _Iyear_2002 _Iyear_2003 _Iyear_2004)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L.(L.growth lgdp75 life1 L.inf L.educ L.lfertil L.to L.gccugdp L.invgdp
    L.dem L.dem2 L.rr1 L.rr2 L.rr3 L.rr5dual) collapsed
Instruments for levels equation
  Standard
    _cons
    D.lpopul lavgdp70 eurerm survivor latcar sahar _Iyear_1978 _Iyear_1979
    _Iyear_1980 _Iyear_1981 _Iyear_1982 _Iyear_1983 _Iyear_1984 _Iyear_1985
    _Iyear_1986 _Iyear_1987 _Iyear_1988 _Iyear_1989 _Iyear_1990 _Iyear_1991
    _Iyear_1992 _Iyear_1993 _Iyear_1994 _Iyear_1995 _Iyear_1996 _Iyear_1997
    _Iyear_1999 _Iyear_2000 _Iyear_2001 _Iyear_2002 _Iyear_2003 _Iyear_2004
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.(L.growth lgdp75 life1 inf educ lfertil to gccugdp invgdp dem dem2 rr1
    rr2 rr3 rr5dual) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -3.94  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   0.61  Pr > z =  0.539
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(13)   =  19.95  Prob > chi2 =  0.096
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(13)   =  10.39  Prob > chi2 =  0.662
  (Robust, but can be weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(1)    =   1.90  Prob > chi2 =  0.168
    Difference (null H = exogenous): chi2(12)   =   8.49  Prob > chi2 =  0.746
  gmm(L.growth lgdp75 life1 inf educ lfertil to gccugdp invgdp dem dem2 rr1 rr2 rr3
rr5dual, collapse eq(level) lag(1 1
> ))
    Hansen test excluding group:     chi2(1)    =   1.90  Prob > chi2 =  0.168
    Difference (null H = exogenous): chi2(12)   =   8.49  Prob > chi2 =  0.746
```

Differentiating two sub-periods

1976-1990

```
xtabond2 growth l.growth  lgdp75 life1 inf educ lfertil  to  gccugdp invgdp dem dem2
rr1 rr2 rr3 rr5 d.lpopul eurer survivor latcar sahar   _Iyear_*, gmm(l.growth  lgdp75
life1 l.inf l.educ l.lfertil l.to l.gccugdp l.invgdp l.dem l.dem2 l.rr1 l.rr2 l.rr3
l.rr5, eq(diff) laglimits(1 1) collapse) gmm(l.growth  lgdp75 life1  inf educ lfertil
to gccugdp invgdp dem dem2 rr1 rr2 rr3 rr5 , eq(level) laglimits(1 1) collapse)
iv(d.lpopul lavgdp70 eurer survivor latcar sahar _Iyear_*)  twostep  robust

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: country                         Number of obs      =       394
Time variable : year                            Number of groups   =        72
Number of instruments = 36                      Obs per group: min =         0
Wald chi2(23) =    107.78                                      avg =      5.47
Prob > chi2   =     0.000                                      max =         6
------------------------------------------------------------------------------
             |              Corrected
      growth |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      growth |
         L1. |   .1673612   .1627922     1.03   0.304    -.1517057     .486428
      lgdp75 |    3.87525   8.522809     0.45   0.649    -12.82915    20.57965
       life1 |   10.70798    35.8855     0.30   0.765    -59.62631    81.04226
         inf |   4.820007   7.410979     0.65   0.515    -9.705245    19.34526
        educ |  -2.650123   3.003918    -0.88   0.378    -8.537695    3.237448
     lfertil |  -6.831154   16.68621    -0.41   0.682    -39.53552    25.87321
          to |   7.384357   22.86781     0.32   0.747    -37.43573    52.20445
     gccugdp |   13.80709   95.28091     0.14   0.885    -172.9401    200.5542
      invgdp |  -.4469774   2.600862    -0.17   0.864    -5.544573    4.650618
         dem |  -3.666674    4.23725    -0.87   0.387    -11.97153    4.638183
        dem2 |   .4922229   .4931981     1.00   0.318    -.4744276    1.458873
         rr1 |   .4152406   6.748236     0.06   0.951    -12.81106    13.64154
         rr2 |   2.572224   6.809878     0.38   0.706    -10.77489    15.91934
         rr3 |  -1.090872   5.643442    -0.19   0.847    -12.15182    9.970071
     rr5dual |  -3.670618   7.260636    -0.51   0.613     -17.9012    10.55997
      lpopul |
         D1. |  -99.67973   202.2265    -0.49   0.622    -496.0363    296.6769
      eurerm |  -2.081596   6.638764    -0.31   0.754    -15.09333    10.93014
      latcar |  -.1027174   5.063944    -0.02   0.984    -10.02787    9.822431
       sahar |  -.7573995   6.165235    -0.12   0.902    -12.84104    11.32624
 _Iyear_1985 |  -.3804164   1.177993    -0.32   0.747     -2.68924    1.928408
 _Iyear_1986 |   .0452853   .5527584     0.08   0.935    -1.038101    1.128672
 _Iyear_1988 |   1.506036   .8430804     1.79   0.074     -.146371    3.158444
 _Iyear_1989 |   .0595408   1.598595     0.04   0.970    -3.073647    3.192729
       _cons |     -22.53   91.79738    -0.25   0.806    -202.4496    157.3896
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(D.lpopul lavgdp70 eurerm survivor latcar sahar _Iyear_1977 _Iyear_1978
    _Iyear_1979 _Iyear_1980 _Iyear_1981 _Iyear_1982 _Iyear_1983 _Iyear_1984
    _Iyear_1985 _Iyear_1986 _Iyear_1988 _Iyear_1989)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L.(L.growth lgdp75 life1 L.inf L.educ L.lfertil L.to L.gccugdp L.invgdp
    L.dem L.dem2 L.rr1 L.rr2 L.rr3 L.rr5dual) collapsed
Instruments for levels equation
  Standard
    _cons
    D.lpopul lavgdp70 eurerm survivor latcar sahar _Iyear_1977 _Iyear_1978
    _Iyear_1979 _Iyear_1980 _Iyear_1981 _Iyear_1982 _Iyear_1983 _Iyear_1984
    _Iyear_1985 _Iyear_1986 _Iyear_1988 _Iyear_1989
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.(L.growth lgdp75 life1 inf educ lfertil to gccugdp invgdp dem dem2 rr1
    rr2 rr3 rr5dual) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -2.45  Pr > z =  0.014
Arellano-Bond test for AR(2) in first differences: z =  -0.57  Pr > z =  0.565
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(12)   =  27.99  Prob > chi2 =  0.006
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(12)   =   9.99  Prob > chi2 =  0.617
  (Robust, but can be weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(1)    =   1.66  Prob > chi2 =  0.197
    Difference (null H = exogenous): chi2(11)   =   8.33  Prob > chi2 =  0.684
  gmm(L.growth lgdp75 life1 inf educ lfertil to gccugdp invgdp dem dem2 rr1 rr2 rr3
rr5dual, collapse eq(level) lag(1 1
> ))
    Hansen test excluding group:     chi2(1)    =   1.66  Prob > chi2 =  0.197
    Difference (null H = exogenous): chi2(11)   =   8.33  Prob > chi2 =  0.684
  iv(D.lpopul lavgdp70 eurerm survivor latcar sahar _Iyear_1977 _Iyear_1978
_Iyear_1979 _Iyear_1980 _Iyear_1981 _Iyear_
> 1982 _Iyear_1983 _Iyear_1984 _Iyear_1985 _Iyear_1986 _Iyear_1988 _Iyear_1989)
    Hansen test excluding group:     chi2(3)    =   4.65  Prob > chi2 =  0.199
    Difference (null H = exogenous): chi2(9)    =   5.34  Prob > chi2 =  0.804
```

1991-2006

```
xtabond2 growth l.growth  lgdp90 life2 inf educ lfertil  to  gccugdp invgdp dem dem2
rr1 rr2 rr3 rr5 d.lpopul eurer survivor latcar sahar   _Iyear_*, gmm(l.growth  lgdp90
life2 l.inf l.educ l.lfertil l.to l.gccugdp l.invgdp l.dem l.dem2 l.rr1 l.rr2 l.rr3
l.rr5, eq(diff) laglimits(1 1) collapse) gmm(l.growth  lgdp90 life2  inf educ lfertil
to gccugdp invgdp dem dem2 rr1 rr2 rr3 rr5 , eq(level) laglimits(1 1) collapse)
iv(d.lpopul lgdp89 eurer survivor latcar sahar  _Iyear_*)  twostep  robust

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: country                         Number of obs      =      1215
Time variable : year                            Number of groups   =        90
Number of instruments = 48                      Obs per group: min =         0
Wald chi2(34) =    324.41                                      avg =     13.50
Prob > chi2   =     0.000                                      max =        15
------------------------------------------------------------------------------
             |              Corrected
      growth |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      growth |
         L1. |   .2953373   .0678485     4.35   0.000     .1623567    .4283178
      lgdp90 |  -1.945849   2.418417    -0.80   0.421     -6.68586    2.794162
       life2 |  -6.976495   8.605581    -0.81   0.418    -23.84312    9.890133
         inf |   3.107425   4.232827     0.73   0.463    -5.188763    11.40361
        educ |   .0378753   .7909321     0.05   0.962    -1.512323    1.588074
     lfertil |  -.3948023   5.063776    -0.08   0.938    -10.31962    9.530015
          to |   .2101951   2.617462     0.08   0.936    -4.919937    5.340327
     gccugdp |   .5611915   21.13497     0.03   0.979    -40.86259    41.98497
      invgdp |   .1967963   .2880482     0.68   0.494    -.3677678    .7613603
         dem |   -.229194   1.955076    -0.12   0.907    -4.061073    3.602685
        dem2 |   .0282113   .2683391     0.11   0.916    -.4977237    .5541462
         rr1 |   1.160023   3.743128     0.31   0.757    -6.176373    8.496419
         rr2 |  -.3558274   3.538937    -0.10   0.920    -7.292017    6.580363
         rr3 |   .0251301   4.142625     0.01   0.995    -8.094266    8.144526
     rr5dual |  -2.672263   4.700805    -0.57   0.570    -11.88567    6.541146
      lpopul |
         D1. |  -80.72933   36.94586    -2.19   0.029    -153.1419   -8.316781
      eurerm |  -1.865697   2.375626    -0.79   0.432    -6.521839    2.790445
    survivor |  -.4388171   1.970914    -0.22   0.824    -4.301738    3.424104
      latcar |  -.4142723    1.49864    -0.28   0.782    -3.351552    2.523008
       sahar |   1.288917   3.639637     0.35   0.723     -5.84464    8.422474
 _Iyear_1992 |  -.7364563   .9022368    -0.82   0.414    -2.504808    1.031895
 _Iyear_1993 |  -1.506088   1.035626    -1.45   0.146    -3.535878    .5237012
 _Iyear_1994 |  -.1331699   .9984994    -0.13   0.894    -2.090193    1.823853
 _Iyear_1995 |  -.5040582   .6593938    -0.76   0.445    -1.796446      .78833
 _Iyear_1996 |  -.8045503   .7835588    -1.03   0.305    -2.340297    .7311967
 _Iyear_1997 |  -.8598281   .7849734    -1.10   0.273    -2.398348    .6786915
 _Iyear_1998 |  -2.016188   .6679209    -3.02   0.003    -3.325289   -.7070873
 _Iyear_1999 |  -1.109312   .6632234    -1.67   0.094    -2.409206    .1905819
 _Iyear_2000 |  -.5412304   .4195414    -1.29   0.197    -1.363516    .2810557
 _Iyear_2001 |  -1.999051   .4710802    -4.24   0.000    -2.922351   -1.075751
 _Iyear_2002 |  -1.611864   .4903975    -3.29   0.001    -2.573025   -.6507021
 _Iyear_2003 |  -.7153633   .4590388    -1.56   0.119    -1.615063    .1843362
 _Iyear_2004 |  -.1683772   .3533443    -0.48   0.634    -.8609193     .524165
 _Iyear_2005 |  -.7173341   .3104961    -2.31   0.021    -1.325895    -.108773
       _cons |   30.02713   29.86249     1.01   0.315    -28.50227    88.55653
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(D.lpopul lgdp89 eurerm survivor latcar sahar _Iyear_1992 _Iyear_1993
    _Iyear_1994 _Iyear_1995 _Iyear_1996 _Iyear_1997 _Iyear_1998 _Iyear_1999
    _Iyear_2000 _Iyear_2001 _Iyear_2002 _Iyear_2003 _Iyear_2004 _Iyear_2005
    _Iyear_2006)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L.(L.growth lgdp90 life2 L.inf L.educ L.lfertil L.to L.gccugdp L.invgdp
    L.dem L.dem2 L.rr1 L.rr2 L.rr3 L.rr5dual) collapsed
Instruments for levels equation
  Standard
    _cons
    D.lpopul lgdp89 eurerm survivor latcar sahar _Iyear_1992 _Iyear_1993
    _Iyear_1994 _Iyear_1995 _Iyear_1996 _Iyear_1997 _Iyear_1998 _Iyear_1999
    _Iyear_2000 _Iyear_2001 _Iyear_2002 _Iyear_2003 _Iyear_2004 _Iyear_2005
    _Iyear_2006
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.(L.growth lgdp90 life2 inf educ lfertil to gccugdp invgdp dem dem2 rr1
    rr2 rr3 rr5dual) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -4.21  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   0.12  Pr > z =  0.901
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(13)   =  24.16  Prob > chi2 =  0.030
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(13)   =  14.99  Prob > chi2 =  0.308
  (Robust, but can be weakened by many instruments.)
```

```
Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(1)    =   0.82  Prob > chi2 =  0.365
    Difference (null H = exogenous): chi2(12)   =  14.17  Prob > chi2 =  0.290
  gmm(L.growth lgdp90 life2 inf educ lfertil to gccugdp invgdp dem dem2 rr1 rr2 rr3
rr5dual, collapse eq(level) lag(1 1
> ))
    Hansen test excluding group:     chi2(1)    =   0.82  Prob > chi2 =  0.365
    Difference (null H = exogenous): chi2(12)   =  14.17  Prob > chi2 =  0.290
```

Final specification (de-jure IMF classification)

```
xtabond2 growth l.growth  lgdp75 life1 inf educ lfertil  to  gccugdp invgdp dem dem2
imf1 imf2 imf3 imfot d.lpopul eurer survivor latcar sahar   _Iyear_*, gmm(l.growth
lgdp75 life1 l.inf l.educ l.lfertil l.to l.gccugdp l.invgdp l.dem l.dem2 l.imf1
l.imf2 l.imf3 l.imfot, eq(diff) laglimits(1 1) collapse) gmm(l.growth  lgdp75 life1
inf educ lfertil to gccugdp invgdp dem dem2 imf2 imf3 imf1 imfot, eq(level)
laglimits(1 1) collapse) iv(d.lpopul lavgdp70 eurer survivor latcar sahar _Iyear_*)
twostep  robust

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: country                         Number of obs      =      1572
Time variable : year                            Number of groups   =        86
Number of instruments = 54                      Obs per group: min =         0
Wald chi2(40) =   2115.34                                      avg =     18.28
Prob > chi2   =     0.000                                      max =        22
------------------------------------------------------------------------------
             |              Corrected
      growth |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      growth |
         L1. |   .2194743   .0889813     2.47   0.014     .0450741    .3938745
      lgdp75 |   .8278055   2.008179     0.41   0.680    -3.108153    4.763764
       life1 |   15.06778    9.94521     1.52   0.130    -4.424474    34.56003
         inf |   .6747789   2.449872     0.28   0.783    -4.126883    5.476441
        educ |   .9265513   .7830165     1.18   0.237    -.6081329    2.461236
     lfertil |  -3.878844   4.211111    -0.92   0.357    -12.13247    4.374782
          to |   5.541247   4.905784     1.13   0.259    -4.073913    15.15641
     gccugdp |  -34.08573   23.09088    -1.48   0.140    -79.34302    11.17157
      invgdp |   .0542639   .3151791     0.17   0.863    -.5634758    .6720036
         dem |  -.3070279   1.872672    -0.16   0.870    -3.977398    3.363342
        dem2 |  -.0165983   .2317589    -0.07   0.943    -.4708374    .4376407
        imf1 |   3.884106   1.967853     1.97   0.048     .0271858    7.741027
        imf2 |   1.128414   1.557652     0.72   0.469    -1.924527    4.181356
        imf3 |   2.166728   1.271682     1.70   0.088    -.3257238    4.659179
       imfot |     -8.252   8.769239    -0.94   0.347    -25.43939    8.935394
      lpopul |
         D1. |  -49.79773   41.77885    -1.19   0.233    -131.6828    32.08731
      eurerm |  -1.266001   1.292554    -0.98   0.327    -3.799361    1.267358
    survivor |   .1272281   1.288206     0.10   0.921     -2.39761    2.652066
      latcar |   -.693221   1.748526    -0.40   0.692    -4.120269    2.733827
       sahar |  -1.367847   2.030865    -0.67   0.501    -5.348269    2.612576
 _Iyear_1985 |   .6885317   1.095963     0.63   0.530    -1.459517    2.836581
 _Iyear_1986 |    .957867    .936421     1.02   0.306    -.8774843    2.793218
 _Iyear_1987 |   1.302504   .9871247     1.32   0.187    -.6322254    3.237232
 _Iyear_1988 |   1.710531   1.142117     1.50   0.134    -.5279769    3.949039
 _Iyear_1989 |   1.604601   1.249326     1.28   0.199    -.8440332    4.053234
 _Iyear_1990 |   .2314261   .9650298     0.24   0.810    -1.659998     2.12285
 _Iyear_1991 |   .2061933   .9429268     0.22   0.827    -1.641909    2.054296
 _Iyear_1992 |   .3483641    .855336     0.41   0.684    -1.328064    2.024792
 _Iyear_1993 |   .7235556   .9544494     0.76   0.448    -1.147131    2.594242
 _Iyear_1994 |   1.338351   1.039831     1.29   0.198    -.6996796    3.376381
 _Iyear_1995 |   1.579079   .6430584     2.46   0.014     .3187082    2.839451
 _Iyear_1996 |   1.039449   .7629419     1.36   0.173    -.4558899    2.534787
 _Iyear_1997 |   1.326498   .7536729     1.76   0.078    -.1506737     2.80367
 _Iyear_1998 |  -.5848857   .8171948    -0.72   0.474    -2.186558    1.016787
 _Iyear_1999 |    .075724   .5343827     0.14   0.887    -.9716468    1.123095
 _Iyear_2000 |   .2102241   .5014947     0.42   0.675    -.7726875    1.193136
 _Iyear_2001 |    -1.4727   .5469504    -2.69   0.007    -2.544703   -.4006973
 _Iyear_2002 |  -.9936467    .519907    -1.91   0.056    -2.012646    .0253524
 _Iyear_2003 |   .0900593   .4105079     0.22   0.826    -.7145214    .8946401
 _Iyear_2004 |   .7603141   .4168512     1.82   0.068    -.0566993    1.577327
       _cons |  -25.06393    23.0104    -1.09   0.276    -70.16348    20.03563
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(D.lpopul lavgdp70 eurerm survivor latcar sahar _Iyear_1980 _Iyear_1981
    _Iyear_1982 _Iyear_1983 _Iyear_1984 _Iyear_1985 _Iyear_1986 _Iyear_1987
    _Iyear_1988 _Iyear_1989 _Iyear_1990 _Iyear_1991 _Iyear_1992 _Iyear_1993
    _Iyear_1994 _Iyear_1995 _Iyear_1996 _Iyear_1997 _Iyear_1998 _Iyear_1999
    _Iyear_2000 _Iyear_2001 _Iyear_2002 _Iyear_2003 _Iyear_2004)
```

```
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L.(L.growth lgdp75 life1 L.inf L.educ L.lfertil L.to L.gccugdp L.invgdp
    L.dem L.dem2 L.imf1 L.imf2 L.imf3 L.imfot) collapsed
Instruments for levels equation
  Standard
    _cons
    D.lpopul lavgdp70 eurerm survivor latcar sahar _Iyear_1980 _Iyear_1981
    _Iyear_1982 _Iyear_1983 _Iyear_1984 _Iyear_1985 _Iyear_1986 _Iyear_1987
    _Iyear_1988 _Iyear_1989 _Iyear_1990 _Iyear_1991 _Iyear_1992 _Iyear_1993
    _Iyear_1994 _Iyear_1995 _Iyear_1996 _Iyear_1997 _Iyear_1998 _Iyear_1999
    _Iyear_2000 _Iyear_2001 _Iyear_2002 _Iyear_2003 _Iyear_2004
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.(L.growth lgdp75 life1 inf educ lfertil to gccugdp invgdp dem dem2 imf2
    imf3 imf1 imfot) collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -4.32  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   0.35  Pr > z =  0.724
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(13)   =  41.96  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(13)   =  17.20  Prob > chi2 =  0.191
  (Robust, but can be weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(1)    =   0.02  Prob > chi2 =  0.898
    Difference (null H = exogenous): chi2(12)   =  17.18  Prob > chi2 =  0.143
  gmm(L.growth lgdp75 life1 inf educ lfertil to gccugdp invgdp dem dem2 imf2 imf3
imf1 imfot, collapse eq(level) lag(1 1))
    Hansen test excluding group:     chi2(1)    =   0.02  Prob > chi2 =  0.898
    Difference (null H = exogenous): chi2(12)   =  17.18  Prob > chi2 =  0.143


test imf2=imf3=imf1=imfot=0


           chi2(  4) =    6.13
         Prob > chi2 =    0.1898
```

A4.2. Output volatility regressions printouts

Hausman-Taylor estimates for three measures of volatility (1976-2006)

```
xthtaylor volatsd growth totvolsd100 msvolsd100 gcvolsd100 civil d.fingdp to foind
inf rr1 rr2 rr3 rr5dual r1totsd r2totsd r3totsd  r5totsd latcar sahar  _Iyear_*,
endog( msvolsd100 gcvolsd100  civil  d.fingdp inf rr1 rr2 rr3 rr5dual  )
varying(growth totvolsd100 msvolsd100 gcvolsd100 civil d.fingdp rr1 rr2 rr3 rr5dual
r1totsd r2totsd r3totsd r5totsd to foind inf _Iyear_* )

Hausman-Taylor estimation                       Number of obs      =      2052
Group variable: country                         Number of groups   =       129

                                                Obs per group: min =         1
                                                               avg =      15.9
                                                               max =        27

Random effects u_i ~ i.i.d.                     Wald chi2(43)      =    403.89
                                                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
     volatsd |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
TVexogenous  |
      growth |   .0161366   .0103654     1.56   0.120    -.0041792    .0364524
 totvolsd100 |   .0352159   .0318297     1.11   0.269    -.0271692     .097601
          to |   .0246036   .0057912     4.25   0.000     .0132531    .0359542
       foind |   .2805979   .0539944     5.20   0.000     .1747708    .3864251
     r1totsd |   .0362099   .0346484     1.05   0.296    -.0316998    .1041195
     r2totsd |   -.042855    .035312    -1.21   0.225    -.1120654    .0263553
     r3totsd |  -.0072881   .0325713    -0.22   0.823    -.0711267    .0565504
     r5totsd |  -.0773263   .0364607    -2.12   0.034     -.148788   -.0058647
 _Iyear_1981 |   .1256204   .3316646     0.38   0.705    -.5244304    .7756711
 _Iyear_1982 |   .3306229   .3300923     1.00   0.317    -.3163461    .9775918
 _Iyear_1983 |   .0126231   .3269598     0.04   0.969    -.6282062    .6534525
 _Iyear_1984 |  -.2138578   .3169846    -0.67   0.500    -.8351361    .4074205
 _Iyear_1985 |  -.2893101   .3114235    -0.93   0.353    -.8996889    .3210687
 _Iyear_1986 |  -.2707929   .3056947    -0.89   0.376    -.8699435    .3283577
 _Iyear_1987 |  -.3709663    .303069    -1.22   0.221    -.9649707     .223038
 _Iyear_1988 |  -.6081487   .3027825    -2.01   0.045    -1.201592    -.014706
 _Iyear_1989 |  -.7276043   .3014378    -2.41   0.016    -1.318411   -.1367972
 _Iyear_1990 |  -.3254499   .2951088    -1.10   0.270    -.9038525    .2529528
 _Iyear_1991 |   -.636421   .2917382    -2.18   0.029    -1.208217   -.0646247
 _Iyear_1992 |  -.9569084   .2913576    -3.28   0.001    -1.527959   -.3858579
 _Iyear_1993 |  -.9099945   .2881175    -3.16   0.002    -1.474694   -.3452946
 _Iyear_1994 |  -1.145879   .2857969    -4.01   0.000    -1.706031   -.5857278
 _Iyear_1995 |  -1.351215    .283585    -4.76   0.000    -1.907032   -.7953989
 _Iyear_1996 |  -.9458284   .2767273    -3.42   0.001    -1.488204   -.4034529
 _Iyear_1997 |  -.9624422   .2779665    -3.46   0.001    -1.507247   -.4176379
 _Iyear_1998 |  -1.192634   .2693907    -4.43   0.000     -1.72063   -.6646384
 _Iyear_1999 |  -1.077165   .2662273    -4.05   0.000    -1.598961   -.5553685
 _Iyear_2000 |  -1.246204   .2637962    -4.72   0.000    -1.763235   -.7291729
 _Iyear_2001 |  -1.469153   .2650858    -5.54   0.000    -1.988711   -.9495942
 _Iyear_2002 |  -1.510875   .2650719    -5.70   0.000    -2.030407   -.9913439
 _Iyear_2003 |  -1.423085   .2662026    -5.35   0.000    -1.944833   -.9013374
 _Iyear_2004 |   -1.60953   .2705089    -5.95   0.000    -2.139717   -1.079342
TVendogenous |
  msvolsd100 |   .0031079   .0024229     1.28   0.200    -.0016408    .0078566
  gcvolsd100 |   .1098179   .0105627    10.40   0.000     .0891153    .1305204
       civil |   .0737059   .0584728     1.26   0.207    -.0408986    .1883104
      fingdp |
         D1. |  -.8543121   .5170652    -1.65   0.098    -1.867741     .159117
         inf |   .3361092   .2793674     1.20   0.229    -.2114408    .8836592
         rr1 |  -.7738789   .4755187    -1.63   0.104    -1.705878    .1581207
         rr2 |    .000167   .4461784     0.00   1.000    -.8743266    .8746607
         rr3 |   .1970633   .4454229     0.44   0.658    -.6759496    1.070076
     rr5dual |   1.530518   .4951627     3.09   0.002     .5600173    2.501019
TIexogenous  |
      latcar |   -.069541   .5674378    -0.12   0.902    -1.181699    1.042617
       sahar |   -.529274   .4465045    -1.19   0.236    -1.404407    .3458588
             |
       _cons |   2.405103   .6629228     3.63   0.000     1.105798    3.704407
-------------+----------------------------------------------------------------
     sigma_u |  1.9987171
     sigma_e |  1.8801432
         rho |  .53054071   (fraction of variance due to u_i)
------------------------------------------------------------------------------
Note:  TV refers to time varying; TI refers to time invariant.


. xthtaylor volatdev growth totvoldev100 msvoldev100 gcvoldev100 civil d.fingdp to
foind inf rr1 rr2 rr3 rr5dual r1totdev r2totdev r3totdev  r5totdev latcar sahar
_Iyear_*, endog( msvoldev100 gcvoldev100  civil  d.fingdp inf rr1 rr2 rr3 rr5dual  )
```

```
varying(growth totvoldev100 msvoldev100 gcvoldev100 civil d.fingdp rr1 rr2 rr3
rr5dual r1totdev r2totdev r3totdev r5totdev to foind inf _Iyear_* )

Hausman-Taylor estimation                       Number of obs      =      2170
Group variable: country                         Number of groups   =       127

                                                Obs per group: min =         2
                                                               avg =      17.1
                                                               max =        30

Random effects u_i ~ i.i.d.                     Wald chi2(43)      =    146.08
                                                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
    volatdev |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
TVexogenous  |
      growth |   .0131716   .0150841     0.87   0.383    -.0163928     .042736
totvoldev100 |  -.0110854   .0535066    -0.21   0.836    -.1159565    .0937857
          to |   .0080751   .0070704     1.14   0.253    -.0057825    .0219327
       foind |   .0992517   .0682822     1.45   0.146    -.0345791    .2330824
    r1totdev |   .0500013   .0555444     0.90   0.368    -.0588637    .1588663
    r2totdev |  -.0008481    .056418    -0.02   0.988    -.1114254    .1097292
    r3totdev |   .0319985   .0546876     0.59   0.558    -.0751871    .1391842
    r5totdev |   .0436489   .0599352     0.73   0.466     -.073822    .1611198
  _Iyear_1981 |   .1370119   .4603864     0.30   0.766    -.7653289    1.039353
  _Iyear_1982 |   .3845036   .4565112     0.84   0.400    -.5102419    1.279249
  _Iyear_1983 |  -.0024293   .4540751    -0.01   0.996    -.8924002    .8875416
  _Iyear_1984 |  -.4996811   .4433616    -1.13   0.260    -1.368654    .3692915
  _Iyear_1985 |  -.6440204   .4308085    -1.49   0.135    -1.488389    .2003486
  _Iyear_1986 |  -.4104425   .4189002    -0.98   0.327    -1.231472    .4105868
  _Iyear_1987 |  -.4369728   .4077236    -1.07   0.284    -1.236096    .3621508
  _Iyear_1988 |   .3298857   .4068812     0.81   0.417    -.4675868    1.127358
  _Iyear_1989 |  -.4299546   .4033791    -1.07   0.286    -1.220563    .3606539
  _Iyear_1990 |  -.4686322   .3998963    -1.17   0.241    -1.252415    .3151502
  _Iyear_1991 |   .0657426    .383662     0.17   0.864    -.6862211    .8177063
  _Iyear_1992 |  -.2164577   .3862003    -0.56   0.575    -.9733964     .540481
  _Iyear_1993 |  -.4530186   .3792376    -1.19   0.232    -1.196311    .2902734
  _Iyear_1994 |  -.7438445   .3720922    -2.00   0.046    -1.473132   -.0145572
  _Iyear_1995 |  -.9800695   .3691337    -2.66   0.008    -1.703558   -.2565808
  _Iyear_1996 |  -1.080225   .3546933    -3.05   0.002    -1.775411   -.3850385
  _Iyear_1997 |  -.5711766   .3579347    -1.60   0.111    -1.272716    .1303625
  _Iyear_1998 |  -.3858063   .3319594    -1.16   0.245    -1.036435    .2648221
  _Iyear_1999 |  -.7321611   .3314418    -2.21   0.027    -1.381775   -.0825472
  _Iyear_2000 |  -1.042782   .3152082    -3.31   0.001    -1.660579   -.4249855
  _Iyear_2001 |  -.4884882    .319825    -1.53   0.127    -1.115334    .1383573
  _Iyear_2002 |  -.9310125   .3135564    -2.97   0.003    -1.545572   -.3164533
  _Iyear_2003 |  -.7136547   .3144104    -2.27   0.023    -1.329888   -.0974217
  _Iyear_2004 |  -.2769415   .3198099    -0.87   0.387    -.9037574    .3498744
TVendogenous |
 msvoldev100 |    .006079   .0033459     1.82   0.069    -.0004789    .0126369
 gcvoldev100 |   .0615928   .0100997     6.10   0.000     .0417976    .0813879
       civil |   .2290875    .076291     3.00   0.003     .0795598    .3786152
      fingdp |
         D1. |   -2.32604   .9043214    -2.57   0.010    -4.098477   -.5536029
         inf |   .9864196   .5531487     1.78   0.075     -.097732    2.070571
         rr1 |   -.811773   .5768911    -1.41   0.159    -1.942459    .3189129
         rr2 |  -.5147532   .5513833    -0.93   0.351    -1.595445    .5659382
         rr3 |  -.7671578   .5575111    -1.38   0.169    -1.859859    .3255439
     rr5dual |  -.1387915   .6358668    -0.22   0.827    -1.385068    1.107485
TIexogenous  |
      latcar |  -.1297731   .5049493    -0.26   0.797    -1.119456    .8599095
       sahar |  -.4668217   .3911723    -1.19   0.233    -1.233505    .2998619
             |
       _cons |   2.665003   .7293685     3.65   0.000     1.235467    4.094539
-------------+----------------------------------------------------------------
     sigma_u |  1.5811338
     sigma_e |  2.8095993
         rho |  .24052573   (fraction of variance due to u_i)
------------------------------------------------------------------------------
Note:  TV refers to time varying; TI refers to time invariant.


xthtaylor volathp growth totvolhp100 msvolhp100 gcvolhp100 civil d.fingdp to foind
inf rr1 rr2 rr3 rr5dual r1tothp r2tothp r3tothp  r5tothp latcar sahar  _Iyear_*,
endog( msvolhp100 gcvolhp100  civil  d.fingdp inf rr1 rr2 rr3 rr5dual  )
varying(growth totvolhp100 msvolhp100 gcvolhp100 civil d.fingdp rr1 rr2 rr3 rr5dual
r1tothp r2tothp r3tothp r5tothp to foind inf _Iyear_* )

Hausman-Taylor estimation                       Number of obs      =      1750
Group variable: country                         Number of groups   =        97

                                                Obs per group: min =         1
                                                               avg =      18.0
                                                               max =        29
```

```
Random effects u_i ~ i.i.d.                      Wald chi2(43)      =   1645.38
                                                 Prob > chi2        =    0.0000

------------------------------------------------------------------------------
     volathp |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
TVexogenous  |
      growth |  -.4004587   .0105452   -37.98   0.000     -.421127   -.3797904
 totvolhp100 |  -.0629619     .04059    -1.55   0.121    -.1425168     .016593
          to |   .0115999   .0050532     2.30   0.022     .0016958     .021504
       foind |   .1397809   .0495754     2.82   0.005      .042615    .2369469
     r1tothp |   .0495223   .0419199     1.18   0.237    -.0326391    .1316837
     r2tothp |   .0698026   .0424476     1.64   0.100    -.0133931    .1529983
     r3tothp |   .0746256   .0421202     1.77   0.076    -.0079285    .1571796
     r5tothp |   .0344199   .0485574     0.71   0.478    -.0607509    .1295907
 _Iyear_1981 |   .0216034   .2903513     0.07   0.941    -.5474747    .5906815
 _Iyear_1982 |   .1470353   .2912025     0.50   0.614    -.4237111    .7177818
 _Iyear_1983 |  -.2577459   .2853443    -0.90   0.366    -.8170104    .3015187
 _Iyear_1984 |  -.0425337   .2772691    -0.15   0.878    -.5859711    .5009038
 _Iyear_1985 |  -.2416713   .2735122    -0.88   0.377    -.7777454    .2944028
 _Iyear_1986 |  -.1170016   .2638579    -0.44   0.657    -.6341536    .4001504
 _Iyear_1987 |   .1020148   .2616183     0.39   0.697    -.4107476    .6147772
 _Iyear_1988 |   .6683828   .2606581     2.56   0.010     .1575023    1.179263
 _Iyear_1989 |   .1607878   .2554101     0.63   0.529    -.3398067    .6613824
 _Iyear_1990 |  -.2695747   .2486612    -1.08   0.278    -.7569418    .2177924
 _Iyear_1991 |  -.3161209   .2424479    -1.30   0.192      -.79131    .1590683
 _Iyear_1992 |  -.0321772   .2419876    -0.13   0.894    -.5064642    .4421099
 _Iyear_1993 |  -.2702818   .2374353    -1.14   0.255    -.7356464    .1950829
 _Iyear_1994 |  -.5260939   .2294909    -2.29   0.022    -.9758879   -.0762999
 _Iyear_1995 |  -.3802183   .2277668    -1.67   0.095     -.826633    .0661963
 _Iyear_1996 |   -.570086   .2258211    -2.52   0.012    -1.012687   -.1274848
 _Iyear_1997 |  -.3213427   .2275652    -1.41   0.158    -.7673623     .124677
 _Iyear_1998 |   .3065628   .2291661     1.34   0.181    -.1425945    .7557201
 _Iyear_1999 |  -.2053541   .2276499    -0.90   0.367    -.6515397    .2408315
 _Iyear_2000 |  -.3222185   .2203307    -1.46   0.144    -.7540587    .1096217
 _Iyear_2001 |  -.6464651   .2247703    -2.88   0.004    -1.087007   -.2059233
 _Iyear_2002 |  -.6492166     .22975    -2.83   0.005    -1.099518   -.1989148
 _Iyear_2003 |  -.5989777   .2275672    -2.63   0.008    -1.045001   -.1529543
 _Iyear_2004 |  -.4924458   .2308845    -2.13   0.033     -.944971   -.0399206
TVendogenous |
  msvolhp100 |  -.0007571   .0036153    -0.21   0.834    -.0078431    .0063288
  gcvolhp100 |  -.0137125   .0082296    -1.67   0.096    -.0298422    .0024172
       civil |   .1034484   .0575926     1.80   0.072    -.0094309    .2163278
      fingdp |
         D1. |   -.200524   .4010431    -0.50   0.617    -.9865541    .5855061
         inf |   .2790544   .2602489     1.07   0.284    -.2310241    .7891328
         rr1 |  -.4576044   .3697975    -1.24   0.216    -1.182394    .2671854
         rr2 |  -.6208199   .3619339    -1.72   0.086    -1.330197    .0885576
         rr3 |  -.6170708   .3663506    -1.68   0.092    -1.335105    .1009633
     rr5dual |  -.0473278    .427517    -0.11   0.912    -.8852457      .79059
TIexogenous  |
      latcar |  -1.166718   .5536562    -2.11   0.035    -2.251864    -.081572
       sahar |  -1.321989   .4703121    -2.81   0.005    -2.243784   -.4001944
             |
       _cons |   3.893723   .6118559     6.36   0.000     2.694507    5.092938
-------------+----------------------------------------------------------------
     sigma_u |  1.6097363
     sigma_e |  1.6299225
         rho |  .49376927   (fraction of variance due to u_i)
------------------------------------------------------------------------------
Note:  TV refers to time varying; TI refers to time invariant.

xthtaylor volathp growth totvolhp100 msvolhp100 gcvolhp100 civil d.fingdp to foind
inf rr11 rr12 rr13 rr2 rr3 rr5dual r11tothp r12tothp r13tothp r2tothp r3tothp
r5tothp latcar sahar  _Iyear_*, endog( msvolhp100 gcvolhp100  civil  d.fingdp inf
rr11 rr12 rr13 rr2 rr3 rr5dual  ) varying(growth totvolhp100 msvolhp100 gcvolhp100
civil d.fingdp rr11 rr12 rr13 rr2 rr3 rr5dual r11tothp r12tothp r13tothp r2tothp
r3tothp r5tothp to foind inf _Iyear_* )

Hausman-Taylor estimation                        Number of obs      =      1750
Group variable: country                          Number of groups   =        97

                                                 Obs per group: min =         1
                                                                avg =      18.0
                                                                max =        29

Random effects u_i ~ i.i.d.                      Wald chi2(47)      =   1690.89
                                                 Prob > chi2        =    0.0000

------------------------------------------------------------------------------
     volathp |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
TVexogenous  |
      growth |  -.4024313   .0104759   -38.42   0.000    -.4229636    -.381899
 totvolhp100 |  -.0633966   .0402622    -1.57   0.115    -.1423091    .0155158
          to |   .0104741   .0050913     2.06   0.040     .0004953     .020453
       foind |   .1507236   .0503833     2.99   0.003     .0519742    .2494731
```

r11tothp	.0454729	.0530628	0.86	0.391	-.0585283	.1494741
r12tothp	.120736	.0457256	2.64	0.000	-1.008884	.1703565
r13tothp	.0427135	.0422702	1.01	0.312	-.0401346	.1255615
r2tothp	.0693006	.0421067	1.65	0.100	-.013227	.1518282
r3tothp	.0751716	.0417798	1.80	0.072	-.0067154	.1570586
r5tothp	.0367132	.0481729	0.76	0.446	-.0577039	.1311303
_Iyear_1981	.1255887	.2935006	0.43	0.669	-.4496619	.7008393
_Iyear_1982	.2277147	.29429	0.77	0.439	-.3490832	.8045125
_Iyear_1983	-.1881393	.288465	-0.65	0.514	-.7535203	.3772417
_Iyear_1984	.0223556	.2799545	0.08	0.936	-.5263452	.5710563
_Iyear_1985	-.1770145	.2764876	-0.64	0.522	-.7189203	.3648912
_Iyear_1986	.0132088	.263913	0.05	0.960	-.5040511	.5304687
_Iyear_1987	.2051125	.2611445	0.79	0.432	-.3067213	.7169464
_Iyear_1988	.797957	.2607127	3.06	0.002	.2869694	1.308945
_Iyear_1989	.2842285	.2555841	1.11	0.266	-.2167071	.7851641
_Iyear_1990	-.1615384	.2484632	-0.65	0.516	-.6485173	.3254405
_Iyear_1991	-.2241242	.2422678	-0.93	0.355	-.6989604	.2507121
_Iyear_1992	.0745952	.2417034	0.31	0.758	-.3991348	.5483251
_Iyear_1993	-.1585813	.2377032	-0.67	0.505	-.624471	.3073084
_Iyear_1994	-.4234425	.2298806	-1.84	0.065	-.8740002	.0271152
_Iyear_1995	-.2749615	.2285297	-1.20	0.229	-.7228715	.1729484
_Iyear_1996	-.4522483	.2261769	-2.00	0.046	-.8955468	-.0089499
_Iyear_1997	-.2161056	.227771	-0.95	0.343	-.6625286	.2303174
_Iyear_1998	.3957489	.228899	1.73	0.084	-.0528848	.8443827
_Iyear_1999	-.0976828	.2276479	-0.43	0.668	-.5438646	.348499
_Iyear_2000	-.1942774	.2215505	-0.88	0.381	-.6285083	.2399536
_Iyear_2001	-.5052051	.2262116	-2.23	0.026	-.9485718	-.0618385
_Iyear_2002	-.5006814	.2310236	-2.17	0.030	-.9534792	-.0478835
_Iyear_2003	-.4493591	.228922	-1.96	0.050	-.898038	-.0006803
_Iyear_2004	-.3050917	.233537	-1.31	0.191	-.7628157	.1526323
TVendogenous						
msvolhp100	-.0008471	.0035955	-0.24	0.814	-.0078942	.0061999
gcvolhp100	-.0129727	.0081851	-1.58	0.113	-.0290152	.0030698
civil	.0902557	.0580546	1.55	0.120	-.0235292	.2040405
fingdp						
D1.	-.2607259	.3980884	-0.65	0.513	-1.040965	.519513
inf	.1909317	.258702	0.74	0.460	-.3161149	.6979783
rr11	-.1313927	.394971	-0.33	0.739	-.9055216	.6427361
rr12	-.8905324	.4040013	-2.20	0.028	-1.68236	-.0987043
rr13	-.9708096	.3988315	-2.43	0.015	-1.752505	-.1891142
rr2	-.6146491	.3609419	-1.70	0.089	-1.322082	.0927841
rr3	-.6281152	.3649746	-1.72	0.085	-1.343452	.0872219
rr5dual	-.0024492	.4253938	-0.01	0.995	-.8362058	.8313074
TIexogenous						
latcar	-1.085689	.5882484	-1.85	0.065	-2.238635	.0672565
sahar	-1.236594	.4998101	-2.47	0.013	-2.216204	-.2569845
_cons	3.910165	.6280593	6.23	0.000	2.679192	5.141139
sigma_u	1.727472					
sigma_e	1.6189334					
rho	.5324003	(fraction of variance due to u_i)				

Note: TV refers to time varying; TI refers to time invariant.

A4.3. Switching regressions printouts

Basic regression

IV homoskedasticity only

```
xtivreg2 r after l.r _Iyear_* (e_inf gap der after_switch e_inf_a gap_a der_a e_inf_s
gap_s der_s e_inf_a_s gap_a_s der_a_s = l3.inf l3.gap l3.der l6.inf l6.gap l6.der
l9.inf l9.gap l9.der l12.inf l12.gap l12.der l3.inf_a l3.inf_s l3.inf_a_s l3.gap_a
l3.gap_s l3.gap_a_s l3.der_a l3.der_s l3.der_a_s l6.inf_a l6.inf_s l6.inf_a_s
l6.gap_a l6.gap_s l6.gap_a_s l6.der_a l6.der_s l6.der_a_s l9.inf_a l9.inf_s
l9.inf_a_s l9.gap_a l9.gap_s l9.gap_a_s l9.der_a l9.der_s l9.der_a_s l12.inf_a
l12.inf_s l12.inf_a_s l12.gap_a l12.gap_s l12.gap_a_s l12.der_a l12.der_s l12.der_a_s
l15.inf_a l15.inf_s l15.inf_a_s l15.gap_a l15.gap_s l15.gap_a_s l15.der_a l15.der_s
l15.der_a_s l18.inf_a l18.inf_s l18.inf_a_s l18.gap_a l18.gap_s l18.gap_a_s l18.der_a
l18.der_s l18.der_a_s l21.inf_a l21.inf_s l21.inf_a_s l21.gap_a l21.gap_s l21.gap_a_s
l21.der_a l21.der_s l21.der_a_s l24.inf_a l24.inf_s l24.inf_a_s l24.gap_a l24.gap_s
l24.gap_a_s l24.der_a l24.der_s l24.der_a_s dc100 ccg nfa l.dc100 l.ccg l.nfa), fe
endog(after_switch)

FIXED EFFECTS ESTIMATION
------------------------
Number of groups =       18                  Obs per group: min =       41
                                                            avg =    136.2
                                                            max =      180
IV (2SLS) estimation
--------------------

Estimates efficient for homoskedasticity only
Statistics consistent for homoskedasticity only

                                                      Number of obs =     2452
                                                      F( 29,  2405) =   287.39
                                                      Prob > F      =   0.0000
Total (centered) SS     =  99242.51041                Centered R2   =   0.7740
Total (uncentered) SS   =  99242.51041                Uncentered R2 =   0.7740
Residual SS             =  22427.71601                Root MSE      =    3.036

------------------------------------------------------------------------------
           r |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       e_inf |   .0565392   .0650692     0.87   0.385    -.0709941    .1840724
         gap |   .0758336    .061095     1.24   0.215    -.0439104    .1955775
         der |   .0409555   .0304274     1.35   0.178     -.018681    .1005921
after_switch |   2.441524   .9130426     2.67   0.007     .6519935    4.231055
     e_inf_a |  -.0712767   .0479194    -1.49   0.137    -.1651969    .0226436
       gap_a |  -.0627625   .0706048    -0.89   0.374    -.2011454    .0756203
       der_a |  -.0597113   .0309756    -1.93   0.054    -.1204224    .0009997
     e_inf_s |   .2077425   .0797179     2.61   0.009     .0514984    .3639867
       gap_s |   -.011509   .0730101    -0.16   0.875    -.1546061    .1315882
       der_s |  -.0368791   .0347495    -1.06   0.289    -.1049869    .0312287
   e_inf_a_s |  -.2791675   .1278478    -2.18   0.029    -.5297446   -.0285905
     gap_a_s |  -.0023572   .0856387    -0.03   0.978    -.1702059    .1654916
     der_a_s |   .0735808   .0408172     1.80   0.071    -.0064195    .1535811
       after |  -.5697832   .6046884    -0.94   0.346    -1.754951    .6153844
           r |
         L1. |   .8343646   .0179872    46.39   0.000     .7991104    .8696188
 _Iyear_1994 |  -.5755603   .7176559    -0.80   0.423     -1.98214    .8310194
 _Iyear_1995 |   .5467629    .684184     0.80   0.424     -.794213    1.887739
 _Iyear_1996 |   .3084017   .6524683     0.47   0.636    -.9704127    1.587216
 _Iyear_1997 |   .4587732   .5929105     0.77   0.439     -.70331     1.620856
 _Iyear_1998 |   .9986886   .5401742     1.85   0.064    -.0600333    2.057411
 _Iyear_1999 |   .5924236   .5095372     1.16   0.245     -.406251    1.591098
 _Iyear_2000 |   .1299194    .371698     0.35   0.727    -.5985953    .8584341
 _Iyear_2001 |   .7467648   .3611649     2.07   0.039     .0388945    1.454635
 _Iyear_2002 |   .1633176   .3522378     0.46   0.643    -.5270558     .853691
 _Iyear_2003 |  -.3387977   .3453492    -0.98   0.327     -1.01567    .3380742
 _Iyear_2004 |  -.1901523   .3374616    -0.56   0.573    -.8515648    .4712603
 _Iyear_2005 |  -.1560589   .3469617    -0.45   0.653    -.8360913    .5239735
 _Iyear_2006 |  -.1280612   .3545921    -0.36   0.718    -.8230489    .5669265
 _Iyear_2007 |   .0666193   .4295894     0.16   0.877    -.7753605     .908599
------------------------------------------------------------------------------
Underidentification test (Anderson canon. corr. LM statistic):         309.210
                                                   Chi-sq(78) P-val =   0.0000
------------------------------------------------------------------------------
Weak identification test (Cragg-Donald Wald F statistic):                3.764
Stock-Yogo weak ID test critical values:                       <not available>
------------------------------------------------------------------------------
Sargan statistic (overidentification test of all instruments):          81.386
                                                   Chi-sq(77) P-val =   0.3444
-endog- option:
Endogeneity test of endogenous regressors:                              13.654
                                                   Chi-sq(1) P-val =    0.0002
Regressors tested:    after_switch
```

IV -HAC

```
xtivreg2 r after  l.r   _Iyear_* (e_inf gap der after_switch e_inf_a gap_a der_a
e_inf_s gap_s der_s e_inf_a_s gap_a_s der_a_s = l3.inf l3.gap l3.der l6.inf l6.gap
l6.der l9.inf l9.gap l9.der l12.inf l12.gap l12.der l3.inf_a l3.inf_s l3.inf_a_s
l3.gap_a l3.gap_s l3.gap_a_s l3.der_a l3.der_s l3.der_a_s l6.inf_a l6.inf_s
l6.inf_a_s l6.gap_a l6.gap_s l6.gap_a_s l6.der_a l6.der_s l6.der_a_s l9.inf_a
l9.inf_s l9.inf_a_s l9.gap_a l9.gap_s l9.gap_a_s l9.der_a l9.der_s l9.der_a_s
l12.inf_a l12.inf_s l12.inf_a_s l12.gap_a l12.gap_s l12.gap_a_s l12.der_a l12.der_s
l12.der_a_s l15.inf_a l15.inf_s l15.inf_a_s l15.gap_a l15.gap_s l15.gap_a_s l15.der_a
l15.der_s l15.der_a_s l18.inf_a l18.inf_s l18.inf_a_s l18.gap_a l18.gap_s l18.gap_a_s
l18.der_a l18.der_s l18.der_a_s l21.inf_a l21.inf_s l21.inf_a_s l21.gap_a l21.gap_s
l21.gap_a_s l21.der_a l21.der_s l21.der_a_s l24.inf_a l24.inf_s l24.inf_a_s l24.gap_a
l24.gap_s l24.gap_a_s l24.der_a l24.der_s l24.der_a_s dc100 ccg nfa l.dc100 l.ccg
l.nfa), fe endog(after_switch) robust bw(1)

FIXED EFFECTS ESTIMATION
------------------------
Number of groups =       18                  Obs per group: min =        41
                                                            avg =     136.2
                                                            max =       180

IV (2SLS) estimation
--------------------

Estimates efficient for homoskedasticity only
Statistics robust to heteroskedasticity and autocorrelation
  kernel=Bartlett; bandwidth=     1
  time variable (t):  .
  group variable (i): country

                                                      Number of obs =      2452
                                                      F( 29,  2405) =    372.38
                                                      Prob > F      =    0.0000
Total (centered) SS     =  99242.51041                Centered R2   =    0.7740
Total (uncentered) SS   =  99242.51041                Uncentered R2 =    0.7740
Residual SS             =  22427.71601                Root MSE      =     3.036

------------------------------------------------------------------------------
             |               Robust
           r |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       e_inf |   .0565392   .0984188     0.57   0.566     -.136358    .2494364
         gap |   .0758336    .060356     1.26   0.209    -.0424621    .1941292
         der |   .0409555   .0581664     0.70   0.481    -.0730486    .1549596
after_switch |   2.441524   1.304728     1.87   0.061    -.1156967    4.998745
     e_inf_a |  -.0712767   .1166452    -0.61   0.541    -.2998971    .1573438
       gap_a |  -.0627625   .0671539    -0.93   0.350    -.1943818    .0688568
       der_a |  -.0597113   .0628795    -0.95   0.342    -.1829528    .0635301
     e_inf_s |   .2077425   .1110233     1.87   0.061     -.009859    .4253441
       gap_s |   -.011509   .0764974    -0.15   0.880    -.1614412    .1384232
       der_s |  -.0368791   .0543724    -0.68   0.498     -.143447    .0696888
   e_inf_a_s |  -.2791675   .1448441    -1.93   0.054    -.5630567    .0047216
     gap_a_s |  -.0023572   .0829223    -0.03   0.977    -.1648818    .1601675
     der_a_s |   .0735808   .0619832     1.19   0.235     -.047904    .1950656
       after |  -.5697832   .6743843    -0.84   0.398    -1.891552    .7519859
           r |
         L1. |   .8343646   .0505545    16.50   0.000     .7352796    .9334496
 _Iyear_1994 |  -.5755603   .9075057    -0.63   0.526    -2.354239    1.203118
 _Iyear_1995 |   .5467629   .8784753     0.62   0.534    -1.175017    2.268543
 _Iyear_1996 |   .3084017   .7459593     0.41   0.679    -1.153652    1.770455
 _Iyear_1997 |   .4587732   .6111996     0.75   0.453    -.7391561    1.656703
 _Iyear_1998 |   .9986886   .6502953     1.54   0.125    -.2758667    2.273244
 _Iyear_1999 |   .5924236   .4173832     1.42   0.156    -.2256325     1.41048
 _Iyear_2000 |   .1299194   .2151695     0.60   0.546    -.2918052    .5516439
 _Iyear_2001 |   .7467648    .509635     1.47   0.143    -.2521015    1.745631
 _Iyear_2002 |   .1633176    .233407     0.70   0.484    -.2941517     .620787
 _Iyear_2003 |  -.3387977   .1307466    -2.59   0.010    -.5950562   -.0825392
 _Iyear_2004 |  -.1901523   .1455122    -1.31   0.191    -.4753509    .0950463
 _Iyear_2005 |  -.1560589   .1742358    -0.90   0.370    -.4975548     .185437
 _Iyear_2006 |  -.1280612   .2241398    -0.57   0.568    -.5673673    .3112448
 _Iyear_2007 |   .0666193    .383146     0.17   0.862    -.6843331    .8175717
------------------------------------------------------------------------------
Underidentification test (Kleibergen-Paap rk LM statistic):            271.811
                                                   Chi-sq(78) P-val =   0.0000
------------------------------------------------------------------------------
Weak identification test (Kleibergen-Paap rk Wald F statistic):          3.822
Stock-Yogo weak ID test critical values:                       <not available>
------------------------------------------------------------------------------
Hansen J statistic (overidentification test of all instruments):        90.875
                                                   Chi-sq(77) P-val =   0.1335
-endog- option:
Endogeneity test of endogenous regressors:                               6.443
                                                   Chi-sq(1) P-val =    0.0111
Regressors tested:    after_switch
------------------------------------------------------------------------------
```

GMM

```
xtivreg2 r after  l.r  _Iyear_*  (e_inf gap der after_switch e_inf_a gap_a der_a
e_inf_s gap_s der_s e_inf_a_s gap_a_s der_a_s = l3.inf l3.gap l3.der l6.inf l6.gap
l6.der l9.inf l9.gap l9.der l12.inf l12.gap l12.der l3.inf_a l3.inf_s l3.inf_a_s
l3.gap_a l3.gap_s l3.gap_a_s l3.der_a l3.der_s l3.der_a_s l6.inf_a l6.inf_s
l6.inf_a_s l6.gap_a l6.gap_s l6.gap_a_s l6.der_a l6.der_s l6.der_a_s l9.inf_a
l9.inf_s l9.inf_a_s l9.gap_a l9.gap_s l9.gap_a_s l9.der_a l9.der_s l9.der_a_s
l12.inf_a l12.inf_s l12.inf_a_s l12.gap_a l12.gap_s l12.gap_a_s l12.der_a l12.der_s
l12.der_a_s l15.inf_a l15.inf_s l15.inf_a_s l15.gap_a l15.gap_s l15.gap_a_s l15.der_a
l15.der_s l15.der_a_s l18.inf_a l18.inf_s l18.inf_a_s l18.gap_a l18.gap_s l18.gap_a_s
l18.der_a l18.der_s l18.der_a_s l21.inf_a l21.inf_s l21.inf_a_s l21.gap_a l21.gap_s
l21.gap_a_s l21.der_a l21.der_s l21.der_a_s l24.inf_a l24.inf_s l24.inf_a_s l24.gap_a
l24.gap_s l24.gap_a_s l24.der_a l24.der_s l24.der_a_s dc100 ccg nfa l.dc100 l.ccg
l.nfa), fe endog(after_switch) gmm bw(1)

FIXED EFFECTS ESTIMATION
------------------------
Number of groups =       18                   Obs per group: min =        41
                                                             avg =     136.2
                                                             max =       180

2-Step GMM estimation
---------------------

Estimates efficient for arbitrary autocorrelation
Statistics robust to autocorrelation
  kernel=Bartlett; bandwidth=     1
  time variable (t):  .
  group variable (i): country

                                                      Number of obs =     2452
                                                      F( 29,  2405) =   287.39
                                                      Prob > F      =   0.0000
Total (centered) SS     =  99242.51041                Centered R2   =   0.7740
Total (uncentered) SS   =  99242.51041                Uncentered R2 =   0.7740
Residual SS             =  22427.71601                Root MSE      =    3.036

------------------------------------------------------------------------------
           r |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       e_inf |   .0565392   .0650692     0.87   0.385    -.0709941    .1840724
         gap |   .0758336    .061095     1.24   0.215    -.0439104    .1955775
         der |   .0409555   .0304274     1.35   0.178     -.018681    .1005921
after_switch |   2.441524   .9130426     2.67   0.007     .6519935    4.231055
     e_inf_a |  -.0712767   .0479194    -1.49   0.137    -.1651969    .0226436
       gap_a |  -.0627625   .0706048    -0.89   0.374    -.2011454    .0756203
       der_a |  -.0597113   .0309756    -1.93   0.054    -.1204224    .0009997
     e_inf_s |   .2077425   .0797179     2.61   0.009     .0514984    .3639867
       gap_s |   -.011509   .0730101    -0.16   0.875    -.1546061    .1315882
       der_s |  -.0368791   .0347495    -1.06   0.289    -.1049869    .0312287
   e_inf_a_s |  -.2791675   .1278478    -2.18   0.029    -.5297446   -.0285905
     gap_a_s |  -.0023572   .0856387    -0.03   0.978    -.1702059    .1654916
     der_a_s |   .0735808   .0408172     1.80   0.071    -.0064195    .1535811
       after |  -.5697832   .6046884    -0.94   0.346    -1.754951    .6153844
           r |
         L1. |   .8343646   .0179872    46.39   0.000     .7991104    .8696188
 _Iyear_1994 |  -.5755603   .7176559    -0.80   0.423     -1.98214    .8310194
 _Iyear_1995 |   .5467629    .684184     0.80   0.424     -.794213    1.887739
 _Iyear_1996 |   .3084017   .6524683     0.47   0.636    -.9704127    1.587216
 _Iyear_1997 |   .4587732   .5929105     0.77   0.439      -.70331    1.620856
 _Iyear_1998 |   .9986886   .5401742     1.85   0.064    -.0600333    2.057411
 _Iyear_1999 |   .5924236   .5095372     1.16   0.245     -.406251    1.591098
 _Iyear_2000 |   .1299194    .371698     0.35   0.727    -.5985953    .8584341
 _Iyear_2001 |   .7467648   .3611649     2.07   0.039     .0388945    1.454635
 _Iyear_2002 |   .1633176   .3522378     0.46   0.643    -.5270558     .853691
 _Iyear_2003 |  -.3387977   .3453492    -0.98   0.327     -1.01567    .3380742
 _Iyear_2004 |  -.1901523   .3374616    -0.56   0.573    -.8515648    .4712603
 _Iyear_2005 |  -.1560589   .3469617    -0.45   0.653    -.8360913    .5239735
 _Iyear_2006 |  -.1280612   .3545921    -0.36   0.718    -.8230489    .5669265
 _Iyear_2007 |   .0666193   .4295894     0.16   0.877    -.7753605     .908599
------------------------------------------------------------------------------
Underidentification test (Kleibergen-Paap rk LM statistic):            309.210
                                                   Chi-sq(78) P-val =   0.0000
------------------------------------------------------------------------------
Weak identification test (Kleibergen-Paap rk Wald F statistic):          3.764
Stock-Yogo weak ID test critical values:                       <not available>
------------------------------------------------------------------------------
Sargan statistic (overidentification test of all instruments):          81.386
                                                   Chi-sq(77) P-val =   0.3444
-endog- option:
Endogeneity test of endogenous regressors:                              13.654
                                                   Chi-sq(1) P-val =    0.0002
Regressors tested:    after_switch
------------------------------------------------------------------------------
```

CUE

```
xtivreg2 r after l.r _Iyear_* (e_inf gap der after_switch e_inf_a gap_a der_a e_inf_s
gap_s der_s e_inf_a_s gap_a_s der_a_s = l3.inf l3.gap l3.der l6.inf l6.gap l6.der
l9.inf l9.gap l9.der l12.inf l12.gap l12.der l3.inf_a l3.inf_s l3.inf_a_s l3.gap_a
l3.gap_s l3.gap_a_s l3.der_a l3.der_s l3.der_a_s l6.inf_a l6.inf_s l6.inf_a_s
l6.gap_a l6.gap_s l6.gap_a_s l6.der_a l6.der_s l6.der_a_s l9.inf_a l9.inf_s
l9.inf_a_s l9.gap_a l9.gap_s l9.gap_a_s l9.der_a l9.der_s l9.der_a_s l12.inf_a
l12.inf_s l12.inf_a_s l12.gap_a l12.gap_s l12.gap_a_s l12.der_a l12.der_s l12.der_a_s
l15.inf_a l15.inf_s l15.inf_a_s l15.gap_a l15.gap_s l15.gap_a_s l15.der_a l15.der_s
l15.der_a_s l18.inf_a l18.inf_s l18.inf_a_s l18.gap_a l18.gap_s l18.gap_a_s l18.der_a
l18.der_s l18.der_a_s l21.inf_a l21.inf_s l21.inf_a_s l21.gap_a l21.gap_s l21.gap_a_s
l21.der_a l21.der_s l21.der_a_s l24.inf_a l24.inf_s l24.inf_a_s l24.gap_a l24.gap_s
l24.gap_a_s l24.der_a l24.der_s l24.der_a_s dc100 ccg nfa l.dc100 l.ccg l.nfa), fe
endog(after_switch) cue

FIXED EFFECTS ESTIMATION
------------------------
Number of groups =        18                   Obs per group: min =        41
                                                              avg =     136.2
                                                              max =       180

CUE estimation
--------------

Estimates efficient for homoskedasticity only
Statistics consistent for homoskedasticity only

                                                      Number of obs =      2452
                                                      F( 29,  2405) =    282.59
                                                      Prob > F      =    0.0000
Total (centered) SS     =  99242.51041                Centered R2   =    0.7700
Total (uncentered) SS   =  99242.51041                Uncentered R2 =    0.7700
Residual SS             =  22830.12785                Root MSE      =     3.063

------------------------------------------------------------------------------
           r |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       e_inf |   .0422352   .0656503     0.64   0.520    -.0864371    .1709075
         gap |   .0806449   .0616406     1.31   0.191    -.0401685    .2014583
         der |   .0514163   .0306991     1.67   0.094    -.0087529    .1115854
after_switch |   2.900872   .9211974     3.15   0.002     1.095358    4.706385
     e_inf_a |  -.0798512   .0483474    -1.65   0.099    -.1746103     .014908
       gap_a |  -.0644475   .0712354    -0.90   0.366    -.2040663    .0751713
       der_a |  -.0707892   .0312523    -2.27   0.024    -.1320425   -.0095359
     e_inf_s |   .2415401   .0804299     3.00   0.003     .0839004    .3991797
       gap_s |  -.0087647   .0736622    -0.12   0.905      -.15314    .1356105
       der_s |  -.0497422   .0350599    -1.42   0.156    -.1184583    .0189739
   e_inf_a_s |  -.3396117   .1289896    -2.63   0.008    -.5924268   -.0867967
     gap_a_s |   -.011375   .0864036    -0.13   0.895    -.1807228    .1579729
     der_a_s |   .0904354   .0411818     2.20   0.028     .0097206    .1711502
       after |  -.6438018   .6100892    -1.06   0.291    -1.839555     .551951
           r |
         L1. |   .8391771   .0181478    46.24   0.000     .8036081    .8747462
 _Iyear_1994 |  -.6897322   .7240656    -0.95   0.341    -2.108875    .7294103
 _Iyear_1995 |   .4620096   .6902947     0.67   0.503    -.8909431    1.814962
 _Iyear_1996 |   .2687289   .6582958     0.41   0.683    -1.021507    1.558965
 _Iyear_1997 |   .4273716   .5982061     0.71   0.475    -.7450908    1.599834
 _Iyear_1998 |   1.008089   .5449987     1.85   0.064    -.0600891    2.076266
 _Iyear_1999 |   .6490213   .5140881     1.26   0.207    -.3585729    1.656616
 _Iyear_2000 |   .1856068   .3750178     0.49   0.621    -.5494146    .9206281
 _Iyear_2001 |   .7834308   .3643907     2.15   0.032     .0692382    1.497623
 _Iyear_2002 |   .1667879   .3553838     0.47   0.639    -.5297515    .8633274
 _Iyear_2003 |  -.3227113   .3484336    -0.93   0.354    -1.005629     .360206
 _Iyear_2004 |   -.146293   .3404756    -0.43   0.667    -.8136129    .5210269
 _Iyear_2005 |  -.1011491   .3500605    -0.29   0.773    -.7872551     .584957
 _Iyear_2006 |  -.0662629   .3577591    -0.19   0.853    -.7674579     .634932
 _Iyear_2007 |   .2323528   .4334262     0.54   0.592     -.617147    1.081853
------------------------------------------------------------------------------
Underidentification test (Anderson canon. corr. LM statistic):         309.210
                                                   Chi-sq(78) P-val =   0.0000
------------------------------------------------------------------------------
Weak identification test (Cragg-Donald Wald F statistic):                3.764
Stock-Yogo weak ID test critical values:                       <not available>
------------------------------------------------------------------------------
Sargan statistic (overidentification test of all instruments):          80.726
                                                   Chi-sq(77) P-val =   0.3635
-endog- option:
Endogeneity test of endogenous regressors:                              13.654
                                                   Chi-sq(1) P-val =    0.0002
Regressors tested:    after_switch
------------------------------------------------------------------------------
```

CUE - HAC

```
xtivreg2 r after  l.r  _Iyear_* (e_inf gap der after_switch e_inf_a gap_a der_a
e_inf_s gap_s der_s e_inf_a_s gap_a_s der_a_s = l3.inf l3.gap l3.der l6.inf l6.gap
l6.der l9.inf l9.gap l9.der l12.inf l12.gap l12.der l3.inf_a l3.inf_s l3.inf_a_s
l3.gap_a l3.gap_s l3.gap_a_s l3.der_a l3.der_s l3.der_a_s l6.inf_a l6.inf_s
l6.inf_a_s l6.gap_a l6.gap_s l6.gap_a_s l6.der_a l6.der_s l6.der_a_s l9.inf_a
l9.inf_s l9.inf_a_s l9.gap_a l9.gap_s l9.gap_a_s l9.der_a l9.der_s l9.der_a_s
l12.inf_a l12.inf_s l12.inf_a_s l12.gap_a l12.gap_s l12.gap_a_s l12.der_a l12.der_s
l12.der_a_s l15.inf_a l15.inf_s l15.inf_a_s l15.gap_a l15.gap_s l15.gap_a_s l15.der_a
l15.der_s l15.der_a_s l18.inf_a l18.inf_s l18.inf_a_s l18.gap_a l18.gap_s l18.gap_a_s
l18.der_a l18.der_s l18.der_a_s l21.inf_a l21.inf_s l21.inf_a_s l21.gap_a l21.gap_s
l21.gap_a_s l21.der_a l21.der_s l21.der_a_s l24.inf_a l24.inf_s l24.inf_a_s l24.gap_a
l24.gap_s l24.gap_a_s l24.der_a l24.der_s l24.der_a_s dc100 ccg nfa l.dc100 l.ccg
l.nfa), fe endog(after_switch) cue robust bw(1)

FIXED EFFECTS ESTIMATION
------------------------
Number of groups =       18                    Obs per group: min =        41
                                                              avg =     136.2
                                                              max =       180

CUE estimation
--------------

Estimates efficient for arbitrary heteroskedasticity and autocorrelation
Statistics robust to heteroskedasticity and autocorrelation
  kernel=Bartlett; bandwidth=     1
  time variable (t):  .
  group variable (i): country

                                                      Number of obs =      2452
                                                      F( 29,  2405) =   1094.82
                                                      Prob > F      =    0.0000
Total (centered) SS     =  99242.51041                Centered R2   =    0.7607
Total (uncentered) SS   =  99242.51041                Uncentered R2 =    0.7607
Residual SS             =  23751.47247                Root MSE      =     3.124

------------------------------------------------------------------------------
             |               Robust
           r |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       e_inf |   -.016242   .0528959    -0.31   0.759     -.119916    .0874321
         gap |   .0714766   .0373982     1.91   0.056    -.0018226    .1447758
         der |  -.0327877   .0256742    -1.28   0.202    -.0831081    .0175328
after_switch |   1.369531   .4532136     3.02   0.003     .4812483    2.257813
     e_inf_a |   .0854806   .0485059     1.76   0.078    -.0095891    .1805504
       gap_a |  -.0429056   .0399902    -1.07   0.283    -.1212849    .0354737
       der_a |   .0604902   .0312054     1.94   0.053    -.0006712    .1216515
     e_inf_s |   .0859971   .0615276     1.40   0.162    -.0345949    .2065891
       gap_s |   .0405186    .049573     0.82   0.414    -.0566428    .1376799
       der_s |   .0184291   .0276208     0.67   0.505    -.0357067    .0725649
   e_inf_a_s |  -.1827443   .0593231    -3.08   0.002    -.2990154   -.0664731
     gap_a_s |  -.0626761   .0511112    -1.23   0.220    -.1628523       .0375
     der_a_s |  -.0292964   .0341586    -0.86   0.391    -.0962461    .0376532
       after |  -.6240062   .3270267    -1.91   0.056    -1.264967    .0169543
           r |
         L1. |   .9375405   .0205506    45.62   0.000      .897262     .977819
 _Iyear_1994 |   .3493746   .5089196     0.69   0.492    -.6480895    1.346839
 _Iyear_1995 |   .4189108   .5287187     0.79   0.428    -.6173587     1.45518
 _Iyear_1996 |   .0210794   .3931964     0.05   0.957    -.7495713    .7917302
 _Iyear_1997 |   .1158844   .3348574     0.35   0.729     -.540424    .7721927
 _Iyear_1998 |   .4771454     .30377     1.57   0.116    -.1182329    1.072524
 _Iyear_1999 |  -.2039649   .2057046    -0.99   0.321    -.6071386    .1992088
 _Iyear_2000 |   .0249157   .1378781     0.18   0.857    -.2453204    .2951518
 _Iyear_2001 |  -.0072555    .164611    -0.04   0.965    -.3298872    .3153762
 _Iyear_2002 |  -.1336665   .0923995    -1.45   0.148    -.3147662    .0474332
 _Iyear_2003 |  -.2500574   .0807378    -3.10   0.002    -.4083006   -.0918142
 _Iyear_2004 |  -.1413168   .0792864    -1.78   0.075    -.2967154    .0140818
 _Iyear_2005 |  -.1618444   .0875732    -1.85   0.065    -.3334846    .0097959
 _Iyear_2006 |  -.2530223   .1075852    -2.35   0.019    -.4638855   -.0421592
 _Iyear_2007 |  -.2333339    .158815    -1.47   0.142    -.5446056    .0779377
------------------------------------------------------------------------------
Underidentification test (Kleibergen-Paap rk LM statistic):            271.811
                                                   Chi-sq(78) P-val =   0.0000
------------------------------------------------------------------------------
Weak identification test (Kleibergen-Paap rk Wald F statistic):          3.822
Stock-Yogo weak ID test critical values:                       <not available>
------------------------------------------------------------------------------
Hansen J statistic (overidentification test of all instruments):        86.056
                                                   Chi-sq(77) P-val =   0.2248
-endog- option:
Endogeneity test of endogenous regressors:                               6.443
                                                   Chi-sq(1) P-val =    0.0111
Regressors tested:    after_switch
------------------------------------------------------------------------------
```

LIML

```
xtivreg2 r after l.r  _Iyear_* (e_inf gap der after_switch e_inf_a gap_a der_a
e_inf_s gap_s der_s e_inf_a_s gap_a_s der_a_s = l3.inf l3.gap l3.der l6.inf l6.gap
l6.der l9.inf l9.gap l9.der l12.inf l12.gap l12.der l3.inf_a l3.inf_s l3.inf_a_s
l3.gap_a l3.gap_s l3.gap_a_s l3.der_a l3.der_s l3.der_a_s l6.inf_a l6.inf_s
l6.inf_a_s l6.gap_a l6.gap_s l6.gap_a_s l6.der_a l6.der_s l6.der_a_s l9.inf_a
l9.inf_s l9.inf_a_s l9.gap_a l9.gap_s l9.gap_a_s l9.der_a l9.der_s l9.der_a_s
l12.inf_a l12.inf_s l12.inf_a_s l12.gap_a l12.gap_s l12.gap_a_s l12.der_a l12.der_s
l12.der_a_s l15.inf_a l15.inf_s l15.inf_a_s l15.gap_a l15.gap_s l15.gap_a_s l15.der_a
l15.der_s l15.der_a_s l18.inf_a l18.inf_s l18.inf_a_s l18.gap_a l18.gap_s l18.gap_a_s
l18.der_a l18.der_s l18.der_a_s l21.inf_a l21.inf_s l21.inf_a_s l21.gap_a l21.gap_s
l21.gap_a_s l21.der_a l21.der_s l21.der_a_s l24.inf_a l24.inf_s l24.inf_a_s l24.gap_a
l24.gap_s l24.gap_a_s l24.der_a l24.der_s l24.der_a_s dc100 ccg nfa l.dc100 l.ccg
l.nfa), fe endog(after_switch) liml bw(1) robust

FIXED EFFECTS ESTIMATION
------------------------
Number of groups =       18                    Obs per group: min =        41
                                                              avg =     136.2

LIML estimation
---------------
k               =1.03430
lambda          =1.03430

Estimates efficient for homoskedasticity only
Statistics robust to heteroskedasticity and autocorrelation
  kernel=Bartlett; bandwidth=     1
  time variable (t):  .
  group variable (i): country

                                                      Number of obs =      2452
                                                      F( 29,  2405) =    357.22
                                                      Prob > F      =    0.0000
Total (centered) SS     =  99242.51041                Centered R2   =    0.7700
Total (uncentered) SS   =  99242.51041                Uncentered R2 =    0.7700
Residual SS             =  22830.12784                Root MSE      =     3.063

------------------------------------------------------------------------------
             |               Robust
           r |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       e_inf |   .0422352   .1118862     0.38   0.706    -.1770576     .261528
         gap |   .0806449   .0686636     1.17   0.240    -.0539333    .2152231
         der |   .0514163   .0664627     0.77   0.439    -.0788482    .1816807
after_switch |   2.900872   1.456692     1.99   0.046      .045807    5.755936
     e_inf_a |  -.0798512   .1318197    -0.61   0.545    -.3382131    .1785108
       gap_a |  -.0644475   .0765669    -0.84   0.400    -.2145159    .0856208
       der_a |  -.0707892   .0706573    -1.00   0.316     -.209275    .0676966
     e_inf_s |   .2415401   .1230334     1.96   0.050     .0003991     .482681
       gap_s |  -.0087647   .0854587    -0.10   0.918    -.1762608    .1587313
       der_s |  -.0497422   .0616615    -0.81   0.420    -.1705965    .0711122
   e_inf_a_s |  -.3396117   .1634682    -2.08   0.038    -.6600036   -.0192199
     gap_a_s |   -.011375   .0931469    -0.12   0.903    -.1939395    .1711896
     der_a_s |   .0904354   .0693432     1.30   0.192    -.0454748    .2263457
       after |  -.6438018   .7448607    -0.86   0.387    -2.103702    .8160983
           r |
         L1. |   .8391771   .0504666    16.63   0.000     .7402644    .9380898
 _Iyear_1994 |  -.6897322   .9605085    -0.72   0.473    -2.572294     1.19283
 _Iyear_1995 |   .4620096   .9085149     0.51   0.611    -1.318647    2.242666
 _Iyear_1996 |   .2687289   .7606725     0.35   0.724    -1.222162     1.75962
 _Iyear_1997 |   .4273716   .6187609     0.69   0.490    -.7853775    1.640121
 _Iyear_1998 |   1.008089   .6670345     1.51   0.131    -.2992749    2.315452
 _Iyear_1999 |   .6490213   .4446991     1.46   0.144    -.2225729    1.520616
 _Iyear_2000 |   .1856067   .2114853     0.88   0.380    -.2288968    .6001103
 _Iyear_2001 |   .7834308   .5154993     1.52   0.129    -.2269292    1.793791
 _Iyear_2002 |   .1667879   .2338662     0.71   0.476    -.2915814    .6251573
 _Iyear_2003 |  -.3227113   .1408731    -2.29   0.022    -.5988175   -.0466052
 _Iyear_2004 |   -.146293   .1599343    -0.91   0.360    -.4597584    .1671725
 _Iyear_2005 |  -.1011491   .1964331    -0.51   0.607    -.4861509    .2838527
 _Iyear_2006 |  -.0662629   .2541286    -0.26   0.794    -.5643457    .4318199
 _Iyear_2007 |   .2323528   .4576128     0.51   0.612    -.6645517    1.129257
------------------------------------------------------------------------------
Underidentification test (Kleibergen-Paap rk LM statistic):            271.811
                                                   Chi-sq(78) P-val =   0.0000
------------------------------------------------------------------------------
Weak identification test (Kleibergen-Paap rk Wald F statistic):          3.822
Stock-Yogo weak ID test critical values:                       <not available>
------------------------------------------------------------------------------
Hansen J statistic (overidentification test of all instruments):        88.717
                                                   Chi-sq(77) P-val =   0.1702
-endog- option:
Endogeneity test of endogenous regressors:                               6.305
                                                   Chi-sq(1) P-val =    0.0120
Regressors tested:    after_switch
```

GMM estimates – "robustness-checks" regressions I

After_switch "quadrant" only

```
xtivreg2 r after  l.r  _Iyear_* (e_inf gap der after_switch e_inf_a_s gap_a_s der_a_s
= l3.inf l3.gap l3.der l6.inf l6.
> gap l6.der l9.inf l9.gap l9.der l12.inf l12.gap l12.der l3.inf_a_s  l12.inf_a_s
l12.gap_a_s l12.der_a_s  l15.inf_a_s  l
> 15.gap_a_s  l15.der_a_s l18.inf_a_s l18.gap_a_s l18.der_a_s  l21.inf_a_s
l21.gap_a_s l21.der_a_s l24.inf_a_s  l24.gap_
> a_s l24.der_a_s l27.inf_a_s  l27.gap_a_s l27.der_a_s l30.inf_a_s  l30.gap_a_s
l30.der_a_s l33.inf_a_s  l33.gap_a_s l33.
> der_a_s l36.inf_a_s  l36.gap_a_s l36.der_a_s dc100 ccg nfa l.dc100 l.ccg  l.nfa),
fe endog(after_switch) cue robust bw(
> 1)
Warning - collinearities detected
Vars dropped:  _Iyear_1991 _Iyear_1992 _Iyear_1993 _Iyear_1994 _Iyear_2008
               _Iyear_2009

FIXED EFFECTS ESTIMATION
------------------------
Number of groups =       18                    Obs per group: min =        29
                                                              avg =     124.9
                                                              max =       168

CUE estimation
--------------

Estimates efficient for arbitrary heteroskedasticity and autocorrelation
Statistics robust to heteroskedasticity and autocorrelation
  kernel=Bartlett; bandwidth=     1
  time variable (t):  .
  group variable (i): country

                                                      Number of obs =     2248
                                                      F( 22,  2208) =   949.68
                                                      Prob > F      =   0.0000
Total (centered) SS     =  90296.59228                Centered R2   =   0.7788
Total (uncentered) SS   =  90296.59228                Uncentered R2 =   0.7788
Residual SS             =  19969.90611                Root MSE      =    2.993

------------------------------------------------------------------------------
             |               Robust
           r |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       e_inf |   .1933189   .0378617     5.11   0.000     .1191113    .2675265
         gap |   .0675573   .0197228     3.43   0.001     .0289013    .1062132
         der |   .0138749   .0135978     1.02   0.308    -.0127763    .0405261
after_switch |   2.930189    .663961     4.41   0.000     1.628849    4.231529
   e_inf_a_s |  -.1625092   .0477142    -3.41   0.001    -.2560274    -.068991
     gap_a_s |   -.059799   .0204107    -2.93   0.003    -.0998031   -.0197948
     der_a_s |   .0134926   .0167025     0.81   0.419    -.0192437     .046229
       after |  -1.404494   .4534395    -3.10   0.002    -2.293219   -.5157688
             |
           r |
         L1. |   .8121522   .0317916    25.55   0.000     .7498418    .8744626
             |
 _Iyear_1995 |   .8141696   .5675453     1.43   0.151    -.2981988    1.926538
 _Iyear_1996 |    1.08234   .4613681     2.35   0.019     .1780753    1.986605
 _Iyear_1997 |   .8555109   .4280516     2.00   0.046     .0165451    1.694477
 _Iyear_1998 |   1.130341   .3461705     3.27   0.001     .4518596    1.808823
 _Iyear_1999 |  -.0446805   .2500268    -0.18   0.858     -.534724    .4453629
 _Iyear_2000 |   .2996502   .1784013     1.68   0.093      -.05001    .6493104
 _Iyear_2001 |    .320913   .2439045     1.32   0.188    -.1571309     .798957
 _Iyear_2002 |  -.0690745    .159515    -0.43   0.665    -.3817182    .2435692
 _Iyear_2003 |   -.456908   .1123573    -4.07   0.000    -.6771243   -.2366917
 _Iyear_2004 |  -.4489974   .1223526    -3.67   0.000    -.6888041   -.2091908
 _Iyear_2005 |  -.3851688   .1202138    -3.20   0.001    -.6207836   -.1495541
 _Iyear_2006 |  -.5212211   .1360137    -3.83   0.000     -.787803   -.2546392
 _Iyear_2007 |  -.7976512   .1935957    -4.12   0.000    -1.177092   -.4182107
------------------------------------------------------------------------------
Underidentification test (Kleibergen-Paap rk LM statistic):            132.634
                                                   Chi-sq(40) P-val =   0.0000
------------------------------------------------------------------------------
Weak identification test (Kleibergen-Paap rk Wald F statistic):          3.747
Stock-Yogo weak ID test critical values:                       <not available>
------------------------------------------------------------------------------
Hansen J statistic (overidentification test of all instruments):        34.561
                                                   Chi-sq(39) P-val =   0.6725
-endog- option:
Endogeneity test of endogenous regressors:                               8.564
                                                   Chi-sq(1) P-val =    0.0034
Regressors tested:    after_switch
------------------------------------------------------------------------------
```

After_switch exogenous

```
xtivreg2 r c l.r after switch after_switch  _Iyear_* (e_inf gap der e_inf_a gap_a
der_a e_inf_s gap_s der_s e_inf_a_s gap_a_s der_a_s = l3.inf l3.gap l3.der l6.inf
l6.gap l6.der l9.inf l9.gap l9.der l12.inf l12.gap l12.der l3.inf_a l3.inf_s
l3.inf_a_s l3.gap_a l3.gap_s l3.gap_a_s l3.der_a l3.der_s l3.der_a_s l6.inf_a
l6.inf_s l6.inf_a_s l6.gap_a l6.gap_s l6.gap_a_s l6.der_a l6.der_s l6.der_a_s
l9.inf_a l9.inf_s l9.inf_a_s l9.gap_a l9.gap_s l9.gap_a_s l9.der_a l9.der_s
l9.der_a_s l12.inf_a l12.inf_s l12.inf_a_s l12.gap_a l12.gap_s l12.gap_a_s l12.der_a
l12.der_s l12.der_a_s l15.inf_a l15.inf_s l15.inf_a_s l15.gap_a l15.gap_s l15.gap_a_s
l15.der_a l15.der_s l15.der_a_s l18.inf_a l18.inf_s l18.inf_a_s l18.gap_a l18.gap_s
l18.gap_a_s l18.der_a l18.der_s l18.der_a_s l21.inf_a l21.inf_s l21.inf_a_s l21.gap_a
l21.gap_s l21.gap_a_s l21.der_a l21.der_s l21.der_a_s l24.inf_a l24.inf_s l24.inf_a_s
l24.gap_a l24.gap_s l24.gap_a_s l24.der_a l24.der_s l24.der_a_s l27.inf_a l27.inf_s
l27.inf_a_s l27.gap_a l27.gap_s l27.gap_a_s l27.der_a l27.der_s l27.der_a_s l30.inf_a
l30.inf_s l30.inf_a_s l30.gap_a l30.gap_s l30.gap_a_s l30.der_a l30.der_s l30.der_a_s
), fe orthog(after_switch) cue robust bw(1)

FIXED EFFECTS ESTIMATION
------------------------
Number of groups =       18                 Obs per group: min =        35
                                                           avg =     131.1
                                                           max =       174

CUE estimation
--------------

Estimates efficient for arbitrary heteroskedasticity and autocorrelation
Statistics robust to heteroskedasticity and autocorrelation
  kernel=Bartlett; bandwidth=     1
  time variable (t):  .
  group variable (i): country

                                                      Number of obs =     2359
                                                      F( 29,  2312) =  1259.68
                                                      Prob > F      =   0.0000
Total (centered) SS     =  93674.52029                Centered R2   =   0.7637
Total (uncentered) SS   =  93674.52029                Uncentered R2 =   0.7637
Residual SS             =  22136.88584                Root MSE      =    3.075

------------------------------------------------------------------------------
             |               Robust
           r |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       e_inf |   .0484907   .0475815     1.02   0.308    -.0447673    .1417487
         gap |   .1070285   .0431413     2.48   0.013     .0224731     .191584
         der |  -.0308811   .0196678    -1.57   0.116    -.0694292     .007667
     e_inf_a |  -.0111401   .0475542    -0.23   0.815    -.1043446    .0820644
       gap_a |  -.0828618   .0446271    -1.86   0.063    -.1703294    .0046057
       der_a |   .0412749   .0228988     1.80   0.071    -.0036059    .0861557
     e_inf_s |  -.0107179   .0519654    -0.21   0.837    -.1125682    .0911325
       gap_s |   .0416637   .0546739     0.76   0.446    -.0654953    .1488226
       der_s |   .0160991   .0205793     0.78   0.434    -.0242356    .0564338
   e_inf_a_s |  -.0383372   .0541301    -0.71   0.479    -.1444303    .0677559
     gap_a_s |  -.0579538   .0559951    -1.03   0.301    -.1677021    .0517945
     der_a_s |  -.0129844   .0243196    -0.53   0.593    -.0606498    .0346811
             |
           r |
         L1. |   .9856345   .0160638    61.36   0.000       .95415    1.017119
             |
       after |  -.3495629   .2321004    -1.51   0.132    -.8044714    .1053456
after_switch |   .4949307   .3366998     1.47   0.142    -.1649889     1.15485
 _Iyear_1994 |   .0283532   .4714565     0.06   0.952    -.8956846    .9523909
 _Iyear_1995 |  -.3362268   .4888693    -0.69   0.492    -1.294393    .6219395
 _Iyear_1996 |  -.4434084   .3721019    -1.19   0.233    -1.172715    .2858978
 _Iyear_1997 |  -.1602535   .3000475    -0.53   0.593    -.7483358    .4278288
 _Iyear_1998 |   .0056439   .2722193     0.02   0.983    -.5278961     .539184
 _Iyear_1999 |  -.2020056   .1920803    -1.05   0.293    -.5784761    .1744649
 _Iyear_2000 |  -.1975097   .1185606    -1.67   0.096    -.4298843    .0348649
 _Iyear_2001 |  -.2272853   .1297946    -1.75   0.080    -.4816781    .0271075
 _Iyear_2002 |  -.1506014   .0809322    -1.86   0.063    -.3092256    .0080227
 _Iyear_2003 |  -.2012373   .0701514    -2.87   0.004    -.3387315   -.0637432
 _Iyear_2004 |  -.0588007   .0630252    -0.93   0.351    -.1823278    .0647265
 _Iyear_2005 |  -.0738361   .0679721    -1.09   0.277     -.207059    .0593867
 _Iyear_2006 |  -.1277928   .0826168    -1.55   0.122    -.2897186    .0341331
 _Iyear_2007 |  -.1478904   .1120434    -1.32   0.187    -.3674915    .0717107
------------------------------------------------------------------------------
Underidentification test (Kleibergen-Paap rk LM statistic):            271.450
                                                   Chi-sq(91) P-val =   0.0000
------------------------------------------------------------------------------
Weak identification test (Kleibergen-Paap rk Wald F statistic):          3.623
Stock-Yogo weak ID test critical values:                       <not available>
------------------------------------------------------------------------------
Hansen J statistic (overidentification test of all instruments):        97.017
                                                   Chi-sq(90) P-val =   0.2879
-orthog- option:
```

```
Hansen J statistic (eqn. excluding suspect orthog. conditions):         85.676
                                                Chi-sq(89) P-val =   0.5801
C statistic (exogeneity/orthogonality of suspect instruments):          11.341
                                                Chi-sq(1) P-val =    0.0008
Instruments tested:   after_switch
------------------------------------------------------------------------------
```

After_switch exogenous and gap period of 3 years

```
xtivreg2 r l.r after after_switch2  _Iyear_* (e_inf gap der e_inf_a gap_a der_a
e_inf_s2 gap_s2 der_s2 e_inf_a2_s2 gap_a2_s2 der_a2_s2 = l3.inf l3.gap l3.der l6.inf
l6.gap l6.der l9.inf l9.gap l9.der l12.inf l12.gap l12.der    l12.inf_a l12.inf_s2
l12.inf_a2_s2 l12.gap_a l12.gap_s2 l12.gap_a2_s2 l12.der_a l12.der_s2 l12.der_a2_s2
l18.inf_a l18.inf_s2 l18.inf_a2_s2 l18.gap_a l18.gap_s2 l18.gap_a2_s2 l18.der_a
l18.der_s2 l18.der_a2_s2    l24.inf_a l24.inf_s2 l24.inf_a2_s2 l24.gap_a l24.gap_s2
l24.gap_a2_s2 l24.der_a l24.der_s2 l24.der_a2_s2 l30.inf_a l30.inf_s2 l30.inf_a2_s2
l30.gap_a l30.gap_s2 l30.gap_a2_s2 l30.der_a l30.der_s2 l30.der_a2_s2 l36.inf_a
l36.inf_s2 l36.inf_a2_s2 l36.gap_a l36.gap_s2 l36.gap_a2_s2 l36.der_a l36.der_s2
l36.der_a2_s2), fe orthog(after_switch2) cue robust bw(1)
               _Iyear_2009

FIXED EFFECTS ESTIMATION
------------------------
Number of groups =        18                    Obs per group: min =        29
                                                               avg =     125.4
                                                               max =       168

CUE estimation
--------------

Estimates efficient for arbitrary heteroskedasticity and autocorrelation
Statistics robust to heteroskedasticity and autocorrelation
  kernel=Bartlett; bandwidth=     1
  time variable (t):  .
  group variable (i): country

                                                      Number of obs =     2257
                                                      F( 28,  2211) =   956.48
                                                      Prob > F      =   0.0000
Total (centered) SS     =  90483.13272                Centered R2   =   0.7658
Total (uncentered) SS   =  90483.13272                Uncentered R2 =   0.7658
Residual SS             =   21191.3221                Root MSE      =    3.076

------------------------------------------------------------------------------
             |               Robust
           r |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       e_inf |   .0723671   .0644057     1.12   0.261    -.0538657    .1985999
         gap |   .1406312   .0487746     2.88   0.004     .0450347    .2362277
         der |   .0425641   .0383653     1.11   0.267    -.0326306    .1177588
     e_inf_a |  -.0934091   .0676086    -1.38   0.167    -.2259196    .0391014
       gap_a |  -.1385905   .0496972    -2.79   0.005    -.2359952   -.0411858
       der_a |  -.0570708    .040128    -1.42   0.155    -.1357203    .0215787
    e_inf_s2 |  -.0800971   .0718242    -1.12   0.265    -.2208699    .0606756
      gap_s2 |  -.0481618   .1177997    -0.41   0.683     -.279045    .1827214
      der_s2 |  -.0234911   .0542067    -0.43   0.665    -.1297343    .0827522
 e_inf_a2_s2 |   .0842237   .0775486     1.09   0.277    -.0677688    .2362163
   gap_a2_s2 |   .0486834   .1177939     0.41   0.679    -.1821885    .2795553
   der_a2_s2 |   .0499085   .0553942     0.90   0.368    -.0586622    .1584793
             |
           r |
         L1. |   .9902524   .0189664    52.21   0.000     .9530791    1.027426
             |
       after |   .4025657   .3214809     1.25   0.210    -.2275254    1.032657
after_swit~2 |  -.0531238   .1990859    -0.27   0.790     -.443325    .3370773
 _Iyear_1995 |   .3491062   .5189275     0.67   0.501     -.667973    1.366185
 _Iyear_1996 |   .0927187    .455372     0.20   0.839    -.7997941    .9852315
 _Iyear_1997 |   .3615707   .4412597     0.82   0.413    -.5032824    1.226424
 _Iyear_1998 |  -.1681852   .3342351    -0.50   0.615    -.8232739    .4869035
 _Iyear_1999 |   .1019094   .2666036     0.38   0.702     -.420624    .6244428
 _Iyear_2000 |  -.2027861   .1628018    -1.25   0.213    -.5218718    .1162997
 _Iyear_2001 |  -.3850583   .1635646    -2.35   0.019     -.705639   -.0644777
 _Iyear_2002 |  -.1032703   .1093149    -0.94   0.345    -.3175236    .1109829
 _Iyear_2003 |  -.2108777   .0729754    -2.89   0.004    -.3539069   -.0678486
 _Iyear_2004 |  -.0355701   .0514003    -0.69   0.489    -.1363127    .0651725
 _Iyear_2005 |  -.0142028   .0583046    -0.24   0.808    -.1284777     .100072
 _Iyear_2006 |  -.0036997   .0748192    -0.05   0.961    -.1503427    .1429433
 _Iyear_2007 |   .0395849   .1076549     0.37   0.713    -.1714148    .2505846
------------------------------------------------------------------------------
Underidentification test (Kleibergen-Paap rk LM statistic):             94.701
                                                Chi-sq(46) P-val =   0.0000
------------------------------------------------------------------------------
Weak identification test (Kleibergen-Paap rk Wald F statistic):          1.801
Stock-Yogo weak ID test critical values:                       <not available>
------------------------------------------------------------------------------
Hansen J statistic (overidentification test of all instruments):        54.769
```

```
                                                    Chi-sq(45) P-val =   0.1509
-orthog- option:
Hansen J statistic (eqn. excluding suspect orthog. conditions):         53.973
                                                    Chi-sq(44) P-val =   0.1441
C statistic (exogeneity/orthogonality of suspect instruments):           0.796
                                                    Chi-sq(1) P-val =    0.3723
Instruments tested:   after_switch2
------------------------------------------------------------------------------
```

SAMPLE SIZE

```
xtivreg2 r after  l.r  _Iyear_* (e_inf gap der after_switch e_inf_a gap_a der_a
e_inf_s gap_s der_s e_inf_a_s gap_a_s der_a_s = l3.inf l3.gap l3.der l6.inf l6.gap
l6.der l9.inf l9.gap l9.der l12.inf l12.gap l12.der l15.inf l15.gap l15.der l18.inf
l18.gap l18.der l21.inf l21.gap l21.der l24.inf l24.gap l24.der l3.inf_a l3.inf_s
l3.inf_a_s l3.gap_a l3.gap_s l3.gap_a_s l3.der_a l3.der_s l3.der_a_s l6.inf_a
l6.inf_s l6.inf_a_s l6.gap_a l6.gap_s l6.gap_a_s l6.der_a l6.der_s l6.der_a_s
l9.inf_a l9.inf_s l9.inf_a_s l9.gap_a l9.gap_s l9.gap_a_s l9.der_a l9.der_s
l9.der_a_s l12.inf_a l12.inf_s l12.inf_a_s l12.gap_a l12.gap_s l12.gap_a_s l12.der_a
l12.der_s l12.der_a_s l15.inf_a l15.inf_s l15.inf_a_s l15.gap_a l15.gap_s l15.gap_a_s
l15.der_a l15.der_s l15.der_a_s l24.inf_a l24.inf_s l24.inf_a_s l24.gap_a l24.gap_s
l24.gap_a_s l24.der_a l24.der_s l24.der_a_s dc100 l.dc100 ccg l.ccg nfa l.nfa), fe
endog(after_switch) cue robust bw(1)

FIXED EFFECTS ESTIMATION
------------------------
Number of groups =       14                  Obs per group: min =        41
                                                            avg =     127.6
                                                            max =       180

CUE estimation
--------------

Estimates efficient for arbitrary heteroskedasticity and autocorrelation
Statistics robust to heteroskedasticity and autocorrelation
  kernel=Bartlett; bandwidth=     1
  time variable (t):  .
  group variable (i): country

                                                      Number of obs =     1787
                                                      F( 29,  1744) =  1360.73
                                                      Prob > F      =   0.0000
Total (centered) SS     =  65870.76538                Centered R2   =   0.7216
Total (uncentered) SS   =  65870.76538                Uncentered R2 =   0.7216
Residual SS             =  18341.41835                Root MSE      =    3.216

------------------------------------------------------------------------------
             |               Robust
           r |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       e_inf |   .0057717   .0300317     0.19   0.848    -.0530893    .0646327
         gap |   .0419571   .0269427     1.56   0.119    -.0108497    .0947639
         der |   .0062262   .0209196     0.30   0.766    -.0347754    .0472278
after_switch |   .5982343   .2810261     2.13   0.033     .0474333    1.149035
     e_inf_a |   .0282807    .031112     0.91   0.363    -.0326976     .089259
       gap_a |  -.0165373   .0298891    -0.55   0.580    -.0751189    .0420443
       der_a |   .0155443   .0258956     0.60   0.548    -.0352101    .0662987
     e_inf_s |   .0752214   .0311973     2.41   0.016     .0140758    .1363671
       gap_s |   .0578428   .0381085     1.52   0.129    -.0168485    .1325342
       der_s |  -.0347541   .0244576    -1.42   0.155    -.0826901    .0131819
   e_inf_a_s |  -.1278614   .0369175    -3.46   0.001    -.2002184   -.0555044
     gap_a_s |  -.0765738   .0402281    -1.90   0.057    -.1554194    .0022717
     der_a_s |   .0292213   .0295141     0.99   0.322    -.0286252    .0870678
       after |  -.2615189   .2673879    -1.73   0.084    -.9855895    .0625518
             |
           r |
         L1. |   .9480729    .016362    57.94   0.000      .916004    .9801417
             |
  _Iyear_1994 |  -.5494123   .5048207    -1.09   0.276    -1.538843    .4400182
  _Iyear_1995 |   .3379422   .3794811     0.89   0.373    -.4058271    1.081712
  _Iyear_1996 |   -.430576   .2896362    -1.49   0.137    -.9982526    .1371006
  _Iyear_1997 |  -.3321357   .3246092    -1.02   0.306     -.968358    .3040866
  _Iyear_1998 |   .1858124   .2513628     0.74   0.460    -.3068496    .6784744
  _Iyear_1999 |  -.4450535    .176917    -2.52   0.012    -.7918045   -.0983026
  _Iyear_2000 |  -.0144689   .1180912    -0.12   0.902    -.2459234    .2169856
  _Iyear_2001 |   .0321105   .1510851     0.21   0.832    -.2640109    .3282319
  _Iyear_2002 |  -.0301583   .1101476    -0.27   0.784    -.2460436     .185727
  _Iyear_2003 |  -.2071146   .0939262    -2.21   0.027    -.3912066   -.0230226
  _Iyear_2004 |  -.0704117   .0884742    -0.80   0.426    -.2438179    .1029946
  _Iyear_2005 |  -.0786768   .0946999    -0.83   0.406    -.2642851    .1069316
  _Iyear_2006 |  -.1267556   .1126541    -1.13   0.261    -.3475537    .0940424
  _Iyear_2007 |  -.1311223   .1493654    -0.88   0.380    -.4238731    .1616286
------------------------------------------------------------------------------
Underidentification test (Kleibergen-Paap rk LM statistic):            190.645
                                                    Chi-sq(72) P-val =   0.0000
```

```
------------------------------------------------------------------------------
Weak identification test (Kleibergen-Paap rk Wald F statistic):          3.766
Stock-Yogo weak ID test critical values:                       <not available>
------------------------------------------------------------------------------
Hansen J statistic (overidentification test of all instruments):        85.854
                                                   Chi-sq(71) P-val =   0.1105
-endog- option:
Endogeneity test of endogenous regressors:                               2.645
                                                   Chi-sq(1) P-val =    0.1097
Regressors tested:    after_switch
------------------------------------------------------------------------------
```

GMM estimates – "robustness-checks" regressions II

LAGGED INFLATION

```
xtivreg2 r l.r l12.inf l12.inf_a l12.inf_s l12.inf_a_s after  _Iyear_* (e_inf gap der
after_switch e_inf_a gap_a der_a e_inf_s gap_s der_s e_inf_a_s gap_a_s der_a_s =
l3.inf l3.gap l3.der l6.inf l6.gap l6.der l9.inf l9.gap l9.der l12.inf l12.gap
l12.der l3.inf_a l3.inf_s l3.inf_a_s l3.gap_a l3.gap_s l3.gap_a_s l3.der_a l3.der_s
l3.der_a_s l6.inf_a l6.inf_s l6.inf_a_s l6.gap_a l6.gap_s l6.gap_a_s l6.der_a
l6.der_s l6.der_a_s l9.inf_a l9.inf_s l9.inf_a_s l9.gap_a l9.gap_s l9.gap_a_s
l9.der_a l9.der_s l9.der_a_s l12.inf_a l12.inf_s l12.inf_a_s l12.gap_a l12.gap_s
l12.gap_a_s l12.der_a l12.der_s l12.der_a_s l15.inf_a l15.inf_s l15.inf_a_s l15.gap_a
l15.gap_s l15.gap_a_s l15.der_a l15.der_s l15.der_a_s l18.inf_a l18.inf_s l18.inf_a_s
l18.gap_a l18.gap_s l18.gap_a_s l18.der_a l18.der_s l18.der_a_s l21.inf_a l21.inf_s
l21.inf_a_s l21.gap_a l21.gap_s l21.gap_a_s l21.der_a l21.der_s l21.der_a_s l24.inf_a
l24.inf_s l24.inf_a_s l24.gap_a l24.gap_s l24.gap_a_s l24.der_a l24.der_s l24.der_a_s
dc100 l.dc100 ccg l.ccg nfa l.nfa), fe endog(after_switch) cue robust bw(1)

FIXED EFFECTS ESTIMATION
------------------------
Number of groups =        18                    Obs per group: min =        41
                                                               avg =     136.2
                                                               max =       180

CUE estimation
--------------

Estimates efficient for arbitrary heteroskedasticity and autocorrelation
Statistics robust to heteroskedasticity and autocorrelation
  kernel=Bartlett; bandwidth=     1
  time variable (t):  .
  group variable (i): country

                                                      Number of obs =     2452
                                                      F( 33,  2401) =   932.92
                                                      Prob > F      =   0.0000
Total (centered) SS     =  99242.51041                Centered R2   =   0.7609
Total (uncentered) SS   =  99242.51041                Uncentered R2 =   0.7609
Residual SS             =  23730.70806                Root MSE      =    3.122

------------------------------------------------------------------------------
             |               Robust
           r |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       e_inf |   .0521272   .0718221     0.73   0.468    -.0886415    .1928959
         gap |   .0841295   .0391897     2.15   0.032     .0073191    .1609399
         der |  -.0312143   .0279493    -1.12   0.264    -.0859939    .0235654
after_switch |    1.50783   .5448341     2.77   0.006     .4399749    2.575685
     e_inf_a |   .0164649    .055291     0.30   0.766    -.0919034    .1248332
       gap_a |  -.0559134   .0415959    -1.34   0.179    -.1374399    .0256132
       der_a |   .0493481   .0342202     1.44   0.149    -.0177223    .1164185
     e_inf_s |   .0471199    .087027     0.54   0.588    -.1234498    .2176896
       gap_s |    .037979   .0524694     0.72   0.469    -.0648591    .1408172
       der_s |   .0124925   .0305704     0.41   0.683    -.0474243    .0724093
   e_inf_a_s |  -.1764988   .0786448    -2.24   0.025    -.3306399   -.0223578
     gap_a_s |  -.0611875   .0537647    -1.14   0.255    -.1665644    .0441894
     der_a_s |  -.0154348   .0378543    -0.41   0.683    -.0896278    .0587582
             |
           r |
         L1. |   .9643444    .021525    44.80   0.000     .9221562    1.006533
             |
         inf |
        L12. |   -1.88119     3.6973    -0.51   0.611    -9.127766    5.365386
             |
       inf_a |
        L12. |   2.894436     4.0852     0.71   0.479     -5.11241    10.90128
             |
       inf_s |
        L12. |  -.0186438   .0471386    -0.40   0.692    -.1110338    .0737462
             |
     inf_a_s |
```

```
        L12. |  -.0208243   .0472718    -0.44   0.660    -.1134753    .0718268
             |
       after |  -.6552752   .4601981    -1.42   0.154    -1.557247    .2466966
  _Iyear_1994 |    .132265   .5163486     0.26   0.798    -.8797598     1.14429
  _Iyear_1995 |   .0526487   .5421019     0.10   0.923    -1.009851    1.115149
  _Iyear_1996 |  -.0529808   .4026701    -0.13   0.895    -.8421997    .7362381
  _Iyear_1997 |   .2241468   .3563067     0.63   0.529    -.4742016    .9224951
  _Iyear_1998 |   .4815466   .3753262     1.28   0.199    -.2540792    1.217172
  _Iyear_1999 |   .0829931   .2570684     0.32   0.747    -.4208518     .586838
  _Iyear_2000 |   .0441149   .1431534     0.31   0.758    -.2364606    .3246905
  _Iyear_2001 |  -.0439393   .1711787    -0.26   0.797    -.3794433    .2915647
  _Iyear_2002 |  -.0513015   .0997062    -0.51   0.607    -.2467219     .144119
  _Iyear_2003 |  -.2034887    .083622    -2.43   0.015    -.3673849   -.0395925
  _Iyear_2004 |  -.0472262   .0840784    -0.56   0.574    -.2120169    .1175645
  _Iyear_2005 |  -.0939503   .0924143    -1.02   0.309    -.2750789    .0871784
  _Iyear_2006 |   -.181795   .1189085    -1.53   0.126    -.4148514    .0512613
  _Iyear_2007 |  -.1402084   .1814569    -0.77   0.440    -.4958573    .2154406
------------------------------------------------------------------------------
Underidentification test (Kleibergen-Paap rk LM statistic):            226.548
                                                   Chi-sq(74) P-val =   0.0000
------------------------------------------------------------------------------
Weak identification test (Kleibergen-Paap rk Wald F statistic):          3.504
Stock-Yogo weak ID test critical values:                       <not available>
------------------------------------------------------------------------------
Hansen J statistic (overidentification test of all instruments):        80.757
                                                   Chi-sq(73) P-val =   0.2497
-endog- option:
Endogeneity test of endogenous regressors:                               6.167
                                                   Chi-sq(1) P-val =    0.0130
Regressors tested:    after_switch
------------------------------------------------------------------------------
```

<u>RESERVES GROWTH</u>

```
xtivreg2 r l.r after _Iyear_* (e_inf gap der dres after_switch e_inf_a gap_a der_a
dres_a e_inf_s gap_s der_s dres_s e_inf_a_s gap_a_s der_a_s dres_a_s = l3.inf l3.gap
l3.der l3.dres l6.inf l6.gap l6.der l6.dres l9.inf l9.gap l9.der l9.dres l12.inf
l12.gap l12.der l12.dres l3.inf_a l3.inf_s l3.inf_a_s l3.gap_a l3.gap_s l3.gap_a_s
l3.der_a l3.der_s l3.der_a_s l3.dres_a l3.dres_s l3.dres_a_s l6.inf_a l6.inf_s
l6.inf_a_s l6.gap_a l6.gap_s l6.gap_a_s l6.der_a l6.der_s l6.der_a_s l6.dres_a
l6.dres_s l6.dres_a_s l9.inf_a l9.inf_s l9.inf_a_s l9.gap_a l9.gap_s l9.gap_a_s
l9.der_a l9.der_s l9.der_a_s l9.dres_a l9.dres_s l9.dres_a_s l12.inf_a l12.inf_s
l12.inf_a_s l12.gap_a l12.gap_s l12.gap_a_s l12.der_a l12.der_s l12.der_a_s
l12.dres_a l12.dres_s l12.dres_a_s l15.inf_a l15.inf_s l15.inf_a_s l15.gap_a
l15.gap_s l15.gap_a_s l15.der_a l15.der_s l15.der_a_s l15.dres_a l15.dres_s
l15.dres_a_s l18.inf_a l18.inf_s l18.inf_a_s l18.gap_a l18.gap_s l18.gap_a_s
l18.der_a l18.der_s l18.der_a_s l18.dres_a l18.dres_s l18.dres_a_s l21.inf_a
l21.inf_s l21.inf_a_s l21.gap_a l21.gap_s l21.gap_a_s l21.der_a l21.der_s l21.der_a_s
l21.dres_a l21.dres_s l21.dres_a_s l24.inf_a l24.inf_s l24.inf_a_s l24.gap_a
l24.gap_s l24.gap_a_s l24.der_a l24.der_s l24.der_a_s l24.dres_a l24.dres_s
l24.dres_a_s dc100 l.dc100 ccg l.ccg nfa l.nfa), fe endog(after_switch) cue robust

FIXED EFFECTS ESTIMATION
------------------------
Number of groups =       18                 Obs per group: min =        41
                                                           avg =     136.2
                                                           max =       180

CUE estimation
--------------

Estimates efficient for arbitrary heteroskedasticity and autocorrelation
Statistics robust to heteroskedasticity and autocorrelation
  kernel=Bartlett; bandwidth=     1
  time variable (t):  .
  group variable (i): country

                                                      Number of obs =     2452
                                                      F( 33,  2405) =  1244.07
                                                      Prob > F      =   0.0000
Total (centered) SS     =  99242.51041                Centered R2   =   0.7580
Total (uncentered) SS   =  99242.51041                Uncentered R2 =   0.7580
Residual SS             =   24020.1389                Root MSE      =    3.141

------------------------------------------------------------------------------
             |               Robust
           r |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       e_inf |   .1674617   .0593858     2.82   0.005     .0510677    .2838558
         gap |   .0885429   .0269093     3.29   0.001     .0358016    .1412842
         der |  -.0013716   .0175316    -0.08   0.938    -.0357328    .0329896
        dres |  -.0386779   .0101854    -3.80   0.000    -.0586409   -.0187149
after_switch |   1.992909   .5232932     3.81   0.000      .967273    3.018544
     e_inf_a |  -.1513319   .0508437    -2.98   0.003    -.2509836   -.0516801
```

```
       gap_a |  -.0592448   .0294365    -2.01   0.044    -.1169393   -.0015503
       der_a |   .0159584   .0207085     0.77   0.441    -.0246295    .0565463
      dres_a |   .0438545   .0106117     4.13   0.000     .023056      .064653
     e_inf_s |  -.1269311   .0667783    -1.90   0.057    -.2578141    .0039519
       gap_s |   .1297136   .0387916     3.34   0.001     .0536835    .2057436
       der_s |   .0228311   .0224871     1.02   0.310    -.0212427    .0669049
      dres_s |   .0398755   .0120994     3.30   0.001     .0161611     .06359
   e_inf_a_s |   .0308215   .0637418     0.48   0.629    -.0941101    .1557531
     gap_a_s |  -.1443775   .0386089    -3.74   0.000    -.2200496   -.0687053
     der_a_s |  -.0255862   .0255559    -1.00   0.317    -.0756749    .0245025
    dres_a_s |  -.0469041   .0127117    -3.69   0.000    -.0718187   -.0219896
           r |
         L1. |    .969786   .0114535    84.67   0.000     .9473376    .9922344
       after |   -1.39131   .3561964    -3.91   0.000    -2.089442   -.6931777
 _Iyear_1994 |   .0283532   .4714565     0.06   0.952    -.8956846    .9523909
 _Iyear_1995 |  -.3362268   .4888693    -0.69   0.492    -1.294393    .6219395
 _Iyear_1996 |  -.4434084   .3721019    -1.19   0.233    -1.172715    .2858978
 _Iyear_1997 |  -.1602535   .3000475    -0.53   0.593    -.7483358    .4278288
 _Iyear_1998 |   .0056439   .2722193     0.02   0.983    -.5278961     .539184
 _Iyear_1999 |  -.2020056   .1920803    -1.05   0.293    -.5784761    .1744649
 _Iyear_2000 |  -.1975097   .1185606    -1.67   0.096    -.4298843    .0348649
 _Iyear_2001 |  -.2272853   .1297946    -1.75   0.080    -.4816781    .0271075
 _Iyear_2002 |  -.1506014   .0809322    -1.86   0.063    -.3092256    .0080227
 _Iyear_2003 |  -.2012373   .0701514    -2.87   0.004    -.3387315   -.0637432
 _Iyear_2004 |  -.0588007   .0630252    -0.93   0.351    -.1823278    .0647265
 _Iyear_2005 |  -.0738361   .0679721    -1.09   0.277     -.207059    .0593867
 _Iyear_2006 |  -.1277928   .0826168    -1.55   0.122    -.2897186    .0341331
 _Iyear_2007 |  -.1478904   .1120434    -1.32   0.187    -.3674915    .0717107

------------------------------------------------------------------------------
Underidentification test (Kleibergen-Paap rk LM statistic):            181.335
                                                   Chi-sq(102) P-val =  0.0000
------------------------------------------------------------------------------
Weak identification test (Kleibergen-Paap rk Wald F statistic):          3.208
Stock-Yogo weak ID test critical values:                       <not available>
------------------------------------------------------------------------------
Hansen J statistic (overidentification test of all instruments):       114.562
                                                   Chi-sq(101) P-val =  0.2899
-endog- option:
Endogeneity test of endogenous regressors:                               5.734
                                                   Chi-sq(1) P-val =    0.0086
Regressors tested:    after_switch
------------------------------------------------------------------------------
```

<u>NFA to GDP</u>

```
xtivreg2 r l.r nfa nfa_a nfa_s nfa_a_s after  _Iyear_* (e_inf gap der after_switch
e_inf_a gap_a der_a e_inf_s gap_s der_s e_inf_a_s gap_a_s der_a_s = l3.inf l3.gap
l3.der l6.inf l6.gap l6.der l9.inf l9.gap l9.der l12.inf l12.gap l12.der l3.inf_a
l3.inf_s l3.inf_a_s l3.gap_a l3.gap_s l3.gap_a_s l3.der_a l3.der_s l3.der_a_s
l6.inf_a l6.inf_s l6.inf_a_s l6.gap_a l6.gap_s l6.gap_a_s l6.der_a l6.der_s
l6.der_a_s l9.inf_a l9.inf_s l9.inf_a_s l9.gap_a l9.gap_s l9.gap_a_s l9.der_a
l9.der_s l9.der_a_s l12.inf_a l12.inf_s l12.inf_a_s l12.gap_a l12.gap_s l12.gap_a_s
l12.der_a l12.der_s l12.der_a_s l15.inf_a l15.inf_s l15.inf_a_s l15.gap_a l15.gap_s
l15.gap_a_s l15.der_a l15.der_s l15.der_a_s l18.inf_a l18.inf_s l18.inf_a_s l18.gap_a
l18.gap_s l18.gap_a_s l18.der_a l18.der_s l18.der_a_s l21.inf_a l21.inf_s l21.inf_a_s
l21.gap_a l21.gap_s l21.gap_a_s l21.der_a l21.der_s l21.der_a_s l24.inf_a l24.inf_s
l24.inf_a_s l24.gap_a l24.gap_s l24.gap_a_s l24.der_a l24.der_s l24.der_a_s dc100
l.dc100 ccg l.ccg), fe endog(after_switch) cue robust bw(1)

FIXED EFFECTS ESTIMATION
------------------------
Number of groups =        18                    Obs per group: min =        41
                                                               avg =     136.2
                                                               max =       180

CUE estimation
--------------

Estimates efficient for arbitrary heteroskedasticity and autocorrelation
Statistics robust to heteroskedasticity and autocorrelation
  kernel=Bartlett; bandwidth=     1
  time variable (t):  .
  group variable (i): country

                                                      Number of obs =     2452
                                                      F( 33,  2401) =  1039.88
                                                      Prob > F      =   0.0000
Total (centered) SS     =  99242.51041                Centered R2   =   0.7553
Total (uncentered) SS   =  99242.51041                Uncentered R2 =   0.7553
Residual SS             =   24286.0814                Root MSE      =    3.159

------------------------------------------------------------------------------
             |               Robust
           r |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
```

```
       e_inf |  -.0141061   .0621169    -0.23   0.820     -.135853    .1076409
         gap |   .0536146   .0411094     1.30   0.192    -.0269583    .1341876
         der |  -.0578651    .027255    -2.12   0.034    -.1112839   -.0044463
after_switch |   1.648584   1.085824     1.52   0.100    -.4795918     3.77676
     e_inf_a |    .118276   .0547081     2.16   0.031     .0110502    .2255019
       gap_a |  -.0290845   .0432228    -0.67   0.501    -.1137995    .0556306
       der_a |   .1064348   .0338234     3.15   0.002     .0401422    .1727274
     e_inf_s |   .0939065   .0823302     1.14   0.254    -.0674577    .2552707
       gap_s |   .0445108    .052239     0.85   0.394    -.0578758    .1468975
       der_s |   .0480307   .0284629     1.69   0.092    -.0077555     .103817
   e_inf_a_s |  -.2112366   .0721198    -2.93   0.003    -.3525889   -.0698843
     gap_a_s |   -.062316   .0539531    -1.16   0.248    -.1680621    .0434301
     der_a_s |  -.0823177    .036154    -2.28   0.023    -.1531782   -.0114572
           r |
         L1. |     .91239    .022348    40.83   0.000     .8685889    .9561912
         nfa |  -.0059718   .0977674    -0.06   0.951    -.1975925    .1856488
       nfa_a |   .0141338    .092836     0.15   0.879    -.1678215    .1960891
       nfa_s |   .0115406   .1019342     0.11   0.910    -.1882468    .2113281
     nfa_a_s |  -.0239091   .1052692    -0.23   0.820     -.230233    .1824147
       after |  -.6222634   .7108014    -0.88   0.381    -2.015408    .7708817
 _Iyear_1994 |   .5809987   .6471196     0.90   0.369    -.6873323     1.84933
 _Iyear_1995 |   .8353883   .6243122     1.34   0.181    -.3882412    2.059018
 _Iyear_1996 |    .349432   .4852784     0.72   0.471    -.6016962     1.30056
 _Iyear_1997 |   .4086554   .3967321     1.03   0.303    -.3689252    1.186236
 _Iyear_1998 |   .6557616   .3434665     1.91   0.056    -.0174205    1.328944
 _Iyear_1999 |  -.0559234   .2079532    -0.27   0.788    -.4635043    .3516574
 _Iyear_2000 |   .0606224   .1478614     0.41   0.682    -.2291807    .3504255
 _Iyear_2001 |   .0164078   .1696396     0.10   0.923    -.3160797    .3488953
 _Iyear_2002 |   -.174255   .0932936    -1.87   0.062    -.3571071    .0085972
 _Iyear_2003 |  -.2740596   .0872068    -3.14   0.002    -.4449817   -.1031374
 _Iyear_2004 |  -.2446399   .0822991    -2.97   0.003    -.4059432   -.0833367
 _Iyear_2005 |  -.2665909   .0948105    -2.81   0.005     -.452416   -.0807658
 _Iyear_2006 |  -.3747586   .1221032    -3.07   0.002    -.6140765   -.1354406
 _Iyear_2007 |   -.400261   .1829405    -2.19   0.029    -.7588177   -.0417043
------------------------------------------------------------------------------
Underidentification test (Kleibergen-Paap rk LM statistic):            173.018
                                                   Chi-sq(76) P-val =   0.0000
------------------------------------------------------------------------------
Weak identification test (Kleibergen-Paap rk Wald F statistic):          3.344
Stock-Yogo weak ID test critical values:                       <not available>
------------------------------------------------------------------------------
Hansen J statistic (overidentification test of all instruments):        90.832
                                                   Chi-sq(75) P-val =   0.1029
-endog- option:
Endogeneity test of endogenous regressors:                               7.515
                                                    Chi-sq(1) P-val =   0.0061
Regressors tested:    after_switch
------------------------------------------------------------------------------
```

<u>**MONEY GROWTH**</u>

```
xtivreg2 r l.r after  _Iyear_* (e_inf gap der dm2 after_switch e_inf_a gap_a der_a
dm2_a e_inf_s gap_s der_s dm2_s e_inf_a_s gap_a_s der_a_s dm2_a_s = l3.inf l3.gap
l3.der l3.dm2 l6.inf l6.gap l6.der l6.dm2 l9.inf l9.gap l9.der l9.dm2 l12.inf l12.gap
l12.der l12.dm2 l3.inf_a l3.inf_s l3.inf_a_s l3.gap_a l3.gap_s l3.gap_a_s l3.der_a
l3.der_s l3.der_a_s l3.dm2_a l3.dm2_s l3.dm2_a_s l6.inf_a l6.inf_s l6.inf_a_s
l6.gap_a l6.gap_s l6.gap_a_s l6.der_a l6.der_s l6.der_a_s l6.dm2_a l6.dm2_s
l6.dm2_a_s l9.inf_a l9.inf_s l9.inf_a_s l9.gap_a l9.gap_s l9.gap_a_s l9.der_a
l9.der_s l9.der_a_s l9.dm2_a l9.dm2_s l9.dm2_a_s l12.inf_a l12.inf_s l12.inf_a_s
l12.gap_a l12.gap_s l12.gap_a_s l12.der_a l12.der_s l12.der_a_s l12.dm2_a l12.dm2_s
l12.dm2_a_s l15.inf_a l15.inf_s l15.inf_a_s l15.gap_a l15.gap_s l15.gap_a_s l15.der_a
l15.der_s l15.der_a_s l15.dm2_a l15.dm2_s l15.dm2_a_s l18.inf_a l18.inf_s l18.inf_a_s
l18.gap_a l18.gap_s l18.gap_a_s l18.der_a l18.der_s l18.der_a_s l18.dm2_a l18.dm2_s
l18.dm2_a_s l21.inf_a l21.inf_s l21.inf_a_s l21.gap_a l21.gap_s l21.gap_a_s l21.der_a
l21.der_s l21.der_a_s l21.dm2_a l21.dm2_s l21.dm2_a_s l24.inf_a l24.inf_s l24.inf_a_s
l24.gap_a l24.gap_s l24.gap_a_s l24.der_a l24.der_s l24.der_a_s l24.dm2_a l24.dm2_s
l24.dm2_a_s dc100 l.dc100 ccg l.ccg nfa l.nfa), fe endog(after_switch) cue robust
bw(1)

FIXED EFFECTS ESTIMATION
------------------------
Number of groups =        18                    Obs per group: min =        41
                                                               avg =     127.6
                                                               max =       180

CUE estimation
--------------

Estimates efficient for arbitrary heteroskedasticity and autocorrelation
Statistics robust to heteroskedasticity and autocorrelation
  kernel=Bartlett; bandwidth=     1
  time variable (t):  .
  group variable (i): country
```

		Number of obs =	2297
		F(33, 2246) =	1099.59
		Prob > F =	0.0000
Total (centered) SS =	96688.54277	Centered R2 =	0.7554
Total (uncentered) SS =	96688.54277	Uncentered R2 =	0.7554
Residual SS =	23650.71604	Root MSE =	3.221

r	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
e_inf	.0251985	.0583834	0.43	0.666	-.0892309	.1396279
gap	.0692428	.0474402	1.46	0.144	-.0237383	.1622239
der	-.1110365	.0496666	-2.24	0.025	-.2083812	-.0136919
dm2	-.0719158	.0332678	-1.16	0.131	-.1371194	-.0067121
after_switch	3.242678	1.033742	3.14	0.002	1.216581	5.268775
e_inf_a	.0232634	.0432436	0.54	0.591	-.0614925	.1080194
gap_a	-.0465438	.0489274	-0.95	0.341	-.1424397	.0493521
der_a	.1268657	.0508038	2.50	0.013	.0272921	.2264393
dm2_a	.0768671	.034176	2.25	0.025	.0098835	.1438508
e_inf_s	.0027383	.0678933	0.04	0.968	-.1303301	.1358067
gap_s	.0412204	.0581355	0.71	0.478	-.072723	.1551638
der_s	.1046936	.050463	2.07	0.038	.0057881	.2035992
dm2_s	.0820515	.035473	2.31	0.021	.0125257	.1515774
e_inf_a_s	-.0503366	.0596022	-0.84	0.398	-.1671548	.0664816
gap_a_s	-.0566336	.0596451	-0.95	0.342	-.1735359	.0602687
der_a_s	-.1044122	.0521626	-2.00	0.045	-.2066491	-.0021753
dm2_a_s	-.0724188	.0369583	-1.96	0.050	-.1448557	.0000181
r						
L1.	.962427	.0171398	56.15	0.000	.9288336	.9960204
after	-2.567001	.936698	-3.30	0.001	-4.926888	-1.255099
_Iyear_1994	.4116847	.4901422	0.84	0.401	-.5489765	1.372346
_Iyear_1995	.1843655	.4857189	0.38	0.704	-.767626	1.136357
_Iyear_1996	-.2034662	.4031923	-0.50	0.614	-.9937085	.5867761
_Iyear_1997	.0001176	.3413668	0.00	1.000	-.668949	.6691841
_Iyear_1998	.0851775	.3049933	0.28	0.780	-.5125984	.6829534
_Iyear_1999	-.5618891	.2154762	-2.61	0.009	-.9842147	-.1395635
_Iyear_2000	-.1105133	.1440825	-0.77	0.443	-.3929099	.1718832
_Iyear_2001	-.1611231	.1256749	-1.28	0.200	-.4074414	.0851952
_Iyear_2002	-.1510089	.0828991	-1.82	0.069	-.3134882	.0114704
_Iyear_2003	-.2116441	.0751998	-2.81	0.005	-.359033	-.0642552
_Iyear_2004	-.0769201	.0713052	-1.08	0.281	-.2166757	.0628355
_Iyear_2005	-.1244375	.0768399	-1.62	0.105	-.2750408	.0261659
_Iyear_2006	-.204704	.097006	-2.11	0.035	-.3948324	-.0145757
_Iyear_2007	-.2072578	.1462973	-1.42	0.157	-.4939952	.0794796

Underidentification test (Kleibergen-Paap rk LM statistic): 289.690
Chi-sq(102) P-val = 0.0000

Weak identification test (Kleibergen-Paap rk Wald F statistic): 3.599
Stock-Yogo weak ID test critical values: <not available>

Hansen J statistic (overidentification test of all instruments): 102.503
Chi-sq(101) P-val = 0.4395
-endog- option:
Endogeneity test of endogenous regressors: 3.033
Chi-sq(1) P-val = 0.0816
Regressors tested: after_switch

A4.4. Markov-switching regressions printouts

BRAZIL

```
---------- EM algorithm converged  -----------------

EQ( 1) MSIAH(2)-VAR(2) model of (R,INF,GAP,DER)
       Estimation sample: 1997 (3) - 2009 (11)

no. obs. per eq. :        153    in the system :        612
no. parameters   :         94    linear system :         46
no. restrictions :         46
no. nuisance p.  :          2

log-likelihood   : -1018.6374    linear system : -1324.4120

AIC criterion    :    14.5443    linear system :    17.9139
HQ  criterion    :    15.3006    linear system :    18.2840
SC  criterion    :    16.4061    linear system :    18.8250

LR linearity test:   611.5492    Chi(46) =[0.0000] **  Chi(48)=[0.0000] **
DAVIES=[0.0000] **


---------- matrix of transition probabilities ------

          Regime 1  Regime 2
Regime 1    0.9280    0.0720
Regime 2    0.3055    0.6945


---------- regime properties ----------------------

              nObs     Prob.  Duration
Regime 1     123.3    0.8092     13.88
Regime 2      29.7    0.1908      3.27

---------- coefficients ---------------------------

Regime 1
                         R          INF          GAP          DER
Const(Reg.1)   0.033154   0.168361  -0.553003   1.534342
R_1            1.512062   0.069416   0.335569   1.003813
R_2           -0.525981  -0.058649  -0.220665  -0.783839
INF_1          0.175150   1.437353   0.074139  -3.569524
INF_2         -0.151178  -0.498899  -0.294670   2.715308
GAP_1          0.002934   0.011779   0.923980  -0.086204
GAP_2          0.023590  -0.000248  -0.095653   0.030469
DER_1          0.000792   0.008877  -0.058029   1.043764
DER_2         -0.000830  -0.002336   0.042139  -0.094434
  SE (Reg.1)   0.248176   0.305073   1.926828   6.422228

Regime 2
                         R          INF          GAP          DER
Const(Reg.2)  14.862039   0.115156  12.522609  17.386301
R_1            0.929438   0.000072  -0.198798  -0.883794
R_2           -0.330997  -0.012328  -0.141222   0.823676
INF_1         -0.676104   1.469799   1.837244   7.341208
INF_2          0.196058  -0.485726  -2.223535  -8.580672
GAP_1          0.174028   0.026013   0.083472  -1.620546
GAP_2          0.400754  -0.003094  -0.440230   1.384143
DER_1          0.103100   0.014683  -0.079141   0.660120
DER_2         -0.114843   0.005402  -0.015969  -0.066849
  SE (Reg.2)   4.399023   0.524573   2.035960  12.752958

---------- contemporaneous correlation -------------

Regime 1
             R        INF        GAP        DER
R       1.0000    -0.0863     0.0518     0.1825
INF    -0.0863     1.0000     0.1560     0.0816
GAP     0.0518     0.1560     1.0000     0.0053
DER     0.1825     0.0816     0.0053     1.0000

Regime 2
             R        INF        GAP        DER
R       1.0000     0.0447    -0.4031     0.0449
INF     0.0447     1.0000    -0.1612     0.2965
GAP    -0.4031    -0.1612     1.0000    -0.1629
DER     0.0449     0.2965    -0.1629     1.0000

---------- standard errors -------------------------

Regime 0
                         R          INF          GAP          DER
```

```
Const(Reg.1)     0.0989     0.1204     0.7558     2.5523
R_1              0.0354     0.0453     0.2726     1.0342
R_2              0.0298     0.0384     0.2293     0.8772
INF_1            0.0547     0.0665     0.4172     1.4799
INF_2            0.0505     0.0612     0.3841     1.3336
GAP_1            0.0084     0.0103     0.0648     0.2166
GAP_2            0.0087     0.0107     0.0672     0.2255
DER_1            0.0030     0.0036     0.0229     0.0828
DER_2            0.0031     0.0039     0.0241     0.0865

Regime 1
                      R        INF        GAP        DER
Const(Reg.2)     4.8523     0.5705     2.2252    13.8530
R_1              0.1679     0.0199     0.0772     0.4846
R_2              0.1667     0.0197     0.0766     0.4786
INF_1            2.1196     0.2430     0.9518     5.8957
INF_2            2.2424     0.2571     1.0062     6.2375
GAP_1            0.5176     0.0615     0.2391     1.4850
GAP_2            0.5321     0.0627     0.2461     1.5184
DER_1            0.0814     0.0095     0.0371     0.2297
DER_2            0.0741     0.0088     0.0342     0.2192

---------- t - values -----------------------------

Regime 0
                     R        INF       GAP       DER
Const(Reg.1)    0.3352     1.3983   -0.7316    0.6012
R_1            42.7170     1.5328    1.2310    0.9707
R_2           -17.6645    -1.5266   -0.9624   -0.8935
INF_1           3.2013    21.6214    0.1777   -2.4120
INF_2          -2.9925    -8.1576   -0.7671    2.0360
GAP_1           0.3513     1.1462   14.2687   -0.3981
GAP_2           2.7239    -0.0233   -1.4240    0.1351
DER_1           0.2663     2.4326   -2.5373   12.6130
DER_2          -0.2642    -0.6039    1.7464   -1.0922

Regime 1
                     R        INF       GAP       DER
Const(Reg.2)    3.0629     0.2018    5.6275    1.2551
R_1             5.5343     0.0036   -2.5753   -1.8236
R_2            -1.9855    -0.6255   -1.8445    1.7211
INF_1          -0.3190     6.0495    1.9304    1.2452
INF_2           0.0874    -1.8891   -2.2099   -1.3757
GAP_1           0.3362     0.4232    0.3492   -1.0913
GAP_2           0.7532    -0.0493   -1.7887    0.9116
DER_1           1.2666     1.5475   -2.1311    2.8741
DER_2          -1.5504     0.6143   -0.4667   -0.3049

IsConverged=1

---------- regime classification -------------------

Regime 1
1997:3 - 1997:4 [0.9393]
1997:7 - 1997:9 [0.9725]
1998:2 - 1998:2 [0.9618]
1998:4 - 1998:8 [0.9877]
1999:6 - 1999:6 [0.6554]
1999:8 - 1999:12 [0.9958]
2000:2 - 2002:8 [0.9900]
2003:3 - 2003:7 [0.9934]
2003:12 - 2009:6 [0.9998]
2009:8 - 2009:11 [1.0000]

Regime 2
1997:5 - 1997:6 [0.9999]
1997:10 - 1998:1 [0.9998]
1998:3 - 1998:3 [1.0000]
1998:9 - 1999:5 [1.0000]
1999:7 - 1999:7 [1.0000]
2000:1 - 2000:1 [1.0000]
2002:9 - 2003:2 [0.9712]
2003:8 - 2003:11 [0.9683]
2009:7 - 2009:7 [1.0000]
```

CHILE

```
---------- EM algorithm converged  -----------------

EQ( 1) MSIAH(2)-VAR(4) model of (R,INF,GAP,DER)
       Estimation sample: 1993 (8) - 2009 (9)

no. obs. per eq. :        194    in the system :        776
no. parameters   :        158    linear system :         78
no. restrictions :         78
no. nuisance p.  :          2
```

```
log-likelihood   : -1398.0468    linear system : -1697.4480

AIC criterion    :    16.0417    linear system :    18.3036
HQ  criterion    :    17.1194    linear system :    18.8356
SC  criterion    :    18.7032    linear system :    19.6175

LR linearity test:   598.8023    Chi(78) =[0.0000] **  Chi(80)=[0.0000] **
DAVIES=[0.0000] **


---------- matrix of transition probabilities ------

          Regime 1  Regime 2
Regime 1    0.9789    0.0211
Regime 2    0.0307    0.9693


---------- regime properties ---------------------

              nObs     Prob.  Duration
Regime 1      97.0    0.5923     47.38
Regime 2      97.0    0.4077     32.60

---------- coefficients ---------------------------

Regime 1
                        R         INF         GAP         DER
Const(Reg.1)   0.162446    0.146435   -1.423734   -1.899264
R_1            1.295433    0.073070    0.668934    1.689308
R_2           -0.338370    0.007786    0.246740   -1.038803
R_3            0.012893    0.005382   -0.600803   -0.961447
R_4           -0.036513   -0.044700   -0.088817    0.819377
INF_1          0.062332    1.433005    1.345915   -0.748706
INF_2          0.124440   -0.677350   -0.089926    0.774987
INF_3         -0.116034    0.458350   -0.396762   -0.046729
INF_4         -0.039266   -0.309833   -0.725640   -0.044634
GAP_1          0.000698    0.009022   -0.097964    0.058513
GAP_2         -0.001666    0.014211   -0.206828   -0.064805
GAP_3         -0.005072    0.026684   -0.033524   -0.061558
GAP_4          0.000379    0.007014   -0.088040    0.042092
DER_1          0.002668    0.023957   -0.064619    0.930231
DER_2         -0.011314   -0.038696   -0.039908   -0.105443
DER_3          0.004187    0.001614   -0.023827    0.163747
DER_4         -0.002651    0.010685    0.064647   -0.120503
  SE (Reg.1)   0.245623    0.373258    3.737806    4.303944

Regime 2
                        R         INF         GAP         DER
Const(Reg.2)   4.078628    0.039574    3.010390    0.507673
R_1            0.290697   -0.005983    0.027774    0.052490
R_2           -0.138903    0.014418    0.024721    0.025464
R_3           -0.022474   -0.005021   -0.297730    0.034019
R_4           -0.053854    0.015943   -0.121018   -0.066913
INF_1          6.143691    0.778663    0.083658    0.013349
INF_2         -9.183264    0.441691   -0.081504   -0.197786
INF_3          4.369789   -0.305859   -0.219648    0.093126
INF_4         -0.098668    0.026040    0.522694   -0.016148
GAP_1          0.354301    0.010630   -0.197267   -0.087983
GAP_2         -0.041634    0.009751    0.084325   -0.002281
GAP_3          0.269890    0.008609    0.030634    0.028090
GAP_4          0.208652    0.001724    0.112954    0.054772
DER_1          0.111242   -0.033027   -0.047554    1.024177
DER_2         -0.091054    0.000689    0.149937   -0.029211
DER_3         -0.405194    0.021119   -0.067711   -0.277449
DER_4          0.435177    0.008444   -0.059334    0.224412
  SE (Reg.2)   3.705405    0.437924    3.318219    2.267827

---------- contemporaneous correlation -------------

Regime 1
             R         INF         GAP         DER
R       1.0000      0.0733      0.0914      0.0806
INF     0.0733      1.0000      0.0573      0.1339
GAP     0.0914      0.0573      1.0000      0.0589
DER     0.0806      0.1339      0.0589      1.0000

Regime 2
             R         INF         GAP         DER
R       1.0000     -0.1225     -0.1858     -0.0797
INF    -0.1225      1.0000      0.0918     -0.1577
GAP    -0.1858      0.0918      1.0000     -0.1183
DER    -0.0797     -0.1577     -0.1183      1.0000

---------- standard errors ------------------------
```

Regime 0

	R	INF	GAP	DER
Const(Reg.1)	0.0727	0.1104	1.1057	1.2734
R_1	0.0739	0.1109	1.1062	1.2736
R_2	0.0764	0.1155	1.1533	1.3278
R_3	0.0382	0.0580	0.5805	0.6685
R_4	0.0378	0.0574	0.5745	0.6615
INF_1	0.0635	0.0965	0.9660	1.1124
INF_2	0.1123	0.1707	1.7085	1.9674
INF_3	0.1107	0.1683	1.6839	1.9391
INF_4	0.0648	0.0984	0.9852	1.1345
GAP_1	0.0066	0.0100	0.1005	0.1157
GAP_2	0.0066	0.0101	0.1009	0.1162
GAP_3	0.0066	0.0101	0.1009	0.1162
GAP_4	0.0067	0.0102	0.1019	0.1173
DER_1	0.0059	0.0089	0.0892	0.1028
DER_2	0.0080	0.0121	0.1213	0.1397
DER_3	0.0085	0.0129	0.1291	0.1487
DER_4	0.0064	0.0097	0.0970	0.1117

Regime 1

	R	INF	GAP	DER
Const(Reg.2)	1.2639	0.1493	1.1314	0.7732
R_1	0.0949	0.0112	0.0849	0.0581
R_2	0.0926	0.0109	0.0828	0.0566
R_3	0.0808	0.0095	0.0723	0.0494
R_4	0.0771	0.0091	0.0690	0.0472
INF_1	0.8691	0.1027	0.7780	0.5318
INF_2	1.4419	0.1702	1.2892	0.8816
INF_3	1.5255	0.1802	1.3650	0.9332
INF_4	0.9589	0.1133	0.8583	0.5866
GAP_1	0.1068	0.0126	0.0955	0.0653
GAP_2	0.1107	0.0130	0.0987	0.0675
GAP_3	0.1078	0.0127	0.0965	0.0659
GAP_4	0.1087	0.0128	0.0973	0.0665
DER_1	0.1635	0.0193	0.1459	0.0997
DER_2	0.2298	0.0270	0.2048	0.1400
DER_3	0.2324	0.0274	0.2079	0.1421
DER_4	0.1607	0.0190	0.1438	0.0983

---------- t - values ------------------------------

Regime 0

	R	INF	GAP	DER
Const(Reg.1)	2.2353	1.3259	-1.2876	-1.4915
R_1	17.5358	0.6587	0.6047	1.3264
R_2	-4.4291	0.0674	0.2139	-0.7823
R_3	0.3373	0.0928	-1.0350	-1.4381
R_4	-0.9664	-0.7790	-0.1546	1.2386
INF_1	0.9815	14.8473	1.3932	-0.6730
INF_2	1.1080	-3.9674	-0.0526	0.3939
INF_3	-1.0482	2.7242	-0.2356	-0.0241
INF_4	-0.6063	-3.1483	-0.7365	-0.0393
GAP_1	0.1056	0.8988	-0.9746	0.5056
GAP_2	-0.2511	1.4100	-2.0494	-0.5577
GAP_3	-0.7649	2.6481	-0.3322	-0.5298
GAP_4	0.0566	0.6895	-0.8644	0.3589
DER_1	0.4548	2.6883	-0.7241	9.0533
DER_2	-1.4189	-3.1943	-0.3290	-0.7549
DER_3	0.4935	0.1252	-0.1846	1.1015
DER_4	-0.4160	1.1033	0.6666	-1.0792

Regime 1

	R	INF	GAP	DER
Const(Reg.2)	3.2270	0.2650	2.6609	0.6566
R_1	3.0635	-0.5336	0.3270	0.9040
R_2	-1.5007	1.3200	0.2987	0.4502
R_3	-0.2781	-0.5261	-4.1167	0.6883
R_4	-0.6984	1.7496	-1.7526	-1.4179
INF_1	7.0690	7.5828	0.1075	0.0251
INF_2	-6.3687	2.5945	-0.0632	-0.2243
INF_3	2.8645	-1.6973	-0.1609	0.0998
INF_4	-0.1029	0.2299	0.6090	-0.0275
GAP_1	3.3183	0.8435	-2.0658	-1.3482
GAP_2	-0.3762	0.7485	0.8545	-0.0338
GAP_3	2.5038	0.6762	0.3176	0.4261
GAP_4	1.9189	0.1344	1.1614	0.8242
DER_1	0.6804	-1.7154	-0.3260	10.2735
DER_2	-0.3963	0.0255	0.7322	-0.2087
DER_3	-1.7434	0.7697	-0.3256	-1.9526
DER_4	2.7086	0.4451	-0.4126	2.2838

IsConverged=1

---------- regime classification -------------------

Regime 1

```
1994:12 - 1994:12 [0.9991]
2001:9 - 2009:2 [1.0000]
2009:4 - 2009:9 [0.9972]

Regime 2
1993:8 - 1994:11 [1.0000]
1995:1 - 2001:8 [1.0000]
2009:3 - 2009:3 [1.0000]
```

COLOMBIA

```
---------- EM algorithm converged  -----------------

EQ( 1) MSIAH(2)-VAR(1) model of (R,INF,GAP,DER)
       Estimation sample: 1995 (4) - 2005 (9)

no. obs. per eq. :        126    in the system :        504
no. parameters   :         62    linear system :         30
no. restrictions :         30
no. nuisance p.  :          2

log-likelihood   :  -998.5176    linear system : -1152.3439

AIC criterion    :    16.8336    linear system :    18.7674
HQ  criterion    :    17.4006    linear system :    19.0417
SC  criterion    :    18.2292    linear system :    19.4427

LR linearity test:   307.6526    Chi(30) =[0.0000] **  Chi(32)=[0.0000] **
DAVIES=[0.0000] **


---------- matrix of transition probabilities ------

          Regime 1  Regime 2
Regime 1    0.9835    0.0165
Regime 2    0.0360    0.9640


---------- regime properties ----------------------

              nObs     Prob.  Duration
Regime 1      68.6    0.6856     60.54
Regime 2      57.4    0.3144     27.76

---------- coefficients ---------------------------

Regime 1
                      R         INF         GAP         DER
Const(Reg.1)  -0.432691    0.862899    3.363104   -0.784719
R_1            0.827747   -0.016555   -0.018561   -0.323775
INF_1          0.258493    0.869323   -0.448843    0.490376
GAP_1          0.009349    0.018955    0.385327   -0.073296
DER_1         -0.001463    0.009499    0.003895    0.945245
  SE (Reg.1)   0.374601    0.274588    5.910542    3.650831

Regime 2
                      R         INF         GAP         DER
Const(Reg.2)  -3.372419    0.081117   -4.634652    5.807489
R_1            0.532668   -0.001506    0.023793   -0.019850
INF_1          0.801896    0.989202    0.203021   -0.232067
GAP_1          0.169324    0.008189    0.469286    0.084054
DER_1          0.147971    0.002653    0.042153    0.895744
  SE (Reg.2)   4.805365    0.523741    6.270731    3.025401

---------- contemporaneous correlation -------------

Regime 1
            R       INF       GAP       DER
R      1.0000    0.1150    0.0708   -0.2593
INF    0.1150    1.0000    0.2256    0.0722
GAP    0.0708    0.2256    1.0000    0.0761
DER   -0.2593    0.0722    0.0761    1.0000

Regime 2
            R       INF       GAP       DER
R      1.0000   -0.0584   -0.0856    0.0073
INF   -0.0584    1.0000    0.1168    0.0611
GAP   -0.0856    0.1168    1.0000    0.2042
DER    0.0073    0.0611    0.2042    1.0000

---------- standard errors -------------------------

Regime 0
                      R         INF         GAP         DER
Const(Reg.1)     0.3192      0.2386      5.0036      3.0947
```

```
R_1              0.0429     0.0322     0.6730     0.4167
INF_1            0.0970     0.0730     1.5225     0.9418
GAP_1            0.0074     0.0052     0.1109     0.0697
DER_1            0.0061     0.0045     0.0954     0.0591

Regime 1
                      R        INF        GAP        DER
Const(Reg.2)     4.0947     0.4480     5.3997     2.6033
R_1              0.0996     0.0109     0.1302     0.0630
INF_1            0.2563     0.0280     0.3363     0.1619
GAP_1            0.0980     0.0107     0.1285     0.0618
DER_1            0.0837     0.0091     0.1097     0.0528

---------- t - values -----------------------------

Regime 0
                     R       INF       GAP       DER
Const(Reg.1)   -1.3556    3.6166    0.6721   -0.2536
R_1            19.3081   -0.5149   -0.0276   -0.7769
INF_1           2.6654   11.9135   -0.2948    0.5207
GAP_1           1.2657    3.6741    3.4753   -1.0519
DER_1          -0.2401    2.1253    0.0408   15.9856

Regime 1
                     R       INF       GAP       DER
Const(Reg.2)   -0.8236    0.1811   -0.8583    2.2308
R_1             5.3455   -0.1387    0.1827   -0.3150
INF_1           3.1282   35.3161    0.6037   -1.4332
GAP_1           1.7271    0.7635    3.6514    1.3595
DER_1           1.7670    0.2902    0.3841   16.9688

IsConverged=1

---------- regime classification -------------------

Regime 1
1999:3 - 1999:5 [0.9956]
2000:4 - 2005:9 [0.9944]

Regime 2
1995:4 - 1999:2 [1.0000]
1999:6 - 2000:3 [0.9983]
```

<u>**CZECH**</u>

```
---------- EM algorithm converged  -----------------

EQ( 1) MSIAH(2)-VAR(2) model of (R,INF,GAP,DER)
       Estimation sample: 1994 (3) - 2009 (10)

no. obs. per eq. :        188    in the system :        752
no. parameters   :         94    linear system :         46
no. restrictions :         46
no. nuisance p.  :          2

log-likelihood   : -1256.5186    linear system : -1515.7929

AIC criterion    :    14.3672    linear system :    16.6148
HQ  criterion    :    15.0229    linear system :    16.9357
SC  criterion    :    15.9854    linear system :    17.4067

LR linearity test:   518.5487    Chi(46) =[0.0000] **  Chi(48)=[0.0000] **
DAVIES=[0.0000] **


---------- matrix of transition probabilities ------

                  Regime 1     Regime 2
Regime 1             1.000   5.440e-008
Regime 2           0.01638       0.9836


---------- regime properties ----------------------

              nObs      Prob.  Duration
Regime 1     127.9    1.000018383601.56
Regime 2      60.1    0.0000     61.05

---------- coefficients ----------------------------

Regime 1
                      R        INF        GAP        DER
Const(Reg.1)   0.052035   0.122742  -4.368178  -1.328240
R_1            1.212877   0.191626   7.183373   0.039800
R_2           -0.252567  -0.177182  -6.252171   0.307170
INF_1          0.161700   1.255024   1.636866  -0.517747
```

	R	INF	GAP	DER
INF_2	-0.140667	-0.315635	-1.506281	0.373422
GAP_1	0.001214	-0.001616	0.227115	0.015018
GAP_2	-0.004002	0.010767	-0.299982	-0.073323
DER_1	0.002568	0.006965	-0.168028	0.985742
DER_2	-0.002163	-0.003791	-0.084143	-0.102940
SE (Reg.1)	0.147055	0.463423	6.152891	3.365823

Regime 2

	R	INF	GAP	DER
Const(Reg.2)	3.048601	1.144398	-0.256085	15.004977
R_1	0.944082	0.079930	-0.146227	-0.048885
R_2	-0.249077	-0.080944	-0.166032	0.071670
INF_1	-0.160763	1.109506	-0.306908	-1.029129
INF_2	0.232093	-0.252258	0.757042	-0.693919
GAP_1	0.016322	0.000903	0.235262	-0.053232
GAP_2	0.039993	-0.001198	-0.183919	0.026776
DER_1	0.159914	0.005679	0.112372	0.524718
DER_2	-0.092651	0.041681	0.140360	0.497614
SE (Reg.2)	1.635872	0.646400	4.903218	2.725536

---------- contemporaneous correlation -------------

Regime 1

	R	INF	GAP	DER
R	1.0000	0.2017	0.2521	-0.2012
INF	0.2017	1.0000	0.2793	-0.1796
GAP	0.2521	0.2793	1.0000	-0.1874
DER	-0.2012	-0.1796	-0.1874	1.0000

Regime 2

	R	INF	GAP	DER
R	1.0000	-0.2663	0.1256	0.1459
INF	-0.2663	1.0000	-0.0404	0.0656
GAP	0.1256	-0.0404	1.0000	0.0395
DER	0.1459	0.0656	0.0395	1.0000

---------- standard errors ------------------------

Regime 0

	R	INF	GAP	DER
Const(Reg.1)	0.0394	0.1228	1.6288	0.8936
R_1	0.0837	0.2622	3.4780	1.9050
R_2	0.0792	0.2483	3.2930	1.8032
INF_1	0.0284	0.0892	1.1839	0.6478
INF_2	0.0283	0.0890	1.1817	0.6467
GAP_1	0.0022	0.0068	0.0904	0.0495
GAP_2	0.0021	0.0065	0.0860	0.0471
DER_1	0.0039	0.0123	0.1629	0.0892
DER_2	0.0039	0.0122	0.1623	0.0889

Regime 1

	R	INF	GAP	DER
Const(Reg.2)	1.9346	0.7622	5.7700	3.1875
R_1	0.1270	0.0502	0.3804	0.2113
R_2	0.1245	0.0492	0.3730	0.2073
INF_1	0.3203	0.1265	0.9594	0.5328
INF_2	0.3351	0.1324	1.0042	0.5581
GAP_1	0.0417	0.0165	0.1250	0.0695
GAP_2	0.0412	0.0163	0.1233	0.0685
DER_1	0.0689	0.0272	0.2064	0.1147
DER_2	0.0730	0.0288	0.2187	0.1216

---------- t - values -----------------------------

Regime 0

	R	INF	GAP	DER
Const(Reg.1)	1.3212	0.9999	-2.6819	-1.4865
R_1	14.4915	0.7308	2.0653	0.0209
R_2	-3.1906	-0.7137	-1.8986	0.1703
INF_1	5.7026	14.0713	1.3826	-0.7992
INF_2	-4.9643	-3.5451	-1.2747	0.5775
GAP_1	0.5611	-0.2373	2.5117	0.3035
GAP_2	-1.9412	1.6619	-3.4878	-1.5573
DER_1	0.6582	0.5677	-1.0316	11.0551
DER_2	-0.5551	-0.3101	-0.5185	-1.1575

Regime 1

	R	INF	GAP	DER
Const(Reg.2)	1.5758	1.5015	-0.0444	4.7074
R_1	7.4342	1.5934	-0.3844	-0.2313
R_2	-2.0013	-1.6460	-0.4451	0.3457
INF_1	-0.5018	8.7708	-0.3199	-1.9315
INF_2	0.6925	-1.9056	0.7539	-1.2433
GAP_1	0.3913	0.0548	1.8817	-0.7660
GAP_2	0.9718	-0.0737	-1.4912	0.3906
DER_1	2.3206	0.2086	0.5443	4.5748

```
DER_2          -1.2698    1.4457    0.6418    4.0934

IsConverged=1

---------- regime classification -------------------

Regime 1
1999:3 - 2009:10 [0.9994]

Regime 2
1994:3 - 1999:2 [1.0000]
```

HUNGARY

```
---------- EM algorithm converged  -----------------

EQ( 1) MSIAH(2)-VAR(3) model of (R,INF,GAP,DER)
       Estimation sample: 1992 (4) - 2009 (10)

no. obs. per eq. :        211    in the system :        844
no. parameters   :        126    linear system :         62
no. restrictions :         62
no. nuisance p.  :          2

log-likelihood   : -1453.7083    linear system : -1620.1860

AIC criterion    :    14.9735    linear system :    15.9449
HQ  criterion    :    15.7826    linear system :    16.3430
SC  criterion    :    16.9751    linear system :    16.9298

LR linearity test:   332.9554    Chi(62) =[0.0000] **  Chi(64)=[0.0000] **
DAVIES=[0.0000] **


---------- matrix of transition probabilities ------

          Regime 1  Regime 2
Regime 1    0.9494    0.0506
Regime 2    0.3178    0.6822


---------- regime properties ----------------------

              nObs     Prob.  Duration
Regime 1     181.4    0.8626     19.75
Regime 2      29.6    0.1374      3.15

---------- coefficients ----------------------------

Regime 1
                      R        INF        GAP        DER
Const(Reg.1)   0.089962   0.124427   0.858185  -1.353430
R_1            1.034452   0.027533   0.897602   0.126418
R_2            0.024086   0.062394  -2.200737  -0.469870
R_3           -0.109985  -0.079365   0.836976   0.483922
INF_1          0.006424   1.117123  -0.175089  -0.041619
INF_2          0.083231  -0.174790   1.974650  -0.829296
INF_3         -0.044941   0.013913  -1.217658   0.812777
GAP_1          0.000048   0.006611   0.426556  -0.072512
GAP_2         -0.008030  -0.007587  -0.271203   0.066542
GAP_3         -0.001458   0.001623   0.069028   0.005113
DER_1          0.008533   0.008882  -0.106174   0.876142
DER_2         -0.014505  -0.024491   0.052231   0.058005
DER_3          0.009513   0.029552  -0.026692  -0.003996
  SE (Reg.1)   0.328746   0.477206   5.809366   3.030896

Regime 2
                      R        INF        GAP        DER
Const(Reg.2)   7.007296  -0.739133   4.511950   7.595300
R_1            0.775233   0.647392  -1.687852   1.484594
R_2            0.153492  -1.036440   0.884958   0.762592
R_3           -0.132151   0.561017   1.418036  -2.284381
INF_1         -0.038149   1.237302   0.317176  -0.370763
INF_2         -0.071939   0.052310  -0.332545   0.209197
INF_3         -0.081831  -0.351668  -0.919306   0.148653
GAP_1          0.000466  -0.153463   0.423355  -0.003898
GAP_2          0.016227   0.163512  -0.010953   0.235740
GAP_3          0.144486   0.020893   0.378735   0.565074
DER_1         -0.021704   0.039001  -0.139622   0.536348
DER_2          0.138117  -0.115150   0.145551   0.466792
DER_3          0.014005  -0.064317  -0.053712  -0.451810
  SE (Reg.2)   0.685224   0.930096   2.617174   2.486991

---------- contemporaneous correlation -------------

Regime 1
```

	R	INF	GAP	DER
R	1.0000	0.2890	0.1428	0.0025
INF	0.2890	1.0000	0.0799	0.0470
GAP	0.1428	0.0799	1.0000	-0.0866
DER	0.0025	0.0470	-0.0866	1.0000

Regime 2

	R	INF	GAP	DER
R	1.0000	0.3175	0.1771	-0.2549
INF	0.3175	1.0000	0.3554	-0.0737
GAP	0.1771	0.3554	1.0000	0.4720
DER	-0.2549	-0.0737	0.4720	1.0000

---------- standard errors ------------------------

Regime 0

	R	INF	GAP	DER
Const(Reg.1)	0.0847	0.1201	1.4490	0.7567
R_1	0.0467	0.0678	0.8248	0.4294
R_2	0.0658	0.0954	1.1589	0.6044
R_3	0.0451	0.0653	0.7922	0.4142
INF_1	0.0451	0.0660	0.7937	0.4143
INF_2	0.0675	0.0979	1.1831	0.6175
INF_3	0.0436	0.0631	0.7596	0.3982
GAP_1	0.0043	0.0063	0.0767	0.0400
GAP_2	0.0046	0.0067	0.0817	0.0426
GAP_3	0.0043	0.0063	0.0759	0.0396
DER_1	0.0079	0.0116	0.1398	0.0729
DER_2	0.0106	0.0154	0.1862	0.0972
DER_3	0.0080	0.0115	0.1397	0.0732

Regime 1

	R	INF	GAP	DER
Const(Reg.2)	0.9413	1.2865	3.5694	3.3726
R_1	0.1656	0.2235	0.6317	0.6104
R_2	0.2490	0.3397	0.9507	0.9027
R_3	0.2066	0.2868	0.7871	0.7552
INF_1	0.1287	0.1749	0.4925	0.4671
INF_2	0.1973	0.2692	0.7530	0.7162
INF_3	0.1330	0.1802	0.5069	0.4799
GAP_1	0.0321	0.0445	0.1229	0.1161
GAP_2	0.0406	0.0551	0.1562	0.1490
GAP_3	0.0375	0.0506	0.1434	0.1365
DER_1	0.0444	0.0600	0.1726	0.1607
DER_2	0.0523	0.0718	0.2014	0.1897
DER_3	0.0423	0.0582	0.1611	0.1530

---------- t - values ------------------------------

Regime 0

	R	INF	GAP	DER
Const(Reg.1)	1.0616	1.0361	0.5923	-1.7887
R_1	22.1291	0.4058	1.0883	0.2944
R_2	0.3660	0.6543	-1.8990	-0.7774
R_3	-2.4402	-1.2161	1.0566	1.1684
INF_1	0.1423	16.9309	-0.2206	-0.1005
INF_2	1.2338	-1.7859	1.6690	-1.3430
INF_3	-1.0318	0.2203	-1.6029	2.0412
GAP_1	0.0110	1.0452	5.5638	-1.8116
GAP_2	-1.7318	-1.1265	-3.3202	1.5613
GAP_3	-0.3389	0.2588	0.9089	0.1290
DER_1	1.0789	0.7670	-0.7594	12.0158
DER_2	-1.3654	-1.5930	0.2805	0.5967
DER_3	1.1827	2.5602	-0.1910	-0.0546

Regime 1

	R	INF	GAP	DER
Const(Reg.2)	7.4446	-0.5745	1.2641	2.2521
R_1	4.6824	2.8969	-2.6720	2.4323
R_2	0.6163	-3.0510	0.9308	0.8448
R_3	-0.6396	1.9558	1.8017	-3.0250
INF_1	-0.2965	7.0759	0.6440	-0.7937
INF_2	-0.3647	0.1943	-0.4416	0.2921
INF_3	-0.6155	-1.9513	-1.8137	0.3098
GAP_1	0.0145	-3.4463	3.4450	-0.0336
GAP_2	0.3992	2.9669	-0.0701	1.5821
GAP_3	3.8547	0.4131	2.6410	4.1395
DER_1	-0.4889	0.6500	-0.8092	3.3381
DER_2	2.6385	-1.6027	0.7228	2.4612
DER_3	0.3308	-1.1046	-0.3333	-2.9529

IsConverged=1

---------- regime classification -------------------

Regime 1

```
1992:4 - 1992:6 [0.9953]
1993:2 - 1993:7 [0.9976]
1993:10 - 1993:12 [0.9999]
1994:2 - 1994:5 [0.9987]
1995:6 - 1996:2 [0.9913]
1996:6 - 1996:8 [0.8695]
1996:11 - 2003:5 [0.9993]
2003:7 - 2003:10 [1.0000]
2003:12 - 2008:9 [1.0000]
2008:11 - 2009:10 [1.0000]

Regime 2
1992:7 - 1993:1 [0.9934]
1993:8 - 1993:9 [0.9466]
1994:1 - 1994:1 [1.0000]
1994:6 - 1995:5 [0.9876]
1996:3 - 1996:5 [0.9574]
1996:9 - 1996:10 [0.7222]
2003:6 - 2003:6 [1.0000]
2003:11 - 2003:11 [1.0000]
2008:10 - 2008:10 [1.0000]
```

ISRAEL

```
---------- EM algorithm converged  -----------------

EQ( 1) MSIAH(2)-VAR(2) model of (R,INF,GAP,DER)
       Estimation sample: 1992 (3) - 2009 (10)

no. obs. per eq. :        212    in the system :        848
no. parameters   :         94    linear system :         46
no. restrictions :         46
no. nuisance p.  :          2

log-likelihood   : -1084.6432    linear system : -1207.8938

AIC criterion    :    11.1193    linear system :    11.8292
HQ  criterion    :    11.7208    linear system :    12.1236
SC  criterion    :    12.6076    linear system :    12.5575

LR linearity test:   246.5013    Chi(46) =[0.0000] **  Chi(48)=[0.0000] **
DAVIES=[0.0000] **


---------- matrix of transition probabilities ------

          Regime 1  Regime 2
Regime 1    0.9817    0.0183
Regime 2    0.0289    0.9711


---------- regime properties ----------------------

              nObs     Prob.  Duration
Regime 1     110.0    0.6126     54.71
Regime 2     102.0    0.3874     34.60

---------- coefficients ----------------------------

Regime 1
                       R         INF         GAP         DER
Const(Reg.1)    0.012114    0.349781   -0.553198    0.778580
R_1             1.619894    0.290740    1.179942   -2.753320
R_2            -0.630860   -0.328981   -1.038249    2.549408
INF_1           0.080224    1.266832    0.300609   -0.215586
INF_2          -0.076236   -0.356674   -0.305687    0.034031
GAP_1           0.013261    0.017876    0.392462   -0.346234
GAP_2          -0.006707    0.005745    0.340316   -0.117301
DER_1          -0.000717    0.064286   -0.037899    0.712747
DER_2           0.006679   -0.069913   -0.009624   -0.048607
  SE (Reg.1)    0.159190    0.450600    1.859682    2.878094

Regime 2
                       R         INF         GAP         DER
Const(Reg.2)    0.311138    0.795295    0.345798    6.222172
R_1             1.320606   -0.084877   -0.025337   -0.037883
R_2            -0.373197    0.091349   -0.075528   -0.261821
INF_1           0.328450    1.479186    0.202810   -0.600279
INF_2          -0.292531   -0.575039   -0.045511    0.509145
GAP_1           0.011706    0.055474    0.363277   -0.096452
GAP_2           0.046266    0.027213   -0.002264   -0.078146
DER_1           0.001504    0.027354   -0.019586    0.901050
DER_2           0.006381   -0.028467   -0.077564   -0.111543
  SE (Reg.2)    0.556210    0.559785    1.129631    2.190280

---------- contemporaneous correlation -------------
```

Regime 1

	R	INF	GAP	DER
R	1.0000	0.0662	-0.0167	-0.0353
INF	0.0662	1.0000	0.0219	0.2190
GAP	-0.0167	0.0219	1.0000	-0.0248
DER	-0.0353	0.2190	-0.0248	1.0000

Regime 2

	R	INF	GAP	DER
R	1.0000	-0.0075	-0.0035	-0.0262
INF	-0.0075	1.0000	-0.0799	0.2592
GAP	-0.0035	-0.0799	1.0000	-0.0343
DER	-0.0262	0.2592	-0.0343	1.0000

---------- standard errors -------------------------

Regime 0

	R	INF	GAP	DER
Const(Reg.1)	0.0403	0.1112	0.4638	0.7290
R_1	0.0687	0.1918	0.7966	1.2308
R_2	0.0672	0.1871	0.7785	1.2015
INF_1	0.0277	0.0775	0.3210	0.4971
INF_2	0.0263	0.0744	0.3058	0.4781
GAP_1	0.0077	0.0218	0.0899	0.1392
GAP_2	0.0081	0.0230	0.0947	0.1478
DER_1	0.0053	0.0150	0.0616	0.0988
DER_2	0.0049	0.0138	0.0572	0.0886

Regime 1

	R	INF	GAP	DER
Const(Reg.2)	0.3362	0.3490	0.6852	1.3437
R_1	0.0792	0.0800	0.1619	0.3124
R_2	0.0798	0.0811	0.1643	0.3161
INF_1	0.0777	0.0784	0.1579	0.3073
INF_2	0.0776	0.0785	0.1579	0.3084
GAP_1	0.0482	0.0487	0.0981	0.1901
GAP_2	0.0483	0.0493	0.0984	0.1936
DER_1	0.0248	0.0262	0.0511	0.0989
DER_2	0.0245	0.0258	0.0515	0.0976

---------- t - values -----------------------------

Regime 0

	R	INF	GAP	DER
Const(Reg.1)	0.3005	3.1468	-1.1926	1.0681
R_1	23.5675	1.5157	1.4812	-2.2370
R_2	-9.3848	-1.7581	-1.3337	2.1218
INF_1	2.9005	16.3474	0.9366	-0.4337
INF_2	-2.9031	-4.7954	-0.9996	0.0712
GAP_1	1.7222	0.8211	4.3662	-2.4880
GAP_2	-0.8261	0.2497	3.5949	-0.7934
DER_1	-0.1354	4.2826	-0.6157	7.2109
DER_2	1.3556	-5.0542	-0.1683	-0.5485

Regime 1

	R	INF	GAP	DER
Const(Reg.2)	0.9255	2.2785	0.5047	4.6306
R_1	16.6727	-1.0608	-0.1565	-0.1213
R_2	-4.6755	1.1261	-0.4596	-0.8283
INF_1	4.2279	18.8697	1.2845	-1.9535
INF_2	-3.7716	-7.3228	-0.2882	1.6507
GAP_1	0.2426	1.1380	3.7041	-0.5074
GAP_2	0.9586	0.5523	-0.0230	-0.4036
DER_1	0.0606	1.0456	-0.3830	9.1108
DER_2	0.2600	-1.1020	-1.5070	-1.1423

IsConverged=1

---------- regime classification -------------------

Regime 1
1998:5 - 1998:7 [0.8631]
1999:9 - 2001:11 [0.9921]
2003:3 - 2009:10 [0.9987]

Regime 2
1992:3 - 1998:4 [0.9992]
1998:8 - 1999:8 [0.9978]
2001:12 - 2003:2 [0.9548]

<u>**PHILIPPINES**</u>

---------- EM algorithm converged -----------------

```
EQ( 1) MSIAH(2)-VAR(1) model of (R,INF,GAP,DER)
       Estimation sample: 1992 (2) - 2008 (12)

no. obs. per eq. :        203    in the system :        812
no. parameters   :         62    linear system :         30
no. restrictions :         30
no. nuisance p.  :          2

log-likelihood   : -1565.2874    linear system : -1855.1659

AIC criterion    :    16.0324    linear system :    18.5731
HQ  criterion    :    16.4418    linear system :    18.7712
SC  criterion    :    17.0443    linear system :    19.0627

LR linearity test:   579.7570    Chi(30) =[0.0000] **  Chi(32)=[0.0000] **
DAVIES=[0.0000] **


---------- matrix of transition probabilities ------

          Regime 1  Regime 2
Regime 1    0.9594    0.0406
Regime 2    0.0734    0.9266


---------- regime properties ----------------------

              nObs     Prob.  Duration
Regime 1     123.2    0.6439     24.63
Regime 2      79.8    0.3561     13.62

---------- coefficients ---------------------------

Regime 1
                        R         INF         GAP         DER
Const(Reg.1)   0.359499    0.623138   -2.303412    3.096238
R_1            0.953614   -0.077159    0.081550   -0.337616
INF_1         -0.012288    0.982791    0.279586   -0.064154
GAP_1          0.002252   -0.004342    0.444946   -0.061866
DER_1          0.006469    0.005401    0.053574    0.927909
  SE (Reg.1)   0.287280    0.750651    4.294077    2.726255

Regime 2
                        R         INF         GAP         DER
Const(Reg.2)  10.564590    1.295270    2.856996    5.331146
R_1            0.352042    0.007161    0.056120   -0.019999
INF_1         -0.185601    0.807258   -0.481639   -0.561927
GAP_1         -0.089179   -0.006990    0.272487    0.210313
DER_1          0.018973    0.020703    0.001555    0.921992
  SE (Reg.2)   4.002760    0.692561    2.318877    4.957797

---------- contemporaneous correlation -------------

Regime 1
             R         INF         GAP         DER
R       1.0000      0.0463      0.3196     -0.0876
INF     0.0463      1.0000      0.1397     -0.1022
GAP     0.3196      0.1397      1.0000     -0.1548
DER    -0.0876     -0.1022     -0.1548      1.0000

Regime 2
             R         INF         GAP         DER
R       1.0000     -0.0405      0.0859      0.0862
INF    -0.0405      1.0000     -0.1964     -0.0686
GAP     0.0859     -0.1964      1.0000      0.1006
DER     0.0862     -0.0686      0.1006      1.0000

---------- standard errors ------------------------

Regime 0
                        R         INF         GAP         DER
Const(Reg.1)      0.1452      0.3282      1.8317      1.2307
R_1               0.0171      0.0376      0.2102      0.1409
INF_1             0.0101      0.0261      0.1480      0.0951
GAP_1             0.0057      0.0144      0.0821      0.0524
DER_1             0.0034      0.0086      0.0492      0.0327

Regime 1
                        R         INF         GAP         DER
Const(Reg.2)      2.4582      0.4341      1.4572      3.0388
R_1               0.1067      0.0189      0.0618      0.1319
INF_1             0.2622      0.0476      0.1573      0.3251
GAP_1             0.1986      0.0362      0.1200      0.2450
DER_1             0.0331      0.0058      0.0195      0.0412

---------- t - values -----------------------------
```

Regime 0

	R	INF	GAP	DER
Const(Reg.1)	2.4752	1.8989	-1.2575	2.5158
R_1	55.7769	-2.0536	0.3879	-2.3968
INF_1	-1.2139	37.6625	1.8896	-0.6746
GAP_1	0.3957	-0.3023	5.4204	-1.1797
DER_1	1.8875	0.6250	1.0881	28.3951

Regime 1

	R	INF	GAP	DER
Const(Reg.2)	4.2977	2.9837	1.9606	1.7544
R_1	3.2989	0.3794	0.9078	-0.1516
INF_1	-0.7079	16.9682	-3.0618	-1.7285
GAP_1	-0.4489	-0.1929	2.2702	0.8584
DER_1	0.5732	3.5484	0.0798	22.3980

IsConverged=1

---------- regime classification -------------------

Regime 1
1993:4 - 1993:6 [0.9121]
1996:1 - 1996:5 [0.9746]
1997:1 - 1997:4 [0.9878]
1999:6 - 2000:9 [0.9764]
2001:3 - 2008:12 [0.9987]

Regime 2
1992:2 - 1993:3 [0.9911]
1993:7 - 1995:12 [0.9963]
1996:6 - 1996:12 [0.7902]
1997:5 - 1999:5 [0.9815]
2000:10 - 2001:2 [0.9955]

POLAND

---------- EM algorithm converged -----------------

EQ(1) MSIAH(2)-VAR(4) model of (R,INF,GAP,DER)
Estimation sample: 1992 (5) - 2009 (11)

no. obs. per eq. : 211 in the system : 844
no. parameters : 158 linear system : 78
no. restrictions : 78
no. nuisance p. : 2

log-likelihood : -1536.6853 linear system : -1772.9723

AIC criterion : 16.0634 linear system : 17.5448
HQ criterion : 17.0779 linear system : 18.0456
SC criterion : 18.5733 linear system : 18.7838

LR linearity test: 472.5740 Chi(78) =[0.0000] ** Chi(80)=[0.0000] **
DAVIES=[0.0000] **

---------- matrix of transition probabilities ------

	Regime 1	Regime 2
Regime 1	0.9810	0.0190
Regime 2	0.0308	0.9692

---------- regime properties ----------------------

	nObs	Prob.	Duration
Regime 1	111.9	0.6193	52.75
Regime 2	99.1	0.3807	32.42

---------- coefficients ----------------------------

Regime 1

	R	INF	GAP	DER
Const(Reg.1)	0.163159	0.208500	-0.227999	-0.295522
R_1	0.518820	0.001954	0.893076	-1.722181
R_2	0.469980	0.043870	0.251882	0.794238
R_3	-0.017807	-0.015093	-1.661788	0.424408
R_4	-0.039924	-0.038466	0.476898	0.394976
INF_1	0.296692	1.409632	2.985640	-2.289210
INF_2	-0.422659	-0.624564	-4.057186	3.853082
INF_3	0.418312	0.053018	2.339991	-0.730478
INF_4	-0.250930	0.111770	-1.086415	-0.682669
GAP_1	0.015007	0.010558	0.307382	-0.099775
GAP_2	-0.000776	0.003948	-0.293982	0.030369
GAP_3	0.005858	0.005204	0.111184	0.020180

GAP_4	-0.002083	0.012964	-0.225294	-0.004444
DER_1	-0.022937	-0.002968	-0.103947	1.097990
DER_2	0.009710	0.020072	-0.125492	-0.209308
DER_3	0.021742	-0.013940	-0.025377	0.264052
DER_4	-0.012175	0.005411	0.174801	-0.278171
SE (Reg.1)	0.394239	0.308321	4.966850	3.850361

Regime 2

	R	INF	GAP	DER
Const(Reg.2)	5.159735	1.151682	3.442008	0.322823
R_1	0.360282	-0.190178	0.001316	0.142256
R_2	0.165781	0.010636	-0.038695	-0.130782
R_3	0.356581	0.032098	0.003189	0.060918
R_4	-0.210942	0.087787	-0.026494	-0.120097
INF_1	-0.162885	1.114759	-0.127027	0.209058
INF_2	0.084996	-0.567713	0.255245	0.187401
INF_3	-0.188623	0.361812	0.046884	-0.276813
INF_4	0.335317	0.040891	-0.271566	-0.044619
GAP_1	0.090562	-0.012889	0.165895	0.139988
GAP_2	-0.020648	0.021337	-0.167190	-0.321225
GAP_3	0.107938	-0.021194	0.069053	-0.135867
GAP_4	0.026140	0.032207	-0.535510	-0.144311
DER_1	-0.014096	0.056293	-0.149096	0.929172
DER_2	0.097235	-0.061399	0.122858	-0.070382
DER_3	-0.071533	0.065927	0.093914	-0.146386
DER_4	0.009294	-0.005699	-0.033672	0.207842
SE (Reg.2)	1.857119	0.890701	2.366833	2.620592

---------- contemporaneous correlation -------------

Regime 1

	R	INF	GAP	DER
R	1.0000	0.1862	0.1306	-0.1169
INF	0.1862	1.0000	0.2131	-0.1291
GAP	0.1306	0.2131	1.0000	-0.0265
DER	-0.1169	-0.1291	-0.0265	1.0000

Regime 2

	R	INF	GAP	DER
R	1.0000	0.1733	0.1102	0.0394
INF	0.1733	1.0000	0.0175	0.0119
GAP	0.1102	0.0175	1.0000	-0.1043
DER	0.0394	0.0119	-0.1043	1.0000

---------- standard errors ------------------------

Regime 0

	R	INF	GAP	DER
Const(Reg.1)	0.0910	0.0670	1.0533	0.8279
R_1	0.0712	0.0553	0.8773	0.6829
R_2	0.0802	0.0621	0.9993	0.7761
R_3	0.0729	0.0569	0.9191	0.7094
R_4	0.0636	0.0479	0.7689	0.5938
INF_1	0.1221	0.0929	1.4901	1.1733
INF_2	0.2132	0.1588	2.5435	2.0162
INF_3	0.2060	0.1614	2.5814	2.0030
INF_4	0.1243	0.0968	1.5339	1.1986
GAP_1	0.0075	0.0058	0.0931	0.0724
GAP_2	0.0078	0.0061	0.0978	0.0758
GAP_3	0.0079	0.0061	0.0981	0.0764
GAP_4	0.0076	0.0059	0.0948	0.0736
DER_1	0.0096	0.0075	0.1202	0.0936
DER_2	0.0151	0.0116	0.1868	0.1459
DER_3	0.0155	0.0119	0.1919	0.1498
DER_4	0.0102	0.0079	0.1274	0.0990

Regime 1

	R	INF	GAP	DER
Const(Reg.2)	1.2277	0.5886	1.5915	1.7432
R_1	0.1009	0.0484	0.1286	0.1424
R_2	0.1071	0.0513	0.1367	0.1516
R_3	0.1013	0.0486	0.1292	0.1429
R_4	0.0951	0.0455	0.1211	0.1351
INF_1	0.2061	0.0988	0.2632	0.2909
INF_2	0.2991	0.1434	0.3814	0.4261
INF_3	0.2942	0.1411	0.3752	0.4167
INF_4	0.1944	0.0931	0.2479	0.2743
GAP_1	0.0676	0.0324	0.0869	0.0979
GAP_2	0.0681	0.0327	0.0872	0.0965
GAP_3	0.0734	0.0352	0.0940	0.1058
GAP_4	0.0736	0.0352	0.0942	0.1084
DER_1	0.0664	0.0318	0.0846	0.0961
DER_2	0.0883	0.0423	0.1125	0.1284
DER_3	0.0902	0.0431	0.1149	0.1344
DER_4	0.0596	0.0286	0.0760	0.0858

---------- t - values ------------------------------

```
Regime 0
                      R         INF         GAP         DER
Const(Reg.1)     1.7933      3.1142     -0.2165     -0.3570
R_1              7.2902      0.0354      1.0180     -2.5218
R_2              5.8631      0.7062      0.2521      1.0233
R_3             -0.2444     -0.2655     -1.8081      0.5983
R_4             -0.6279     -0.8027      0.6203      0.6651
INF_1            2.4290     15.1656      2.0037     -1.9511
INF_2           -1.9824     -3.9327     -1.5951      1.9111
INF_3            2.0306      0.3285      0.9065     -0.3647
INF_4           -2.0186      1.1547     -0.7083     -0.5696
GAP_1            2.0138      1.8220      3.3000     -1.3778
GAP_2           -0.0998      0.6503     -3.0063      0.4005
GAP_3            0.7412      0.8508      1.1332      0.2640
GAP_4           -0.2757      2.1994     -2.3755     -0.0603
DER_1           -2.3778     -0.3965     -0.8650     11.7263
DER_2            0.6434      1.7282     -0.6718     -1.4345
DER_3            1.4059     -1.1685     -0.1322      1.7629
DER_4           -1.1991      0.6835      1.3723     -2.8110

Regime 1
                      R         INF         GAP         DER
Const(Reg.2)     4.2027      1.9565      2.1628      0.1852
R_1              3.5724     -3.9321      0.0102      0.9988
R_2              1.5478      0.2072     -0.2831     -0.8629
R_3              3.5205      0.6610      0.0247      0.4262
R_4             -2.2186      1.9273     -0.2188     -0.8891
INF_1           -0.7905     11.2796     -0.4826      0.7186
INF_2            0.2842     -3.9601      0.6693      0.4398
INF_3           -0.6410      2.5648      0.1250     -0.6643
INF_4            1.7251      0.4390     -1.0955     -0.1627
GAP_1            1.3401     -0.3979      1.9084      1.4304
GAP_2           -0.3031      0.6527     -1.9180     -3.3288
GAP_3            1.4713     -0.6028      0.7343     -1.2836
GAP_4            0.3550      0.9138     -5.6862     -1.3313
DER_1           -0.2123      1.7704     -1.7619      9.6724
DER_2            1.1015     -1.4528      1.0919     -0.5479
DER_3           -0.7928      1.5283      0.8171     -1.0894
DER_4            0.1559     -0.1996     -0.4430      2.4222

IsConverged=1

---------- regime classification -------------------

Regime 1
1998:8 - 1999:7 [0.9905]
2001:3 - 2001:7 [0.9757]
2002:1 - 2009:11 [1.0000]

Regime 2
1992:5 - 1998:7 [0.9980]
1999:8 - 2001:2 [0.9988]
2001:8 - 2001:12 [0.9989]
```

THAILAND

```
---------- EM algorithm converged  -----------------

EQ( 1) MSIAH(2)-VAR(1) model of (R,INF,GAP,DER)
       Estimation sample: 1992 (2) - 2009 (11)

no. obs. per eq. :        214    in the system :        856
no. parameters   :         62    linear system :         30
no. restrictions :         30
no. nuisance p.  :          2

log-likelihood   : -1715.6325    linear system : -2002.3743

AIC criterion    :    16.6134    linear system :    18.9942
HQ  criterion    :    17.0075    linear system :    19.1848
SC  criterion    :    17.5886    linear system :    19.4660

LR linearity test:   573.4836    Chi(30) =[0.0000] **  Chi(32)=[0.0000] **
DAVIES=[0.0000] **


---------- matrix of transition probabilities ------

                  Regime 1     Regime 2
Regime 1             1.000   5.186e-007
Regime 2           0.01177       0.9882


---------- regime properties ----------------------
```

```
              nObs      Prob.  Duration
Regime 1     130.0    1.00001928403.90
Regime 2      84.0    0.0000     84.99

---------- coefficients ----------------------------

Regime 1
                          R         INF         GAP         DER
Const(Reg.1)      0.086295    0.247307    2.846755    2.552441
R_1               0.910334   -0.048312   -1.998159   -1.289946
INF_1             0.048445    0.932922    0.903525    0.278426
GAP_1             0.002617    0.012130    0.631791   -0.005389
DER_1            -0.006226    0.005023   -0.126947    0.582040
  SE (Reg.1)      0.221017    0.703523   11.053750    2.756053

Regime 2
                          R         INF         GAP         DER
Const(Reg.2)      2.579828    0.454148   -1.736207   -2.276469
R_1               0.762461    0.051891    0.492429    0.748444
INF_1            -0.111336    0.800181   -0.431303   -0.888873
GAP_1             0.061913   -0.001445    0.532460    0.094530
DER_1             0.052507    0.008892   -0.185733    0.862492
  SE (Reg.2)      2.356980    0.520691    5.777604    5.523107

---------- contemporaneous correlation -------------

Regime 1
             R        INF        GAP        DER
R       1.0000     0.1665     0.1648    -0.0624
INF     0.1665     1.0000     0.1410     0.0848
GAP     0.1648     0.1410     1.0000    -0.0660
DER    -0.0624     0.0848    -0.0660     1.0000

Regime 2
             R        INF        GAP        DER
R       1.0000     0.1301     0.0716     0.3630
INF     0.1301     1.0000     0.1224     0.2600
GAP     0.0716     0.1224     1.0000     0.0521
DER     0.3630     0.2600     0.0521     1.0000

---------- standard errors -------------------------

Regime 0
                          R         INF         GAP         DER
Const(Reg.1)        0.0493      0.1569      2.4651      0.6165
R_1                 0.0248      0.0790      1.2406      0.3106
INF_1               0.0120      0.0382      0.5996      0.1496
GAP_1               0.0014      0.0044      0.0694      0.0173
DER_1               0.0038      0.0121      0.1908      0.0477

Regime 1
                          R         INF         GAP         DER
Const(Reg.2)        1.2577      0.2778      3.0835      2.9477
R_1                 0.0953      0.0211      0.2336      0.2234
INF_1               0.2171      0.0480      0.5322      0.5087
GAP_1               0.0357      0.0079      0.0876      0.0837
DER_1               0.0326      0.0072      0.0798      0.0764

---------- t - values ------------------------------

Regime 0
                         R        INF        GAP        DER
Const(Reg.1)        1.7493     1.5764     1.1548     4.1399
R_1                36.6545    -0.6119    -1.6106    -4.1525
INF_1               4.0400    24.4474     1.5069     1.8605
GAP_1               1.8860     2.7465     9.1044    -0.3114
DER_1              -1.6320     0.4137    -0.6655    12.1909

Regime 1
                         R        INF        GAP        DER
Const(Reg.2)        2.0512     1.6347    -0.5631    -0.7723
R_1                 8.0005     2.4647     2.1078     3.3504
INF_1              -0.5129    16.6868    -0.8105    -1.7473
GAP_1               1.7334    -0.1831     6.0817     1.1288
DER_1               1.6125     1.2362    -2.3265    11.2889

IsConverged=1

---------- regime classification -------------------

Regime 1
1999:2 - 2009:11 [1.0000]

Regime 2
1992:2 - 1999:1 [1.0000]
```