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EFFECTS OF FDI SPILLOVERS ON THE PRODUCTIVITY OF DOMESTIC FIRMS IN SELECTED TRANSITION COUNTRIES

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ABSTRACT

The transition to a market based economy in Central and East European countries (CEECs) was characterised by deep structural and institutional reforms. These reforms, particularly the liberalisation of trade and capital flows, played a prominent role and enabled the entry of these countries in the "FDI market". It was expected that the entry of MNCs into these countries would foster firm restructuring, change the export structure and above all generate knowledge spillovers and create linkages with indigenous firms. Therefore, CEECs started to offer various incentives to attract FDI, hoping that some of the technology brought by MNCs will spill over to local firms. This would enable them to increase their productivity and achieve higher rates of growth that would result in convergence with more advanced countries.

The aim of this thesis is to investigate productivity spillovers from FDI to local firms in five transition countries using firm level data for the period 2002-2010. Several elements differentiate this study from the previous analyses. We compare the effects of horizontal spillovers and vertical linkages from FDI across countries and two main sectors (manufacturing and services) and assess the heterogeneity of MNCs. To the best of our knowledge this is the first study taking into account MNCs' origin and the extent of foreign ownership in a group of transition economies. Given the importance of FDI in services we further disentangle vertical linkages according to sectoral source and investigate the moderating role of firms' absorptive capacity. Semi-parametric approach based on control function is applied to estimate firms' total factor productivity (TFP) which is then used in the estimation of horizontal and vertical spillovers from FDI along with other firm and industry level determinants. FDI spillovers are estimated using the dynamic panel econometric technique.

Our findings indicate that local firms in the advanced stage of transition benefit from horizontal spillovers arising mostly in service sector and from partially owned foreign firms while the effects of MNCs' origin are ambiguous. We also find that net effects of FDI spillovers are driven by vertical linkages. In particular, positive effect of backward linkages on firm productivity are found for fully owned and non-EU MNCs. However, for a limited set of countries, these positive effects of backward linkages are in certain cases further supported or offset by negative effects of partially owned foreign firms and EU MNCs. On the other hand, forward linkages when positive are limited to EU MNCs while non-EU MNCs and both partially and fully owned foreign firms exhibit mostly negative productivity effects with the exception of two countries. Furthermore, we find that MNCs in manufacturing and service sectors generate significant productivity spillovers to manufacturing firms which are further strengthened with higher levels of absorptive capacity. However, in most cases these spillovers occur through different vertical channels, namely through manufacturing backward and services forward spillovers thus shedding new light on the increasing importance of forward linkages and FDI in services. Human capital and investment in intangibles are found to be strong determinants of firm productivity together with increased competition, while firms' age and size have U-shape and inverse U-shape effects, respectively.

This thesis shows that the effects of FDI spillovers differ among countries suggesting that sectoral and MNCs' heterogeneity play an important role in driving the overall results. Therefore, based on these findings we have developed a set of policy recommendations for policy makers and investment promotion agencies with the aim to maximise the benefits of MNC's entry for indigenous firms' productivity and their inclusion into Global Value Chains.

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LIST OF ABBREVIATIONS

ACF – Ackerberg, Caves and Frazer
AMADEUS – Analyse MAjor Database from EUropean Sources
BEEPS – Business Environment and Enterprise Survey
CEE – Central and Eastern Europe
CEEC – Central and Eastern European Country
CIS – Commonwealth of Independent States
FATS – Foreign Affiliates Statistics
FDI – Foreign Direct Investment
FE – Fixed Effects
FTA – Free Trade Agreements
GDP – Gross Domestic Product
GFCF – Gross Fixed Capital Formation
GMM – Generalised Method of Moments
GVC – Global Value Chain
ICT – Information and Communication Technology
IV – Instrumental Variable
JV – Joint Venture
LP – Levinsohn and Petrin
LSDV – Least Squares Dummy Variable
MNC – Multinational Corporation
NACE – Nomenclature Générale des Activités Économiques dans les Communautés Européennes
NMS – New Member States
NUTS - Nomenclature of Territorial Units for Statistics
OECD – Organisation for Economic Co-operation and Development
OLI – Ownership-Location-Internalisation
OLS – Ordinary Least Squares
OP – Olley and Pakes
R&D – Research and Development
SBS – Structural Business Statistics
TFP – Total Factor Productivity
TiVA – Trade in Value Added
UNCTAD – United Nations Conference on Trade and Development
VTT – Vertical Technology Transfer
WIIW – Vienna Institute for International Economic Studies
WIOD – World Input-Output Database
WO – Wholly Owned

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PREFACE

Since the collapse of the communist system Central and Eastern European Countries (CEEC) have been characterised by significant structural changes and increased globalisation amplified by the liberalisation of trade and capital markets. One of the most pertinent features of CEECs' integration into global trade and capital flows has been a surge in FDI. Increased inflow of foreign investment in these countries was primarily motivated by the opening of new markets. Also increased globalisation of countries around the world enabled MNCs to become major players in global production of tangible goods, technology and investment in R&D. The opening of CEECs to international capital flows was closely followed by the increase in global stock of FDI from US$ 2.1 trillion in 1990 to US$ 26 trillion in 2015 (UNCTAD, 2015). The increased internalisation of firms has also had a profound impact on host economies since the share of foreign firms' output in global GDP rose from 21 percent in 1990 to 47 percent in 2014. Over the same time period the value added of foreign firms increased eightfold, exports fourfold and employment twofold (UNCTAD, 2015). As both theoretical (Helpman et al., 2004) and empirical literature (e.g. Mayer and Ottaviano, 2007) suggest, MNCs are more productive due to their advanced production technology, management and organizational know-how, marketing expertise, production networks, access to finance and codified and tacit knowledge giving them advantage over their domestic counterparts. In international technology diffusion, MNCs are seen as an important agent since almost two thirds of all private R&D expenditure is conducted by them (UNCTAD, 2005). With this in mind, an investigation of the role of MNCs on the prospects of industrial development, increase in exports, competition and technology diffusion that ultimately determine economic growth is highly relevant for countries which lack advanced knowledge and technology.

During the process of transition from centrally planned to market economy Central and East European countries (CEECs) have completely transformed their economic and institutional framework and relied on internationalisation of their trade and capital markets. Owing to a number of reasons such as obsolete capital, technological backwardness, lack of innovation and specialisation in industries with low value added the performance of these countries was lagging behind those of more advanced Western economies. The expectations were that opening to FDI would bring the necessary capital, technology, know-how, access to new markets and open new jobs resulting in a reduction in technology gap, enterprise restructuring, modernization of industries and ultimately economic growth. Therefore, most countries liberalised their FDI regime and started offering generous investment and tax incentives. The particular aim of these incentives was the that the entry of foreign firms will increase the productivity of indigenous firms through technology spillovers or the inclusion of latter in Global Value Chains (GVC). However, the success of CEECs in attracting FDI has been far from uniform across the region, depending partially on privatisation policies in early transition period and later on institutional progress, comparative advantages, macroeconomic policies and transition specific factors such as regional integration (Seric, 2011). The differences in determinants were also linked to FDI motives and types. Despite clear theoretical arguments in favour of positive effects of FDI, empirical results remain inconclusive at both macro and micro level.

Notwithstanding the importance of the direct effects of FDI in terms of their contribution to capital accumulation, positive changes in export structure, enterprise restructuring, improvements in infrastructure and development of the service sector, the emphasis of this research is on the FDI spillover process. The issue of FDI spillovers has attracted considerable attention among policy makers as the existence of spillovers may be regarded as indicator of efficiency of policy measure (Rugraff, 2008). The process of transition and large influx of FDI has provided a unique opportunity to investigate the effects of FDI spillovers on domestic firms' productivity. As CEECs have established their institutional frameworks and well-functioning market economies, the main question remains how firms in these countries can become more competitive and productive. The answer lies in FDI spillovers, occurring horizontally through demonstration, worker mobility and competition or vertically through buyer-supplier linkages, which have become the major factors for positioning of CEECs in GVCs and for the development of knowledge based economy. Since technological spillovers and transfer predominantly occur between firms, the analysis has to be conducted at firm level using firm level data.

The current empirical research on FDI spillovers has, by and large, neglected foreign affiliates in the service sector which is somewhat surprising given the large share of FDI in services. In addition, the existing research has focused on the characteristics of local firms and industries that could influence the extent and magnitude of knowledge spillovers. Notwithstanding their importance, the role of foreign affiliates' characteristics has received much less attention. Foreign affiliates may differ in their productivity levels, knowledge stock, motives, mode of entry, ownership levels, autonomy, functional scope, technological intensity and embeddedness in the local economy. There is also relatively little research on the ability of domestic firms to enter GVCs through vertical linkages with foreign affiliates in the service sector. Although the existing evidence points to positive effects of backward linkages when domestic firms act as suppliers to foreign affiliates in the manufacturing sector, little is known about the effects of linkages in the service sector.

This research aims to fill these gaps in the literature by investigating the relationship between total factor productivity (TFP) and FDI spillovers differentiating between firms which are vertically integrated with MNCs and those in direct competition in the same sector. For this reason, several empirical models are being developed at the firm level and estimated using a rich firm level database containing firms in manufacturing and service industries from several CEECs. In this way we aim to address one of the empirical shortcomings in the FDI spillovers literature related to use of different data, methodologies and models applied in single country framework. By analysing theoretically, the reasons for MNCs' existence and their potential benefits for the host country economy we are able to gain insight into the possible channels of influence on indigenous firms as well as their differential impact conditional on firm, sector and country heterogeneity. This will inform the choice of variables used to construct the empirical models differentiating between horizontal and vertical FDI spillover channels and their effects conditional on across differences in MNCs such as the level of ownership and their origin. It will also enable us to investigate specificities of domestic firms operating in different sectors, the interrelationship between different sectors, the moderating role of domestic firm's absorptive capacity and to examine how these factors determine domestic firms' TFP in short and long run. In addition, the investigation will address several firm specific factors such as the firms' intangible assets, human capital, experience and size which are found to be relevant for explaining TFP. We further control for competition and demand effects at industry level which if not included may provide an upward bias in FDI spillover variables. The originality of our approach also lies in the estimation method and checking for robustness of several TFP estimates at industry level in a multi-country framework which, to the best of our knowledge, has not been addressed in firm level productivity estimation in transition countries. When estimating the effects of FDI spillovers we emphasize the dynamic nature of TFP and control for the potential endogeneity between our variables of interest and TFP using instrumental variable methods which has rarely been addressed in empirical work on FDI spillovers.

Bearing in mind the context outlined above, the aim of this thesis is to quantify the effects of FDI spillovers on productivity of domestic firms. For this purpose, several research objectives have been developed:

- To provide a comprehensive and critical review of theories explaining the emergence of MNCs and sources of their technological advantages and identify potential benefits to host countries
- To critically evaluate the theoretical and empirical literature related to FDI spillovers with special emphasis on potential channels and determinants of FDI spillovers from supply and demand sides
- To provide a comprehensive analysis of productivity convergence and FDI performance in the New Member States (NMS) at country and industry level with special emphasis on the inclusion of NMS in GVC
- To critically examine the methods used for the estimation of firm level productivity and their application in the context of NMS
- To develop an empirical model to investigate the effects of FDI spillovers on domestic firms' productivity in selected NMS, highlighting the sectoral and foreign affiliates heterogeneity
- To empirically evaluate the interrelationship between FDI in services and downstream manufacturing productivity and examine the moderating role of manufacturing firms' absorptive capacity in selected NMS
- To discuss some policy implications and provide policy recommendations to governments and Investment Promotion Agencies in order to devise effective policies to improve productivity effects of FDI.

The novelty of this research is reflected in: (i) the critical examination of methods available for estimating firm level productivity and the application of relatively new econometric method applied in the context of industry and country heterogeneity which are theoretically more appropriate than methods employed in existing studies; (ii) the examination of supply side factors affecting FDI spillover process in the context of European transition countries; (iii) exploring the effects of FDI in services and manufacturing on both upstream and downstream manufacturing firms by examining four possible channels of vertical linkages simultaneously, thus shedding new light on the importance of supplier-client relationship in manufacturing firms.

The structure of this thesis is as follows. **Chapter 1** starts with defining the concept of FDI and continues with review of theories explaining the emergence and growth of MNCs. The focus is on a critical examination of different approaches explaining the motives for FDI. Despite being a relatively old concept, its explanation still generates considerable debate among scholars in international business and international economics literature. The purpose is to examine their suitability for the analysis of FDI spillover process in the context of this thesis as they rest on different assumptions regarding technology transfer and effects on economic development of host countries. The second part of this chapter is concerned with explanation of motives and their potential effects on host countries. In addition, we discuss other strategically important decisions of MNCs upon their entry into host markets. Finally, we examine the potential benefits associated with FDI, differentiating between direct and indirect effects.

Chapter 2 examines the concept of FDI spillovers. We emphasize that term *technology* is used in its broadest sense including both codified and tacit knowledge, management and organizational skills, product and process technology. We also use the term *spillovers* in broad sense including pecuniary and pure technological externalities since it is not possible to empirically disentangle voluntary and involuntary knowledge transfer. We continue by explaining channels of influence of MNCs pointing out the differences between horizontal and vertical spillovers as well as heterogeneous approaches within each main channel. We distinguish between three strands of literature according to the way in which intra industry spillovers occur. The earliest neoclassical approach is based on the simple notion that the mere foreign presence explains the spillover benefits due to the public good nature of spillovers. The second strand recognizes the costs related to absorbing the spillovers and argues that they are endogenously determined. The most recent strand emphasizes worker mobility as the potential channel. Regarding vertical spillovers, theoretical studies distinguish between backward and forward linkages and discuss their impact on host country development through increased demand for intermediate inputs, assistance in acquisition of new technology, knowledge diffusion and availability and quality effects.

The second part of this chapter is devoted to the critical examination of factors which may influence the extent and intensity of spillovers with particular emphasis on foreign and domestic firms' heterogeneity and methodological issues pertinent to the examination of FDI spillovers. The last part of the chapter identifies the shortcomings of the current empirical literature which, together with insights from Chapter 1, leads to the conceptual framework used throughout this thesis.

Chapter 3 starts with the investigation of major features of the transition process in NMS and the role played by FDI. In the first part, we analyse the convergence process of NMS and the distribution of FDI across countries and industries. We show that countries which liberalised their trade and capital accounts quickly were the forerunners in structural and institutional reforms, and succeeded in attracting large amounts of FDI. In the second part of the chapter, we focus on the effects of FDI on structural change and the inclusion of NMS in GVCs. We also provide a comparative analysis of the performance of foreign and domestic firms across industries and countries and argue that the contribution of foreign firms to structural change in NMS has been substantial. For the analysis of this chapter we rely on several databases such as UNCTAD FDI database to gauge the size of FDI stock and its relative importance for each country. The Total Economy Database and the Eurostat database are used to gain more insight into the productivity convergence and the structure of FDI across industries. We also used the Eurostat Foreign Affiliates (FATS database and Structural Business Statistics (SBS) when measuring performance of foreign and domestic firms. Finally, the OECD TiVA is used to measure GVC participation of countries and industries.

Chapter 4 discusses the importance of the correct measurement of productivity followed by a detailed review of the available methods for the estimation of firm level productivity. We emphasize that the choice of preferred methods depends on several assumptions which are critically examined. In addition, we discuss the potential problems (such as measurement errors in output and inputs, for example) when estimating TFP in a production function framework. Furthermore, several methodological problems related to firm level estimation of TFP such as simultaneity bias, selection bias, omitted price bias and the presence of multiproduct firms are discussed together with potential solutions offered by different estimation methods. We argue that the semiparametric methods which incorporate assumptions on firms' behaviour and timing of inputs are the most appropriate methods for the estimation of TFP at firm level. Other issues that are considered in this chapter include a detailed description of the Amadeus database used in this and the following empirical chapters, estimation of TFP using several methods in order to test their robustness as well as the estimation of foreign ownership premium using non-parametric and parametric methods to gauge the potential for FDI spillovers.

In **Chapter 5** we develop an empirical model of FDI spillovers and apply it to firms from the Czech Republic, Estonia, Hungary, Slovakia and Slovenia. The construction of FDI spillover variables relies on a combination of firm and industry level data obtained from Amadeus and World Input Output Database in order to separate intra-industry and inter-industry spillovers. A dynamic system GMM model is used in order to capture the dynamic nature of productivity as suggested by semi parametric techniques described in Chapter 4. Furthermore, by using internal instruments we control for possible endogeneity of FDI spillover variables. To capture the heterogeneity of the supply side of the spillover process the baseline model is augmented in order to take into account different ownership levels and the country of origin of foreign investors. In addition, the role of knowledge capital, other firms and industry characteristics are included as potential determinants of firm level productivity. This chapter is of particular interest as it sheds more light on the supply side of spillovers process including firms from the service sector which differentiate our study from previous analysis.

Chapter 6 focuses on the cross-sectoral spillovers. The goal here is to establish whether the effects of FDI differ between manufacturing and service firms. In addition, we test the hypothesis that the previous findings of insignificant forward linkages were related to the fact that the relationship between services and manufacturing sectors was ignored. It is argued that the liberalisation of services has important implications for productivity of downstream manufacturing firms as it provides more variety, better quality and reduced prices of intermediate inputs than those available in local markets. This question is of interest for both economists and policy makers because of the far-reaching liberalisation of service industries in the last ten years - since these countries joined the EU. The analysis follows the same methodological approach as in Chapter 5 and employs the same control variables. Due to the richness of firm level data we are able to test the moderating effects of local firms' absorptive capacity on the occurrence and magnitude of FDI spillovers in manufacturing sector through five channels of influence, one horizontal and four vertical. To the best of our knowledge the empirical model based on firm level data and annual input output tables for NMS is the first study to disentangle vertical linkages according to industry source and to measure their impact on productivity of domestic firms in manufacturing industries which are at the same time both suppliers and customers.

Chapter 7 formulates the conclusions of this thesis. Special emphasis is given to contributions to knowledge, limitations of the thesis and possible directions for future research. We also provide some policy recommendations aimed at improving the effectiveness of policies related to attracting the right type of foreign investor, linkage promotion, strengthening absorptive capacity and providing incentives in certain industries which would result in improving the technological competences of local firms.

CHAPTER 1.
THEORIES OF FOREIGN DIRECT INVESTMENT

1.1 INTRODUCTION

The increased globalization over the last two decades has led to the strong growth of international business activity and foreign direct investment (FDI) with the latter becoming one of the core features of global economic flows. A growing number of firms from different industries have expanded abroad through direct investment, and majority of countries now compete to attract multinational companies (MNCs). The inflow of FDI is widely thought to be an important channel for the diffusion of new knowledge, technologies and various skills across national borders. In addition, by complementing domestic savings, FDI can create new employment, transform the production structures, upgrade the technology of production process and help diversify the export structure resulting in overall economic growth (Alfaro, 2014).

The understanding of the theories of FDI is crucial for empirical investigation of the effects of MNC entry on economic growth through productivity spillovers which is the main focus of this thesis. MNCs are often perceived as a source of direct technology transfer from home country to subsidiaries abroad and indirectly, through the public good nature of knowledge, to host country firms. Hence, in this chapter we discuss the various features of MNCs' operations such as the sources of their superior advantages over host country firms, reasons for cross border production activities, organization of value adding activities across borders and their impact on economic development of host and home countries. In the process of internationalisation MNCs often interact with host country environment and thus it is expected that some of technology and knowledge brought will spill over to host country firms and workers and increase their efficiency.

The aim of this chapter, therefore, is to provide a theoretical background to the concept of FDI, its definition and measurement as defined by international organization (e.g. IMF, OECD) and their types. Furthermore, we aim to explain both the existence and growth of MNCs and the main motives of their international activities as they appear to be important factors in determining the spillover benefits. The main objective is to provide a comprehensive analysis of FDI from different theoretical perspectives and to pinpoint to di(similarities) of each conceptual and theoretical approaches. Although there are already comprehensive reviews of FDI theories there appears to be no reviews that critically discuss and appraise the merits of each approach. This review will help us to identify the determinants and strategic objectives of MNCs which affect the size and scope of spillovers analysed in the next chapter and the potential benefits accruing to the host economy. Moreover, we cannot discuss the literature on technology spillovers from FDI and absorptive capacity in the next chapter without knowing what are the sources of superior knowledge of MNCs, their underlying motives and potential benefits it can bring.

The European economies that have undergone a transformation from a centrally planned system towards a market system offer a rich basis for evaluation of the increasing importance of multinational companies (MNCs). At the macroeconomic level, the institutional and economic transformation process has produced a higher degree of openness and a stronger integration with the world economy. From a microeconomic perspective, the liberalisation policies have led to the emergence of private ownership through the entry of new firms and numerous forms of privatization in both of which FDI played a prominent role. Privatisation created new ownership structures and influenced economic performance in various ways (Estrin et al., 2009). Foreign direct investment (FDI) has been a particularly important element of economic integration because it has opened possibilities for accelerated growth through providing necessary capital for the much needed investment, the introduction of technological innovation, enterprise restructuring and changes in export structure.

The structure of the chapter is arranged in the following manner. In section 1.2 various concepts and definitions are explained. Section 1.3 provides a critique of the different strands of theoretical models. The emphasis here is on the source of ownership advantages, their preservation and exploitation in different economic and institutional environments and the role played by the host location. Section 1.4 discusses the motives, ownership and investment modes of MNCs which have emerged from the review of FDI theories while Section 1.5 discuss the potential direct and indirect benefits of MNCs' entry on host country Finally, Section 1.6 concludes.

1.2 CONCEPT OF FDI – DEFINITION, MEASUREMENT AND TYPES

A multinational company can be defined as a company that owns, controls and operates assets in at least two countries with the purpose of generating income (Alfaro, 2014). The acquisition of such assets is usually conducted through two main type of investment: portfolio investment characterised by acquisition of securities, and foreign direct investment involving the construction of completely new production facilities ("greenfield FDI") or acquisition of already existing firms ("brownfield FDI") in other countries. The definition of FDI is related to the extent of control of host country firms. However, as noted by Desai (2009, p.1):

> *"…it used to be the case that "production or distribution might move abroad, [while] the loci of critical managerial decision-making and the associated headquarters functions were thought to remain bundled and fixed. Now firms are unbundling headquarters functions and reallocating them worldwide. The defining characteristics of what made a firm belong to a country - where it was incorporated, where it was listed, the nationality of its investor base, the location of its headquarters, are no longer unified nor are they bound to one country".*

Since control can be exercised in different ways due to fragmentation of production process, the measurement of FDI becomes problematic (Alfaro, 2014). OECD (1996, p.7-8) states that the purpose of FDI is to *"obtain a lasting interest by a resident entity in one economy (direct investor) in an entity resident in an economy other than that of the investor (direct investment enterprise)".* The lasting interest distinguishes FDI from portfolio investments as it implies long run strategic relationship between entities. In other words, FDI involves not only the transfer of financial capital, but also technology, know how, organizational and marketing expertise, tangible and intangible assets and values. Foreign direct investor can be an individual, group of individuals, incorporated or unincorporated private or public company which through direct investment enterprise controls at least 10 per cent of voting rights in another company abroad (IMF, 2009). FDI consists of equity capital, reinvested earnings, other long term and shot term capital shown in the balance of payments. The threshold of 10 per cent enables a foreign investor to influence or participate in the management of acquired enterprise. If foreign investor controls more than 50 percent of voting rights direct investment enterprise is called a subsidiary which enables foreign investor to appoint or remove the management board. In cases when the extent of ownership ranges from 10 to 50 per cent, direct investment enterprise is called an associate (OECD, 1996).

In the international trade literature FDI is usually classified as horizontal or vertical depending on the motives of investment. Horizontal FDI arises as a substitute for exports and the main aim is to provide host market with the same goods produced at home. The main motive for such investments is to circumvent high trade barriers and transportation costs (Markusen, 1984). Vertical FDI involves the breakup of value chain across different geographical locations motivated by cost differences in factor markets (Helpman, 1984). Both types of FDI involve substantial communication and transport costs, training costs of personnel, language and cultural barriers, institutional barriers. So the question arises, why is someone willing to invest abroad? The simplest answer is the pursuit of profit, but MNCs also seek to acquire new resources to improve their competitiveness, to diversify supplies and sales across diverse geographical locations. Finally, how can MNCs offset local's firm advantages? The answer to this question is provided by different strands of literature on FDI which is critically reviewed below.

1.3 THEORIES OF FDI

The importance of, and growing interest in, the causes and consequences of FDI has led to the development of a number of theories that try to explain why MNCs conduct FDI, where they choose to locate their production and how they choose a particular entry mode. Theories explaining FDI have emerged from different fields such as economics, international business, organization and management, all trying to explain the same phenomena from different points of view.

In general, FDI theories can be divided in several strands:[1]

[1] Apart from theories discussed in this section there are other theories explaining FDI such as the internal financing hypothesis (Froot and Stein, 1991) and the currency area hypothesis (Aliber, 1970) and theories based on other factors. The latter include tax policies, agglomeration economies, institutions, political and country risk (Hartman, 1985; Wei and Wu, 2001; Asiedu, 2002). The reason for excluding those theories is because they mostly deal with macroeconomic factors while we are more interested in industry and firms' characteristics explaining MNCs' advantages. In addition, some of the factors explained in other

- Neoclassical theory based on perfect markets
- Industrial organization and imperfect markets
- Macro development approaches
- Internalisation theories
- Evolutionary theories
- New trade theories

1.3.1 THE NEOCLASSICAL THEORY OF CAPITAL MOVEMENT

In the neoclassical financial theory of portfolio flows, multinational companies have been viewed as simply an arbitrageur of capital in response to changes in interest rate differentials (Nurkse, 1933; Ohlin, 1933; Iversen, 1935). The rationale for this hypothesis is that firms investing abroad behave in such a way as to equate the marginal return and the marginal cost of capital. The assumption of risk neutrality implies that domestic investment and FDI are perfect substitutes. A somewhat different approach is taken by Tobin (1958) and Markowitz (1959) in their portfolio diversification theory where the assumption of risk neutrality is relaxed. According to them FDI occurs as a means of reducing the average risk of international transactions. Similar view is shared by the neoclassical models of international trade which extended studies based on trade to capital flows, such as the Heckscher-Ohlin (H-O) model (1919; 1933) which prevailed before 1960s. It regarded the movement of foreign investment as part of the international factor movements. Based on the Hecksher-Ohlin (H-O) model, international movements of factors of production, including foreign investment, are determined by different proportions of the factor endowment available in different countries. It was assumed that capital moves from countries where capital is abundant and marginal productivity is low to countries where capital is scarce and marginal productivity is high. The MacDougall–Kemp model (MacDougall, 1960; Kemp, 1964) again assumed that capital was expected to move to the capital scarce countries with expected higher capital returns. However, capital returns could be manipulated by imposing taxes on internationally mobile capital

theories also appear in theories discussed in this chapter. Finally, our review is mostly focused on explanation of sources of superior technological advantages of MNCs, organization and ownership of cross border activities and their evolution as a response to technological change. This has important implications for MNCs' embeddedness in host country and location choice and the potential for spillovers arising from heterogeneous nature of MNCs.

to enhance their welfare. Aliber (1970) claimed that difference in capital returns is due to a difference in capital endowments and exchange rates as interest rates include a premium that is charged according to the expected currency depreciation. This enables firms from countries with stronger currencies to borrow money more cheaply in countries with weak currencies, thus enabling them to finance foreign activities more cheaply.

In summary, all the above approaches assume that capital flows from one country to another, ignoring the firms in the process. Moreover, they are based on strong assumptions of perfect capital markets, freely available technology, homogeneity of inputs and absence of transaction costs which are unlikely to hold in the real world. In addition, empirical studies estimating the relationship between relative rates of return in a number of countries and the allocation of FDI among them found no support for this hypothesis (Agarwal, 1980). The theory based on perfect markets is not consistent with the observation that countries can be both receivers and sources of FDI simultaneously (Hymer, 1976). This is because a rate of return differential assumes FDI flows from high rate to low rate countries. Furthermore, the theory disregards the fact that the objective of MNCs may not be only of a financial nature but rather to circumvent trade barriers and to transfer technology and know-how. Similarly, it cannot account for the uneven distribution of FDI among different types of industries (Tortian, 2007). Finally, as argued by Caves (1982), under perfect markets international differences in expected returns are not sufficient for FDI as an increase in short term profits would encourage new entry that would eliminate any abnormal profits.

1.3.2 INDUSTRIAL ORGANIZATION THEORY

Although FDI plays an important role in the economic growth and international trade of host countries, the theories explaining this phenomenon arose only in the second half of the 20th century and in the framework of international production theory in which the focus moved from the country to the firm level. In order to explain the existence of MNCs and their incentives to invest abroad, several important theoretical frameworks emerged. The market imperfection theory developed by Hymer (1976) emphasized the role of MNCs as global industrial organizations. In his seminal thesis on FDI he expressed dissatisfaction with market perfections emphasised by the neoclassical theory and argued that FDI could not exist in the world of perfect competition characterised by homogenous products, perfect information, perfect mobility of factors of production and free entry. He argues that FDI exist because of the imperfect final output markets caused by monopolistic advantages and entry barriers. In order to compete with indigenous firms, foreign entrants must possess some specific monopolistic advantages including intellectual property rights and intangible assets, superior marketing and distribution skills, access to raw materials and finance, economies of scale, management skills and ability for horizontal and vertical integration (Rugman et al., 2011). These firm specific advantages are necessary in order to overcome locational disadvantages arising from differences in language, culture, legal system and other inter-country differences (Rugman et al., 2011). FDI is seen as a means of transferring knowledge and other firm assets, both tangible and tacit, in order to organize production abroad for the purpose of making a profit and maintaining market power in oligopolistic industries.[2] This rent seeking activity of FDI and the desire to invest due to imperfect markets is the main contribution of Hymer in comparison to neoclassical theory which is more concerned with capital movements. He was concerned with the relationship between the efficiency with which production is organized within the firms and the extent of market power and collusion.

Drawing upon the industrial organization theory and monopolistic competition, Kindelberger (1969) recognised that the existence of FDI can be explained by the following factors: market imperfections in the goods markets resulting from product differentiation, market imperfections in factor markets arising from access to proprietary knowledge and capital, internal or/and external economies of scale (e.g., vertical integration), and government interference with international production. According to Kindelberger (1969), the firm has to possess comparative advantages which are large enough to overcome locational disadvantages and must be transferable to foreign subsidiaries. Lall and Streeten (1977) argue that some of the firm specific advantages cannot be sold to other firms as they are inherent in organization or difficult to define, value and transfer. Intangible assets such as organizational and managerial capabilities

[2] According to Hymer (1968), FDI is the most efficient internalisation strategy for three reasons: (i) it is difficult to put a price on firm's advantage; (ii) FDI does not involve contractual costs as licencing agreement; (iii) oligopolistic power cannot be sold.

explain why firms can compete on international markets. Caves (1971) emphasized that FDI is more likely to occur in oligopolistic industries. He put emphasis on product differentiation as a necessary condition for direct investment as it stimulates rivalry through advertising.

The above authors recognize FDI as a separate form of capital flows beyond mere financial capital, put firms in the centre of analysis and recognize market imperfections. However, Hymer's theory was criticized for focusing on structural market imperfections as a reason for FDI and for neglecting the strategic objectives of MNCs (Dunning and Rugman, 1985). Robock and Simmonds (1983) argued that possessing firm-specific advantages does not necessarily imply that firms will engage in FDI as they may exploit their specific advantages through trade or licensing. Finally, Hymer's theory does not explain where and when FDI takes place.

1.3.3 MACROECONOMIC DEVELOPMENT APPROACH

While the market power approach is concerned with ownership advantages as a main determinant of MNCs' activities, the work of Vernon (1966) and Kojima (1978, 1982) emphasized location advantages. It is worth noting that Hymer does not disregard location but he treats it as an exogenous factor influencing MNCs' behaviour. The macroeconomic development approach draws extensively on neoclassical theory of geographical distribution of factor endowments. Vernon used a microeconomic concept based on product cycle model in order to explain the technological development associated with the growth of US foreign direct investment in Europe in the 1950s and 1960s. He argued that the ability of US firms to innovate new products and processes was determined by home country endowments, institutions and markets. Factors such as high level of income per capita and domestic demand offered unique opportunities for exploitation of knowledge and fostered innovation at home. This gave American firms an advantage to increase exports and enabled the development of US MNCs which engaged in import-substituting investments in Europe.

Vernon argued that the internalisation strategy of MNCs varies according to which of the four stages of the product cycle the firms are in: innovation, growth, maturity and decline.

The propensity of a MNC to engage in international production changes as the product moves from its innovatory to its mature phase and its production techniques are finally standardized. The greatest part of new products is firstly manufactured in the home country to satisfy the local demand and to facilitate the efficient coordination between R&D and production units. In a later phase of the cycle as demand increases firms start to export to countries with similar level of income. Later on, as the product becomes more and more standardized the role of R&D becomes less important while a decisive role is assumed by wage costs, transportation costs and higher entry barriers into marketing and distribution channels. The importance of location characteristics in the stage when a product becomes standardized and reaches maturity is critical as the firm decides to invest abroad to maintain its competitive position against its domestic and foreign rivals.

Vernon's theory provides useful insights into the importance of the absorptive capacity of domestic firms to imitate foreign products leading to the setting up of production facilities by the MNC on the local markets, thus further enhancing the potential for indirect effects of FDI. Cantwell (1995) questioned Vernon's hypothesis that innovations are always generated in home country and that technological leaders are predominantly international investors. He demonstrated that innovation is dispersed within MNCs and that the internationalization of technological development is led by firms with the strongest records in innovation. Furthermore, Vernon's theory is not able to explain FDI from developing to developed countries nor does it take into account other means of exploiting innovations abroad such as licensing. Furthermore, Clegg (1987) argues that Vernon's theory explains only new FDI and has little to say about already existing investments from countries with already high outward FDI.

Micro variables such as factor endowments and intangible assets and macro elements such as trade and industrial policy are combined in various works by Kojima (1978, 1982). Kojima views the MNC as an instrument by which the comparative trading advantage of nations may be better advanced (Ben Hamida, 2007). He states that MNCs invest abroad in sectors requiring intermediate and internationally mobile products that fit the production process comparatively well, but that need to be combined with inputs in which the host country is relatively well endowed. Hence, FDI is seen as a complement to trade. Kojima suggested that FDI would be undertaken from a comparatively disadvantaged industry in the home country to a comparatively advantaged industry in the host country. Thus FDI would promote an upgrading of industrial structure in both countries and accelerate trade between them. Kojima concluded that the lower the technological gap between the investing and host countries, the easier it is to transfer and upgrade the technology in the latter.

The change in the international position of countries through different stages of development was also explained by the concept of "Investment Development Path" (IDP) introduced by Dunning (1988a, 2003) and Narula (1996) who introduced the dynamic approach to FDI. It is based on the Ownership Location Internalisation OLI paradigm described in detail in the next section. The model assumes that development causes structural changes within an economy and that the latter are closely related to FDI (Lall, 1996). It provides a concept which explains how economic development influences the environment which foreign and domestic firms face. This in turn has an impact on inward and outward FDI. It also allows for government intervention which consequently influences FDI flows and domestic firms' ownership advantages. IDP identifies five stage of development.

The first stage is characterised by very little FDI mostly oriented to resource based sectors and labour intensive sectors and no outward FDI. Domestic firms have not yet developed ownership advantages, and location advantages are insufficient due to limited GDP per capita, low level of human capital, inappropriate infrastructure and political and/or economic instability. The Government tries to improve the basic infrastructure and macroeconomic policies to change the structure of domestic market.

The second stage is characterised by the rising levels of inward FDI due to improvement in locational advantages. FDI is mostly oriented towards transportation, communications and construction industries and vertical integration in labour intensive manufacturing is expected. Ownership advantages start to emerge and are mostly based on low cost standardised products and natural resources. As agued by Dunning (1993) improved locational advantages generate agglomeration economies and increase labour productivity. In this stage domestic firms start to enter MNC's global network and start to benefit from transfer of technology and know-how which affect their ownership advantages.

The third stage is characterised by increased outward FDI and a slowdown in inward FDI due to increasing production costs. FDI is mostly of horizontal type associated with market access and efficiency concerns and in activities requiring more sophisticated products or high quality of labour. Competition on domestic markets is rising due to diffusion of ownership advantages to local firms. Ownership advantages of domestic firms are associated with intangible asset and limited process and product innovation. Location advantages result in created assets due to increased R&D expenditure and investment in education. Furthermore, the government's role is still relevant and oriented towards a reduction in market failures and promotion of linkages with local firms with the aim of reducing delocalisation risks (Fonseca et al., 2007).

The final two stages of IDP are characterized by outward FDI exceeding inward FDI. Net outward investment tends to fluctuate around zero due to similarities of economic structures (Narula and Dunning, 2010). Ownership advantages of local firms allow them to compete in foreign markets by engaging in efficiency seeking in less developed countries and strategic asset seeking FDI in developed countries through strategic alliances. Location advantages are mostly based on created assets such as qualified labour, technological capacity of high tech sectors, agglomeration economies (Fonseca et al., 2007). The role of government is to reduce transaction costs, support innovation, and foster economic restructuring (Narula and Dunning, 2010).

A similar macro development approach is known as the "Flying Geese" model which explains the stages of industrial development of host countries supported by FDI (Ozawa, 1992). It describes the link between various stages of industrial development and phases of FDI. As the home country of FDI moves up on the technology ladder, activities of lower technological level are moved abroad through FDI. However, the "flying geese" model is only suitable for explaining FDI in labour intensive industries, less so for high technology industries due to difficulties in recycling comparative advantages from the early stages based on low labour costs (Damijan et al., 2013b).

Recently, the literature on global supply chains has offered an explanation for vertical and horizontal specialisation beyond labour intensive industries (Baldwin, 2012). It is based on the second "unbundling of globalization" which has shifted the locus of globalization from sectors to stages of production.[3] Fractionalisation and dispersion are seen as the main nucleus of supply chains. The first one is concerned with functional unbundling of the production process into different stages and it is governed by the trade-off between specialisation and coordination costs. The second one is concerned with geographical location of production stages and it is governed by dispersion and agglomeration forces (Damijan et al., 2013b). FDI is seen as the crucial part of supply chains and recent advances in information and communication technology (ICT) have enabled geographical dispersion of production stages at lower coordination costs. This in turn has led to vertical specialisation between so called “headquarters” and “factory” economies in which MNCs combine advanced technology with low wage costs. The consequence of global supply chain for host country is their fast inclusion in international trade and growing exports especially those arising from export of intermediate inputs. In addition, MNCs invest in production facilities, training and technology transfer. However, as noted by Baldwin (2012) “factory” economies can be easily supplanted by another low wage country. Furthermore, slicing of the value chain provides only limited gains as most of the know-how and technology is concentrated in the parent company. Most of the activities offshored abroad are low value added activities such as assembly and as Baldwin (2012) argues, the fabrication stages are not the development panacea as they once were.

1.3.4 INTERNALISATION THEORIES

Hymer (1976) argued that the existence of firm specific advantages is a necessary condition for foreign firms to invest successfully abroad, but not sufficient to explain the motivation for moving production abroad. A firm can exploit its advantages either through export or licencing without the need to set up a foreign subsidiary. Reasons for wishing to set up a foreign subsidiary are referred to as internalisation advantages. Internalisation implies the implementation and full control of production process from raw material inputs to sales stage rather than using the arm’s length transactions. The

[3] Unbundling is a term introduced by Baldwin (2011) meaning on going structural changes in the economy and economic progress caused firstly by industrial revolution in 19th century followed by reduction of transport and trade costs in the second half of 20th century. While these factors drove the first unbundling, advances in information and communication technology have led to second unbundling characterised by reduction in coordination costs and slicing up the production process into different stages located in different countries.

choice to internalise is driven by market failures affecting the contractual relationship with local firms, creating difficulties and uncertainty for MNCs to fully exploit their ownership advantages.

The internalization theory, developed by Buckley and Casson (1976), Hennart (1977) and Rugman (1981), explains the emergence of multinational enterprises through the failure of markets for intermediate products. It is closely related to transaction costs theory which views transaction costs as the main determinant of the existence and growth of productive organizations (Coase, 1937; Williamson, 1985), and to the resource based view (RBV) to explain efficiency aspect of firm specific advantages (Penrose, 1959). Although the views of Buckley and Casson (1976) do not differ much from those of transaction cost theorists, the market failure argument is somewhat different. As argued by Hennart (1982) the transaction cost focus is primarily on market failure arising from asset specificity, market power and contractual imperfections while internalisation theory focuses on market failure in markets for information. Transaction costs such as information, enforcement and bargaining costs are the result of high risk and uncertainty arising from markets for intermediate goods (Faeth, 2009). According to Hennart (1982) FDI will arise if MNCs are able to organize interdependencies of economic actors more efficiently than markets. These interdependencies are related to access, combination and management of resources such as production, marketing techniques, management skills, intermediate inputs and financial capital across geographical locations (Rugman et al., 2011).

Rugman (1981) argues that internalisation theory is a general theory of FDI and notes that although firms' specific advantages (FSA) are necessary they are not sufficient condition for FDI to take place. The internal market permits MNCs to protect, transfer, deploy and exploit the knowledge through foreign subsidiary without incurring the risk of FSA dissipation as in the case of weak patent protection systems. Magee (1977) added public good properties of technology and argued that FDI can prevent undesired diffusion. In this way, the firm is able to better control the application of its knowledge and to prevent it from spilling over to other firms, as would be the case in international trade.

There are three sets of issues that may affect market transactions between MNCs and local producers in host economies (Rugman et al., 2011). First, the hold-up problem arises because of the presence of incomplete contracts when it is not possible to write contracts covering all possible contingencies affecting the relationship between the firms because of uncertainty (Hart and Moore, 1988). The terms of the contract can be renegotiated ex-post, but if the investment is specific to the relationship, then the supplier's bargaining position will be weak causing the initial investment to be suboptimal. Hence, the wholly owned subsidiary arises as a possible solution. The second problem is related to the dissipation of intangible assets due to knowledge being at least partially non-excludable, non-rival, and non-codifiable (Arrow, 1962; Romer, 1990). As local firms learn the MNCs' technology they become competitors and may threaten the future profits of MNCs. Furthermore, local suppliers can produce low quality products under high quality brands thus creating reputational risk for MNCs. The third issue is related to principal-agent problem arising from hidden action or hidden information about the local market (Akerlof, 1970; Stigler, 1961; Spence, 1973). For these reasons, intangible assets such as technology are costly to exchange through market-based transactions and internalisation emerges as a possible solution.

To sum up, the internalisation theory focuses on explaining why the international transactions of intermediate products are organized by hierarchies rather than standard market transactions. In this respect the answer may be that internalising the transaction is an answer to market failure of intermediate goods because of asymmetric information, asset specificity, uncertainty and irreversible commitment and opportunistic behaviour. The result is the creation of MNCs which is regarded as an internal market which brings activities under common ownership and control and provides an answer to market failure for information (Rugman, 1985).

The internalisation hypothesis explains why firms use FDI in preference to exporting and licensing. However, the major drawback of this theory is that it only considers internal factors of the firm, largely ignoring external factors, such as host country environment. Dunning (1992) argues that internalisation hypothesis is not sufficient to explain the level and structure of the foreign production of firms. Moreover, the hypothesis cannot be tested directly as much of the argument rests on the incidence of costs in external and internal markets whose specification and measurement is difficult to quantify (Moosa, 2002, Dreyhaupt, 2006). Finally, it does not explain the reason why companies choose to go abroad and invest in specific location.

An alternative explanation offered by property rights approach sheds more light on the limits and costs of vertical integration i.e. governance costs disregarded by transaction costs approach (Grossman and Hart, 1986; Hart and Moore, 1990; Hart, 1995). The central idea of the theory is that internalisation matter because ownership of assets is a source of power in case of incomplete contracts. The owner of the assets holds *residual* rights of control and it can decide on the use of these assets to make threats that improve their bargaining power over their supplier (Grossman and Hart, 1986). However, in the presence of relationship specific investments vertical integration entails transaction costs because by reducing suppliers' bargaining power it also creates disincentive for the latter to make investments that are specific.

Other contributions of property right approach have formalised the prevalence of FDI over offshoring. For example, Antras and Helpman (2008) show that improvements in contractibility of manufacturing leads to prevalence of FDI rather than offshoring which is in contrast to transaction costs predictions. Similarly, Acemoglu et al. (2007) show that headquarters contract with their suppliers and that internalisation decision depends on the technological complementarity across inputs. An extension of the previous model is provided by Antras and Chor (2013) who show that when production is conducted in sequential steps, the make or buy decision depends on the average buyer demand elasticity and the degree of complementarity of inputs. For instance, firms find it optimal to vertically integrate upstream stages and outsource downstream stages if demand elasticity is low relative to input substitutability in which case stage inputs are sequential substitutes and vice versa.

1.3.5 OLI PARADIGM

The emergence of eclectic paradigm was a response to growing role of international production and MNCs in the world economy. It combined several economic theories: the macroeconomic theories of trade, international capital movements and location, the theories of industrial organisation, and the microeconomic theories of the firm (Dunning et al., 1986). Ownership advantages drew on theory of industrial organization while macroeconomic and microeconomic theories were used to elaborate the concepts of location advantages and internalisation advantages, respectively. The main contribution of eclectic paradigm is provision of framework for FDI motives and a discussion of the choice of market entry modes. In cases where production depends on resources and capabilities of firms which are not equally endowed, traditional theory of factor endowments and perfect markets cannot explain FDI. As argued by Dunning and Lundan (2008) two types of market failures must exist in order for firms to engage in FDI. First, structural market failures that give rise to monopolistic advantages through barriers to entry. This type of market failure enables firms to control property rights and govern geographically dispersed activities resulting in ownership advantages. Second, transactional market failure of intermediate goods markets at lower transaction cost compared to hierarchical mode of governance leads to internalisation advantage.

According to Dunning (1977, 1979, 1980, 1988b, 2003) international activities of MNCs are determined by three sets of factors which must be met simultaneously:

- Ownership advantages based on asset specificity, institutional assets and transaction cost minimising advantages. The first type includes managerial and marketing skills, intangible assets, technology. The second type is based on organizational systems, norms and values while the third type is related to common governance of specific and complimentary assets. All of the advantages are combined in MNC activities, thus making them impossible to sell, as they are closely tied to the infrastructure and culture of the firm. This is contrary to Hymer’s assumption that all assets are tradable.
- Localisation advantages related to both home and cost countries. They include natural resources, created assets, costs, quality and productivity of factor inputs. Furthermore, they can be related to institutional development, government policies and incentives given to MNCs, cultural, language and legal similarities, agglomeration economies and availability of good infrastructure, proximity to major markets, transportation costs.
- Internalisation advantages which determine the choice of transfer of ownership advantages. Through internalisation MNCs are able to avoid transaction cost

arising due to risk and uncertainty and contract enforcement costs. Internalisation also allows MNCs to save on cost through for example transfer pricing.

The eclectic paradigm further asserts that the significance of each of these advantages and configuration between them is likely to be context specific, and is likely to vary across industries (or types of value-added activities), regions or countries (the geographical dimension) and among firms (Dunning, 1988b). Thus there are likely to be differences in the ownership advantages of firms coming from different countries or even regions. The extent of market failures influencing the decision to internalise is likely to be different across industries, while the importance of comparative locational advantages may be different depending on the type of FDI, strategic objectives and mode of entry of MNCs (Faeth, 2009).

According to Dunning (1981), the importance of each component in his model is different which determines the choice of firms whether to engage in international trade or international production. Of the three advantages, ownership advantages are essential. However, if the firm has only ownership advantages without the other two advantages, it will benefit from licensing rather than FDI. In the case where the firm has ownership and internalization but not location advantages, it will prefer to sell its products by exporting.

Overall, eclectic paradigm provides a more comprehensive view of FDI than theories discussed above. It acknowledges that ownership, location and internalisation advantages are dynamic in nature and interdependent of one another. For example, firms' specific advantages in combination with internalisation advantages give MNCs an advantage over domestic firms especially if local markets provide some cost savings. As argued by Dunning (2001) the combination of OLI variables as a whole exceeds the sum of individual benefits. However, one of the main criticisms of the eclectic paradigm is that it includes so many variables that might be different when explaining the motives of FDI. Dunning himself acknowledged this fact and stated that it was an inevitable consequence of trying to incorporate several trade theories which could satisfactorily explain cross border transactions. Dunning (1992) acknowledged that OLI characteristics change over time, hence he incorporated some additional components in order to capture the dynamics of MNCs' activities and host market environment. Institutional assets are a new addition to the paradigm, and cover the range of formal and informal institutions that govern the value-added processes within firms (Dunning and Lundan, 2010). They developed a theoretical framework that integrates the institutional theory (North, 1990; 2005) with the evolutionary theory (Nelson and Winter, 1982) in the context of the OLI paradigm. Finally, some authors argue that ownership and internalisation activities are jointly determined (Rugman, 1985) and former advantages are derived from latter (Itaki, 1991). Furthermore, Itaki (1991) argues that ownership advantages are determined by location advantages emphasizing the lack of theoretical parsimony. However, despite some of the shortcomings, OLI paradigm *"undoubtedly represents the most comprehensive framework to explain foreign entry mode choices and the economic efficiency implications thereof"* (Rugman et al., 2011, p. 762).

1.3.6 EVOLUTIONARY APPROACHES TO THE THEORY OF MNC

Theories explained above are based on the premise that the source of ownership advantages is technological innovation in the home country which allows firms to expand abroad. The central role in the development of technology and know-how was assumed to take place within the parent company. For example, product life cycle theory (Vernon, 1966) supported the view that innovation activities exploring new competencies are based in parent companies within the home country. This type of subsidiaries is often called competence exploiting (Cantwell and Mudambi, 2005). They are characterised by cost reduction and quality improvements of existing products and exploitation of existing competencies transferred from the parent company. The dynamics of learning process and allocation of competences to foreign affiliates as well as their embeddedness in local environment are omitted in internalisation theories.

According to resource based view, firms' growth and competence is driven by internal factors such as its productive assets and intra-firm coordination of activities (Penrose, 1959). The evolutionary perspective emphasizes organizational capabilities and routines which are tacit and evolve gradually (Nelson and Winter, 1982). Based on these insights, Cantwell (1989) developed technological accumulation theory where development of technology is a cumulative process within the firm determined by product and process innovation with the aim to increase productivity, reduce costs and increase profits. In other words, technology accumulation theory of the MNC has put emphasis on the path dependency of existing assets and on the accumulation of new assets. MNCs are viewed as a repository of knowledge and scholars have turned attention on the role of competition and firms' strategies when trying to maintain and continuously upgrade their technological know-how. In addition, geographical dispersion is regarded as an important factor enabling the transfer of knowledge between foreign affiliates. In this context, location advantages of host country act both as a determinant of MNC's activities and source of their new knowledge and are considered endogenous due to spillover effects.

By operating in many countries, MNCs gain access to localised knowledge which can then be used to improve their competitive advantages. In this process subsidiaries play an important role as a new source of knowledge, ideas and capabilities (Zanfei, 2000). Several authors have demonstrated that the bulk of innovation activities is conducted outside of parent company (Almeida and Phene, 2004; Kenney et al., 2009). This paved the way to so called "double network" structure where context specific knowledge is transferred through internal networks between subsidiaries spread across different locations and external networks between subsidiaries and its suppliers, customers and partners in host locations (Zanfei, 2000).

This led to different type of subsidiaries named competence creating whose aim is to benefit from localised knowledge (Cantwell and Mudambi, 2005). Upon the initial entry foreign subsidiaries are limited to adaption of products to local markets, but over time they start to develop their own capabilities, thus contribution to product upgrading and diversification of markets (Birkinshaw and Hood, 1998). Besides technological competencies, competence creating subsidiaries also cover market competencies such as market sales activities and supply competences evident in production, logistics and distribution activities (Asmussen et al., 2009; Figueiredo, 2011). These competences contribute to overall competitiveness of MNCs if they are successfully transferred to parent company and other subsidiaries in the network through revers knowledge transfer (Ambos et al., 2010; Frost and Zhou, 2005).

The major determinants separating competence creating subsidiaries from those based on exploiting the existing knowledge are location and strategic interdependence. In relation to first determinant, regions or countries with good infrastructure, science base and skilled workforce are more attractive for R&D subsidiaries. In particular, the emphasis is put on agglomeration economies which lead to specialisation externalities or intra industry spillovers (Marshall, 1890; Jaffe et al., 1993; Almeida, 1996) and diversity externalities or inter industry spillovers (Jacobs, 1969; Feldman and Audreutsch, 1999). In order to take advantage from innovative activities arising from different locations, MNC must allow greater autonomy to its subsidiary as it enables the latter to improve its ability to form external linkages with other companies and institutions in local environment (Birkinshaw et al., 1998; Andersson and Forsgren 2000). It has also been argued that autonomy is an indicator of the subsidiary's strategic importance over production and technology, hence leading to a higher local sourcing (Liu, 2010) and generation of independent competencies (Cantwell and Iguchi, 2005). As subsidiary becomes more competent MNC may transfer some of the business functions to it (Yamin and Otto, 2004). As a result, subsidiary can better respond to demand in local markets and develop more intense linkages with domestic firms (Hansen et al., 2009).

Another approach to evolutionary theory of MNCs is taken by Kogut and Zander (1993) who focus on the role of knowledge in explaining the boundaries of the firms. They define MNCs or firms in general as social communities that specialise in the creation and internal transfer of knowledge. Moreover, Kogut and Zander argue that MNCs arise due to their superior efficiency as an organisation vehicle by which knowledge can be transferred across borders. According to this view, tacit knowledge because of its non-codifiability, non-teachability and complex nature is the source of MNCs' ownership advantages. Non-codifiability protects knowledge against imitation while non-teachability and complexity places constraints on the extent to which a local firm can imitate the MNC's activities. The costs of extending it to more users is high, thus tacit knowledge is typically transferred within MNCs as it requires a complex learning-by-experience process that cannot be organized via markets (Kogut and Zander 1993).

The authors criticize internalisation theory arguing that limits to the firms are determined by firm's efficiency to acquire knowledge and not by failure of the market to protect knowledge and transaction costs (Ietto-Gillies, 2014). The cost of technology transfer varies with the degree of tacitness and therefore the decision between FDI and licensing depends on accumulation of learning experience about codification procedures.

1.3.7 NEW TRADE THEORY

New trade theory provides an alternative framework for analysing FDI based on general equilibrium models. It is mainly based on industrial organization approach, internalisation theory and OLI framework combined with features of imperfect competition such as product differentiation and economies of scale. Ownership advantages arise from knowledge capital, location advantages from country size, trade costs and differences in factor endowments and internalisation advantages from joint input property of knowledge capital (Faeth, 2009). Within the new trade theory three models have been developed based on proximity and concentration advantages, differences in factor endowments and their integration in knowledge capital models.

Horizontal model. The first set of models is related to horizontal type of FDI as an alternative to exports and it is based on only one factor of production and similar factor endowments across countries (Markusen, 1995, 2002). Markusen (1984) incorporated knowledge based ownership advantages such as R&D, marketing, scientific workers and product complexity which enable firms to engage in FDI. This enables easy transfer of knowledge based assets between production plants as latter has a joint input nature which can be used in multiple locations without diminishing in value. This in turn gives rise to firm economies of scale due to public good nature of knowledge which can be supplied to other plants at very low costs. Under these circumstances increase in cost efficiency gives rise to MNC.

Extensions of theoretical models (Horstmann and Markusen, 1987, 1992; Brainard, 1993) are based on trade-offs between additional fixed costs of setting up a new production plant and benefits arising from avoiding trade and transportation costs. This is also known as *"proximity concentration hypothesis"* between the advantages of accessing the local market to avoid transportation costs (proximity) and scale economies in production in one plant (concentration). The models predicts that FDI will arise when transportation and tariff costs are larger than plant level fixed costs and when firm level scale effects due to knowledge capital are larger than plant level economies of scale. Markusen and Venables (1998, 2000) extended the models to incorporate multi country framework to consider similarities in size of countries, technology and factor endowments further explaining the importance of MNCs over trade.

Vertical model. Vertical FDI takes place by geographical fragmentation of production in order to exploit difference in factor costs between countries. This type of FDI is modelled under assumption that different parts of production process require different inputs. Therefore, it becomes profitable to split production chain across several locations to benefit from example low labour costs. Models of vertical FDI have been developed by Helpman (1984) and Helpman and Krugman (1985) by incorporating extended Heckscher-Ohlin trade theory with two factors of production and two sectors. The latter assumption is based on one perfectly competitive industry with constant returns to scale and the other producing differentiated products under increasing returns to scale. Similar to horizontal models, firms are assumed to possess knowledge capital called *"general purpose input"* (H) which is internalised by the firms. Products in differentiated industry are produced using labour and H factor with the latter being located in the headquarters. The driving force of the model is absence of Factor-Price-Equalisation (FPE) which enables firms to geographically fragment their production.[4] In addition, the model assumes no trade and transportation costs thus firms have no motivation to have plants in multiple countries. Hence, the focus of Helpman's model was to show that MNC have an incentive to reallocate their production across geographical space if the countries differ in their relative factor endowments. However, vertical model has been criticised by Zhang and Markusen (1999) as labour abundant countries do not receive much FDI. They posit that notwithstanding that some of the labour intensive activities is undertaken abroad, MNCs still needs skilled workforce supported by good institutions and infrastructure in the host country.

Knowledge capital model. A more sophisticated model of MNC behaviour was developed by Markusen et al. (1996) and Markusen (1997) that combined horizontal and vertical motivations of MNCs. According to Markusen (1995) knowledge capital consisting of intangible capital, trademarks, brand names and human capital is the primary source of firms' specific advantages and provides opportunity for MNCs to go abroad. He argues that knowledge being partially nonexcludable, nonrival, and

[4] The assumption states that factor prices of labour and capital in countries with different factor endowments will be equalised due to international trade (Samuelson, 1948).

noncodifiable (Arrow, 1962; Romer, 1990) generates a risk of expropriation and thus provides MNCs incentive to internalise and thus limit technology spillovers.

The assumption of the model is two countries, two sectors and two factors of production which allow vertical and horizontal MNCs to emerge endogenously. Carr et al. (2001) construct a model which allows empirical investigation of knowledge capital model and motives for horizontal and vertical FDI. Studies such as Markusen and Maskus (2002) showed that horizontal FDI is the most prevalent type of FDI. However, firm level data studies showed more complex forms of FDI and only a fraction of MNCs can be purely classified as horizontal and vertical FDI (Hanson et al., 2001; Feinberg and Keane, 2006). This led to new theoretical model developed by Yeaple (2003) which shows how complex internalization strategies lead to complicated FDI structures which are determined by complementariness between host countries.

Ekholm et al. (2007) extended the model into a three-region framework with two high cost countries and one low cost to include export-platform FDI. The latter occurs when a firm in a large high-cost country move a part of its production to a low cost country in order to supply the other high-cost country. Low cost country mainly imports intermediate products and assembles final goods, combining intermediates and unskilled labour.

Firm heterogeneity. Recently, both horizontal and vertical model of FDI have been criticised as both assumed that firms are homogeneous in productivity. However, empirical evidence has pointed out that international activity is conducted mostly by large and most productive firms (Ramondo et al., 2015). Several authors have thus incorporated heterogeneous choices of firms within the sectors to be consistent with micro level facts. Helpman et al. (2004) developed a model in which firms display heterogeneous levels of productivity. Decisions about market entry are made in several sequences. First, potential entrants pay sunk costs f_E in order to enter the industry upon which they learn about their productivity. Upon observing its productivity firm may exit the market incurring negative ex post profits $-f_E$ or decide to operate on domestic market by paying an additional costs f_D. If it chooses to produce it has the option to sell its product variety abroad either by engaging in exporting by paying an additional fixed costs f_x or to serve the foreign market through local production in which case it incurs an additional higher fixed costs f_I. Concentration force depends on the difference between the last two parameters, while proximity force stems from additional iceberg-type transport costs of $\tau > 1$ per unit of output sold in the export market (Arnold and Hussinger, 2011). Production abroad does not incur these additional transport costs and goods are produced using the same level of firm's efficiency as in the home country. The implication of the model is that internationalization mode depends on the sales volume on the foreign market which is a function of strictly increasing productivity levels. The model predicts three cut off productivity levels which explain proximity concentration trade off. Firms with the lowest productivity serve the home market, more productive firms serve foreign market through exports and only the most productive firms engage in FDI as their volume of sales is able to recoup higher fixed costs.

Antras and Yeaple (2013) developed a one factor (labour) model similar to Helpman's vertical model (1984) with the exception that cross country differences in factor prices emerge not from relative factor endowments, but from Ricardian technological differences. Firms in differentiated sector enter the market by incurring fixed costs f_E after which they learn about their productivity and decide whether to stay on the market or exit. They further encounter an additional costs of F_D associated with provision of headquarter services which are combined with manufacturing production. Since the assumption is that wage in foreign country is lower than home offshoring of manufacturing becomes a viable alternative. However, by fragmenting their production additional fixed costs $F_i - F_D > 0$ arise at home country since headquarters services and manufacturing production are geographically separated and such fragmentation entails iceberg costs $\tau > 1$. The latter are related to transportation costs from shipping manufacturing goods back to home country. Antras and Yeaple (2013) show that only the most productive firms are able to achieve high levels of profit which enable them to engage in vertical FDI.

1.4 MOTIVES AND MODE OF MNCS' ENTRY

In the previous section a summary of literature explaining the determinants of MNCs activities abroad was provided. The discussion in this section is oriented towards strategic objectives of MNCs and modes of entry into foreign market with the aim to show how different motives influence type and amount of technology transfer to host countries and the nature of potential FDI spillovers. Taxonomy used by Behrman (1972) and later on expanded by Dunning (1992) based on OLI paradigm distinguishes between four different motives of FDI:

1. Resource seeking
2. Market seeking
3. Efficiency seeking
4. Strategic asset seeking

As noted in Narula (2003), the first three kinds of investment are related to exploitation of already existing firm specific advantages, while the strategic asset-seeking investment represents an asset augmenting activity and are closely related to technological accumulation hypothesis discussed in Section 1.3.6 whereby firms choose to acquire or purchase the assets of existing firms additional assets with the aim to strengthen their global competitiveness (Dunning and Lundan, 2008).

The main aim of resource seeking motive is acquisition of natural resource not available in the home country (e.g. natural resources or raw materials) or available at lower costs (e.g. unskilled labour). It also includes acquisition of technological and managerial capabilities, skilled labour and marketing skills which are more available in developed countries. Market seeking motive takes place when MNCs is interested to gain direct access to large foreign market or one with high growth potential or indirect access where MNC invest in one country which serves as an export platform. It has been noted that this type of FDI is an alternative mode to serve foreign markets for companies which previously exported to host country and decided to carry out FDI due to unfavourable tariffs or other market restrictions (Dunning, 2008). Other reasons include proximity to suppliers and customers, adaptation of products to local culture and tastes of the host market and reduction of transportation and production costs. It can also reflect global marketing strategy where market seeking FDI is a response to competitor’s investment (Knickerbocker, 1973). In international trade models discussed in Section 1.3.7 these motives are known as vertical and horizontal, respectively.

The third motive is driven by the desire to increase efficiency by taking advantage of lower labour costs abroad thus being very closely related to resource seeking motive (Nunennkamp and Spatz, 2002) or achieving economies of scale and scope by gaining from common dispersed activities (Campos and Kinoshita, 2003). This type of investment is undertaken in countries with similar economic structure and income levels to contribute to risk diversification. Lastly, strategic asset seeking motive which is not entirely consistent with OLI paradigm is concerned with possibility to gain access to assets created in host countries. For example, these assets can be accessed through existence of agglomeration economies such as availability of specialised labour, better linkages with suppliers and customers and technological spillovers. In addition, this localized knowledge can be the result of organizational capabilities of the firms which are embedded in organizations and tacit making them hardly communicated and transferred via arm's length transactions (Kogut and Zander, 1995). This tacitness is an embedded component of both individual skills and organizational routines (Nelson and Winter, 1982) and gives rise to the concept of knowledge based assets. Much of the knowledge based capital is disseminated through learning by doing and is not easily transferable. Therefore, technology available locally requires close contacts giving rise to asset seeking FDI where MNCs benefit from reverse technology spillovers (Sanna-Randaccio and Veugelers, 2007).

Apart from motives which are seen as important determinants of FDI as they influence both the likelihood of choosing FDI among other set of alternatives as well as the choice of location, MNCs face other two strategically important decisions. First, they must make a decision on whether they will invest in a completely new venture (greenfield) or if they would merge /acquire an already existing firm in the host country (M&A or brownfield). Second, they must make a decision about the ownership of the new company, i.e., whether it is a wholly owned subsidiary or joint venture with local firms. Recent contributions to international trade and FDI theory discussed in Section 1.3.7 have recognized firms' productivity as an important factor in explaining their international activities. A further distinction made by Nocke and Yeaple (2007, 2008) is to sort firms according to their mode of entry in host markets. They recognize that firms are heterogeneous in several dimensions and that this heterogeneity is embodied in intangible asset which can be transferred across firms only through ownership. The role of M&A is to improve the assignment of intangible asset to firms to exploit complementarities. Greenfield investment occurs when firms' relatively immobile asset is highly valuable that it makes it profitable to move it abroad despite high relocation costs. Nocke and Yeaple (2008) show that most productive firms tend to enter foreign market through greenfield investment. Similar conclusions are made by Raff et al. (2009). An alternative explanation for M&A is provided by Neary (2007) who introduces an oligopolistic market structure in a general equilibrium framework and shows that M&A is the result of the reduction in trade costs. Firm efficiency is also an important determinant of ownership mode. For example, Mugele and Schnitzer (2008) showed that the most efficient firms will choose wholly owned subsidiaries, however if there exists large cultural differences the value of local partner increases. Javorcik and Wei (2009) find that joint venture is preferred in countries with high levels of corruption.

1.5 POTENTIAL BENEFITS OF FDI

The attitude towards MNCs in 1960s and 1970s was generally hostile as FDI was blamed for depleting scarce resources, exploiting host-country employees, and forming global monopolies (Ghosh, 2001). However, Caves (1974) showed that MNCs may improve allocative efficiency by entering into industries with high entry barriers and reducing monopolistic distortions, and induce higher technical efficiency if the increased competitive pressure or some demonstration effect spurs local firms to more efficient use of existing resources. This shifted the attention to studies on the FDI's contribution at the macroeconomic level in terms of its impact on economic growth (e.g. Borensztein et al., 1998; Alfaro at al. 2004, Carkovic and Levine, 2005) and at the microeconomic level in terms of firms' productivity (e.g. Aitken and Harrison, 1999; Javorcik, 2004a; Blalock and Gertler, 2008).[5]

The characteristics of FDI discussed in previous sections provide incentive to MNCs to transfer technology in the form of capital goods and technological and managerial know how to their foreign subsidiaries. As noted by Blomström and Kokko (2002, p. 3), MNCs *"undertake a major part of the world's private R&D efforts and produce, own, and control most of the world's advanced technology"*. Bloom and Van Reenen (2010) found

[5] It is worth noting that the entry of MNCs also have social, political, cultural and environmental effects.

that MNCs have better management practices and styles which can be transplanted abroad resulting in higher productivity, profitability, innovation and employment growth. Therefore, the potential for a large magnitude of technology transfer, know-how and management practices across countries is a major motivation for governments to provide fiscal and other type of incentives to attract MNCs (de Mello, 1997; Weber, 2010).

MNCs possess firm specific advantage that enables them to compete on foreign markets. Higher labour or total factor productivity (TFP) is associated with higher potential for technology transfer (UNECE, 2001). FDI is usually associated with increased competition in product markets leading to changes in market structure such as the breakup of local monopolies and factor markets by increasing the demand for highly qualified personnel (Blomström and Kokko, 2002). Greater competition can also lead to reallocation of resources from less productive to more productive foreign firms, leading to higher aggregate productivity. However, this may lead to crowding out of local firms. Recent empirical evidence points to the beneficial impact of foreign acquisition on productivity of acquired firms after controlling for possible cherry picking behaviour (Arnold and Javorcik, 2009; Guadalupe et al., 2011).

There is also ample empirical evidence that MNC pay higher wages than domestic firms (Girma et al. 1999; Lipsey and Sjöholm, 2001; Sjöholm and Lipsey, 2006; Harrison and Rodriguez-Clare, 2010). Besides paying higher wages, MNCs are found to undertake substantial investments in training of their personnel contributing to skill development (Fosfuri et al., 2001; Alfaro et al., 2009). Also, in addition to direct effect, the presence of MNCs can indirectly encourage individuals to upgrade their skills and knowledge, and invest in training with the aim of securing a job with MNCs. If inward FDI is oriented towards high technology and high skill industries it may help host countries to specialize in those activities and thus contribute to their international competitiveness by affecting the composition of exports and ultimately their balance of payments (Resmini, 2000, UNCTAD, 2002). The focus on industries with higher R&D content can help countries move up the global value chain (UNCTAD, 2002; Sohinger, 2005) which in turn can help them to generate more income, create high skilled jobs and pay higher wages. FDI is also a significant contributor to domestic employment both directly through greenfield investment and indirectly through creation of backward and forward linkages, thus creating employment in upstream and downstream industries.

The potential effects of FDI discussed above refer to direct transfers from the parent company to its subsidiary. However, knowledge and technology developed within MNCs can spill over intentionally or unintentionally to local firms through multiple channels thus affecting the industry in which foreign subsidiary operates or related industries in downstream and upstream sectors. It is generally argued that the indirect effects of FDI are the main reason why governments around the world offer generous incentives to MNCs (Buckley et al., 2007a). For this reason, the next chapter is entirely devoted to the theoretical discussion of FDI spillovers with the aim of identifying the exact channels of such spillovers and the conditions for their occurrence, and to review the findings in the literature which will inform our empirical model in subsequent chapters.

Although the above discussion mainly pointed to the beneficial effects of MNC's presence in a host economy, FDI can also have negative effects. For instance, if the level of technology transferred to host country is low and foreign firms operate in low value added industries positive direct and indirect effects on growth and international competitiveness may be limited or even negative. Furthermore, if MNCs source their intermediate inputs from abroad or buy only low value added intermediate inputs, the inclusion of indigenous firms in GVCs may not occur, thus limiting their potential to increase productivity. Besides positive competition effects which aims to increase the efficiency and innovativeness of incumbent firms, MNCs may crowd out local firms due to their larger size, higher productivity and better access to finance. Regarding the latter, the evidence points out that MNCs finance some of their investment from local financial markets and not bring scarce capital from abroad (Lipsey, 2002, Harrison et al., 2004). This may in turn exacerbate local firm's financing constraints and eventually lead to exit from the market due to their inability to finance necessary investment. Furthermore, MNCs can be present in strategic industries of a host country and thus may exacerbate their influence to push for the policies which are beneficial for them but not necessarily for local firms (Golub, 2003).

To summarise, the theoretical literature suggests diverse effects of FDI on host country which is also corroborated by empirical evidence providing mixed findings on both direct and indirect effects (e.g. Lipsey and Sjöholm, 2004; Smeets, 2008). The current consensus is that the effects of FDI are not exogenous in most cases and depend on the country and firms' absorptive capacity. The most important factors moderating the effects of FDI are human capital (Borenzstein et al.,1998; Xu, 2000; Wang and Wong, 2009), the technological level of host country/firms (Havranek and Irsova, 2011), complementarity of different policies (Rodrik and Rosenzweig, 2009; Harrison and Rodriguez-Clare, 2010), competitive environment (Moran, 2007), development of financial markets (Hermes and Lensink, 2003; Alfaro et al., 2004, Alfaro and Charlton, 2013), the state of intellectual property rights system and general institutional quality (Javorcik, 2004b: Bénassy-Quéré et al., 2007), the MNC heterogeneity (Neto et al., 2010; Javorcik and Spatareanu, 2011), sectors of operation (Alfaro, 2003) and the length of time since FDI entry (Merlevede et al., 2014).

1.6 CONCLUSIONS

In this chapter we have described the concept and measurement of FDI, the reasons why MNCs choose FDI among many other internalization alternatives, and the expected effects on host countries. The theoretical review identified several strands of literature trying to explain the sources of MNC's ownership advantages, the reasons for internalisation of their activities and location characteristics of host country that determine the motive, entry mode and ownership structure. Some theories are based on perfect markets, while others are based on imperfect markets and general equilibrium models. However, no theory provides a unified framework explaining international investment, although the OLI framework tried to combine several strands of literature in defining ownership advantages, causes of internalisation and the role of location in attracting MNCs. The determinants and motives of FDI put forward by Dunning gained strong theoretical and empirical support in later models combining ownership and location advantages with technology and country characteristics in explaining both horizontal and vertical FDI. Recent theoretical contributions are related to the subsidiary being the relevant unit of analysis and source of FSA due to idiosyncratic resource base, strategic motives and the role within MNCs which has implications on the amount of knowledge transferred through internal networks. Furthermore, FSA can be augmented through subsidiary autonomy and its embeddedness in host country locations.

The heterogeneity of FDI is found to be highly important when discussing the potential impact of MNCs as the latter differ in terms of knowledge, technology and productivity which enable them to overcome the liability of foreignness. By exploiting firm specific advantages in combination with location characteristics MNCs increase their competitive advantage. However, due to public good characteristics of knowledge and the need for interaction with local environment, some of the foreign knowledge is expected to spread across location resulting in improvements at both micro and aggregated productivity levels. In addition, knowledge can be transferred either voluntarily to suppliers and customers or involuntarily through knowledge spillovers. As we shall see in the next chapter a separate theoretical literature analysing indirect effects of MNCs' entry has evolved explaining multiple channels of influence on indigenous firms. However, empirical studies often fail to capture the multiple channels through which FDI spillovers can occur, or when they do, firms are treated as homogenous entities. The provision of government incentives to MNCs is only warranted if the effects of FDI beyond direct effects such as direct capital financing or increase of employment are positive. Therefore, the next chapter will provide a conceptual framework for analysing the determinants of FDI spillovers paying attention to domestic and foreign firms' heterogeneity, types of linkages and other complementary factors.

CHAPTER 2.
FDI SPILLOVERS AND LINKAGES: THEORY AND EMPIRICAL EVIDENCE

2.1 INTRODUCTION

Governments around the world provide a range of incentives such as help with information about local business opportunities, tax holidays, employment subsidies and land grants to attract MNCs to their countries. The main motive for these policies is the assumption that MNCs add value to the host country's economy such as job creation, provision of necessary capital and increased tax revenues identified in the previous chapter, and also generate indirect effects resulting in productivity growth. Productivity spillovers have been identified as one of the most important benefits of FDI (Blomstrom and Kokko, 1998). When a MNC sets up a subsidiary, it is expected to bring in a certain amount of firm-specific intangible assets that allow it to compete successfully with local firms and to overcome the "liability of foreignness". The MNCs' superiority arises from their advanced process and product knowledge, better managerial and organizational know-how and scale efficiency (Kokko and Kravtsova, 2008). With this superior knowledge, it is often expected that MNCs perform better, and are more efficient and productive than their domestic counterparts. In the process of transferring knowledge to their subsidiaries there is a possibility that some of this knowledge spills over to local firms involuntarily or voluntarily through several channels. These knowledge spillovers may affect firms within industry or across industries through backward and forward linkages. However, empirical evidence on indirect effects of FDI are ambiguous due to complexity of spillover channels and the mechanism through which knowledge spills over to local firms. Furthermore, one must take into account the heterogeneity of supply and demand side factors influencing the potential and actual spillovers. Moreover, the spillover process is influenced by external factors such as institutional environment, supply side factors (access to finance, skills acquisition) and spatial proximity. Recent studies have started to acknowledge these heterogeneous factors and appear to significantly influence the existence and magnitude of knowledge spillovers from FDI. The failure to take them into account may thus be a source of the empirical ambiguity (Smeets, 2008).

The chapter is structured as follows. In section 2.2 the concept and measurement of knowledge spillovers from FDI is briefly explained. The discussion of theoretical foundations of intra industry spillovers is provided in Section 2.3. In Section 2.4

theoretical models of vertical technology transfer are presented and discussed. Section 2.5 provides an overview of conceptual framework of the determinants of FDI spillover. This is followed in Section 2.6 by a critical review of empirical literature and the identification of shortcomings and limitations related to investigation of FDI spillovers in transition countries. Finally, Section 2.7 concludes.

2.2 KNOWLEDGE SPILLOVERS FROM FDI

The previous chapter explained the nature of advantages of MNCs over domestic firms and noted that by engaging in FDI, MNCs can potentially bring direct and indirect benefits to their host economies. By expanding abroad, MNCs try to exploit the knowledge gained in their home country for the purpose of making profit and maintaining competitive advantage. However, some of the knowledge may spill over to local firms due to its public good nature, first recognized by Arrow (1962), as well as other mechanisms. Knowledge spillovers gained significance in the new economic growth literature as an important factor explaining long run growth (Romer, 1986; Lucas, 1988; Grossman and Helpman, 1991). The key feature of endogenous growth theory (EGT) is that certain factors such as human capital and the utilisation of knowledge pool are not subject to diminishing returns as investment in physical capital. Scholars in EGT argue that knowledge is non-rival and incompletely excludable, thus making it available to all firms in the economy. In this context FDI is seen as a source of new technology which, with its increasing returns on output, positively influences economic growth through spillovers.

Although the term knowledge spillovers is commonly used, it lacks a precise definition. For example Jaffe et al. (2000, p. 215) suggest that knowledge spillovers occur as *"investments in knowledge creation by one party produce external benefits by facilitating innovation by other parties".* This definition implies that knowledge is created by R&D and thus knowledge spillovers are the same as technological spillovers (Hallin and Holmström-Lind, 2012). Other taxonomies include those defined in Table 2.1.

TABLE 2.1 TAXONOMY OF KNOWLEDGE/TECHNOLOGY SPILLOVERS

Author	Type of spillovers	
Griliches (1979)	Knowledge spillovers – arise from R&D activities, reverse engineering and exchange of information	Rent spillovers - from imperfect price adjustments following quality improvements of goods and services
Grunfeld (2003)	Embodied spillovers– related to transfer of tangible goods	Disembodied spillovers– related to transfer of intangible assets
Keller (2004)	Active spillovers- codified knowledge such as patents, books, journals	Passive spillovers– mainly related to tacit knowledge such as norms, routines, experience embodied in workers and difficult to transfer

Source: Author's compilation

Blomström and Kokko (1997, p.3) note that technology *"is an inherently abstract concept, and therefore difficult to observe and evaluate"*. Since technology can take many forms, it can be transferred through variety of channels making empirical analysis of technology spillovers from a certain source somewhat limited. In addition, market for technology is inefficient as involved parties in transaction are not able to agree about mutually acceptable prices (Kraemer-Mbula and Wamae, 2010). This is due to imperfect information about the value and specifics of technology. This is one of the reasons why market for technology are internalised which gives rise to FDI, as explained in more detail in Chapter 1.

The term technology has been associated with the production function and the decisions on the combination of inputs with the aim of achieving higher levels of output. With that in mind Freeman and Soete (1997) define technology as the knowledge of production techniques embodied in tangible assets. However, Evenson and Westphal (1995) argue that the knowledge of the production process and efficiency of its use is tacit, not codifiable and non-transferable.

Estimating the effects of knowledge spillovers is not an easy task.[6] As suggested by Krugman (1991a, p.53) *"knowledge flows […] are invisible; they leave no paper trail by which they may be measured and tracked"*. Furthermore, knowledge diffusion depends

[6] The terms knowledge and technology spillovers will be used interchangeably in this thesis.

on the type of knowledge transferred from MNCs to local firms. In comparison to codified knowledge that is easy to convey through tangible forms, tacit knowledge requires extensive interactions and is difficult to transmit to other parties (Polanyi, 1962). Therefore, the degree of tacitness can influence the mechanism and channels of knowledge spillovers. Spencer (2008) argues that tacit knowledge can be mostly transferred through worker mobility when employees previously working for MNCs leave the company to become an entrepreneur or decide to join another company.

Since knowledge spillovers are difficult to measure, those investigating indirect effects of FDI resort to second best solution by estimating productivity spillovers. The general premise is that technology plays an important role in augmenting productivity. The most common approach in evaluating the effects of FDI spillovers on host country firms is to use a Cobb Douglas production function in which the output, value added or productivity of domestic firms is related to a measure of foreign presence in the industry. The latter is usually defined as a share of foreign firms in industry sales, capital or employment. However, the problem is that productivity is a *"measure of ignorance"* (Abramovitz, 1956, p.11) and thus many factors apart from technological externalities may have an impact on it. Ornaghi (2004) points that if there are other factors that affect productivity, then estimating productivity spillovers is not a good indicator of technological externalities. Recently, Zanfei (2012) has challenged the so called externality framework based on production function since benefits accruing to domestic firms entails certain costs associated with purchase, adoption and development of technology. Furthermore, the production function is not able to disentangle pure technological externalities from pecuniary externalities or other competition related effects (Driffield and Jindra, 2012). The former induces changes in the firm's technology which allows firms to use fewer inputs for the same amount of output and affect long term competitiveness of firms. The latter type of externalities occurs through market transactions and formation of linkages, and affect the firms' profit function by changing the prices of inputs. They may have an even larger beneficial effect since they are available to a large number of firms, some of them not involved in linkages with MNCs (Castellani, 2012). In order to properly measure pecuniary effects, one would need to have information on input and output prices before and after the entry of MNCs which is mostly unavailable in firm level databases.

The next sections will discuss in detail the channels through which MNCs affect local firms and provide an insight into some of the issues faced in estimating FDI spillovers.

2.3 INTRA-INDUSTRY (HORIZONTAL) SPILLOVERS

Although traditional theories of FDI answered the question of 'under what circumstances would MNCs invest abroad', they did not take into account the costs and benefits as well as the impact of technology transfer on host economies. The earliest discussion on productivity spillovers dates back to early 1960s and is related to the works of MacDougall (1960), Corden (1967) and Caves (1971) who investigated costs and benefits of FDI and technology spillovers together with several other effects influencing welfare in the host economy. Caves (1974) provided the taxonomy of various spillover effects and concluded that MNCs contribute to allocative and technical efficiency and technology transfer and diffusion.

In this section the main theoretical studies modelling intra industry spillover effects from FDI will be presented and discussed. Horizontal spillovers involve involuntary leakage of knowledge through which its codified and tacit elements are transferred from MNCs to local firms (Hallin and Holmström-Lind, 2012). Three channels of technology transfer are recognised. Earlier studies viewed spillovers as an increasing function of foreign presence (Findlay, 1978). Most of these studies consider technology possessed by MNCs as a public good which can be transferred to domestic firms without costs through demonstration and imitation effects. The second strand of literature argues that spillovers involve costs and are not determined only by foreign presence. They are the outcome of interaction between foreign and domestic firms suggesting that technology diffusion and transfer are endogenously determined (Wang and Blomstrom, 1992). The more recent models, however, argue that spillovers occur through worker mobility where workers previously employed and trained in MNCs' subsidiaries take some of the knowledge acquired to improve the efficiency of their new employers (Fosfuri et al., 2001). In what follows, each of these strands will be critically analysed.

2.3.1 DEMONSTRATION EFFECTS

Knowledge spillovers are commonly expected to arise from demonstration and imitation effects. Saggi (2002) defines demonstration effects as occurring through reverse engineering of MNCs' products, technologies and management practices by host country firms. Its scope depends on the complexity of goods produced and processes used by two types of firms (Barrios and Strobl, 2002). The entry and presence of MNCs in an industry reduce the risk associated with development of new products and processes since domestic firms have more information about the costs and benefits of new methods, thus reducing the uncertainty and providing incentives to imitate. Demonstration effect occurs without active involvement of MNCs and is based on quasi-public good characteristics of new products and processes as firms can observe the outcome of technological innovations at no or very little cost. In addition, demonstration effects include the foreign firms' knowledge of distribution networks, transport infrastructure and consumer tastes which may help domestic firms wishing to become exporters or to enter global supply networks (Farole and Winkler, 2014). However, as argued by Zanfei (2012), the firms' absorptive capacity is a key conditioning factor which enables local firms to evaluate and use external knowledge.

Koizumi and Kopecky (1977) are the first to explicitly model FDI and technology transfer in the modified model of international capital movement. Technology transfer is proxied by capital stock owned by foreign firms and it is assumed that technological benefits to indigenous firms depend on the extent of foreign ownership of a country's capital stock. According to them the transmission of foreign technology is viewed as automatic and technology was treated as a public good. As MNCs are unable to internalise the total returns, host country firms can exploit the technology free of charge.

Findlay (1978) developed a similar model of international technology transfer to examine the relationship between FDI from an advanced developed economy and technological change in a developing country. In his model, the rate of technological diffusion to the developing country is assumed to depend on two factors, the *"relative backwardness"* and the *"contagious effect"*. The first factor was introduced by Veblen (1915) and Gerschenkron (1962) who stated that the rate of technological convergence and technology diffusion is faster the higher is the technology gap between the backward and the advanced country. The second factor, used firstly by Arrow (1971), stresses the importance of personal contacts as the most efficient way of technology diffusion between the parties that have the knowledge and those who adopt it. Findlay captures both effects and argues that the rate of technological change in the developing country is an increasing function of technology gap and foreign presence. FDI spillovers occur since increased foreign presence lead to smaller technological gap. However, Cantwell (1989) argues that Findlay's hypothesis does not always hold as domestic firms differ in their capability to internalise technologies in their production process.

Models of spillovers discussed above assume that differences in the level of technology between MNCs and domestic firms are the main determinant of demonstration and imitation effect. Furthermore, they assume that spillovers are exogenous, do not depend on the behaviour of foreign and domestic firms and do not take into account the absorptive capacity of the recipient(s).

2.3.2 COMPETITION EFFECTS

Another strand of literature emphasizes the competition effects in addition to the set of technologies available from FDI. Competition has two effects which are mainly pecuniary in nature. First, it reduces the monopoly power of domestic firms and forces them to benefit from new technology and management practices by introducing stricter or more cost conscious management (Blomstrom and Kokko, 1998). Second, it encourages more efficient allocation of resources and reduction of market distortions across industries resulting in increased productivity. However, increased competition may result in negative spillovers effects in the short run due to the inefficiency of domestic firms and hence reduction in their market share. If fixed costs account for a considerable part of the production costs, average cost curves will be downward sloping, in which case a loss in market share will push firms up on their average cost curves and force them to produce at a less efficient scale (Aitken and Harrison, 1999). This implies that spillover process does not involve only MNC and is not automatic. Therefore, it must include the costs of technology transfer as well as the effort of domestic firms. Competition effects cannot be regarded as pure externalities as MNCs face the transaction costs of dealing with competition policy, or offer higher wages to attract qualified workers.

Das (1987) recognized the costs associated with spillovers and used a price-leadership model from oligopoly theory to analyse the transfer of technology from the parent firm to its subsidiary abroad. He examined the optimal behaviour of MNCs when there is a risk that local rivals succeed in learning their production techniques. Similar to previous models, he assumed that the rate of increase in efficiency of local firms is positively related to the output of MNC's subsidiary. Therefore, the latter will decide to increase the price in order to reduce the amount of output at the expense of short term profit which will eventually lead to fewer spillovers to local firms. However, the behaviour of local firms is not explicitly taken into account.

In the models discussed above the advanced technology introduced by foreign firms is considered to be a public good and transferred automatically. Furthermore, it is assumed that technologies can be transferred without facing any difficulties and are adopted by local firms without any adjustment cost. As a result, these models do not deal adequately with the issue of interaction between MNCs' subsidiaries and host country firms. The contribution of Wang and Blomstrom's model (1992) lies in its highlighting of the essential role played by competition. Whereas in previous models the extent of spillovers is determined by the degree of foreign presence, in Wang and Blomstrom's model they are instead endogenously generated by the technological competition between foreign subsidiaries and domestic firms. Furthermore, the authors identified two types of costs: the cost to the MNCs of transferring technology to its subsidiaries and the costs of learning to domestic firms.

Wang and Blomstrom (1992) construct a model based on two firms in which the rate of technological transfer is determined by strategic decisions of the two firms. They also follow Findlay's assumption of a positive relationship between the technology gap and spillovers. Each firm solves the dynamic optimisation problem subject to other firm's action. The objective of MNCs is to decide on how much technology will be transferred to local subsidiary while the domestic firm's objective is to decide on how much to invest in learning to capture MNC's technology. The conclusion of the model is that the extent of spillovers depends on the investment decisions of both types of firms. The potential for spillovers is higher the more the MNCs invest in new technology, thus increasing the technology gap. However, learning by domestic firms will reduce technology gap and force the foreign subsidiary to import more advanced technology from its parent company in order to restore its market share and profit levels. This in turn provides an additional incentive to local firms to increase their investment in learning and thus more spillovers.

Perez (1997) developed a model of spillover effects using an evolutionary perspective (Nelson and Winter, 1982) which is different from previous models that fall in the framework of industrial organization theory. He emphasized that domestic firms' catching up process is path dependent and that absorptive capacity is the main source of continuous technological development. Spillovers emerge as a result of a dynamic interaction between foreign and domestic firms at the existing technology level. Perez (1997) was able to show that domestic firms with high technology level are more successful in learning from FDI and thus to stay more competitive, while firms which lag far behind the technological level of MNCs are crowded out with increased foreign presence.

2.3.3 WORKER MOBILITY

A third channel of intra-industry knowledge spillovers is worker mobility. Local firms can benefit from employees previously employed in MNCs as the latter is likely to have provide the host country workforce with a higher degree of training, education and valuable work experience (Smeets, 2008). Given that a large part of labour training constitutes knowledge that is not completely firm specific, this generates a positive externality for the receiving firm by increasing the quality of its human capital. This in turn leads to higher productivity for domestic firms that hire these workers after they leave the MNC. Also some of the MNC's senior managers may, at some point in time, choose to start up their own company, and would be able to apply the knowledge acquired in the MNC for their own firm's benefit. Worker mobility generates both pecuniary and pure knowledge effects. The former arises due to increased supply of trained workers which are available at lower costs while the latter effect arises from tacit knowledge embedded in human skills as long as the salary does not reflect accumulated knowledge. (Ben Hamida, 2007; Zanfei, 2012). However, spillovers through this channel are more likely to occur in medium and long run as knowledge must be absorbed by local employees and in the short term foreign firms are more likely to offer higher wages and other benefits resulting in negative spillover effects (Sinnai and Meyer, 2004; Crespo and

Fontoura, 2007). Several models were recently developed which model spillovers through this channel.

Fosfuri et al. (2001) construct a model in which a firm has to choose between FDI and exports to serve the foreign market, and needs to train the host country workers if it chooses the former. When training is completed, both foreign subsidiary and local firms compete for the services of employees previously employed by MNCs. Knowledge spillovers occur if the local firms make a higher offer to the trained employees. Even if workers do not change their employment status, the host country welfare might still be improved because of pecuniary spillovers embodied in the wages that the MNC pays to the trained workers to prevent them from moving to a local competitor. The conditions for occurrence of spillovers depend on several assumptions: competition in the product market is low; the training of workers is general involving organizational, marketing and managerial skills; and the absorptive capacity of domestic firms is high.

The difference between technology spillovers which occur when worker is hired by the local firm and pecuniary spillovers occurring when worker is retained by the multinational subsidiary at a higher wage is shown in Glass and Saggi (2002). In contrast to the previous model, the role of training is kept aside and the emphasis is put on the superior technology that can be transferred to host country firms if the latter hire the workers previously employed in a MNC. As the attractiveness of its workers to the host country firms is recognized, the MNC weights the cost of paying higher wages to keep them within its boundaries against the benefit of limiting technology transfer to the host firms. In their model with multiple host and source firms the foreign firm can increase its profits by raising the wage it pays to workers to a level which is enough to prevent them from switching employers. Wage premium can raise foreign firm’s profit by preventing the cost reduction for the host country firm which would otherwise occur.

Markusen and Trofimenko (2009) develop a model in which knowledge is transmitted when foreign experts visit the host country firms and train its workers. They show that hiring foreign experts increases the (real) wages and value added of the hiring plant. This effect is both instantaneous (it occurs during the period of hiring) and persistent (it remains even after the foreign expert has left the plant). They shed light on the timing issue and find that the longer the plant postpones the decision to hire foreign experts, the smaller their contribution to the improved wage and productivity.

2.4 INTER-INDUSTRY (VERTICAL) SPILLOVERS

Unlike intra-industry spillovers which are regarded as technological externalities, MNCs also create pecuniary externalities by creating linkages with their suppliers and customers. The reasons for engaging in vertical relationship from the viewpoint of MNC are to overcome the deficiency of market transactions (Lall, 1980) and to prevent the leakage of information and knowledge to direct competitors (Javorcik, 2004a). Through linkage formation local firms can gain access to knowledge and technology of MNCs (Kugler, 2006). The concept of backward and forward linkages was developed by Hirschman (1958). The first type involves the benefits to domestic suppliers, while the second type creates spillovers to domestic customers. Hirschman suggested that the importance of backward linkages is best approximated by the percentage of inputs purchased from other industries while forward linkages should be measured by percentage of output sold to other industries.

By creating vertical linkages technological externalities arise as MNCs facilitate learning by doing in local firms resulting in increased productivity (Eden, 2009). Suppliers can benefit from inter-firm exchange of technical and managerial knowledge (Giroud, 2007). MNCs provide technical assistance on product design, quality control and inventory management as well as financial and procurement assistance (Zanfei, 2012). Customers of MNCs can benefit from spillovers and knowledge embodied in products, processes and technologies as well as improved access to enhanced or previously unavailable inputs and products (Jindra et al., 2009). Lall (1980) has identified *"complementary"* activities which may lead to spillovers through vertical linkages with suppliers:

- help prospective suppliers to set up production facilities;
- help suppliers to raise the quality of their products or facilitate innovations by providing technical assistance or information;
- provide or assist in purchasing of raw materials and intermediaries;
- provide training and help in management and organization; and
- assist suppliers to diversity by finding additional customers.

Besides cooperation effects listed above, MNCs may force domestic suppliers to meet the higher standards of quality, reliability, and speed of delivery of MNCs (Blomstrom and Kokko, 1998).

The recent surge in the literature on industry linkages has spurred the development of several theoretical models which have analysed the effects of MNCs on economic development. Rodríguez-Clare (1996) developed a model with monopolistic competition in the intermediate products sector, which domestic firms and MNCs use as inputs in their final goods production. It is based on three premises. First, greater variety of inputs leads to higher production efficiency in final good sector due to the *"love of variety of inputs"* (Ethier 1982) by local and foreign firms. Second, intermediate goods industry is characterised by increasing returns to scale. Third, the proximity of supplier and user is required as the domestic firms buy all of their inputs locally. The latter is required in order to ensure the development of final good industry. These assumptions lead to a "good" equilibrium characterised by high wages, complex goods and high variety of inputs while production of simple goods and small variety of inputs lead to "low" equilibrium (Glass et al., 2002). Under the scenario of two economies, one developed and the other developing, MNCs will establish a subsidiary overseas to enjoy the benefits of cheap labour, similar to vertical model of FDI discussed in the previous chapter. However, the crucial assumption is that intermediate products are not tradable and firms cannot use them unless they have a plant operating in the country in which inputs are produced.[7]

The linkage coefficient developed by the author measures the ratio of employment generated in supplier industries per unit of labour hired directly by MNCs (Glass at al., 2002). If positive, it implies that an increase in the number of MNCs which produce more complex goods and employ more specialized intermediate inputs will increase the variety of inputs produced locally and thereby help develop supplier industry in the host country. Increased demand and variety of intermediate inputs also generate positive externalities to other final goods producers, thus establishing forward linkages. As the complexity of final and intermediate products increases, the positive linkage effect is expected to lead to higher productivity of domestic firms and higher wages and skill levels in host economy. Backward linkages will be higher under conditions that MNCs use complex intermediate inputs, the higher are the communication costs between parent company and subsidiary and the higher is the similarity of variety of inputs produced between host and home country.

[7] This assumption implies that relying on foreign suppliers entails additional coordination costs.

Markusen and Venables (1999) develop a model with two imperfectly competitive industries with increasing returns to scale, producing intermediate and final goods which are linked by an input-output relationship. It is somewhat different from Rodriguez-Clare model (1996) as it assumes intra industry competition. According to the model there are three effects of MNCs' entry. First is the competition effect as foreign investment takes place in the final goods sector increasing total output and reducing market price, leading to the exit of domestic firms. The second effect is the creation of backward linkages to intermediate goods suppliers in the upstream sector. As firms operate in monopolistically competitive markets their number increases to generate more variety of inputs which lead to lower average costs and increase in profits. The increased entry thus causes a third effect as the reduction in prices of inputs benefits firms in downstream sector because of improved and cheaper intermediate products supplied by domestic firms. The stronger the demand effect compared to the competition effect, the better is the situation for the upstream and downstream firms.

Similarly, Pack and Saggi (2001) have developed a model of technology transfer in which MNCs induce entry of other suppliers by transferring technology to firms in upstream sector, thus reducing concentration and lowering prices. Given the benefit of lower-priced inputs, downstream firms will lower prices and increase output, and new firm entry may occur. This would induce higher output in upstream sector due to stronger demand from downstream sectors. If the above argument holds, then benefits accrue widely to all sectors and consumers, not only through improved productivity but also through increased competition resulting in lower deadweight loss, thus improving welfare.

In the models discussed above the basic premise is that MNCs alter the incentives for entry and that the interaction between MNCs and local suppliers is based on love of variety for inputs in final goods industry. However, as noted by Lin and Saggi (2007) these models ignore the strategic interaction which occur in an oligopolistic market structure and emphasize demand creation effects. In addition, the connection between technology transfer and backward linkages and the contractual relationship which may be used by MNCs to protect their knowledge is not addressed.

Lin and Saggi (2007) explicitly consider vertical technology transfer (VTT) through backward linkages focusing on supply side effects. They develop a two-tier model in which the production of final goods depends on intermediate goods and the market structure if both markets are oligopolistic. Upon entry, MNC are faced with the choice of sourcing their inputs from the market by interacting with all suppliers vs. sourcing the intermediate good locally with selected suppliers who exclusively agree to serve MNCs in return of VTT. Two types of contractual agreement are discussed: one in which domestic supplier must abide by an exclusivity condition that forbids serving MNC's rivals and another contract in which domestic firms do not face such a restriction. Generally, MNC is faced with a trade-off: on one hand it would like to prevent local firms and rivals to benefit from VTT, on the other hand it would prefer to have multiple suppliers in order to secure more competitive price. In reality, the MNC can combine these two contracts, although the number of local suppliers that accept exclusivity contract is likely to be smaller relative to the case where the multinational commits to sourcing only from its exclusive suppliers. The conclusion is that while the entry of the multinational creates additional demand for the intermediate goods, it can also reduce the number of suppliers available to local producers. This negative supply-side effect can dominate the positive demand-side effect so that the total output of the intermediate good as well as the final good can shrink due to the MNC's entry.

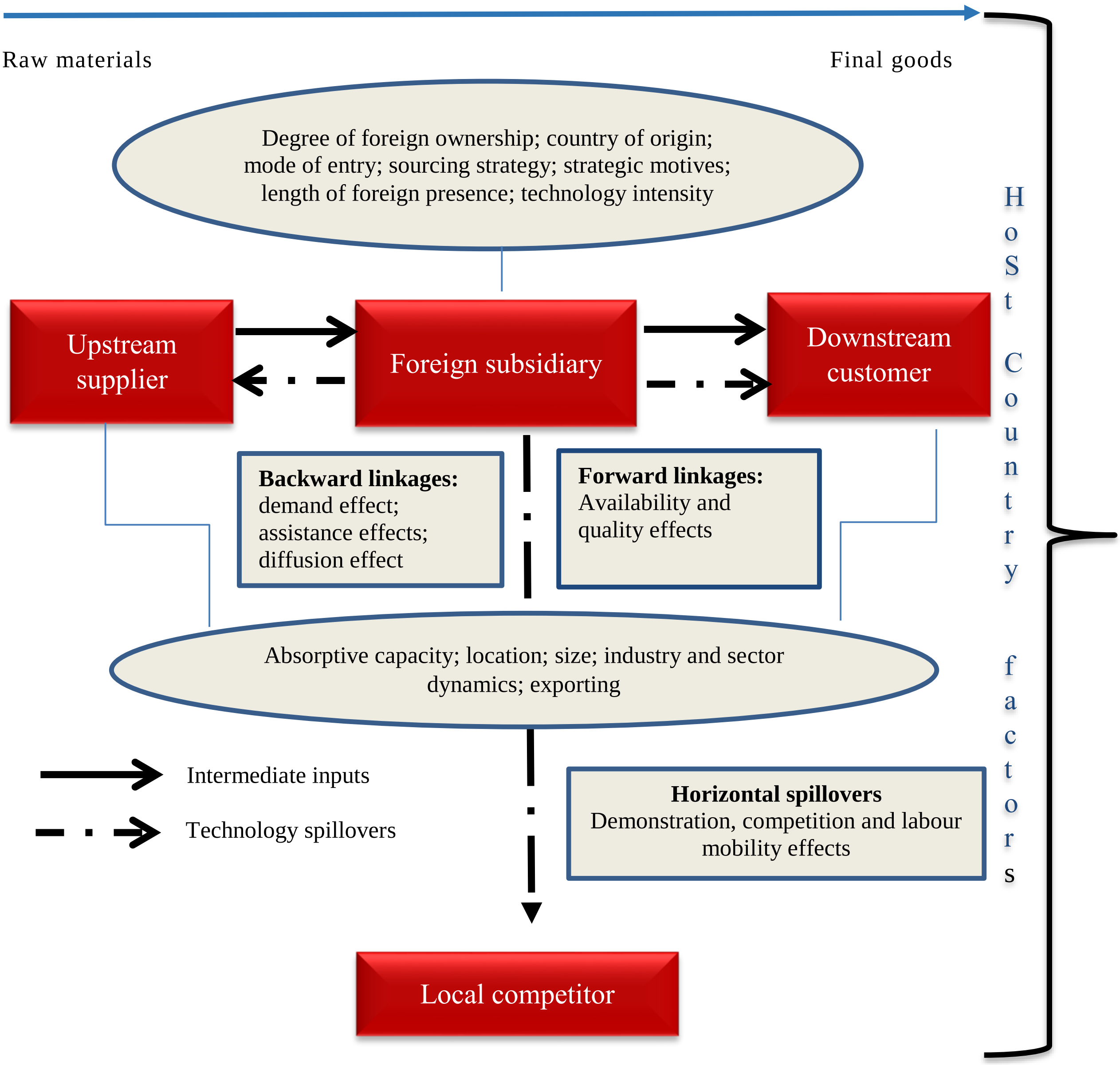
Recently, Alfaro et al. (2010) combined the theoretical model and the calibration exercise in which positive backward linkages depend on local financial markets, market structure and competition for skilled and unskilled labour. They model a small open economy in which domestic and foreign firms compete for skilled and unskilled labour and intermediate products in the final goods industry. In order to operate in the upstream sector, firm must develop a new variety of inputs which requires capital investment, the latter being conditional on developed local financial markets. Increased variety of inputs leads to positive FDI spillovers in final goods sector. Hence, financial markets act as a channel for realisation of linkage effects. Furthermore, their model implies also the existence of horizontal spillovers in the final goods sector by raising productivity of domestic firms due to greater availability of intermediate inputs.

2.5 DETERMINANTS OF FDI SPILLOVERS

In the previous section, we discussed the channels through which MNCs influence the productivity of host country firms. However, spillovers do not occur automatically. In what follows theoretical arguments derived from formalised models as well as those without mathematical representation will be used to develop a conceptual framework which is built on the premise that the realisation of FDI spillovers depends on domestic firms and MNCs' heterogeneity. This interaction is influenced by the host country environment and institutional framework which affect foreign and domestic firms' characteristics as well as the knowledge transmission channels. Figure 2.1 below illustrates the channels and mechanisms through which MNCs can influence local companies, and factors affecting their occurrence. As can be seen the realisation of vertical linkages and thus productivity spillovers between MNCs and local firms can occur through several mechanisms such as demand effects by requiring better and more diverse inputs, product quality and delivery time (Farole and Winkler, 2014). Also, assistance effects such as personnel training, leasing of machinery, sharing of production techniques and support in product design may help domestic firms to benefit from spillovers if MNCs is not fully compensated for these benefits (Lall 1980; Crespo and Fontoura, 2007; Farole and Winkler, 2014).

The benefits accruing to domestic firms are however conditional on MNCs heterogeneity such as their motives, level of ownership, country of origin, mode of entry and sourcing strategies. The extent of knowledge diffusion effects depends on local firms' characteristics in terms of size, absorptive capacity and spatial proximity. Finally, host country requirements such as level of foreign control or preference for certain types of FDI may also influence FDI spillovers. The same reasoning applies to the occurrence of intra industry spillovers where times since foreign entry or mode of entry may induce demonstration and competition effects as well as the type of knowledge available to local firms. The actual benefit to local firms depends on their ability to attract employees previously working for MNCs or their capacity to withstand fierce competition. Aspects of host country policy such as access to finance, trade policy, development of physical infrastructure, learning and innovation infrastructure influence domestic firms' capacity to learn and finance necessary investments while intellectual property right regime and foreign investment policies influence the type of technology brought in by foreign firms (Farole and Winkler, 2014).

FIGURE 2.1 A CONCEPTUAL FRAMEWORK FOR FDI SPILLOVER CHANNELS AND MECHANISMS AND THEIR POTENTIAL DETERMINANATS



Source: Author's adaptation based on Farole and Winkler (2014)

2.5.1 MNCs' HETEROGENEITY

In the theoretical models discussed in the previous section FDI is treated as a homogenous exogenous factor while in reality there is a large heterogeneity arising from different motives, origins of FDI, modes of entry, ownership characteristics, trade orientation and the complexity of technology they use. It can be argued that different types of FDI give rise to different amount of knowledge spillovers. First, specific spillover channels are more relevant for certain types of FDI than for others and, second, the tacit component in knowledge spillovers may cause different spillover effects from various types of FDI (Smeets and de Vaal, 2006). As argued by Castellani and Zanfei (2007), "*not every multinational company is a good source of externality and not every domestic firm is equally well placed to benefit from multinational activity"*. Here, we discuss some of these heterogeneities.

Level of control (ownership). Müller and Schnitzer (2006) and Gattai and Molteni (2007) derive a theoretical framework to study the relation between knowledge spillovers and the choice between FDI and joint venture (JV). Both studies conclude that FDI is the MNC's best option where the risk of knowledge spillovers to other firms is high. Muller and Schnitzer take into account the active role of the host country. In particular, they examine the role of taxation and local infrastructure investments and find that these instruments can help MNCs to align their interest with those of the host country and thus choose to invest in JV increasing knowledge spillovers. Gattai and Molteni find that full ownership is the optimal solution in environments characterised by weak IPR and when local firms have high capacity to learn.

Smeets and de Vaal (2006) argue that fully owned or partially owned firms differ in potential for transfer of knowledge as well as the time necessary to establish cooperation with local firms. The channels and mechanism of knowledge spillovers may differ as partially owned foreign firms are more likely to generate benefits to local firms through pecuniary spillovers in addition to pure knowledge spillovers Knowledge based view of the firm discussed in Section 1.3.6 pointed out that not only the ownership of specific technology, but also the ownership of specific architectural capabilities that enable MNCs to transfer tacit knowledge is a source of their unique competitive advantages (Kogut and Zander, 1993; Tallman, 2003). In this respect, joint ventures are seen as an important vehicle for transfer of tacit knowledge as they are more embedded in host country environment. By establishing joint ventures, the interests of domestic and foreign firm are more aligned and the incentives for knowledge sharing is high due to mutually beneficial interest to improve performance.

Partial ownership can create higher potential for spillovers, especially by creating vertical linkages since it is expected that MNCs are already integrated to a certain extent into the local economy, thus sourcing inputs from the host market (Javorcik and Spatareanu, 2008). However, the transfer of foreign technology may be gradual, thus limiting the scope for spillovers in early years. Joint ventures are specifically beneficial for firms with high degree of mutual dependence characterised by frequent exchange of knowledge where local firms have substantial scope for learning new techniques and best practices (Konwar et al., 2014).

However, wholly owned subsidiary are more likely to transfer more sophisticated technology. As demonstrated by Ramacharandran (1993) foreign firms are more likely to opt for full ownership in the weak institutional environment characterised by weak property rights. In case where knowledge transfer is complex and not easy to codify, where the capability of potential partners is weak or there is a potential for knowledge dissipation and MNCs pursue asset exploiting strategies, they (MNCs) will create a wholly owned subsidiary thus try to prevent leakage of know-how and other valuable knowledge information to competitors. Since wholly owned subsidiaries bring more advanced technology the potential for technology transfer is also greater and more rapid compared to joint ventures (Mansfield and Romero, 1980). However, the latter depends on the industry in which foreign firms enter as well as absorptive capacity of domestic firms. In summary, the volume of knowledge based assets and its quality is increasing with higher levels of ownership. However, the diffusion of knowledge is more likely to occur with joint ventures.

Home country characteristics. One of the important factors influencing the potential of FDI spillovers and the extent to which local firms can benefit from MNC entry is related to the origin of investment. Although there is no formal theoretical treatment dealing with this element of heterogeneity, one may derive several propositions based on the home country differences affecting the performance of MNC's subsidiary and thus indirectly the productivity of domestic firms (influenced by potential spillovers). Banga (2003) argues that productivity differences according to investors' home country are expected, since FDI from distinct countries brings different levels of technology and different modes of transfer. Facing different opportunities and obstacles in the environment, firms in different countries can create different technologies and management practices by exploiting the availability of specific industry knowledge, complementary products, technologies and institutional framework (Ghemawat, 2003).

Egger and Keuschnigg (2011) argue that the innovativeness and productivity of MNCs are related to development of their home country financial market and institutions. If a MNC's subsidiary relies upon technological inputs from home country, the degree of development of financial markets and credit tightness affect their productivity and innovativeness and impede intra firm knowledge transfer. This in turn influences the extent of technology spillovers to host country. Exposure to different technologies and management practices can facilitate local firms' learning capability since *"it increases the prospect that incoming information will relate to what is already known"* (Cohen and Levinthal, 1990, p. 131). A greater variety of technologies can further strengthen and increase local firms' competitive advantage by enhancing economies of scale and scope (Zhang and Li, 2010). This in turn enables local firms to compete on a global scale and satisfy stringent supplier requirements from MNCs. Furthermore, MNCs from different geographical locations require different inputs and offer different products and technologies thus creating forward and backward linkages within the host country (Zhang et al., 2010). A greater diversity of MNCs can also have beneficial effect on worker mobility channel of FDI spillovers as employees previously employed by MNCs can imitate some of the best practices and apply them in domestic firms. Differences in home country can affect the production strategy and technologies used in host countries.

Finally, theoretical model of vertical linkages (Rodriguez-Clare, 1996) predicts that the share of intermediate inputs transferred from source to host country is positively correlated to geographical distance. Increased geographical distance creates incentives for MNCs to source locally in order to reduce transport costs. The same line of reasoning can also be applied to cultural, legal and social differences. Nevertheless the differences in these latter factors could also pose problems for domestic firms in assimilating the new technology.

Mode of entry. Another type of FDI heterogeneity affecting productivity spillover is the mode of entry in the host market. Several authors (Mattoo et al., 2004; Görg, 2000, Muller, 2007) have developed theoretical models to examine how the extent of technology transfer and level of competition affect the choice of entry, but without considering the possibility of spillover effects. If the cost of adaptation due to specific production technology is high, foreign firms have a smaller cost advantage over domestic firms and greenfield FDI is thus the preferred mode of entry. However, in the case of marketing costs and costs of building distribution facilities, the opposite holds. Furthermore, the intensity of competition influences the choice of entry mode in a non-monotonic way. In the case of high or low competition greenfield entry is preferred. The analysis also showed greenfield investment is the optimal mode of entry only if the technological gap between the domestic firm and the MNCs is sufficiently large. Muller (2002) explicitly modelled the effects of technology spillovers on the mode of MNCs' entry under different forms of competition. He further introduced the notion of asymmetric information about spillover potential and their effects on the mode of entry. Under the assumption of perfect information and price competition, MNCs will engage in more acquisitions while opposite holds for quantity competition. In contrast, when MNCs are faced with imperfect information acquisition, activity will be reduced because MNCs cannot take into considerations otherwise efficient acquisitions. In the model spillovers can occur only under greenfield investment especially if foreign firm is R&D intensive as in this situation it has a strong competitive advantage.

However, these models failed to recognize the variety of spillover channels associated with the mode of entry and the speed through which spillovers occur under these two distinct modes. It has been asserted that acquisitions delay spillovers or even restrict them (Braconier et al., 2001). On the contrary, when FDI occurs through greenfield investment, the potential for spillovers is high as new and advanced technology becomes instantly available. However, the scope of spillovers may be diminished as MNCs import a technology that may significantly differ from the one existing in the host country. Moreover greenfield investors have incentive to protect intellectual property rights, thus limiting the potential for knowledge spillovers. In the case of acquisition or merger the scope for spillovers is larger as MNCs bring technology which shares similar characteristics with the existing host country technology and thus the potential for demonstration effects is larger (Crespo and Fontoura, 2007). In addition, MNCs are likely to use the existing network of suppliers and customers, thus creating vertical linkages.

MNC's motives. Although the issue of FDI motivation in the context of FDI spillovers is not explored, it can still affect the extent of productivity spillovers. In the previous chapter we explained that FDI motivations can broadly be classified into two categories. The first one is related to OLI paradigm and the exploitation of existing ownership advantages brought from the home country. The second one is related to technological accumulation hypothesis and the literature examining R&D internationalisation in which MNCs locate near leading research centres or universities with the aim of sourcing technology from its rivals. Fosfuri and Motta (1999) posed the question of whether high productivity firms (leaders) or low productivity firms (laggards) engage in asset seeking strategies. They show that a laggard MNC can choose to enter in a foreign market through FDI even when this involves sunk costs and the transport costs of exports are zero. The potential for positive spillovers can arise due to geographical proximity to a technological leader in a host country. Benefits coming from spillover effects cause a reduction in the production costs of the MNC both in the home country and in its foreign subsidiary. In this way technology sourcing outweighs the costs associated with establishing the subsidiary. The expectation therefore, is that spillovers to domestic firms are more likely to occur from traditional motivations of FDI.

In this regard resource seeking investments have limited potential for spillovers, due to their high capital and technology intensity and limited time horizon (Farole and Winkler, 2014). On the other hand, efficiency seeking FDI especially those oriented towards the manufacturing sector are expected to contribute to spillovers due to strong requirements for a broad range of inputs. However, it must be noted that the spillover potential arising from efficiency seeking motives depends on technology and skill intensity of the production process as well as sourcing behaviour of MNCs in different manufacturing sectors (Farole and Winkler, 2014). Market seeking motives are also conducive to spillovers, especially from MNCs in the retail sector which source a significant amount of inputs from food sector as shown by Javorcik and Li (2013).

2.5.2 DOMESTIC FIRMS' HETEROGENEITY

Although the presence of MNCs provides a potential for knowledge spillovers and thus indirectly affects the productivity of indigenous firms, the actual effects are conditional upon the receiving party's characteristics (country, industry and firm). Failing to take into account factors that transform potential spillovers into actual knowledge spillovers may severely bias the empirical results (Smeets, 2008).

Technological gap vs. absorptive capacity. The necessary condition for turning knowledge spillovers potential to actual is the existence of absorptive capacity. Two views dominate the literature with respect to the role of technological capability of domestic firms in adopting new technologies from MNCs. One view is represented by Findlay (1978) who suggests that the wider the technology gap between the advanced and less advanced countries (and firms), the larger is the potential for technological imitation and adoption. Moreover, the speed of adoption is a function of contagion where for a given level of foreign presence, the larger the technology gap between the foreign and domestic firms, the higher the spillovers. Glass and Saggi (1998), however, argue that the larger the technological gap the less likely are the domestic firms to have the human capital, organizational capabilities, sources of finance, physical infrastructure and distribution networks to benefit from spillovers. Moreover, the absorptive capacity influences not only the actual occurrence of spillovers but also their potential by affecting the MNCs' decision to invest and the type of technology to employ. A large technology gap is therefore a signal of low domestic absorptive capacity which affects the probability of positive spillover benefits to domestic firms. Some authors suggest that technological gap and absorptive capacity are complementary. Abramovitz (1986, p.388), for example, argues that *"a country's potential for rapid growth is strong not when it is backward without qualification, but rather when it is technologically backward but socially advanced",* thus suggesting the importance of the absorptive capacity.

The importance of absorptive capacity is emphasized in a seminal paper by Cohen and Levinthal (1989) who define absorptive capacity as a firm's ability to learn from external knowledge through identification, assimilation and exploitation. They hold that absorptive capacity is a by-product of the firm's investment in R&D. Later on Cohen and Levinthal (1990) redefined the concept of absorptive capacity by including cognitive aspects underlying the learning process. The firm's level of absorptive capacity depends upon its existing level of technological competence at the time of foreign entry as well as the learning and investment efforts it makes afterwards in order to benefit from foreign knowledge. As argued by Cohen and Levinthal (1990) absorptive capacity is path-dependent because learning experience, prior organizational knowledge and problem solving capacity facilitate the use of new knowledge, thus creating a cumulative process.

Similarly, Nelson and Phelps (1966) argue that human capital enables understanding of new technological developments, their evaluation and adaptation, thus affecting firm's productivity. Narula and Marin (2003) suggest that absorption does not imply imitation as each firm possess specific technology; domestic firms need to invest in their own research and development, employee training and adapt organizational structures to be able to efficiently exploit foreign knowledge and increase their productivity. Ben-Hamida and Gugler (2009) show that firms which are not far behind the technological frontier of the industry may fully exploit the advantages arising from imitation and demonstration channels. Firms with less developed technological capabilities are able to benefit from worker mobility since this channel provides (technical, managerial, etc.) assistance to managers of local firms who lack the necessary experience on how to act under competitive environment. In the case of backward linkages firms with high level of human capital are more able to meet the quality standards by producing high quality inputs, thus cooperation with foreign firms is more likely to arise.

The concept of absorptive capacity has been expanded to include support infrastructure such as developed financial markets. Hermes and Lensink (2004) and Alfaro et al. (2009) argue that developed financial system reduces the risk of undertaking investments for domestic firms which aim to increase their absorptive capacity, thus favouring FDI spillovers.

Trade orientation. Blomstrom and Sjoholm (1999) argue that firms engaged in export activities already face international competition and therefore have higher absorptive capacity and productivity levels which enable them to benefit from foreign technology. Moreover, exporters may be in a better position to become suppliers of MNCs. However, they may also have limited contact with local market and face less competition from MNCs, thus having fewer incentives to improve resulting in reduced potential for intra-industry spillovers.

Size. Crespo and Fontoura (2007) hypothesize that firms' size also have an important impact on FDI spillovers as larger firms are more likely to have the necessary production scale which enables them to imitate the production processes used in MNCs or have better access to finance which enables them to invest in production technology and increase the quality of their products. Furthermore, their larger scale enables them to compete more efficiently with MNCs. Finally, small firms are less likely to experience large labour turnover thus limiting spillovers occurring through worker mobility.

2.5.3 OTHER POTENTIAL FACTORS

The efficiency of FDI spillover channels also depends on technological similarities between MNCs and local firms in the industry in which they operate. Furthermore, the extent of spillovers may be conditional on spatial proximity and institutional framework.

Industry characteristics. FDI is industry specific (Wang et al., 2009). And, therefore, the technological intensity of industries is an important factor influencing the extent of FDI spillovers as it is often argued that MNCs are located in industries with high value added and have competitive advantage over local firms in technologically advanced sectors. Hence, learning opportunities for local firms are higher in such sectors. However, in high-tech industries, MNCs' knowledge is characterised by more complex and tacit elements which are difficult to codify and transfer (Spencer, 2008; Hashai, 2009). Moreover, as argued by McCharty et al. (2010), high tech industries are characterised by continuous change in demand, regulation, competition and technology which reduces the chances for domestic firms to learn from MNCs. In addition, it is more likely that domestic firms have larger technological gap in such industries which may impede successful integration of external knowledge and force MNC to use global suppliers (Hatani, 2009). Furthermore, the nature of knowledge flows may be different in manufacturing and services industries. This may reflect the way in which knowledge is protected and transferred to host country firms, thus influencing the mode of entry and level of control and subsequently the extent of spillovers.

Spatial proximity. Economic distance discussed in previous section is concerned with relative backwardness and absorptive capacity. It determines whether and to what extent local firms can benefit from FDI spillovers. On the other hand, geographical distance affects the transmission costs, thus reducing the possibilities for indigenous firms to benefit from knowledge spillovers of foreign subsidiaries located further away. As knowledge is mainly tacit, geographical distance inhibits its transmission and absorption. Therefore, spatial proximity facilitates the process of knowledge diffusion influencing the existence and magnitude of spillovers for both domestic firms and MNCs with asset seeking motives. Marshall (1890) and later on Arrow (1962) and Romer (1986) recognized that the concentration of an industry in a region promotes knowledge spillovers between firms and facilitates innovation within industry located in the region. These specialisation externalities arise due to specialised input markets which reduce transportation and distribution costs and enable producers to share specialised services. Furthermore, externalities of the labour market favour the creation of pools of specialised workers. Finally, physical proximity facilitates the exchange of information, ideas and knowledge in specialised areas such as clusters thanks to informal contacts and the mobility of workers across firms.

Apart from Marshall, Arrrow, Romer (MAR) externalities, Jacobs (1969) put forward the idea of urbanisation externalities. According to Jacobs, industrial diversity and variety leads to exchange of existing ideas and development of new ones and transmission of innovations from one industry to another fostering knowledge spillovers. The more diverse the structure of industries and R&D conducted in a region, the more the domestic firm could potentially benefit from linkages, demonstration and worker mobility effects.

Girma (2005) argues that the relevance of geography is important for both horizontal and vertical channels of spillovers and provides four reasons. First, demonstration effects will be local, as the benefits are likely to spread to neighbouring firms, at least in the initial stage of foreign entry. Second, if one considers the worker mobility channel, the low mobility of labour can be a strong obstacle for technology spillovers. Furthermore, skilled employee previously employed in MNC often prefers to find new employment in the same region. Third, in the case of vertical linkages MNCs may prefer industries with local linkage in order to minimize transaction costs and facilitate communication with the domestic suppliers or distributors. Fourth, knowledge externalities will be transmitted more effectively over small distances which is in accordance with the literature on economic geography (Krugman, 1991b).

Institutional characteristics. Meyer and Sinani (2009) emphasize the importance of institutional framework for creating incentives and business practices that facilitate the knowledge acquisition process. North (1995) describes institutions as the rules of the game in a society and consists of both informal constraints such as traditions and customs and more formal rules such as laws and property rights. They shape the interaction between firms and determine the knowledge acquisition, investment decisions, innovation and overall economic performance (Acemoglu and Johnson, 2005). These also have implications for FDI as countries at different level of technological development will attract different types of FDI, thus affecting the potential, extent and intensity of spillovers. The institutional environment thus has a significant impact on the extent of technology transfer and consequently on productivity improvements and efficiency of domestic firms (Tihanyi and Roth, 2002). It has been shown that FDI is especially sensitive to bureaucratic inefficiency, corruption and weak enforcement of property rights (Bénassy-Quéré et al., 2007; Wei, 2000; Antras et al., 2009). Good investment and business climate is also seen as a strong determinant of FDI spillovers as it encourages more dynamic FDI characterised by economies of scale, good management practices and technology (Moran, 1998). A particularly important aspect of institutional environment is the liberalised foreign trade regime (Keller, 1996; Hoekman et al., 2005). Import competition is likely to enhance learning practises and enable local firms to learn from and acquire complementary technologies that help them utilise knowledge from MNCs. Labour market regulations affect absorptive capacity through firm's willingness to invest in training and thus skill intensity (Almeida and Aterido, 2011). In addition, labour market rigidities can limit the spillover effect through low worker mobility. On the other hand, flexible labour markets can reduce the incentive for investment in training and possibility of workers to obtain necessary skills and knowledge (Farole and Winkler, 2014). Access to finance can inhibit firms' investment decisions and thus negatively influence firms' absorptive capacity. Firms faced with financial constraints might not be able to fully internalise the spillover potential as they do not have resources to employ high skilled workers or invest in new technologies. It has been shown both theoretically and empirically that the level of development of financial markets is crucial for the positive effects of FDI to be realised (Alfaro et al., 2010; Hermes and Lensink, 2003).

2.6 REVIEW OF THE EMPIRICAL LITERATURE

In this section empirical evidence will be analysed with the aim of shedding more light on the often contrasting evidence related to productivity spillovers. We also highlight the substantive problems in previous empirical investigation, methodological approaches and the measurement of FDI spillovers. Finally, we identify shortcomings and gaps in the current literature investigating FDI spillovers in transition countries.

2.6.1 EMPIRICAL EVIDENCE ON FDI SPILLOVERS

The empirical literature on intra-industry spillovers was pioneered by Caves (1974), Globerman (1979), Blomström and Persson (1983) and Blomström (1986) using data for Australia, Canada and Mexico, respectively. These studies were based on production function framework where labour productivity or its changes have been regressed on a number of explanatory variables, one of them being the share of foreign presence. Using aggregated data for the manufacturing sector, all these studies found a positive and statistically significant coefficient for the foreign presence variable and concluded that spillovers exist at industry level. However, the findings of these studies can be challenged as the analysis of spillovers from FDI was limited to a very short time span using a contemporaneous level of foreign presence while at the same time it used aggregated data ignoring heterogeneity of industries arising from significant differences in technological capabilities and capacities to learn and innovate. Furthermore, none of the above mentioned channels of intra industry spillovers was taken into account explicitly. Hence, the mechanisms of spillover occurrence and their diffusion as well as the learning and technological changes were treated as a "black box" (Görg and Strobl, 2005).

As Aitken et al. (1997) note, cross-section studies are subject to a critical identification problem. For example, MNCs may enter in industries which are more productive, dynamic and innovative or acquire more efficient domestic firms ("cherry picking behaviour"). If this is the case, the coefficients on cross-section estimates of productivity spillovers of FDI are likely to be biased upwards and overstate the positive impact of foreign investment. The seminal paper of Aitken and Harrison (1999) spawned a second-generation of empirical studies of FDI spillovers in which panel data are used to deal with the endogeneity and selection bias problem that affected cross section studies. Furthermore, the second generation studies started to use firm level data to address aggregation bias and included factors such as industry and regional dynamics, support infrastructure, and general firm-level specificities that were not considered earlier.

The results for developing countries find mostly insignificant or even negative effects of FDI horizontal spillovers on productivity level (e.g. Blomström and Sjöholm, 1999; Lopez-Cordova, 2002; Kugler, 2006; Liu, 2008; Walkirch and Ofusu, 2010; Wooster and Diebel, 2010; Hale and Long, 2011; Xu and Sheng, 2012). If positive they have been limited to certain type of industries (Blomström and Sjöholm, 1999) or types of firms (Abraham et al., 2010). Similar results are found in transition countries (Djankov and Hoekman, 2000; Sgard, 2001; Konings, 2001; Damijan et al., 2003a; Torlak, 2004; Gersl et al., 2007; Damijan et al., 2013a). However, recent studies provide some encouraging results and find positive horizontal spillovers for export oriented firms (Yudayeva et al., 2006), firms which invest in intangible asset (Kolasa, 2008), domestic firms with high levels of human capital and productivity levels (Damijan et al., 2013a).

The picture is more optimistic for industrialized countries where horizontal spillovers are mostly positive (Haskel et al., 2002; Görg and Strobl, 2003; Karpaty and Lundberg, 2004; Keller and Yeaple, 2009; Belderbos and Van Roy, 2010). Since firm data seems to be the most appropriate level of analysis as they are able to incorporate more heterogeneity, the empirical results based on firm panel data do not provide convincing evidence of beneficial effects of FDI spillovers. Görg and Greenaway (2004) list several possible reasons for mixed findings:

1. MNCs may be effective in protecting their knowledge resulting in no or very limited knowledge spillovers to domestic firms.

2. Given that the coefficient of the horizontal spillovers variable captures the net effects between competition and demonstration channels, the entry of MNCs may induce crowding out effect in the short term.

3. Positive spillovers may affect only a subset of firms, industries or regions, thus calling for incorporation of firm heterogeneity.

4. Knowledge spillovers may occur through vertical relationships which have not been taken into account in several studies.

5. The existence of FDI spillovers may depend on complementarities such as developed financial markets, the availability of good infrastructure and institutional framework.

Recent studies have attempted to incorporate some of these issues in empirical models. Studies discussed above failed to disentangle demonstration and competition effects. Spillovers from competition, unlike those from demonstration effects, are not proportional to the presence of foreign firms as they depend on the interaction between foreign and domestic firms (Kokko, 1996). Taking these considerations into account Chen et al. (2011) include two measures of spillovers, one related to contagion effect that is measured by employment share of foreign owned firms in industry and the second based on productivity of competitor. They analyse the system of equations for domestic and foreign firms and find that spillovers from contagion exhibit an inverse U-shaped relationship, whereas spillovers from competition are more linear. Kosova (2010) disentangled competition effects and technology spillover effects for firms in the Czech Republic. She analysed the effects of foreign presence on growth and survival/exit of domestic firms by developing a model that combines a dominant firm/competitive fringe framework with a model of firm and industry dynamics by Jovanovic (1982) and Sun (2002). She found that upon initial entry, MNCs induce crowding out effect which is short term phenomena. This effect is offset by the increasing number of foreign companies in the sector. Local competitors adapt their production processes to the changing market conditions, with their growth and survival rates actually increasing as more MNCs enter.

Castellani and Zanfei (2006) suggest the use of absolute levels of foreign activity in the sector to measure foreign presence as the relative changes of the same magnitude in foreign and aggregate activities within a sector have no effect on the dependent variable. The correct assessment of horizontal spillovers further implies the recognition of time effect (Altomonte and Pennings, 2009; Kosova, 2010; Merlevede et al., 2014). Altomonte and Pennings (2009), using firm panel data for Romania, find that MNCs have initial positive effects turning negative with the increase in their presence in the sector. They also find robust evidence that after a given threshold in the FDI presence, the spillover effect is outweighed by a marginally decreasing role of learning, as domestic firms converge to the technology frontier and by a negative competition effects. Furthermore, they show that industries characterised by economies of scale display the highest FDI threshold.

Wang et al. (2011) developed two constructs (pace and regularity) to examine how local firms benefit from the process of foreign entry. By using a panel of Chinese firms they find that low to moderate and regular foreign entry is beneficial to local firms while opposite hold for fast and irregular entry as local firms are not able to assimilate foreign knowledge and benefit from externalities. Their analysis adds a further explanation to crowding out effects which arise due to fast foreign entry in a short period of time. Recently, Merlevede et al. (2014), using firm level data for Romania, analysed the time since foreign entry starts to affect spillovers to domestic firms both within and across industries. In order to avoid lumping together old and new FDI in a single variable they construct separate measures based on the time since MNCs entered host country. This helps them to identify the longevity of spillovers. They find that foreign entry initially negatively affects the productivity of firms within a sector but, after majority-foreign-owned firms have been present for a while, negative effects is completely offset by a permanent positive effect on local competitors. Effects of minority foreign owned firms are smaller, less robust, and transient.

Several studies investigate the worker mobility channel. Görg and Strobl (2005) estimate a model of worker mobility in a panel of 228 Ghanaian manufacturing firms. They control for the underlying capability of entrepreneurs, using years of schooling and previous experience in the same industry to control for possible ambiguity in the direction of causality between productivity and labour mobility. Their results indicate that an owner's (of a local firm) previous experience with a MNC increases the local firm's productivity, but only if that MNC is operating in the same sector as the local firm. Moreover, having an owner that also received explicit training in the MNC, does not contribute significantly to firm level productivity. Poole (2010) analyses knowledge spillovers through worker mobility at the worker rather than firm or plant level, using data on Brazilian formal-sector workers. The results indicate that ex-ante identical workers in firms with a higher proportion of workers with some experience at a MNC earn higher wages. The magnitude of wage spillovers from workers with experience at MNC varies with sectoral characteristics, such as skill-intensity and the unionization rate. Balsvik (2011) using data from Norwegian manufacturing industry and tracing the flow of workers from MNCs to non-MNCs finds a robust and significantly positive correlation between the share of workers with MNC experience and the productivity of non-MNCs. The results hold even after controlling for unobservable worker characteristics, thus providing evidence consistent with labour mobility channel of FDI spillovers.

The third generation of empirical studies estimating FDI spillovers address some of the ambiguities by incorporating vertical linkages in the empirical model, incorporate foreign and domestic firms' heterogeneity and introduce some host country factors.

Vertical linkages. Javorcik (2004a) analyses vertical knowledge spillovers from MNCs on a sample of Lithuanian firms. She finds evidence of positive knowledge spillovers through backward linkages, but not through forward linkages or horizontal spillovers. Moreover, she shows that the productivity effect is larger when the foreign investors are domestic market-oriented rather than export oriented, and there is no variation of spillovers between joint ventures and wholly owned affiliates. Kugler (2006) analyses inter industry spillovers from FDI for eight Colombian manufacturing sectors, and finds strong and robust evidence of backward linkages, whereas forward linkages are largely absent. Another important contribution analysing vertical spillovers is a paper by Blalock and Gertler (2008) who analyse plant level data in Indonesia and find positive vertical spillovers. Furthermore, they also find that FDI in downstream sectors increases firm output and firm value-added, while decreasing prices and market concentration. Girma et al. (2008) show that export-oriented domestic firms face significant vertical spillovers in the UK. Investigating 17 emerging markets, Gorodnichenko et al. (2013) find that backward spillovers are consistently positive and that forward spillovers are positive only for old and service sector firms. Schoors and Marlevede (2007) employ dynamic input-output tables to construct spillover linkages for manufacturing industry and service sector in Romania taking into account structural breaks and environmental changes into account. The authors separate out labour market effects from other effects in their identification of intra-industry spillovers, while inter-industry spillovers are identified through backward, forward, and supply-backward linkage effects.[8] The results suggest that labour market effects differ from other intra-industry effects and spillovers across industries dominate those within industries.

Studies using firm level surveys are rare. Giroud et al. (2012) find that greater autonomy in basic and applied research of foreign subsidiary increases the intensity of backward linkages in five transition countries. Furthermore, the authors find that MNCs' technological intensity, measured in terms of their relative innovation intensity also have

[8] In theoretical model of Markusen and Venables (1999) besides an initial backward linkage effect (from MNCs in industry *k* to domestic suppliers in industry *j*) there is a second forward linkage effect (from local suppliers in sector *j* to other local clients in sectors *k*).

positive impact on development of backward linkages. Focusing on automotive sector in Poland, Gentile-Lüdecke and Giroud (2012) examine the mechanisms behind knowledge spillovers of suppliers. They find that R&D intensity of suppliers does not have an impact on knowledge acquisition, but on knowledge creation in terms of new products, services, and technologies. The most recent study in this area, Godart and Görg (2013), examines the underlying mechanism through which positive backward linkages occur. Using cross section data from 25 East European and Central Asian countries they find that the demand effect has a positive effect on productivity growth which cannot be said for the more cooperative learning mechanisms such as technology transfer from MNCs.

The majority of empirical studies have found positive and significant backward linkages from FDI. These findings are further corroborated in a meta regression analysis by Havranek and Irsova (2011). However, the findings for forward spillovers are less clear. Kolasa (2008) argues that forward spillovers may become positive only if domestic firms have sufficient absorptive capacity. Similarly, Alfaro et al. (2010) argue that clients of MNCs require high up-front capital investment in order to benefit from forward spillovers.

The main problem with measuring vertical linkages is the use of industry input output tables for one year which measures the extent of linkages based on increase in demand from downstream sectors in which MNCs operate and do not capture changes in industry sourcing which may be influenced by new investment (Driffiled and Jindra, 2012). Barrios et al. (2011) further emphasize the problem with measurement of backward linkages. It is assumed that foreign and domestic firms have the same input sourcing behaviour and that share of domestic inputs is the same as imported inputs. Furthermore, as argued by Smeets (2008) knowledge transfer and knowledge spillovers are distinct albeit related concepts and should be treated separately in empirical estimations. If the demand effect is accompanied by the desire of MNCs to increase the quality of inputs by providing knowledge transfer directly to suppliers this will affect the level of technology and shift the production function (Giroud et al., 2012). Spillovers from vertical linkages will then occur if productivity improvements exceed those related to voluntary knowledge transfer. Giroud et al. (2012) noted that what matters is also the intensity of knowledge transfer as it reflects supply side effect modelled in Lin and Saggi (2007). If intensity is low, this will limit the degree of knowledge transfer to suppliers and also the extent of technology externalities to other firms in the sector.

MNC heterogeneity. The search for explanation of ambiguous findings of FDI spillovers turned researchers to examine the role of MNCs' heterogeneity. Differences in country of origin are based on the premise of technological gaps as MNCs from different countries bring different technologies. Buckley et al. (2007c) investigate the relation between FDI from Hong Kong, Macau and Taiwan (HMT) and from other countries outside China in a sample of 158 Chinese industries. They find that FDI from HMT generate more knowledge spillovers in labour intensive industries and that FDI from Western economies (USA, EU and Japan) generates more knowledge spillovers in technology intensive industries. Kosteas (2008) found relatively higher positive spillover effects of FDI from Canada than from the US and the rest of the world on a sample of Mexican firms. Abraham et al. (2010) and Du et al. (2012) found that FDI from emerging economies in Asia into China generate positive spillovers while FDI from Hong Kong, Macau and Taiwan have no spillover effects due to their export orientation.

An alternative hypothesis made by Javorcik and Spatareanu (2011) is that different effects of MNCs' origin are due to transaction costs related to geographical distance. By using firm-level panel data from Romania they examine whether the nationality of foreign investors affects the degree of backward spillovers from FDI. They posit that investments from the EU will affect knowledge spillover from FDI differently than from other geographical origins due to Romanian membership in the EU. Their results suggest that FDI from USA has positive knowledge spillovers in upstream sector while the effect is negative for FDI from the European Union which is explained by crowding out effect in downstream sector, thus affecting the demand for intermediate inputs in upstream sector. The results hold even when controlling for differences in foreign ownership share and in regions where the MNCs operate. The positive effect of distance is confirmed in the meta-analysis by Havranek and Irsova (2011) too.

Gorodnichenko et al. (2014) found that FDI from non-OECD countries provides more linkages to local firms than FDI from more developed countries. Specifically, they found that non-OECD FDI has positive vertical linkages in larger and older firms in a sample of 17 transition economies, and this effect is positive for the whole sample in case of backward linkages, and only for services in case of forward linkages. On the contrary, FDI from developed countries seems to benefit only local suppliers in services industry and relatively new firms. Ayyagari and Kosova (2010) analysed the impact of FDI on domestic firms' entry in the Czech Republic and found that horizontal spillovers are driven by MNCs from the EU. When they further split the non-EU countries into Slavic versus Non-Slavic they do not find any significant differences. The positive effects of EU investment are consistent with trade literature that emphasize geographical (Redding and Venables, 2004) and cultural proximity (Disdier and Mayer, 2007) as a determinant factor of increasing trade and investment flows. Similar results are found in a study of Greek FDI within industries in Bulgaria by Monastiriotis and Alegria (2011) confirming that cultural and geographical proximity play a role in FDI spillover process.

Another determinant of FDI spillovers is related to the level of foreign ownership. Dimelis and Louri (2002), on a sample of Greek firms, found that minority owned foreign firms generate positive effects on domestic firms with low and medium productivity levels while the opposite holds for majority owned foreign firms. Javorcik (2004a) and Javorcik and Spatareanu (2008) on the sample of firms in Lithuania and Romania respectively find positive effects of partially owned foreign firms on development of supplier relationship with domestic firms, while negative effects are evident from fully owned or greenfield investment which is consistent with the view that greenfield investments are less likely to source locally due to costs of finding a local supplier which would meet the stringent quality requirements. However, they find that fully owned foreign firms are more likely to provide spillovers within the industry. Positive backward linkages from partially owned foreign firms are reported by Abraham et al. (2010) for Chinese manufacturing industries and Almeida and Fernandes (2006) for firms in developing countries.

Merlevede and Schoors (2007) investigated two horizontal and three vertical forms of spillovers for Romanian firms and found positive effects of horizontal labour market spillovers and forward linkages coming from fully owned or majority owned firms. Both types of spillovers tend to exhibit a U-shape relationship with the level of technology suggesting that both technology gap and absorptive capacity hypothesis are at work. Backward spillovers are found to be positive across all firms’ size classes when local firms supply fully owned foreign firms, but negative in case of majority or minority owned foreign firms. Recently, Gorodnichenko et al. (2014) found that partially owned foreign firms generate positive backward linkages, but these are limited to large firms and firms created after year 1990. The effects of forward linkages are insignificant while fully owned foreign firms seems to have positive within industry effects only on firms established during the socialist system.

Takii (2005) reported negative spillovers from majority owned foreign firms in Indonesia, while Blomstrom and Sjoholm (1999) and Kinoshita (2000) did not find any significant effect of degree of foreign ownership. The prevalence of positive effects of shared ownership on backward linkages is based on the premise that these firms face lower costs of finding local suppliers and are more familiar with the quality of their inputs. As far as horizontal spillovers is concerned, lower technological gap combined with better access to knowledge by local firms may result in higher degree of knowledge spillovers.

FDI spillovers can also vary with the motives of MNCs. Driffield and Love (2007) analyse the manufacturing sector in the UK by distinguishing two motives. The technology seeking motive is tested using R&D intensity differentials between home and host countries. They found negative spillovers in sectors where MNCs are mostly oriented to technology sourcing activities and positive in case of technology exploiting activities. In contrast Smeets and Cantwell (2008) found support for their hypothesis that technology seeking FDI has a larger productivity effect using industry level data of US MNCs' activities across 14 OECD countries.

Empirical studies investigating the mode of entry and spillover effects associated with it are rather scarce. Few exceptions are Stancik (2009) and Balsvik and Haller (2010). The former analysed firms in the Czech Republic. The analysis showed that both acquisitions and greenfield investments have negative effect on domestic suppliers. In the case of horizontal spillovers the impact of takeover is positive, while the impact of greenfield entry remains negative. The effect on forward spillover is initially negative but in time, positive horizontal spillovers translate into forward spillovers affecting the consumers. The opposite holds for greenfield investment. Balsvik and Haller (2010) study Norwegian manufacturing plants and again find opposite effects for greenfield entry and acquisitions, the latter having positive effects on productivity of domestic plants operating in the same industry. The explanation provided by the authors is that greenfield investment has a larger impact on market structure by stealing market shares and on labour demand by attracting employees from existing firms.

Domestic firm heterogeneity. The lack of consensus in empirical literature has spurred the investigation also towards domestic firms' heterogeneity, mainly by exploring their absorptive capacity and technological gap. The former is measured as investment in

R&D, level of human capital and intangible assets, while the latter is measured as productivity difference between domestic and foreign firms' TFP.

Kathuria (2000) and Kinoshita (2001) are among the first studies that found complementarities between the firms' level of R&D expenditure and the extent of FDI spillovers in India and the Czech Republic, respectively. Konings (2001) reported positive horizontal spillovers only for R&D intensive firms in Bulgaria and Romania. Keller and Yeaple (2009) found positive spillovers in US for high technology sectors which traditionally invest more in R&D. Similar results are found in other developed countries (Barrios and Strobl, 2002; Karpaty and Lundberg, 2004; Branstetter, 2006; Todo, 2006) and developing countries (Blake et al., 2009; Zhao and Zhang, 2010). Kolasa (2008) found that investment in R&D increases vertical spillovers, but not horizontal spillovers. A possible explanation is the large technological gap in high tech sector which is too large for domestic firms to upgrade their technology based only on their R&D effort. Damijan et al. (2003b) analysing a group of transition countries also found mixed evidence of the moderating effects of R&D. They are positive for Hungary and Slovakia and negative for Estonia and Latvia. Some studies have focused on human capital as an alternative measure of absorptive capacity and found that domestic firms in transition countries with educated workforce benefit from FDI spillovers (Damijan et al., 2013a; Gorodnichenko et al., 2014). Similar findings are found in Sinani and Meyer (2004) for firms in Estonia.

Some authors have tested Findlay's (1978) hypothesis that large technological gaps provide greater opportunities for learning, induce more pressure for change and therefore provide more incentives for firms to quickly adopt foreign technologies. Griffith et al. (2002) measure backwardness as a relative distance between frontier level TFP and domestic firms' TFP in the UK. The former is measured as the TFP of most productive firm at the four-digit industry level. They found a positive effect for the technological gap. Peri and Urban (2006) also showed the positive and significant effect of large technology gaps on the extent of spillovers for a panel of German and Italian firms.

Other studies have found negative moderating effects for technological gap. For example, Dimelis (2005) and Blalock and Gertler (2008) found that domestic firms with large technological gaps in Greece and Indonesia respectively do not benefit from FDI spillovers. Flores et al. (2007) try to identify the range within which productivity spillovers are maximized using firm level data for Portugal. The results suggest that spillover potential is the largest when the average level of domestic productivity is between fifty and eighty per cent of the corresponding productivity level of foreign firms. Castellani and Zanfei (2003) investigate manufacturing industry in France, Italy and Spain. They find that large TFP gaps are associated with positive spillovers, while high levels of absorptive capacity have no effect, thus confirming catching up hypothesis which suggest that the larger the productivity gap between host country firms and foreign-owned firms, the larger the potential for technology transfer to the former (Findlay, 1978). They argue that heterogeneity plays a crucial role as different sectors have different absorptive capacities, thus high technological gaps may be associated with high and low absorptive capacity.

All studies described above assume that spillover effects are linearly related to absorptive capacity. Studying the manufacturing sector in the UK, Girma (2005) used three different specifications to assess the significance of absorptive capacity measured as domestic firms' total factor productivity gap relative to the maximum TFP of the corresponding industry. He applied linear, quadratic and endogenous threshold models. The potential for spillovers is maximised at intermediate levels of absorptive capacity when it starts to decline, thus indicating an inverse-U relationship. Using the same measure, Girma and Görg (2007) employing quantile regression found a U-shaped relationship on the sample of firms in electronics and engineering industries in the UK.

Host country heterogeneity. In addition to knowledge spillovers across industries, some studies have taken a regional approach. Torlak (2004) investigated regional horizontal productivity spillovers at NUTS2 level in five transition countries. She found evidence for productivity spillovers at regional level for the Czech Republic and Poland. However, when controlling for location-specific variations in productivity due to agglomeration economies or other region-specific effects positive effect remained only in the case of the Czech Republic, whilst a negative effect is detected in Bulgaria. Halpern and Murakozy (2007) examined productivity spillovers in Hungary where horizontal and vertical spillovers are weighted by distance to the foreign firm measured in kilometres. Although vertical spillovers were insignificant indicating the limited role of transport costs in supplier choice, horizontal spillovers were negative and significant suggesting that the magnitude of horizontal spillovers is decreasing with distance. They also found insignificant effects of county boundaries in determination of spillover effects. Nicolini and Resmini (2010), investigating manufacturing firms operating in Bulgaria, Poland and Romania, took into account both spatial dependence and spatial heterogeneity by estimating a spatial error model. They document positive and significant intra and inter industry spillovers at regional level. Negative spillovers are found outside the region, though limited to specific groups of regions, such as the capital regions and regions bordering with former EU-15 countries. Large firms in regions with high levels of human capital enjoy higher total factor productivity growth rates

Finally, a set of studies have investigated the moderating role of host country factors. Smeets and de Vaal (2015) found that increased protection of IPR leads to two opposing effect on a sample of 17 countries. They found that stronger protection of IPR is beneficial for local suppliers, however, it is negative for local customers and competitors. They explain this by the ability of MNCs to exert stronger monopolistic pressures as IPR improves.

Studies investigating the role of financial development found that spillovers are lower or even negative for local Chinese manufacturing firms if they are credit constrained (Agarwal et al., 2011). Similarly, Javorcik and Spatareanu (2009) found that less credit constrained firms in the Czech Republic are more likely to become suppliers of MNCs. Havranek and Irsova (2011) found negative FDI spillovers in more developed financial systems suggesting that MNCs may crowd out local competitors when competing for limited financial resources and thus reduce their absorptive capacity.

Studies investigating the moderating role of trade policy found that more open countries benefit more from FDI spillovers (Lesher and Mirodout, 2008; Meyer and Sinani, 2009). Recently, Du et al. (2011) found that higher tariffs on final goods and intermediate inputs are negatively correlated with the extent of both horizontal and vertical FDI spillovers in China. They also found that firms enjoying investment subsidies generate positive backward linkages, while the opposite holds for firms not receiving them.

2.6.2 SHORTCOMINGS OF THE STUDIES ON FDI SPILLOVERS IN TEs

The review of the literature on FDI spillovers has uncovered several shortcomings and a number of gaps in the state of knowledge on this subject. The first one is related to the geographical coverage of the studies. Most studies have focused on single CEEC with ambiguous results due to different methodologies, empirical models and sources of data employed (Javorcik, 2004a; Sinani and Meyer, 2004; Halpern and Murakozy, 2007; Vahter and Masso, 2007; Kolasa, 2008, Bekes et al., 2009; Iwasaki et al., 2012; Vahter, 2011; Merlevede et al., 2014). Some studies have investigated several countries together, but are limited to the early transition period (Konings, 2001; Damijan et al., 2003a) or early 2000s (Gersl et al., 2007; Nicolini and Resmini, 2010; Damijan et al., 2013a) and mainly focused on the manufacturing sector and static input output tables, thus excluding dynamic changes in the structure of the analysed economies. Furthermore, the institutional framework was still under development in TEs and this could have affected inward FDI and investor characteristics. Domestic firms were still experiencing an on-going restructuring process which influenced their absorptive capacities and productivity levels. Very few studies have concentrated on non EU countries - mostly from Russia and Ukraine (Yudayeva et al., 2003; Tytell and Yudaeva, 2007; Gorodnichenko et al., 2013). Another gap is related to the length of the period covered. Most studies used periods not exceeding five years-something which may influence the domestic firms' learning process and the establishment of vertical linkages (Iwasaki et al., 2013; Merlevede et al., 2014).

There is also an evident lack of research on FDI spillovers which include the service sector where the potential for FDI spillovers may be different due to lower sunk costs, their *"footloose"* nature and the character of global value chains (UNCTAD, 2004). A related issue is the lack of positive findings on forward spillovers which are more likely to occur through interaction between services and manufacturing sector. This issue has largely been ignored in existing empirical studies with few exceptions such as Arnold et al. (2011) and Fernandes and Paunov (2012). Little is known about the separate effects of manufacturing and services linkages on manufacturing firms' performance as existing empirical work is focused solely on manufacturing linkages.

Another gap is related to lack of empirical analysis investigating MNCs' heterogeneity on a sample of TEs because foreign firms differ in terms of technology they bring to countries, level of control, their origin, mode of entry and motives. As argued by Narula and Dunning (2010) the potential for spillovers and linkages of one subsidiary may differ from that of a sister subsidiary in another host location although they are controlled by the same parent company. Only few studies investigated MNC heterogeneity but these generally focused on Romanian manufacturing sector and backward linkages (Javorcik and Spatareanu, 2011; Merlevede and Schoors, 2007; Merlevede et al., 2014; Leanerts and Merlevede, 2014).

Furthermore, those studies that incorporated both types of vertical linkages including manufacturing and service sectors, investor heterogeneity and analysed a group of countries are based on cross section data and only a small number of firms (Gorodnichenko et al., 2013). Similarly, the literature on complementarities has emphasized the importance of the absorptive capacity of domestic firms to respond successfully to MNCs' entry, the technology they bring and increased competitive pressure. Weaknesses in this area may inhibit successful absorption of new technology. Therefore, the between country variation of absorptive capacity and its moderating effects on manufacturing firms' productivity according to different source of vertical linkages may shed new light on the conflicting results in the literature.

From a methodological point of view, the issue of simultaneity between MNCs' presence and domestic firms' performance have rarely been appropriately addressed. Foreign firms may enter less productive sectors to gain a higher market share at the expense of less productive local firms. If this is correlated with local firms' ability to benefit from FDI spillovers, the coefficient measuring spillovers may be downward biased (Keller, 2009). Also, other sources of endogeneity such as the measurement of FDI spillover variables and TFP have received less attention.

Finally, most studies have used static panel estimation technique controlling for unobserved heterogeneity which only partially addresses the issue of endogeneity and establishing causality remains a difficult task. In addition to that, studies using firm level productivity as dependent variable often fail to acknowledge path dependency and the assumption of first order Markov process made in estimations methods related to productivity estimation and place the latter in dynamic framework.

The new economic growth theory has long recognized the importance of technological change and knowledge for economic growth. In this framework the role of FDI is associated with development of new technology and MNCs as repositories of knowledge enable the introduction of new technology at a faster pace and thus contribute to growth. Since knowledge is non-excludable and non-rival, it generates a pool available to everyone. Under these assumptions, theoretical literature on FDI spillovers has developed several possible channels of MNCs' influence on indigenous firms. The first strand of literature views spillovers as a function of degree of foreign presence, implying that knowledge spills over when MNCs come into contact with domestic firms due to its public good nature, giving rise to demonstration or imitation effects. In the second strand of studies spillovers are endogenously determined by technology competition and costs faced by MNCs and domestic firms. The third strand of studies assumes that worker mobility is an important channel of knowledge diffusion especially of its tacit elements. The more recent theoretical models pay more attention to previously ignored potential channel of FDI spillovers, namely vertical linkages between suppliers and customers. The latter are mostly pecuniary in nature and affect firm's profit function. However, they also involve knowledge transfer which may amplify the beneficial effects on firms' competitiveness. Since knowledge spillovers are difficult to quantify, the literature has resorted to the estimation of productivity spillovers. In most cases the entry of MNCs is believed to have beneficial effects on domestic firms by increasing their productivity, improve access to foreign market and encourage new entry.

However, empirical evidence are less clear cut and provide mixed evidence due to many factors at country, region, industry and firm level which influence the relationship between MNCs and domestic firms. The lack of uniformly positive spillover effects can be attributed to firm level panel analysis which addresses some of the shortcomings present in aggregate cross sectional studies such as aggregation bias and endogeneity and enables identifying true causal effects. Recently, empirical work has started to incorporate firm heterogeneity, vertical linkages and other potential determinants providing more encouraging results. Firm heterogeneity seems to play an important role in identifying positive spillover effect. The source of such heterogeneity can be attributed to both MNCs and domestic firms. Regarding the former, the literature has identified differences such as degree of foreign ownership, mode of entry, nationality of investor, motives, autonomy, technological capability and embeddedness of subsidiaries.

Similarly, a broad consensus in the theoretical and empirical research is that the local firms' absorptive capacity or initial technology gap is crucial in order to benefit from FDI spillovers. Firms with medium technology gaps are found to benefit the most from knowledge spillovers. The reason is that firms with high technology gap will have little ability to absorb advanced technology due to insufficient internal knowledge resources to recognize and assimilate a variety of knowledge elements brought by MNCs. Similarly, those firms close to technological frontier have little to gain due to high technological competition which may prevent closer interaction between foreign and domestic firms. However, the factors which influence the development of absorptive capacity are not yet fully understood as the latter is a multidimensional phenomenon which is difficult to capture with variables typically available in firm level datasets. In addition, spatial proximity is an important factor considered by a number of studies on FDI spillovers as knowledge is mainly tacit in nature. Therefore the occurrence of spillovers through worker mobility and vertical linkages depend on proximity as the latter facilitates the transfer of tacit elements embodied in these two main channels.

Apart from firm heterogeneity, empirical work has put a significant emphasis on the differentiation of horizontal spillovers regarded as pure knowledge spillovers and vertical linkages which through intentional knowledge transfer have the highest potential for development. Most empirical studies have found positive and significant effects for backward linkages and to a lesser extent for forward linkages. Horizontal spillovers are less likely to have beneficial impact due to efficient prevention of knowledge leakage by MNCs. In addition, horizontal spillovers capture net effects of different intra industry channels. They are measured as a degree of foreign presence in an industry which ignores the competition effects and worker mobility effects. Furthermore, it is a static approach disregarding the process of FDI accumulation in an industry and the evolution of MNCs ownership advantages and their familiarity with local environment (Wang et al., 2011; Merlevede et al., 2014).

Finally, one must acknowledge the shortcoming when estimating knowledge spillovers from FDI. The most common approach is based on production function which is not able to disentangle pure technological externalities from pecuniary externalities or other competition related effects (Driffield and Jindra, 2012). Therefore, estimating productivity spillovers is only the second best solution in the absence of information on firm level R&D and innovation. Furthermore, in order to understand the exact mechanisms and processes of knowledge flows and their impact on domestic firms' development, one must resort to qualitative methods which are again cross section in nature and lack the appropriate standards on how to measure technology indicators (Driffield and Jindra, 2012).

This chapter has demonstrated the complex nature of FDI spillovers and provided insights under what circumstances FDI creates spillovers and their potential determinants. It has been shown that spillover channels, and the heterogeneity of MNCs and domestic firms as well as their industries and countries are interrelated and coexist, and are shaped by host country factors such as intellectual property rights protection, labour market and trade policies. Further empirical research conducted in this thesis will try to address some of the problems discussed in this chapter. More specifically, it will try to shed more light on the following questions: does the productivity of domestic firms vary with the degree of MNCs' ownership; what is the effect of MNCs' nationality on different channels of spillovers; does the effect of different spillover channels vary with sector characteristics; whether there is an interrelationship between MNCs' presence in the service sector and the productivity of downstream manufacturing firms; does the effect of manufacturing firms' absorptive capacity differ according to the source of vertical linkages. In order to identify the true causal relationship between domestic firms' TFP and measure of FDI spillovers, a firm level panel dataset and the dynamic instrumental variable estimator will be employed to address the possible endogeneity and capture the changing nature of investors' characteristics, domestic firms learning efforts and development of linkages over time.

CHAPTER 3.
CONTRIBUTION OF INWARD FDI TO NMS ECONOMIES – COUNTRY AND INDUSTRY ANALYSIS

3.1 INTRODUCTION

The breakup of the central planning system was in major part the consequence of its lower productivity levels and technological obsolescence. Since productivity growth is regarded as probably the most important single indicator of a country's economic progress, it is only through increases in productivity that domestic firms may increase competitiveness on both domestic and international markets. Integration of formerly centrally planned economies of Central and Eastern Europe (CEE) into global financial and trade flows provides an interesting case for the analysis of the multiple impact of FDI. Hence, by taking a closer look into the nature of FDI, this chapter seeks to provide explanations for the contribution of FDI to structural changes experienced by these economies, their international competitiveness and their integration into global production networks.

Although this chapter aims to provide a context for the empirical analysis in the rest of the thesis, the analysis of the transition process and its impact on economic development is kept to a minimum as there is already a substantial amount of work undertaken on this topic. Instead, the focus is on the key dimensions of the transition process and the role played by FDI in alleviating some of the structural problems inherited from the previous system. Special emphasis is paid to the process of income and productivity convergence before moving to the analysis of FDI trends in these countries and its contribution at both country and industry levels.

This chapter is structured as follows. Section 3.2 provides a brief overview of the structural problems Central and East European countries (CEECs) inherited from the previous economic system with special emphasis on their stance towards FDI and its role. Section 3.3 is devoted to the analysis of income and productivity convergence at national and industry level. The main features, extent and nature of FDI in CEECs are presented in Section 3.4. Section 3.5 analyses the contribution of foreign firms to total employment, turnover and value added and investigates the direct role of FDI in technology upgrading and productivity convergence. Section 3.6 analyses the effects of FDI on exports and their ability to integrate into the MNCs' production networks. Finally, Section 3.7 concludes.

At the beginning of the transition process the CEECs were left with deep structural distortions inherited from the socialist system, reflected in a hierarchically organized system of ownership of production factors and products (Podkaimer, 2013). The economy of CEECs was mainly focused on agriculture and heavy industry, while the production of consumption goods and services were mainly neglected (Campos and Coricelli, 2002). In addition, the allocation of resources was not led by market signals but by centralized decisions based on annual or five year plans. The main tool for growth strategy was the artificially low prices of strategically important inputs for basic industries maintained through a combination of subsidies and taxes (Kornai, 1992).

Furthermore, exchange rates were fixed at low (or below the equilibrium level) so as to facilitate the import of strategically important goods such as raw material and intermediate goods, and the export of goods for final use abroad, mostly to countries within the Eastern bloc (Lavigne, 1999). The fixed exchange rate was supplemented by extensive restrictions on exports and imports beyond that arranged by the state. These structural distortions caused shortages, misallocation of resources, low incentives, overgrown industrial sector and underdeveloped service sector. After the beginning of transition and the opening of the economy, countries were faced with severe macroeconomic imbalances such as hyperinflation, high budget deficits, high current account deficits, and debt problems (Kalotay, 2001).

In the early transition period foreign firms contributed to the elimination of shortages by supplying the goods and services long demanded by the population, which also resulted in an increase in trade deficits. In addition, the entry of foreign firms contributed to the amelioration of price distortions.

Apart from structural problems, domestic enterprises were faced with obsoleted capital and inefficient technology which prevented their successful restructuring (Filer et al., 2001; Orts et al., 2008). The absence of private ownership acted as a disincentive for innovation and product development. Rewards for managers were tied closely to plan fulfilment. In addition, enterprises had to perform many non-core activities. For all these reasons, the consumption of energy and inputs was several times higher than in market based economies (Gros and Steinherr, 1995). Another source of enterprise inefficiency in centrally planned economies was the existence of soft budget constraints (Kornai, 1986). Liquidity and insolvency problems were solved through administrative refinancing by the so-called 'monobanks' which controlled central capital allocation (Estrin, 2002). Such soft budgetary constraints acted as obstacles to the restructuring of loss making enterprises as they were not subject to the threat of bankruptcy.

Under these circumstances, the inflow of foreign capital was needed and beneficial as it provided the necessary funds to finance new investment in fixed assets given limited domestic savings (Demekas et al., 2005; Sohinger, 2005). Besides source of new capital, FDI was recognized as a source of technological progress (Campos and Kinoshita, 2002; Uzagalieva and Kocenda, 2010). The entry of foreign firms also contributed to the introduction of new products and management, organizational and marketing practices which facilitated enterprise restructuring (Rojec et al., 1995; Weiszburg, 1997; Kalotay and Hunya, 2000; Kalotay, 2001).

Since enterprises in transition economies, apart from those in former Yugoslavia, Hungary and Poland, did not have any experience of private business, their integration into world markets and conducting of private business was challenging (Mihalyi, 2000; Kalotay, 2001). In these circumstances, privatisation policies were seen as an important element in transition process. The basic aim of privatisation process was to eliminate the inherent inefficiencies of state ownership and planning (Mihaly, 2001). With the exception of Hungary and in major part Estonia, other countries relied on different forms of privatisation (mass privatisation, voucher privatisation, management buy outs) and little space was left to foreigners (Kalotay and Hunya, 2000). The reasons for the small role of FDI in early privatisation period were non-economic reasons which emphasized the creation of a domestic capitalist class, fairness, special treatment of residents and political forces opposing and blocking sales of domestic firms to foreigners (Kalotay and Hunya, 2000; Rojec, 2005). It is only in the second phase of the privatisation process, after 1996, that foreign companies were put on equal terms with domestic investors. In that period, efficiency remained the main motive for privatisation, but corporate governance and firms' restructuring replaced social considerations. With the shift in the concept of privatisation and policies from nation-wide distribution/discount schemes to case by case direct sales of companies, the use of foreign privatisation in CEECs increased (Kalotay and Hunya, 2000).

The main benefits of privatisation by foreign firms were product quality upgrading, the introduction of new products, transfer of technology, improved market access to foreign markets, training of the management and workforce and improved productivity (Estrin, 1997; Hunya, 2000; Kalotay and Hunya, 2000; Kalotay, 2001; Rojec, 2005). Furthermore, large vertical networks were broken up and sold, while core competencies were developed to match the higher quality standards (Szanyi, 2001). Defensive restructuring of privatised companies which was characterised by labour shedding lasted shorter than in purely domestic companies and strategic restructuring that followed resulted in increased employment and investment. An important feature of FDI was its involvement in the privatisation of services sector especially network industries and financial sector which resulted in increased quality of service and reduction in operating costs which facilitated the development of private sector (Kalotay, 2001).

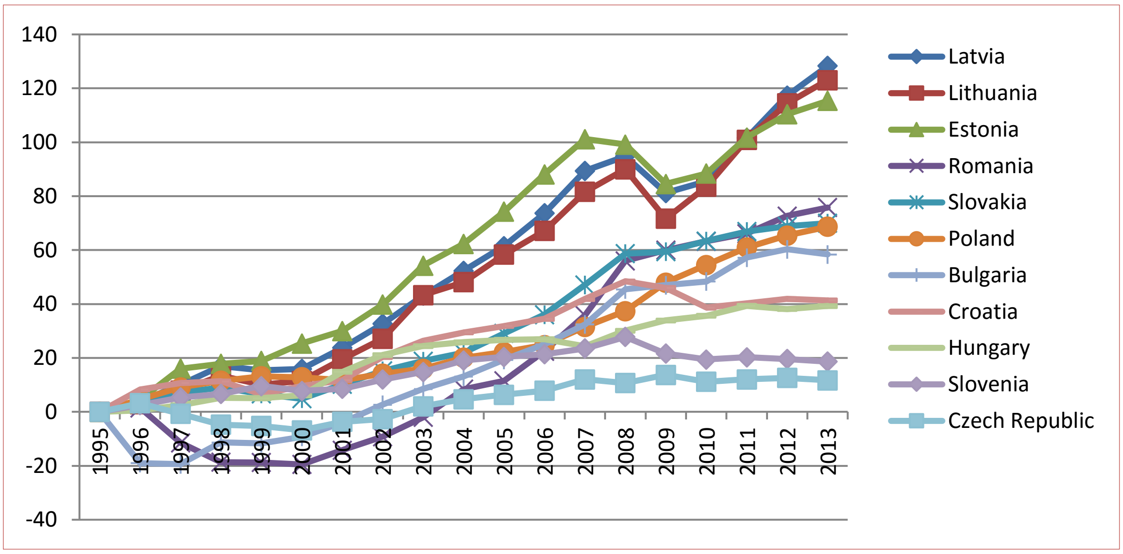
The above mentioned improvements enabled some privatized companies to experience a new role as they became part of an international network which equipped them to meet quality requirements better (Kurtz and Wittke, 1998). This is especially true for companies in automotive and electronic industry that have grown in size and and operate as specialised sub-assemblers in the MNC’s network. The success of restructuring was also conditional on the type of FDI. Efficiency seeking FDI was characterised by the introduction of new production programmes, reorganised marketing activities, training and reorganisation of management, and financially consolidated acquired companies (Rojec, 2005). On the other hand, market seeking investors did not contribute to restructuring to the same extent. They were more interested in using local marketing networks and maintaining a large number of products that were well established in regional markets (Szanyi, 2001).

To summarize, considering the arguments described in Chapter 1 on the potential benefits of FDI and the evidence on the role of FDI in early transition period discussed above we can say that FDI has contributed to a reduction of structural and macroeconomic distortions and helped in speeding up the transformation of economy and enterprise restructuring. The next section aims to shed more light on the speed and nature of catching up process given the substantial economic growth witnessed by CEECs that joined the EU from mid-1990s to 2008. Special emphasis is put on productivity convergence over the period.

Following unprecedented economic and institutional transformational and the initial decline in economic activity at the onset of transition, CEECs that joined the EU achieved remarkable growth rates starting from mid-1990s. The most important factor explaining recovery and growth are related to initial conditions, macroeconomic policies and structural reforms (Havrylyshyn, 2001; Fischer et al., 1998; Berg et al., 1999; Falcetti et al., 2006; Kutan and Yigit, 2009).

Figure 3.1 below indicates that the catching up rate of CEECs was quite spectacular over the period 1995-2013; on average 5.23 percent per year measured in GDP per capita expressed in PPP.[9] CEECs' income per capita growth outpaced EU-15 by 2.37 percentage points on average during the analysed period. The highest growth was witnessed in the Baltic countries gaining nearly 8 percent, despite being hit relatively hard during the financial crisis (2007-2009). In contrast, the Czech Republic and Slovenia grew less than four percent per year on average. However, as shown in the graph below, recent crisis put a brake on the income convergence process in all countries where average growth rates of GDP per capita fell to five percentage points lower in comparison to pre-crisis period.

FIGURE 3.1 GDP PER CAPITA (PPP) GROWTH CONVERGENCE, DIFFERENCES TO EU-15 AVERAGE (1995=100)

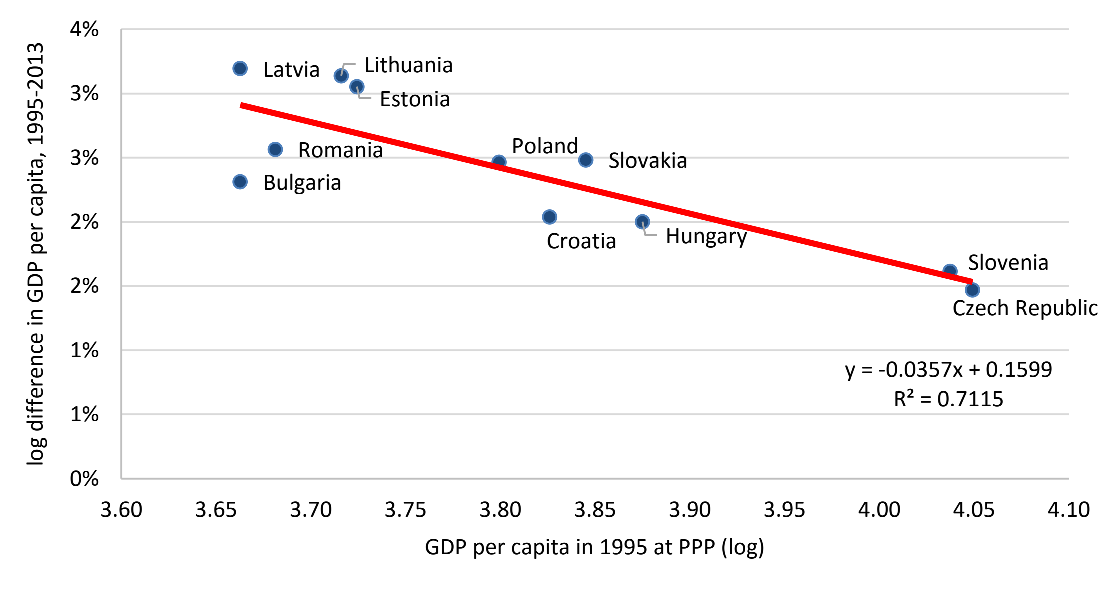


Source: Eurostat; authors' calculations.

[9] Please refer to Appendix I (Table I.1) for annual average growth rates.

In general, as can be seen in Figure 3.2, the scatter diagram and the fitted trend line indicate a strong inverse relationship between the starting per capita GDP (in 1995) and subsequent growth for the period 1995-2013. These results can be taken as evidence of absolute unconditional convergence.[10] Countries with lower initial development such as the Baltic region, Bulgaria and Romania show different convergence path. The former group of countries have grown faster, while on the other hand Bulgaria and Romania have lagged behind. More developed countries such as the Czech Republic and Slovenia converge as expected.

FIGURE 3.2 ABSOLUTE BETA-CONVERGENCE OF NMS DURING 1995-2013 PERIOD



Source: Eurostat; authors' calculations

The differences in convergence can also be seen in Figure 3.3 which shows relative GDP per capita levels as a percentage of EU-15 across different countries. Stronger growth in income per capita in comparison to EU-15 enabled NMS to narrow the income gap by 23 percentage points during the analysed period.[11] However, there still exist significant differences within the group of countries. By the time of recent crisis in 2007, the Czech Republic and Slovenia reached 74 and 79 percent of GDP per capita of EU-15,

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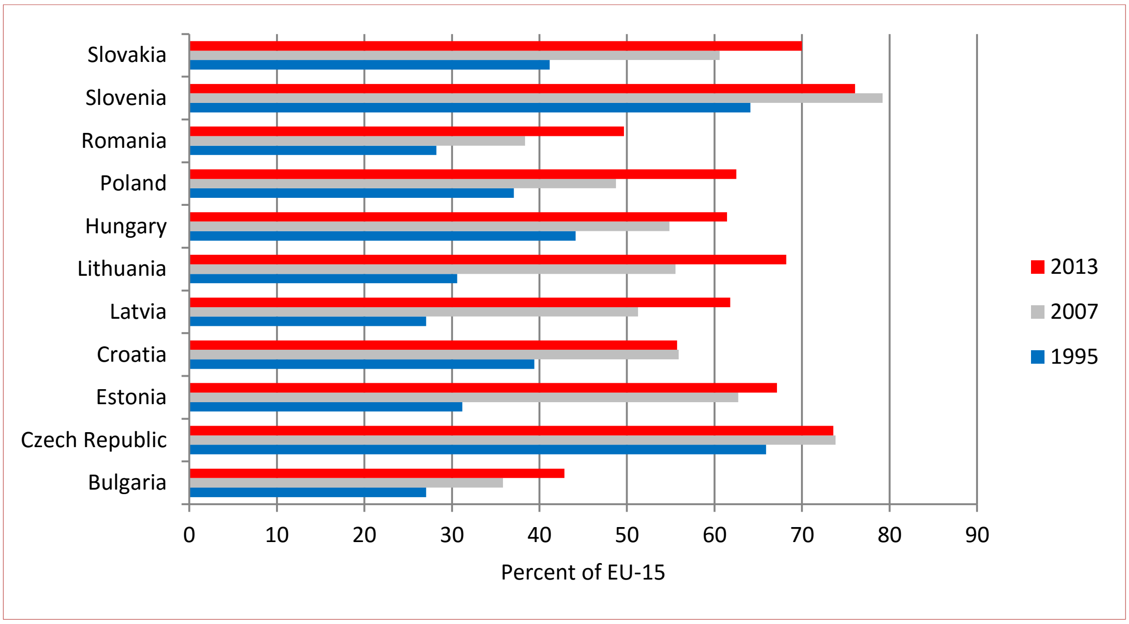
[10] Beta-convergence means that poorer countries are growing faster than richer ones and therefore are 'catching up'. It is estimated as univariate cross-country regression of GDP per capita growth. If the estimated coefficient is negative, it means that countries with lower initial levels of income grow faster. Beta convergence can be absolute or conditional, the latter adding other explanatory variables apart from starting level of GDP per capita.

[11] Please refer to Appendix I (Table I.2) for more detailed data on GDP levels of NMS as percentage of EU 15.

respectively, while other countries were still lagging behind, most notably Bulgaria and Romania whose income levels stood below 40 percent of EU 15 levels. During the crisis years (2007-2009) which brought major GDP losses in the Baltic countries, Poland and Slovakia were affected only minimally. Income gap decreased further after crisis, passing the threshold of 60 percent of EU-15 with the exception of three countries which joined the EU in the last two waves.

FIGURE 3.3 GDP PER CAPITA (PPP) LEVELS, PERCENT OF EU-15

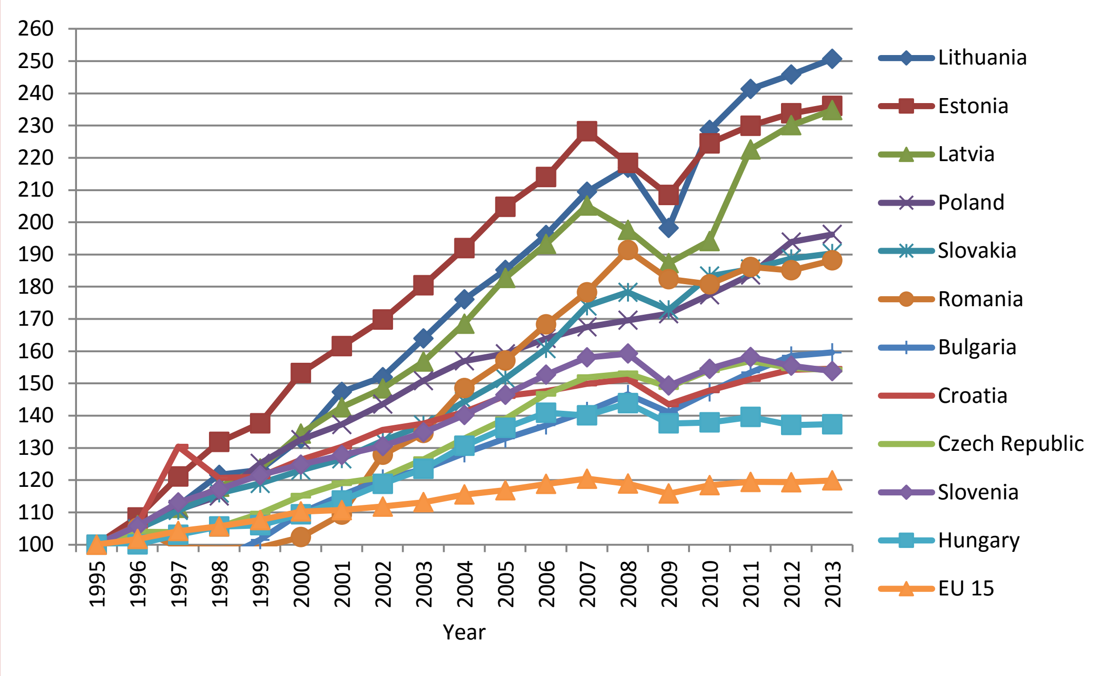


Source: Eurostat

One of the major contributions to income convergence and GDP growth was the increase in labour and total factor productivity. Figures 3.3 and 3.4 below show the significant rise in both measures of productivity in comparison to EU-15.[12] The most significant rise in labour productivity was experienced by the Baltic countries while Hungary and Slovenia were lagging behind. A similar picture emerges when looking at TFP where Latvia, Lithuania and Romania emerge as top performers with an average increase between 2.33 and 4.22 percentage points per annum. On the other hand, the Czech Republic, Bulgaria, Hungary and Croatia experienced the lowest TFP growth with an average growth between 0.60 and 1.04 percentage points per annum. As a group, NMS experienced on average 2.48 percentage points increase in labour productivity and 1.36 percentage points in TFP over EU-15 during 1995-2013 period.

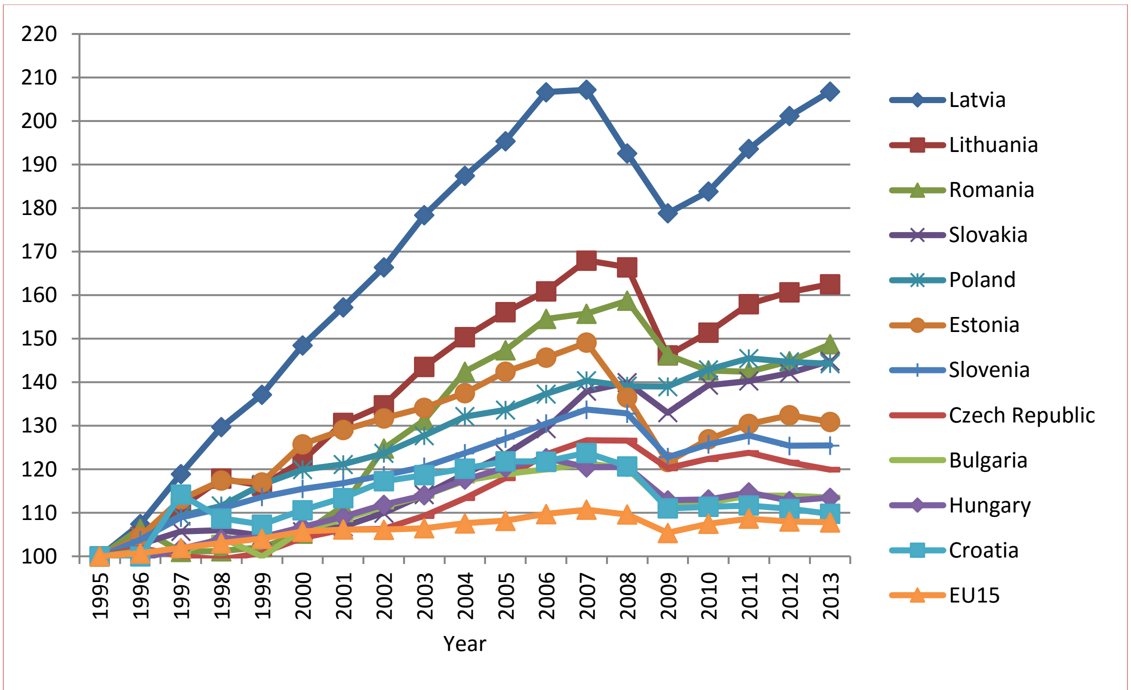
[12] Please refer to Appendix I (Tables I.3 and I.4) for more detailed information on labour and total factor productivity growth rates for each NMS and EU 15.

FIGURE 3.4 LABOR PRODUCTIVITY PER PERSON EMPLOYED (CONVERTED TO 2013 PRICE LEVEL WITH 2005 PPP, 1995=100)



Source: Total Economy Database™; authors' calculations.

FIGURE 3.5 TOTAL FACTOR PRODUCTIVITY OF NMS AND EU-15 (1995=100)



Source: AMECO database; authors' calculation.

A more detailed look at growth and productivity changes at the industry level (shown in Figures I.3 and AI.5 in Appendix I) suggest that all industries have had much higher growth rates in comparison to the EU-15. The average growth in labour productivity is especially pronounced in the manufacturing of machinery and electrical and optical equipment, coke industry, transport services and telecommunication.[13] However, despite remarkable growth in productivity, its levels are still well below EU 15 as shown in Figures I.4 and I.6 in Appendix I.

The contribution of productivity to overall GDP growth in the 1990s can mainly be attributed to labour shedding which enabled firm restructuring and reallocations of resources from low to high productivity uses (van Ark and Piatkowski, 2004; Alam et al., 2008). When put in context with other drivers of economic growth in the second decade of transition one can notice significant differences in the role of factor inputs and TFP across countries in Table 3.1. The most significant contribution to growth in pre-crisis period was made by TFP in Estonia, Lithuania and Romania and capital growth in Bulgaria and Latvia. A recent analysis by Benkovskis et al. (2013) found that TFP contribution to value added growth over the period 1996 to 2009 is largest in goods producing industries in Poland, the Czech Republic, Slovenia and Slovakia while in Hungary, Bulgaria and Lithuania efficiency gains are more important in services sector. A more detailed picture of contribution of individual industries to TFP growth is provided in Figure I.7 in Appendix I.

In post crisis period TFP growth largely declined with the exception of Latvia, Lithuania, Poland and Romania where growth was weak while contribution of capital remained strong largely due to investments in ICT (Alam et al., 2008). Labour markets were largely affected in the Baltic countries, Croatia and Slovenia, thus contributing negatively after crisis due to lower labour force participation and reduction in working hours (van Ark et al., 2013).

[13] The data on labour productivity at industry level are calculated only for 8 NMS due to unavailability of PPP indices in GGDC Productivity Level Database for Romania and Bulgaria, and the unavailability of data on output and employment hours at industry level for Croatia.

TABLE 3.1 GROWTH CONTRIBUTIONS OF SUPPLY SIDE FACTORS IN NMS, (%)

	Labour		**Capital**		**TFP**		**GDP growth**	
Country/ Period	2000-2007	2008-2013	2000-2007	2008-2013	2000-2007	2008-2013	2000-2007	2008-2013
Bulgaria	1.01	-0.54	5.65	3.89	-1.06	-2.70	5.60	0.64
Croatia	1.25	-1.21	2.42	1.72	0.74	-2.40	4.41	-1.90
Czech R.	0.19	-0.08	2.34	1.59	2.03	-1.30	4.56	0.20
Estonia	0.89	-1.23	2.82	0.95	3.87	-0.16	7.58	-0.44
Hungary	0.31	-0.42	2.58	1.62	0.67	-2.02	3.56	-0.83
Latvia	1.12	-2.88	5.33	0.91	1.62	0.37	8.07	-1.61
Lithuania	0.99	-1.48	2.81	1.29	3.44	0.40	7.24	0.21
Poland	0.24	0.11	1.87	2.68	1.88	0.19	4.00	2.98
Romania	-0.91	-0.40	0.66	0.73	5.74	0.35	5.49	0.68
Slovakia	0.37	0.07	2.08	2.12	2.97	-0.45	5.41	1.74
Slovenia	0.97	-1.40	1.92	0.99	1.41	-0.98	4.30	-1.38

Source: Total Economy Database™; authors' calculations.

3.4 OVERVIEW OF FDI IN NEW MEMBER STATES

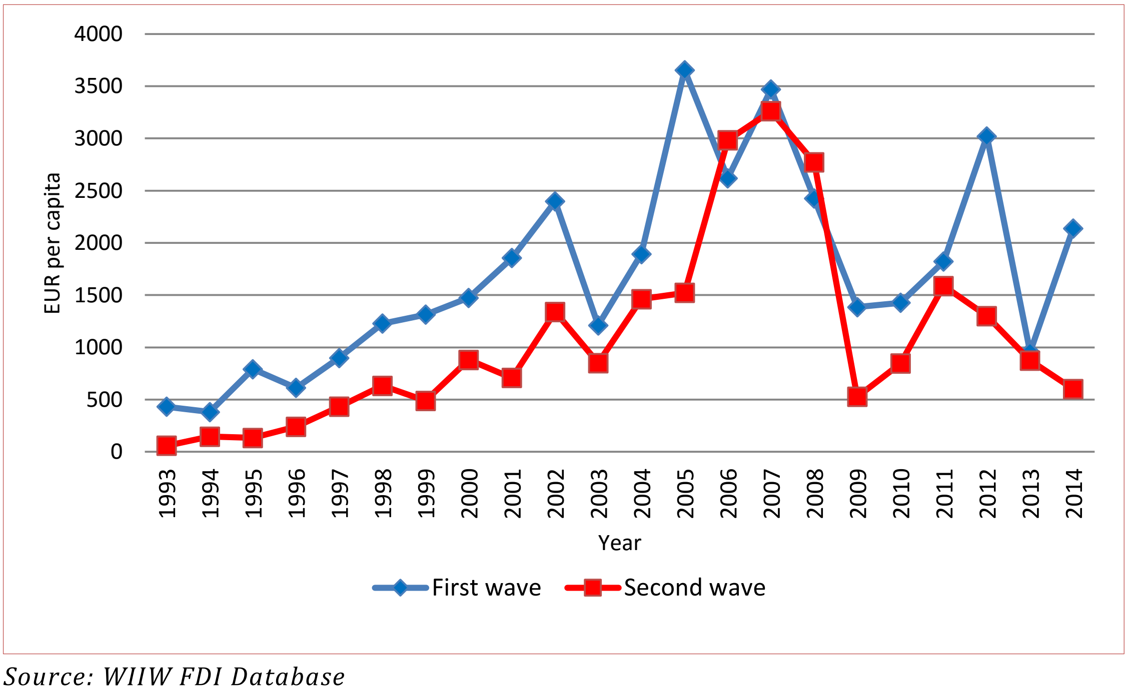
In the early years of transition, FDI in NMS played only a marginal role in global and European FDI flows. Positive initial conditions were shown to have played an important role for attraction of FDI (Garibaldi et al., 2002). In later stages of transition, the main determinants of FDI were progress in structural reforms and privatisation of state owned enterprises (Campos and Kinoshita, 2008). In addition, MNCs were offered general incentives such as tax exemptions for varying periods, job creation benefits, training grants (UNCTAD, 2008).

An important driving force of FDI in NMS which significantly influenced their development in comparison to other transition economies especially the CIS group, is attributed to Association agreements signed between EU-15 and CEECs in 1990s followed by signing of bilateral free trade agreements (FTA). The Association agreements have played an important role in motivating economic and structural reforms, liberalisation of trade and full convergence of their domestic systems to the EU's *"acquis communautaire"* which include a comprehensive body of laws, rules and regulations that govern the EU (Kaminsky, 2006). By joining the EU single market, CEECs were able to benefit from trade based fragmentation of production which is one of the MNCs' characteristics. Furthermore, Association agreements allowed CEECs to refund to the exporters the duty paid on imported inputs. Hence, MNCs from outside the EU found CEECs useful to undertake horizontal FDI to overcome trade barriers whereas EU MNCs could move their production chain to establish export platform and benefit from low costs.

3.4.1 COUNTRY ANALYSIS OF INWARD FDI

After the early stages of transition, NMS were quite successful in attracting FDI, although there were considerable differences among countries. Those countries which have been frontrunners in economic and institutional reforms and open to foreign privatizations were the most successful in attracting FDI (Figure 3.6). Furthermore, the quality of human capital, low labour costs and favourable geographical location contributed further to the increase in FDI. For example, annual FDI inflows in NMS averaged roughly 5 percent of GDP between 1995 and 2007, while their stock of inward FDI grew from 25 percent of GDP in year 2000 to 50 percent in year 2014 (UNCTAD, 2014).

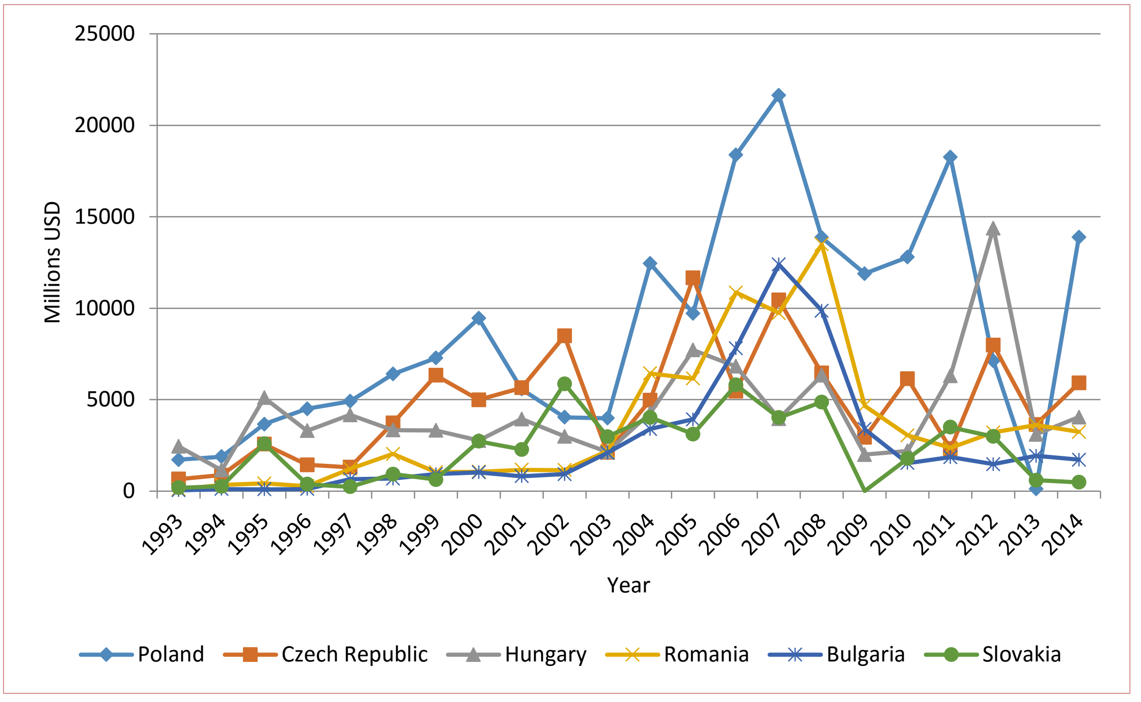
FIGURE 3.6 ANNUAL FDI INFLOWS PER CAPITA IN GROUPS OF NMS, EUR



Source: WIIW FDI Database
Note: First wave: the Czech Republic, Hungary, Poland, Slovenia and Estonia; Second wave: Bulgaria, Romania, Slovakia, Latvia and Lithuania. Agenda 2000 announced in 1997 by European Council defined two waves

Figure 3.7 below shows a more detailed look of inward FDI. Out of total 675 billion USD of FDI that went to NMS the bulk of it (294 billion USD) was invested in period 2004-2008 followed by significant decline at the onset of recent financial crisis. Although foreign investors quickly regained confidence and continued with their investment in subsequent period, the amount of FDI in comparison to pre-crisis period has been reduced with the exception of Hungary.

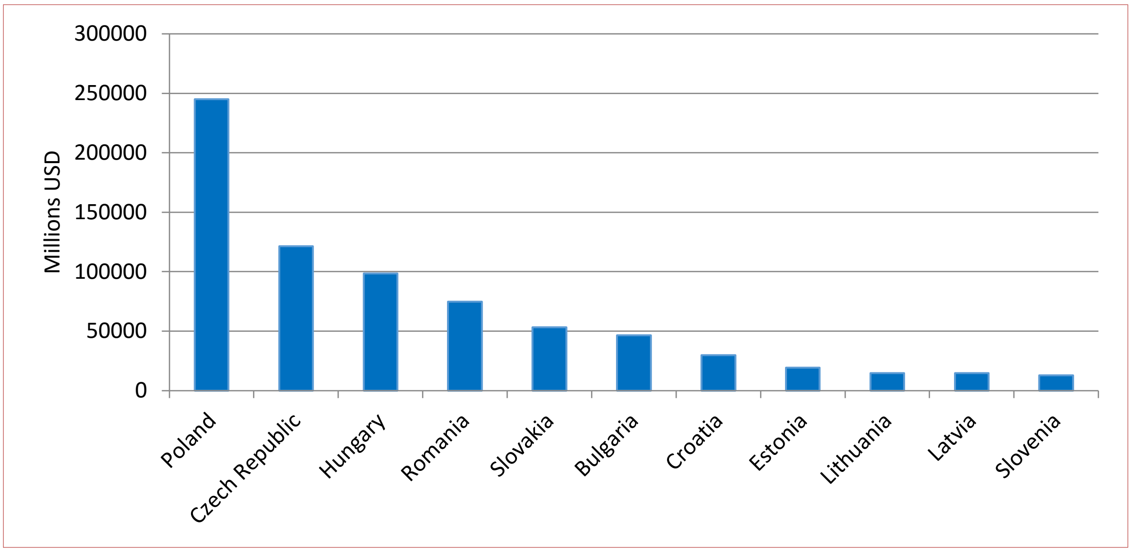
FIGURE 3.7 ANNUAL FDI INFLOWS TO NMS, MILLIONS USD



Source: UNCTAD FDI Database
Note: Only countries which attracted more than 5 percent of total inward FDI in NMS are shown in order to make the graph clearer. Other countries (Croatia, Estonia, Latvia, Lithuania and Slovenia) attracted 95.5 billion USD of FDI between 1993-2014.

FDI has been largely concentrated in several countries as shown in Figure 3.8. The largest recipients of FDI at the end of year 2014 are Poland, the Czech Republic, and Hungary followed by Romania and Slovakia. The first three countries account for 64 percent of total inward FDI stock in NMSs. On the other hand, the Baltic countries and Slovenia account less than 10 percent.

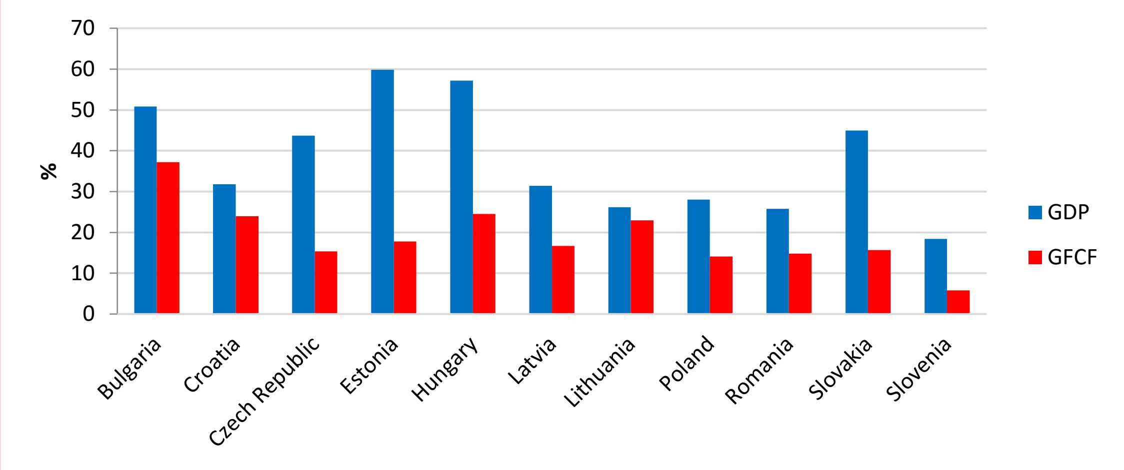
FIGURE 3.8 THE STOCK OF INWARD FDI IN NMS, MILLIONS USD, 2014



Source: UNCTAD FDI Database

However, once the size of the economy is taken into account, a somewhat different picture emerges as shown in Figure 3.9. Estonia stands out as top performer, followed by Hungary and Bulgaria. It seems that large countries such as Poland and Romania attracted large amount of FDI mainly due to the size of their market. One of the reasons for Bulgarian success in attracting FDI is related to EU accession as well as large scale privatisation (Kalotay, 2008). The strong positions of Hungary, the Czech Republic and Slovakia can be attributed to their strong orientation to manufacturing sector and being recognized as fast reformers among NMS (Sohinger, 2005). The importance of FDI for NMS can also be gauged by analysing its share in Gross Fixed Capital Formation (GFCF). In all countries except Slovenia the share of FDI inflow in GFCF averaged above 14 percent suggesting an important contribution towards physical capital or provision of capital necessary for its purchase. The highest contributions are in Bulgaria, Hungary, Croatia and Lithuania. These ratios are remarkable knowing that a significant part of FDI is related to acquisitions through privatisation which may not necessarily lead to large scale fixed capital formation. However, given the old vintage of capital at the onset of transition, MNCs found it necessary to invest in new capital upon acquisition (Meyer and Estrin, 2001).

FIGURE 3.9 AVERAGE FDI INWARD STOCK (INFLOWS) AS A PERCENTAGE OF GDP (GFCF) IN NMS, 1995-2014



Source: UNCTAD FDI Database

In terms of mode of entry, Figure 3.10 shows the average value of greenfield and M&A projects in each country. All NMSs have attracted significantly more greenfield FDI in comparison to brownfield, although the latter played a more significant role in the privatisation process in early transition period. Poland and Romania attracted the major bulk of greenfield FDI, while the value of M&A deals is highest in Poland and the Czech Republic. A significant difference between these two modes is the content of local value added which may have also important implication for FDI spillovers and local sourcing. In the case of greenfield FDI, the local value added is low and technological sophistication is usually higher than in brownfield FDI, although they may converge in later stages when initial investment is followed by new investments (Fillipov and Kalotay, 2009).

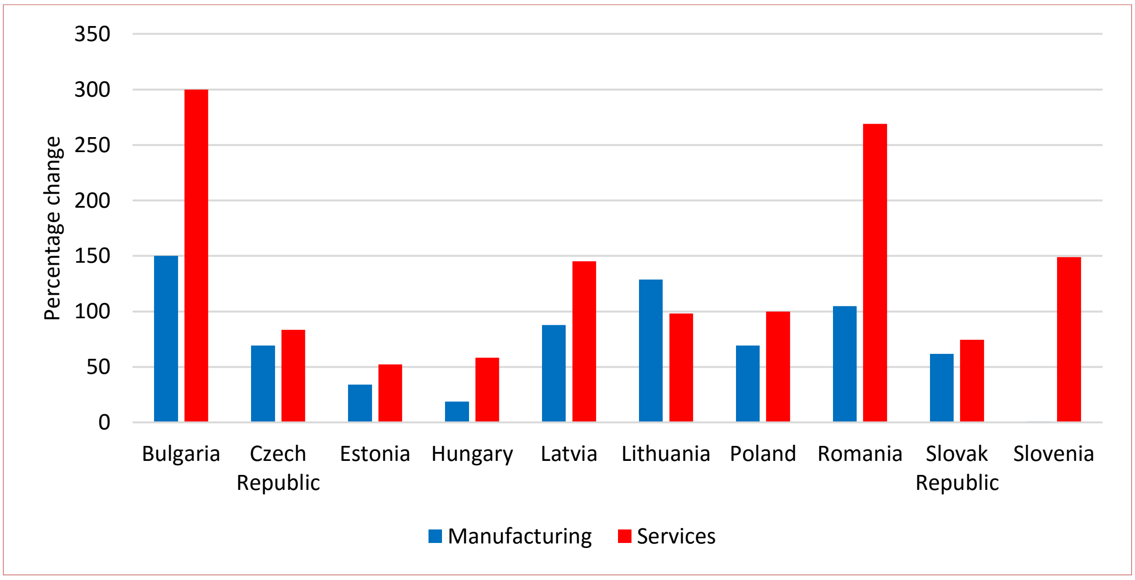
FIGURE 3.10 AVERAGE VALUE OF GREENFIELD AND M&A PROJECTS, MILLIONS USD (2003-2014)

Source: UNCTAD FDI Database

3.4.2 CROSS INDUSTRY ANALYSIS OF FDI

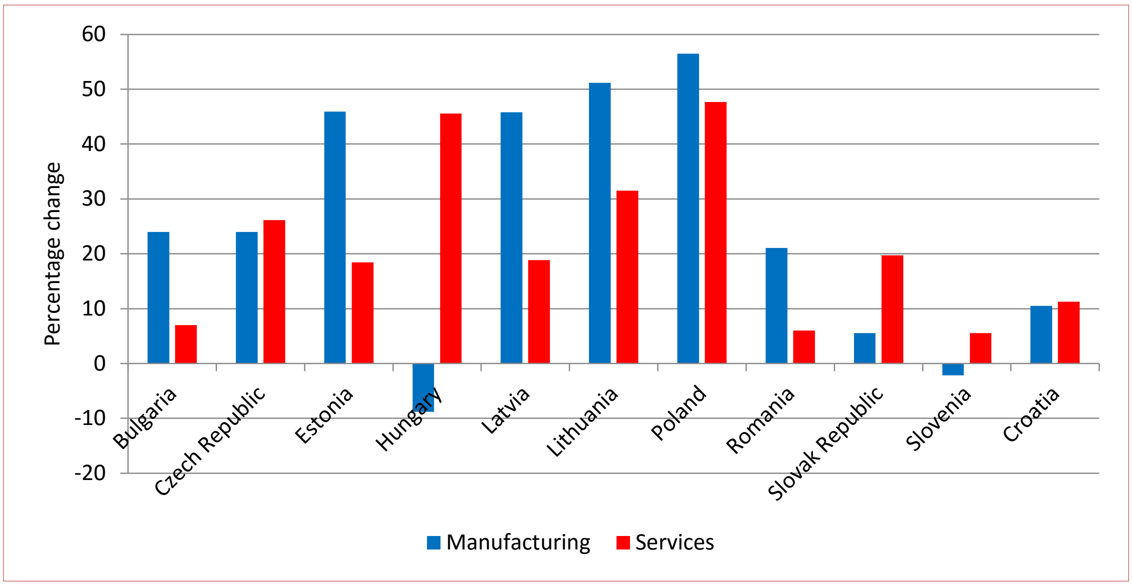
As established in the previous section, the size of FDI differs among NMSs, however its importance can be further analysed by looking at more disaggregated level. Figure 3.11 and 3.12 show the change in sectoral shares of FDI stock in two major sectors of economy before and after the financial crisis. As can be seen from Figure 3.11, the share of manufacturing FDI rose less rapidly during the period 2004-2007 and was replaced by FDI in services reflecting the increasing trend of services liberalisation, second wave of privatisation and in general low levels of FDI in services in comparison to manufacturing. From early 2000s NMS emerged as locations for outsourcing of specific business functions as well as offshoring of corporate business functions (Fillipov and Kalotay, 2009). The FDI in these shared service centres were especially developed in Hungary, Slovakia and Poland and attracted by good infrastructure, employees with good language and functional skills and relatively low labour costs (Ernst and Young, 2014). This led to the development of the business service sector providing administration, financial, customer care and services related to the software industry. Services liberalisation was also accompanied by the privatisation of network industries and the financial sector, greenfield entry into wholesale and retail trade as well as the opening of country' real estate market to foreigners.

FIGURE 3.11 PERCENTAGE CHANGE OF FDI STOCK IN NMS BETWEEN 2004-2007



Source: Eurostat; authors' calculations
Note: Data for Croatia are not available in Eurostat Statistics for selected years. In case of Slovenia, change in FDI stock in manufacturing sector is equal to 1 percent and therefore is not visible on the graph. The classification of sectors is based on NACE Rev. 1.1

FIGURE 3.12 PERCENTAGE CHANGE OF FDI STOCK IN THE NMS BETWEEN 2008-2012



Source: Eurostat; authors' calculations
Note: The classification of sectors is based on NACE 2

However, in the period after the crisis which caused a large decline in all countries which relied on export platform FDI, especially in industries such as automotive and electronics exposing the weakness in economic growth model of NMS based on consumption, reliance on consumer credit and FDI from Europe (Fillipov and Kalotay, 2009), the trend in most countries except Hungary, Slovakia and Slovenia has been reversed and manufacturing FDI showed a strong increase (Figure 3.12). The strongest increase is evident in automotive, rubber and plastic, chemicals, and other transport equipment (Ernst and Young, 2014). Some countries such as Poland also received increase in R&D operations that suggests that foreign subsidiaries are increasing their functional scope and competences (Fillipov and Kalotay, 2009; Ernst and Young, 2014). The possible consequence is a shift from export platform based on low value added activities and assembly to high value added activities in GVC based on R&D.

A more detailed analysis of distribution of FDI across manufacturing and service sectors is provided in Table 3.2 below. It must be noted that motives of FDI in these two sectors are somewhat different. The service sector is more of interest to market seeking investors and those wishing to optimized their costs. On the other hand, manufacturing FDI is mostly motivated by low input and production costs, highly skilled labour, and the Pan-European agreement on the cumulation of the rules of origin (Jimboeran and Kelber, 2014; Kaminski, 2006). This has created an environment in which not only efficiency seeking investors, but also those involved in complex integrated production characterized by international fragmentation of production such as those in automotive and electronics sector (Kaminski, 2006) have been attracted. Other common factors affecting FDI in both sectors were geographical and cultural proximity and the privatisation process.

According to Eurostat statistics the share of services in FDI stock in NMS at the end of year 2012 stood at around 63 percent, while manufacturing FDI accounted for 25 percent, the rest being distributed across construction, primary sector and utilities. Large inflows of services FDI went to financial intermediation (NACE 2, K) as a result of the privatisation of state owned banks, followed by investment in wholesale and retail trade (NACE 2, G) which accounted for 19 percent and real estate activities (NACE 2, L) accounting for 15 percent being largely driven by large share in Bulgaria. A closer look at country level reveals that large countries have been the host of significant FDI in wholesale and retail trade emphasizing market seeking motives. While Hungary attracted the least amount of FDI in financial intermediation (20%), on the other hand, Croatia and Slovenia attracted about 53 and 60 percent respectively of their total FDI in services. Hungary also differs from other countries by attracting large amount of FDI in Professional, scientific and technical activities (NACE 2, M) and administrative and support activities (NACE 2, N) reflecting increased interest of foreign investors in setting up shared service centres. In terms of attracting FDI in information and communication technology, Lithuania and Bulgaria emerge as clear frontrunners where the share stood around 15 percent. Successful attraction of FDI in services also led to subsequent investments in manufacturing. The largest number of investment projects in terms of value has been attracted by food industry (NACE 2, C10_12), coke and refined petroleum (NACE 2, C19), motor vehicles (NACE 2, C29) and basic and fabricated metals (NACE 2, C24_25). A closer look at country level reveals significant differences. The Czech Republic, Slovakia, Hungary, Poland and Romania have attracted the largest amount of investment oriented to manufacturing of motor vehicles. Almost one third and one fifth of total manufacturing FDI in the Czech Republic and Slovakia went to this industry. Estonia, Hungary, Croatia and Lithuania also received a substantial amount of FDI in high tech sectors such as electronics (NACE 2, C26) or pharmaceuticals (NACE 2, C21). In Estonia and Latvia, most of manufacturing FDI went to wood processing, paper and publishing sectors (NACE 2, C16_18).

TABLE 3.2 SHARE OF INWARD FDI STOCK ACROSS INDUSTRIES AND COUNTRIES, 2012

COUNTRY CODE	BG	HR	CZ	EE	HU	LV	LT	PL	RO	SK	SI
INDUSTRY	% SHARE OF MANUFACTURING										
Manufacture of food products; beverages and tobacco products	14	8	10	15	12	16	10	19	12	6	4
Manufacture of textiles and wearing apparel	4	3	1	5	1	3	4	1	4	1	2
Manufacture of wood, paper, printing and reproduction	3	2	4	20	5	26	6	8	7	4	11
Manufacture of coke and refined petroleum products	22	40	1	0	0	0	33	0	7	10	0
Manufacture of chemicals and chemical products	8	2	4	13	4	2	16	7	5	4	7
Manufacture of basic pharmaceutical products and pharmaceutical preparations	0	16	2	2	13	1	12	3	2	0	25
Manufacture of rubber and plastic products	2	1	7	2	7	1	3	9	7	7	10
Manufacture of basic metals and fabricated metal products, except machinery and equipment	18	3	11	7	8	4	1	13	16	18	5
Manufacture of computer, electronic and optical products	1	2	3	10	14	0	0	3	2	7	3
Manufacture of machinery and equipment n.e.c.	6	2	8	2	3	1	1	4	6	9	6
Manufacture of motor vehicles, trailers and semi-trailers	2	1	30	5	15	4	1	14	15	22	8
Manufacture of other transport equipment	0	0	1	0	1	1	1	3	2	0	0
Other manufacturing	19	19	17	20	17	40	10	18	16	13	17
Total manufacturing	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
INDUSTRY	% SHARE OF SERVICES										
Wholesale and retail trade; repair of motor vehicles and motorcycles	16	14	20	17	16	21	19	24	24	21	22
Transportation and storage	1	1	5	8	3	7	3	2	3	0	1
Accommodation and food service activities	4	4	1	1	1	1	1	1	1	1	0
Information and communication	15	11	9	4	8	5	15	7	10	8	3
Financial and insurance activities	27	53	40	33	20	43	31	42	39	47	60
Real estate activities	26	7	15	22	9	19	20	12	11	13	9
Professional, scientific and technical activities	6	8	8	12	37	2	9	10	7	7	3
Administrative and support service activities	3	1	1	4	7	1	2	2	3	3	1
Arts, entertainment and recreation	0	2	0	0	0	1	0	0	0	0	0
Other service activities	1	0	0	0	0	0	0	0	1	0	0
Total services	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Eurostat; authors' calculations
Note: Industry classification is based on NACE 2

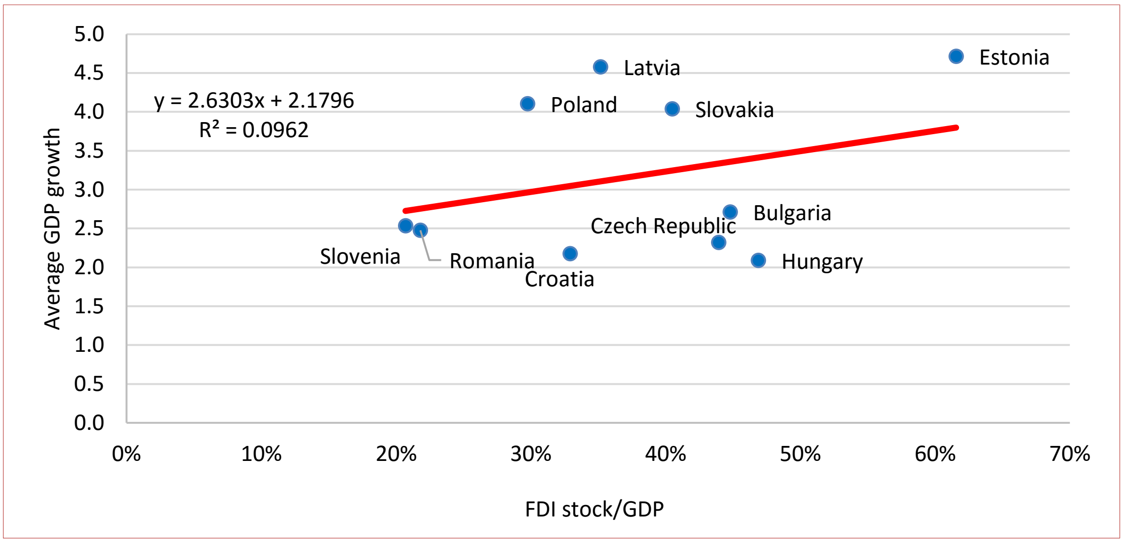
One of the major factors affecting the success of automotive and electronics industry in attracting FDI was the revolution in ICT which reduced coordination and transportation costs and completely revolutionised MNCs' operations where vertical integration was replaced by complex and geographically dispersed supply chains (Kaminski, 2006). These chains also include support services. Substantial evidence points out that without MNC's involvement most of local firms in electronics and automotive industry would have disappeared from the market (World Bank, 2003; Szanyi, 2004; Kaminski, 2006). The increased presence and export orientation of FDI was crucial in the shift to higher value added activities, modernisation of industries, export growth and the change of export structure towards more skilled labour and capital intensive products (Kaminski, 2006; Welfens and Borbly 2006; Kutan and Vuksic, 2007; Damijan et al., 2011). Furthermore, the evidence points out that the entry of large MNCs has attracted sequential investment of other global MNCs as well as foreign suppliers in order to be closer to their customers. Some of these MNCs modernized local suppliers and enabled them to enter GVCs by creating backward linkages, thus making them less likely to move abroad and divest (Javorcik and Kaminski, 2004; Kaminski, 2006).

3.5 IMPACT OF FDI ON NMS ECONOMIES

Policy makers have argued that FDI could play a significant role in the economic recovery of NMS after the initial transition shock (Carlin and Landesmann, 1997; Jensen, 2006). Based on the proposition of endogenous growth theory (Romer, 1986, 1990; Aghion and Howitt, 1997; Grossman and Helpman, 1991) in which FDI is seen as a bundle of knowledge and technology it is argued that the former can influence economic growth through direct and indirect technology transfer resulting in enhanced level of human capital, better quality of products and improvement in the technology systems (UNECE, 2001). Due to increased availability of data in 2000s a significant amount of research has been undertaken to explore whether FDI has caused economic growth and its role in productivity convergence in NMS. FDI was seen as the main vehicle of economic restructuring, technology diffusion and increased export competitiveness (Damijan and Rojec, 2007; Bijsterbosch and Kolasa, 2009). In a recent meta-analysis Iwasaki and Tokunaga (2014) found that CEE and FSU countries benefited from FDI which is 1.86 times larger in terms of its impact on growth than the world average. Figure

3.13 shows the growth of GDP in relation to cumulative FDI inflows/GDP ratio. Overall, simple correlation suggests a positive relationship. However, it must be noted that other factors may have contributed to GDP growth as well and, further, FDI and growth may be endogenously determined.

FIGURE 3.13 GROWTH OF GDP AND RATIO OF FDI STOCK TO GDP(PPP)



Source: UNCTAD FDI Database and World Development Indicators; author's calculations
Note: Data on GDP for Lithuania are missing for years before 2005 and therefore country is excluded from the figure. GDP growth refers to period 1996-2013. FDI stock and GDP(PPP) refer to year 2013.

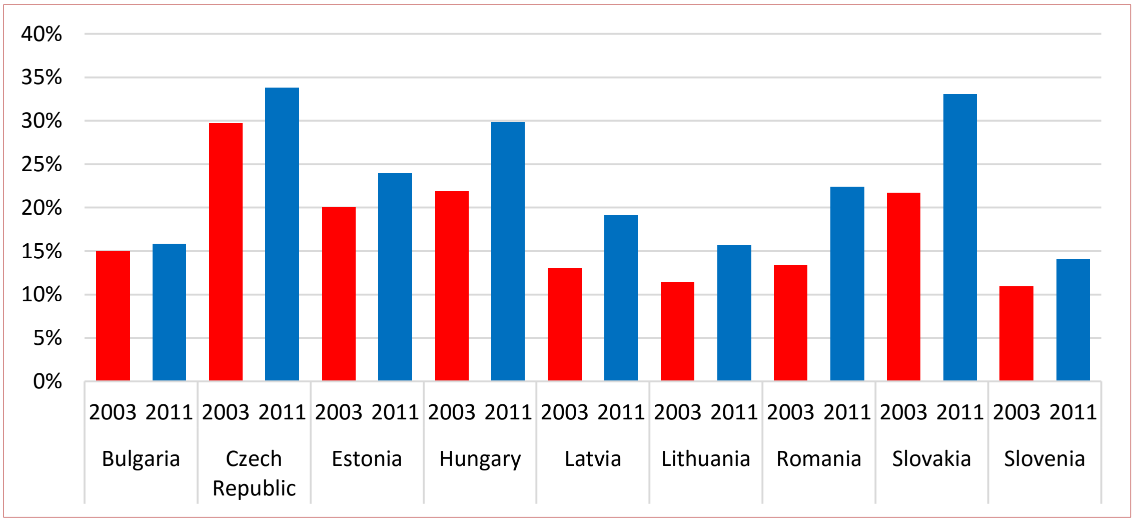
In section 3.3 it was shown that the growth of productivity in NMS by and large exceeded those experienced in most advanced economies of EU-15 and was the most important contributing factor to GDP growth in the pre-crisis period. However, the gaps in levels of productivity are still relatively large at both national and industry levels. The recent financial crisis has shown that the growth of CEECs based on FDI, export and private consumption may not be enough for sustainable economic growth. Kutan and Yigit (2008) found effect of R&D on industry productivity growth in CEECs to be insignificant due to their relatively low levels. Kravtsova and Radosevic (2012) argue that TFP growth is mostly driven by production capabilities based on passive learning and the import of knowledge from abroad, thus limiting further economic growth. They found that levels of productivity in transition countries are lower than expected given their production capabilities and latter does not translate to innovative capability. Hence technical change, which is necessary for the rapid catching up process, generation of new knowledge and improvements in absorptive capacity, is limited.

The aim of this section is to shed more light on the direct role of FDI as the latter provides necessary technology, management techniques, know-how, finance for acquisition of new equipment and market access which are assumed to lead to better resource reallocation across and within industries, industrial and export restructuring and increased productivity. The direct importance of FDI can be measured by the share of foreign affiliates in employment, value added, turnover and productivity premium. For this purpose, we rely on Eurostat Foreign Affiliates Statistics (FATS). Given that the database has incomplete information, the year 2003 and 2011 are taken as the reference years.

3.5.1 SHARE OF FOREIGN AFFILIATES IN EMPLOYMENT

As can be seen from Figure 3.14 the share of foreign affiliates in employment of total business economy has grown between two periods.[14] Countries in which employment share is significant are the Czech Republic, Slovakia and Hungary which also received relatively large amount of FDI in general. The increasing role of foreign affiliates in total employment can be observed in Slovakia and Romania where the shares increased by 11 and 9 percent, respectively.

FIGURE 3.14 SHARE OF FATS IN TOTAL DOMESTIC EMPLOYMENT OF BUSINESS ECONOMY



Source: Eurostat FATS statistics and SBS statistics; authors' calculations
Note: Data for Croatia and Poland are not available. Employment data for Lithuania refer to year 2004; for Bulgaria, the Czech Republic. and Hungary year 2006; for Slovenia year 2010.

[14] For data in year 2003 NACE 1.1 Rev. was used while data for 2011 refer to NACE 2 industry classification. Total business economy in year 2003 includes industry codes C-K_X_J while in year 2011 due to change in NACE classification the following industry codes were used, B-N_S95_X_K.

A closer look at the industry level at Table 3.3 reveals that in year 2011 share of FATS in ICT and manufacturing sector was 31 percent on average. Other industries where FATS employment share is significant are utilities (22 percent); mining and quarrying (24 percent), administrative and support activities (19 percent) and wholesale and retail trade (18 percent). The smallest share is evident in construction (6 percent) and transportation and storage (9 percent).

TABLE 3.3 SHARE OF FOREIGN AFFILIATES IN INDUSTRY EMPLOYMENT IN %, 2011

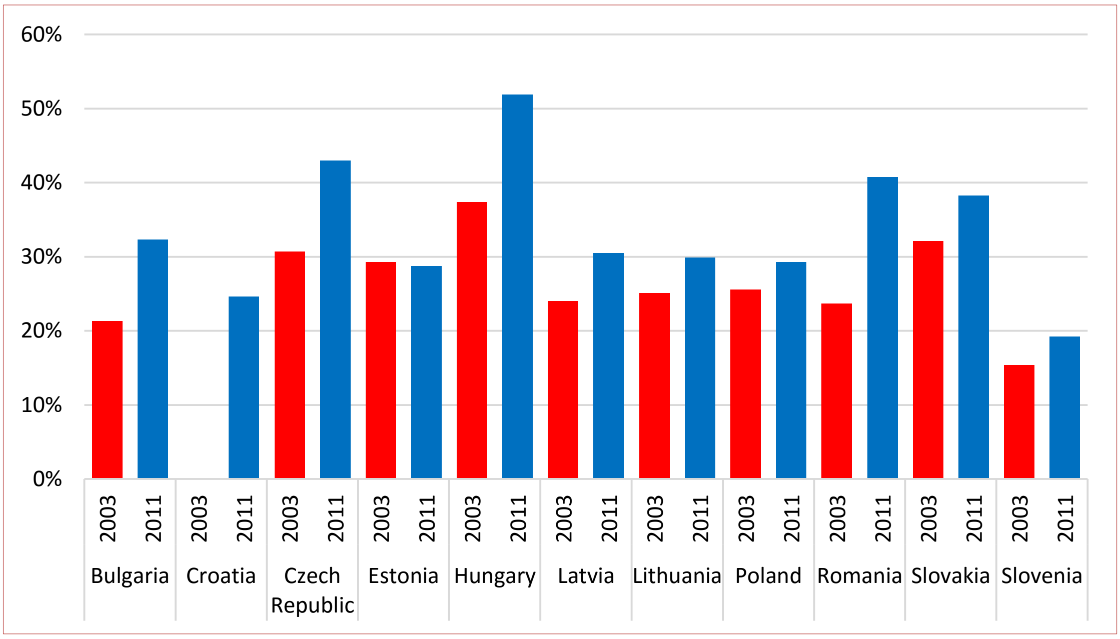
	BG	HR	CZ	EE	HU	LV	LT	PL	RO	SK	SI
Accommodation and food service activities	8	7	12	17	11	16	9	9	7	6	7
Administrative and support service activities	10	\	26	38	19	24	16	13	21	18	22
Construction	6	2	8	7	7	5	6	6	5	6	4
Electricity, gas, steam and air conditioning supply	28	\	21	13	51	16	28	8	23	55	1
Information and communication	36	\	43	40	35	29	35	27	45	42	13
Manufacturing	23	14	42	36	47	22	22	28	37	47	21
Mining and quarrying	20	\	49	9	26	47	28	2	42	32	7
Professional, scientific and technical activities	12	5	13	7	11	14	13	9	18	12	5
Real estate activities	12	13	9	\	14	6	7	3	15	21	6
Transportation and storage	7	6	14	10	11	12	6	8	7	12	8
Water supply; sewerage, waste management and remediation activities	7	4	35	\	9	19	3	7	10	19	4
Wholesale and retail trade; repair of motor vehicles and motorcycles	10	15	25	21	24	25	15	14	16	15	19

Source: Eurostat FATS statistics

3.5.2 SHARE OF FOREIGN AFFILIATES IN VALUE ADDED AND TURNOVER

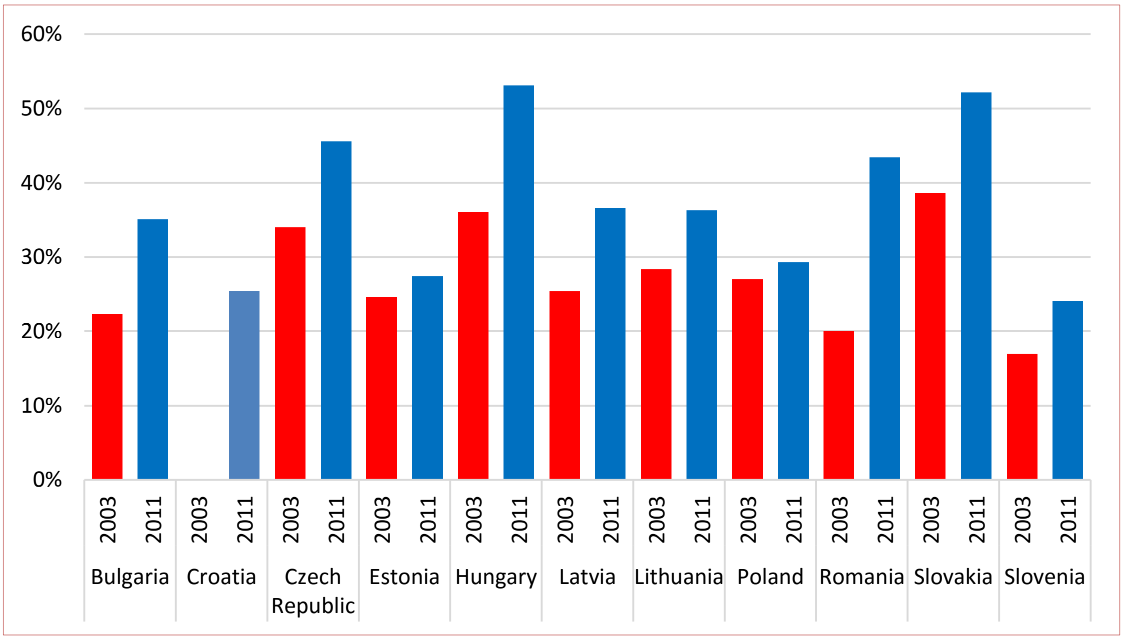
The share of FATS in total domestic business sector' value added is even higher than its share in employment. Figure 3.15 shows that FATS contribute between one third and one half of total value added created in NMS with the exception of Croatia and Slovenia. Regarding the share of turnover shown in Figure 3.16 the share of FATS is highest in Hungary, Slovakia, the Czech Republic and Romania where foreign affiliates contribute more than one third or in some countries even one half of total turnover.

FIGURE 3.15 SHARE OF FATS IN TOTAL VALUE ADDED OF BUSINESS ECONOMY



Source: Eurostat FATS statistics and SBS statistics; authors' calculations
Note: Data for Croatia for year 2003 is not available. Value added data for Lithuania and Poland refer to year 2004 and 2007, respectively.

FIGURE 3.16 SHARE OF FATS IN TOTAL TURNOVER OF BUSINESS ECONOMY



Source: Eurostat FATS statistics and SBS statistics; authors' calculations
Note: Data for Croatia for year 2003 is not available. Turnover data for Lithuania and Poland refer to year 2004 and 2007, respectively.

As was the case with employment figures, foreign affiliates make an important contribution in manufacturing and ICT industries with over 50 percent of turnover attributed to them. Other industries in which FATS contribute significantly to turnover are: mining and quarrying (37 percent), wholesale and retail trade (34 percent), utilities (33 percent), real estate activities (25 percent) and administration and support activities (24 percent). Regarding individual member states, FATS are an important contributor to manufacturing turnover in the Czech Republic (66 percent), Slovakia (78 percent), Hungary (69 percent) and Romania (60 percent). In general, the effects of FDI are substantial, but differ among countries reflecting their initial conditions, differences in policies towards FDI, their industrial structures, different levels of FDI penetration and their motives, prospects related to their productivity and technology catch up, institutional transformation and future profitability perceived by MNCs.

TABLE 3.4 SHARE OF FATS IN TURNOVER AT INDUSTRY LEVEL IN %, 2011

	BG	HR	CZ	EE	HU	LV	LT	PL	RO	SK	SI
Accommodation and food service activities	14	13	19	22	21	28	13	14	14	8	8
Administrative and support service activities	14	\	29	25	31	35	32	23	30	25	21
Construction	21	5	19	11	17	11	13	19	15	24	5
Electricity, gas, steam and air conditioning supply	33	\	37	22	70	29	43	13	48	64	6
Information and communication	54	\	63	60	67	37	61	48	68	62	25
Manufacturing	53	23	66	54	69	31	58	44	60	78	30
Mining and quarrying	42	\	58	17	54	51	41	3	67	60	9
Professional, scientific and technical activities	31	13	23	6	32	28	24	18	34	22	10
Real estate activities	33	26	28	\	30	27	33	6	41	29	17
Transportation and storage	18	10	25	16	32	23	15	16	16	27	13
Water supply; sewerage, waste management and remediation activities	28	8	38	\	21	18	20	15	31	22	12
Wholesale and retail trade; repair of motor vehicles and motorcycles	29	27	40	20	45	48	29	26	40	34	31

Source: Eurostat FATS statistics
Note: Industry classification is based on NACE 2

3.5.3 THE ROLE OF FATS IN TECHNOLOGY UPGRADING AND PRODUCTIVITY IMPROVEMENTS

The productivity catch-up and structural change in NMS much depended on the restructuring of their manufacturing industries. Given the importance of foreign affiliates in selected indicators analysed in the previous subsections, an important question is how these large inflows of foreign capital affected the competitiveness of the manufacturing sector, especially the shift from low to high value added industries. For this purpose, we first compare the penetration of foreign affiliates across different technology groups presented in Table 3.5. Manufacturing industries have been classified into four groups: high-tech; medium-high-tech; medium-low-tech; and low-tech according to OECD (2007b) classification.

By the end of 2011, the number of enterprises in high and medium tech industries remained below those in other groups. However, when comparing the share of turnover, value added and employment, FATS in high and medium technology groups contribute significantly more than the low technology group. For example, the dominance of foreign affiliates is especially pronounced in Estonia, Hungary, the Czech Republic and Slovakia where more than three quarters of foreign affiliates' turnover is earned in high tech and medium high tech industries. In contrast, in Croatia and Lithuania foreign firms' turnover is more concentrated in low technology industries. The same picture emerges when comparing the share of high tech and medium high tech foreign affiliates in employment. In all countries, but Bulgaria, Lithuania and Latvia foreign affiliates in these technology groups employ the majority of employees indicating their superior size. In terms of value added FATS in Estonia, Hungary, Slovakia, the Czech Republic are clear frontrunners in creating value added in high tech and medium high tech industries. Finally, when comparing labour productivity of each technology group with average manufacturing productivity, results point out that FATS in high tech group are the driving force of manufacturing productivity. However, the results are more heterogeneous across countries. For instance, in the Czech Republic and Slovenia, foreign affiliates in medium high and medium low industries have the highest levels of productivity. Similarly, in Croatia and Bulgaria and to certain extent in Latvia, low tech industries are the main drivers of productivity.

TABLE 3.5 SHARE OF DIFFERENT TECHNOLOGY GROUPS IN VARIOUS FEATURES OF FOREIGN AFFILIATES , 2011

	BG	HR	CZ	EE	HU	LV	LT	PO	RO	SK	SI
Number of enterprises (% of total)											
High tech	3	4	5	9	6	3	4	4	6	6	5
Medium high	13	20	28	19	25	18	15	26	22	32	19
Medium low	24	37	39	23	31	34	27	38	31	39	43
Low	60	39	28	49	39	45	55	31	41	23	33
Turnover (% of total)											
High tech	10	0	25	72	52	3	8	23	19	28	11
Medium high	23	39	47	13	33	19	46	41	42	50	54
Medium low	52	24	24	6	10	27	19	22	27	18	29
Low	15	37	5	9	5	52	28	15	11	4	6
Employment (% of total)											
High tech	16		15	50	40	5	7		15	16	6
Medium high	32		47	23	35	32	23		50	52	48
Medium low	23		30	9	16	28	24		19	24	28
Low	29		7	18	9	36	46		17	8	18
Value added (% of total)											
High tech	16	0	11	52	41	4	5	18	14	18	14
Medium high	26	31	51	23	41	20	45	40	37	49	49
Medium low	40	32	31	9	13	30	17	26	32	26	30
Low	18	37	7	15	6	45	33	16	17	7	6
Labour productivity (% of manufacturing average)											
High tech	92	0	99	105	152	110	72	119	132	136	66
Medium high	82	90	105	106	110	71	173	87	97	89	118
Medium low	160	108	106	96	79	114	70	95	102	95	128
Low	66	102	90	93	59	106	85	99	69	79	89

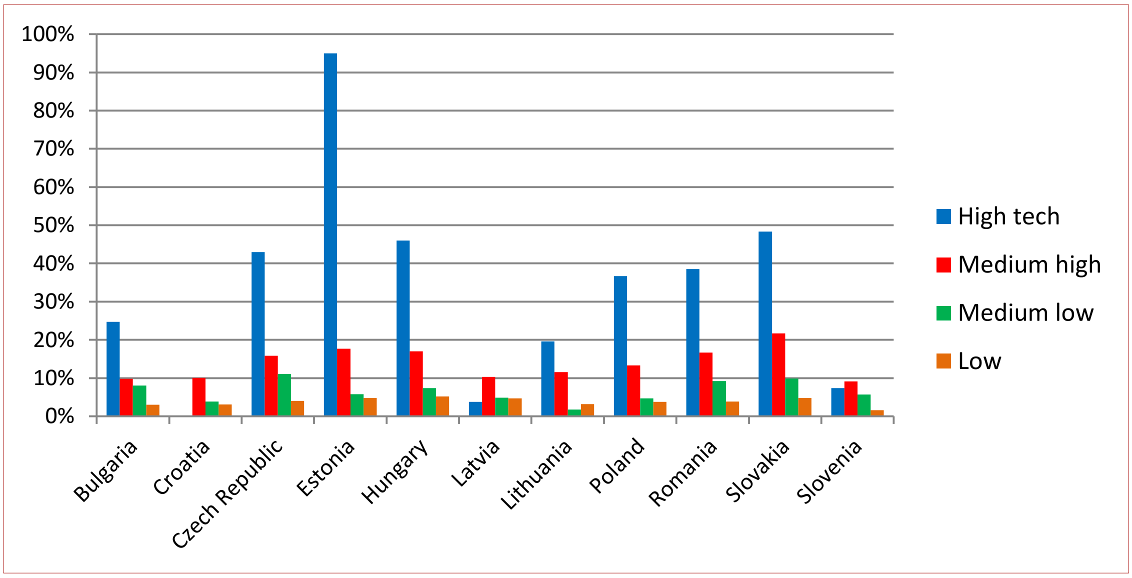
Source: Eurostat FATS statistics; author's calculations

Note: Employment data for Croatia and Poland are missing while for Slovenia year 2010 is taken as a reference year for employment. For Romania data on labour productivity and value added in medium low and low technology industries are taken from year 2008. Data for Croatian high tech industries are missing for all indicators. Labour productivity is calculated as gross value added per person employed.

The analysis of specialisation and industrial structure by technology intensity of FATS shows that although foreign affiliates are mostly concentrated in low technology industries, their contribution to total foreign turnover, employment and productivity of low technology groups is much lower than those located in high tech and medium high tech industries. The next step is to analyse the contribution of foreign affiliates to industry restructuring by comparing them with domestic enterprises. Figures 3.17, 3.18, 3.19 and 3.20 provide information on share of FATS in total domestic turnover, employment, value added and productivity premium by technology intensity of manufacturing industries for year 2011. As can be seen from Figure 3.17, FATS contribute an important share to manufacturing turnover which is especially pronounced in high tech industries.

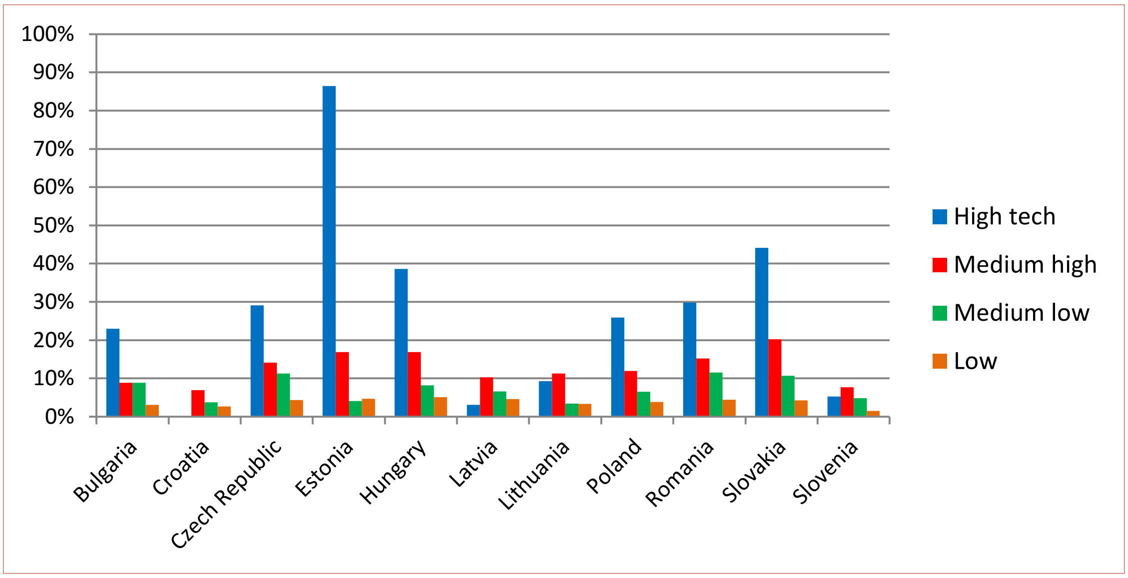
For example, in Estonia 95 percent of turnover in high tech industries is accounted by FATS, followed by Slovakia at 48 percent, Hungary at 46 percent and the Czech Republic at 43 percent. Given relatively low share of high tech FATS in total number of firms in this technology group (ranging between 5 and 15 percent with the exception of Estonia where share is slightly above 20 percent), their contribution is significant. Similar results hold in terms of value added and employment shown below. The share of FATS' turnover, value added and employment in other technology groups is more in line with their share in total number of firms. The notable exceptions are Slovakia and Slovenia in terms of employment where FATS generate several times more jobs in medium low and low tech industries and in terms of value added and turnover in medium low tech industries in Slovakia and the Czech Republic respectively. In general, the more sophisticated is the industry, the higher is the share of FATS in each of the indicator clearly demonstrating the role of latter in upgrading of technological structure.

FIGURE 3.17 FATS SHARE OF TURNOVER IN TOTAL DOMESTIC ECONOMY IN DIFFERENT TECHNOLOGY GROUPS, 2011



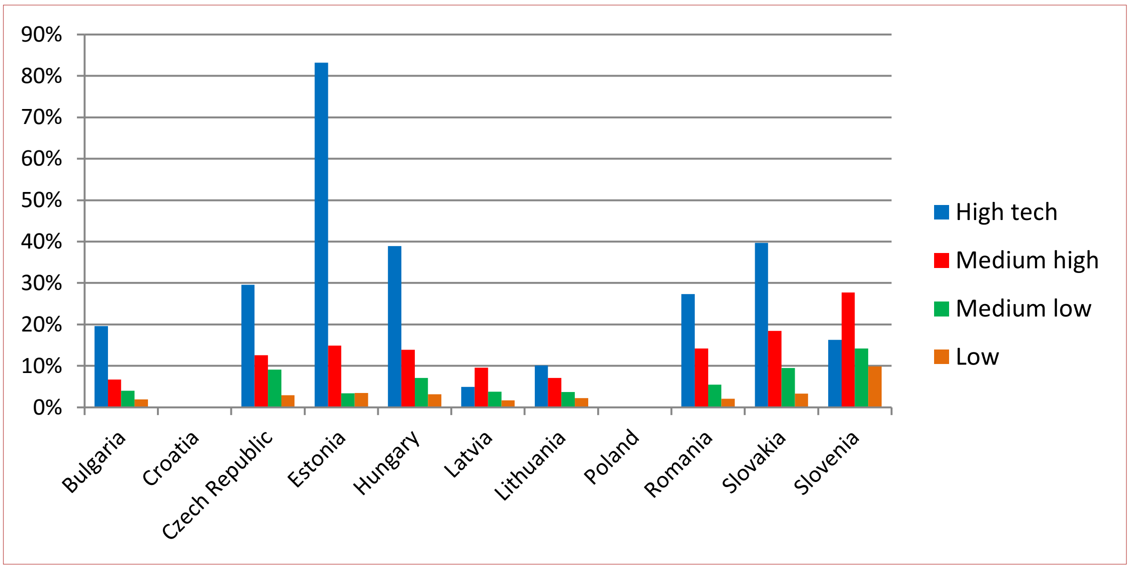
Source: Eurostat FATS and SBS statistics; authors' calculations

FIGURE 3.18 FATS SHARE OF VALUE ADDED IN TOTAL DOMESTIC ECONOMY BY TECHNOLOGY INTENSITY, 2011



Source: Eurostat FATS and SBS statistics; authors' calculations
Note: For Romania value added data for medium low and low tech industries are for year 2008

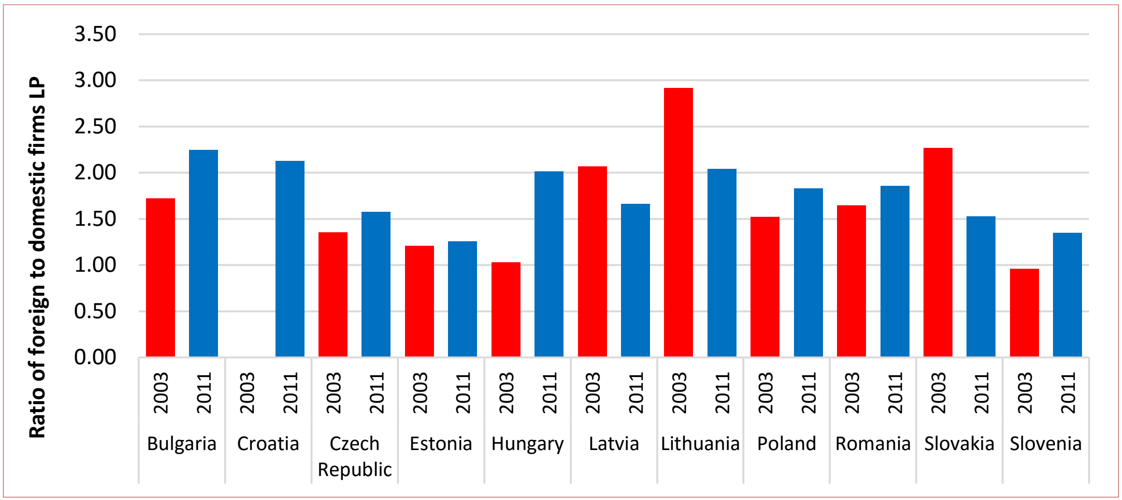
FIGURE 3.19 FATS SHARE OF EMPLOYMENT IN TOTAL DOMESTIC ECONOMY BY TECHNOLOGY INTENSITY, 2011



Source: Eurostat FATS and SBS statistics; authors' calculations
Note: For Slovenia employment data are for year 2010; Data for Croatia and Poland are not available

The growing role of FATS over the years can be assumed to bring also technological improvements and increased productivity for the manufacturing industry and whole economy. One way to gauge their contribution is to compare levels of productivity with those of domestic firms. As can be seen from Figure 3.20 FATS exhibit a productivity advantage over domestic firms in the 2003-2011 period. Labour productivity premium has even increased between the two periods with the exception of Latvia, Lithuania and Slovakia. The largest differences exist in Bulgaria, Hungary and Slovenia while smallest one is evident in Estonia and Romania.

FIGURE 3.20 FATS LABOUR PRODUCTIVITY PREMIUM



Source: Eurostat FATS and SBS statistics; authors' calculations
Note: For Lithuania and Poland data on labour productivity are for years 2004 and 2007, respectively. Labour productivity is measured as vale added per person employed.

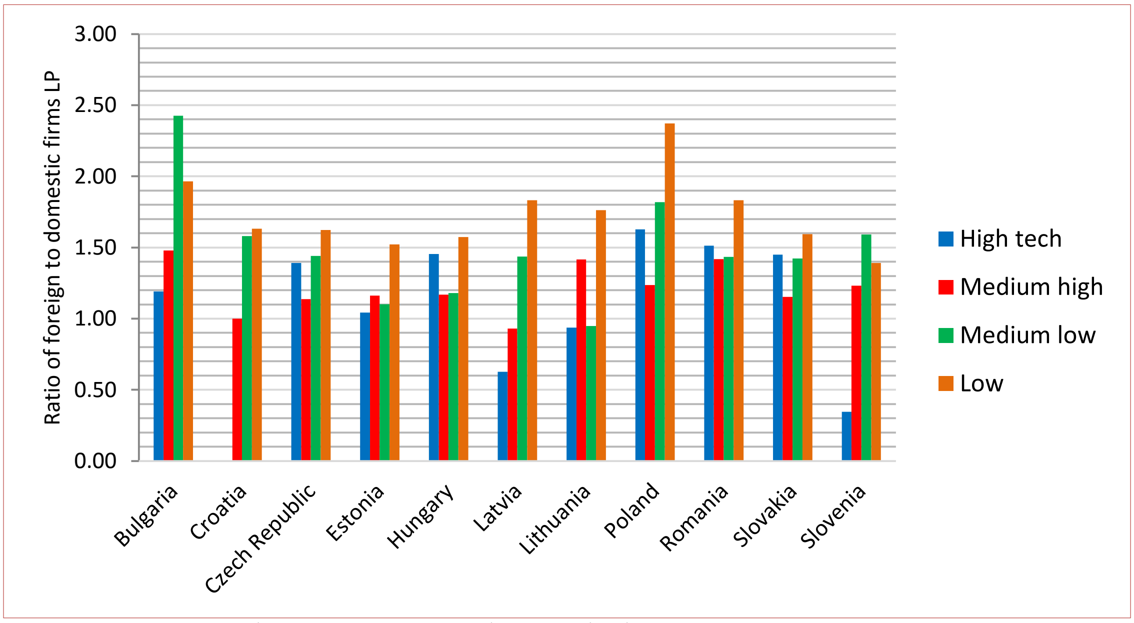
A more detailed look at the industry level reveals that in year 2011, significant differences in productivity between foreign and domestic firms still existed. Table 3.6 below shows that on average FATS are three times more productive than domestic firms in real estate sectors, followed by construction sectors (2.08 times), and hospitality sector (1.88 times). Looking at manufacturing sector only, the highest gaps are observed in Lithuania and Bulgaria at 1.83 and 1.81 times, respectively. The lowest gaps on the other hand are observed in Slovenia (1.24), Estonia (1.26) and Slovakia (1.31). A closer look at technology intensity groups of manufacturing industries presented in Figure 3.21 reveals that mostly low tech industries are lagging further behind in labour productivity. However, there are considerable differences among countries. For instance, while in Bulgaria and Latvia medium low and low tech industries have significant gaps, their high tech industries are more competitive and in Latvia they are even more productive than FATS. On the other hand, countries which received significant FDI in high tech industries such as the Czech Republic, Hungary, Poland and Slovakia exhibit higher gaps in those industries than in medium high or in certain cases in medium low industries as well.

TABLE 3.6 RATIO OF LABOUR PRODUCTIVITY OF FOREIGN TO DOMETIC FIRM BY INDUSTRY, 2011

	BG	HR	CZ	EE	HU	LV	LT	PL	RO	SK	SI
Accommodation and food service activities	2.08	2.33	1.89	1.36	2.27	1.76	1.77	2.08	2.40	1.58	1.18
Administrative and support service activities	1.98	2.32	1.43	0.84	2.21	1.77	1.85	1.95	1.82	1.67	1.10
Construction	2.29	1.77	2.10	1.12	2.35	2.59	1.62	2.66	3.21	2.27	0.86
Electricity, gas, steam and air conditioning supply	1.42	/	0.87	1.26	1.09	1.40	1.41	1.58	1.31	1.00	1.69
Information and communication	1.65	2.00	1.55	1.54	2.11	1.28	1.88	1.85	1.62	1.48	1.55
Manufacturing	1.81	1.58	1.40	1.26	1.40	1.62	1.83	1.64	1.46	1.31	1.24
Mining and quarrying	2.46	/	1.10	1.23	2.11	1.05	1.26	0.78	0.00	2.07	0.68
Professional, scientific and technical activities	2.34	1.91	1.69	1.32	3.02	1.96	1.79	2.12	1.92	1.60	1.87
Real estate activities	3.31	1.88	4.35	0.00	2.86	3.74	6.13	2.47	3.09	1.10	4.16
Transportation and storage	1.79	1.51	1.76	2.41	2.88	1.60	1.71	1.48	1.45	1.01	0.80
Water supply; sewerage, waste management and remediation activities	2.95	1.14	1.23	0.00	1.32	0.72	1.43	1.30	2.14	0.92	2.10
Wholesale and retail trade; repair of motor vehicles and motorcycles	2.15	1.49	1.60	1.10	2.00	1.73	1.86	2.13	2.15	1.37	1.52

Source: Eurostat FATS and SBS statistics: author's calculations
Note: Labour productivity is expressed as gross value added per person employed.

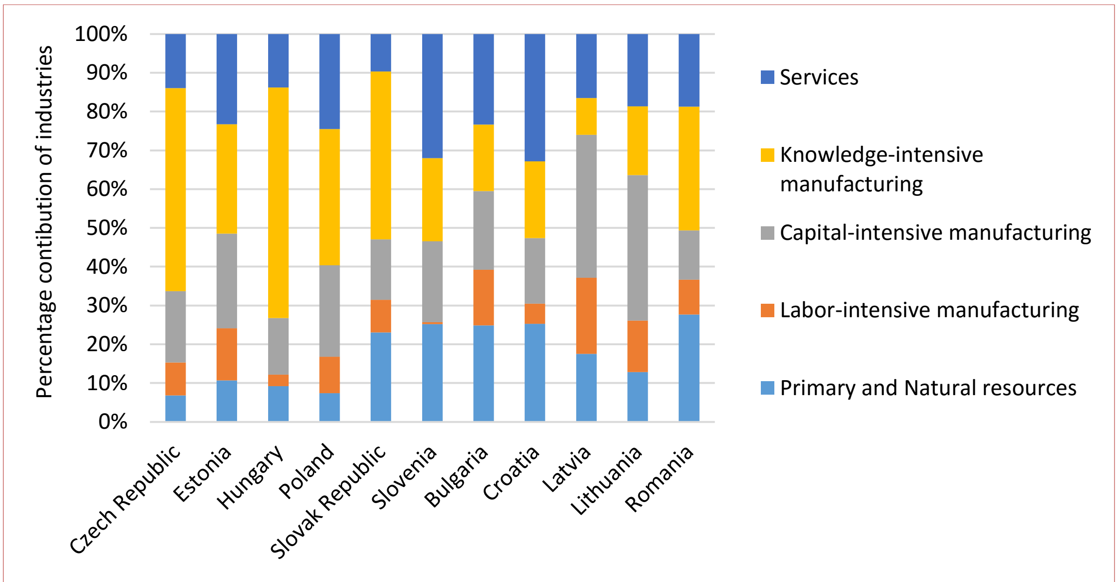
FIGURE 3.21 RATIO OF LABOUR PRODUCTIVITY FOR FOREIGN TO DOMESTIC FIRM BY TECHNOLOGY INTENSITY GROUP OF MANUFACTURING INDUSTRIES, 2011



Source: Eurostat and SBS statistics; author's calculations
Note: Labour productivity is expressed as gross value added per person employed; data for Croatia for high tech industries are not available.

As mentioned in Section 3.3 trade liberalisation of NMS was one of the transformation priorities towards market economy. The reorientation of trade towards more developed economies of EU resulted in increased economic growth and development (Blanchard, 1998). By the end of 2012 over 70 percent of foreign trade was conducted with the EU states with Germany being the main trading partner for most NMS (Cieslik, 2014). The trade integration with European and other more developed economies resulted in structural change of NMS's exports. Figure 3.22 shows the contribution of various sectors grouped into five main categories to total export growth in the period 1995-2010. Countries which received large amount of FDI in knowledge intensive and capital manufacturing sectors such as transport and electrical equipment, machinery, motor vehicles and chemical industry (see Table 3.2) also show significant export growth in these sectors which is in line with recent empirical analysis by Damijan et al. (2013b, 2013c), finding that FDI contribute significantly to export supply capacity and export restructuring in all manufacturing industries. In the Czech Republic, Hungary and Slovakia knowledge intensive sectors account between 40 and 60 percent of total exports, the rest being accounted by capital intensive industries. Croatia and Slovenia on the other hand experienced a significant growth in export of services accounting a third of total export growth.

FIGURE 3.22 SECTORAL CONTRIBUTION TO EXPORT GROWTH IN %, 1995-2010

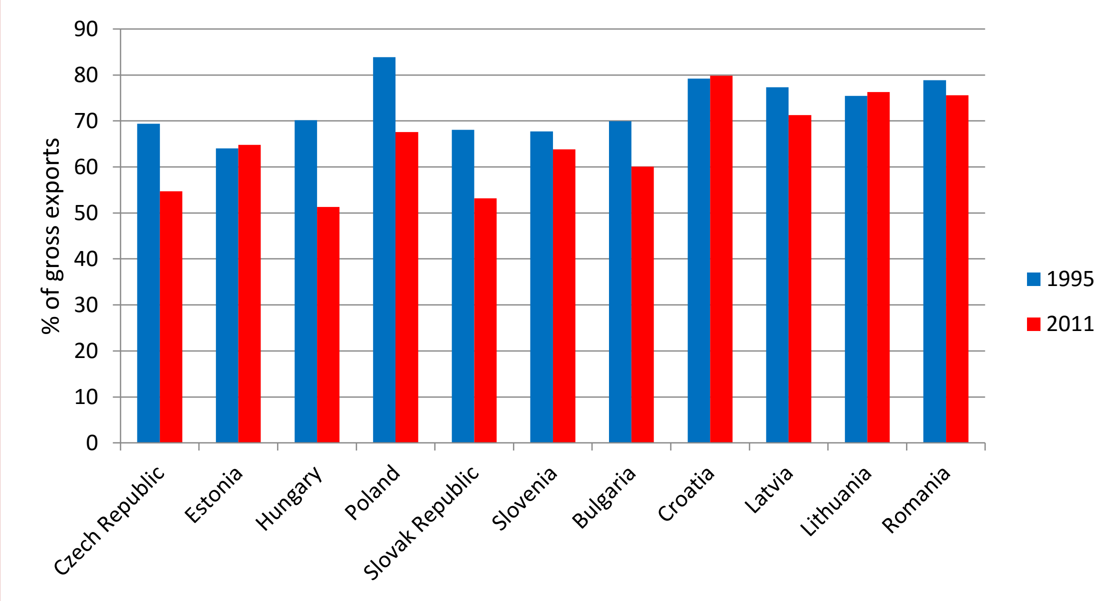


Source: OECD TiVA database; authors' calculations

Given that imports of intermediate products became an important determinant of export performance, Beltramello et al. (2012) argue that looking only at the evolution of exports of final products may misrepresent international competitiveness of countries. The shortcomings of trade statistics in countries which are heavily involved in re-export of intermediates products after initial processing is that export tend to be highly inflated and do not capture domestic value added (IMF, 2013). Trade transformation enabled NMS to participate in GVC and become an important link in the European production model (Dicken et al., 2001; IMF, 2013). One of the main features which enabled NMS to become increasingly involved in GVC are large inflows of foreign investment. The increased fragmentation and geographical dispersion of production is the main feature of MNCs seeking efficiency gains. The latter can be achieved by sourcing inputs either from domestic or foreign suppliers within or outside the firm boundary leading to outsourcing and offshoring of certain functions. MNCs are the main coordinators of GVC and most of worlds' trade in intermediate and final products is occurring as intra firm trade within MNCs (OECD, 2013).

In order to evaluate the role of FDI in participation of NMS in GVC gross exports are decomposed into five main categories following the work of Koopman et al. (2011). Figure I.1 in Appendix I shows the components of this decomposition which are calculated for manufacturing and service industries. In general, participation in value chain can be decomposed according to the origin of the value added embodied in exports. Backward participation is measured as the share of foreign value added in gross exports while forward participation is measured as share of domestic value added in inputs used in partner country's export. The OECD TiVA database which has recently become available is based on this approach. The first indicator which can shed some light on the participation of NMS in GVC is the evolution of domestic value added in gross exports shown in Figure 3.23. Between 1995 and 2011 we can observe a decrease in domestic value added in almost all countries with the exception of Estonia, Croatia and Lithuania indicating that at the same time the share of foreign value added has increased, thus contributing to creation of linkages with global supply networks.

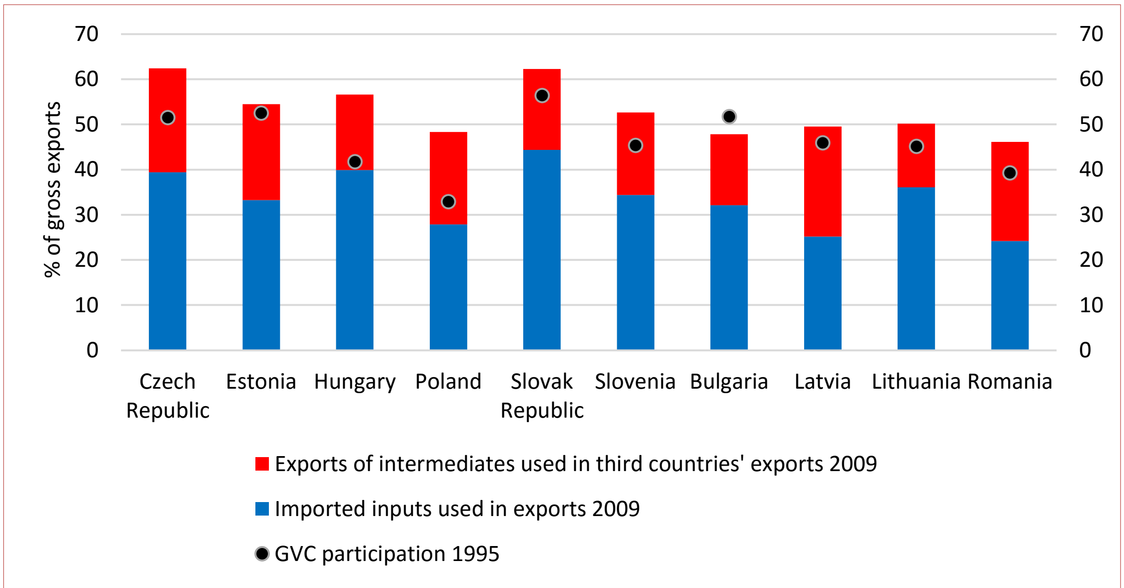
FIGURE 3.23 DOMESTIC VALUE ADDED SHARE IN COUNTRY EXPORT, %



Source: OECD TiVa Database

The participation in GVC is measured as the sum of forward and backward participation indices as shown in Figure 3.24. As can be seen, all countries with the exception of Bulgaria experienced an increase in GVC's participation in two periods of observation. The largest increase was experienced in the Czech Republic, Hungary and Poland.

FIGURE 3.24 PARTICIPATION OF NMS IN GVC



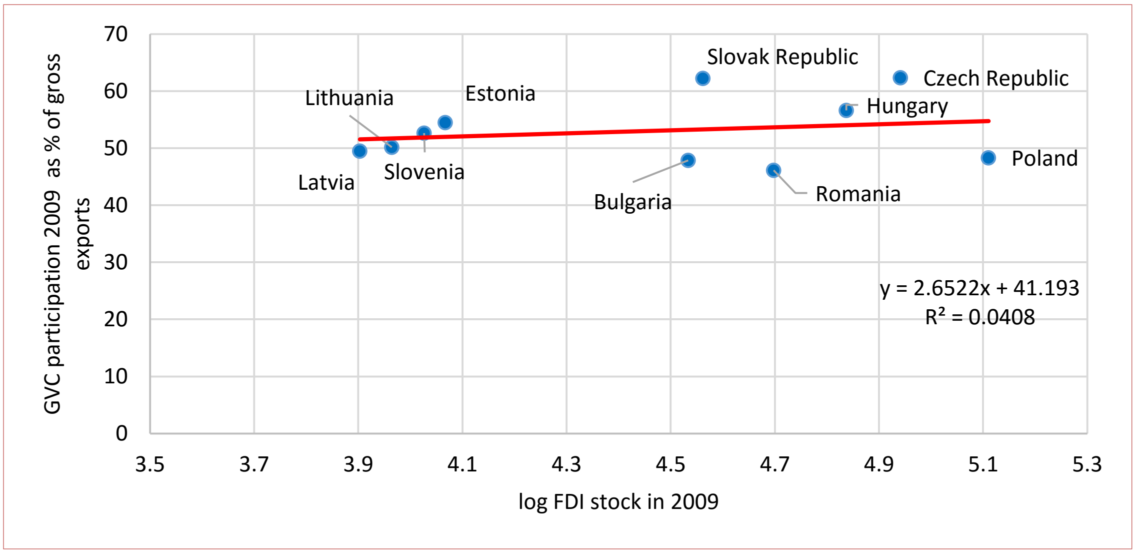
Source: OECD TiVA Database

Note: GVC participation is defined as the sum of the foreign value added (FVA) embodied in a country's exports and the indirect value-added (IVA) exports (i.e. value of inputs produced domestically that are used in other countries' exports) expressed as a percentage of gross exports.

Data for Croatia are not available due to lack of data on backward and forward participation indices.

The increased participation in GVC can be attributed to increased FDI inflows. For example, it is expected that export platform and complex vertical type FDI attracted by core NMS such as the Czech Republic, Hungary, Slovakia and Poland can increase backward participation by importing a large share of intermediates for export processing. Foreign affiliates have thus become an important link in GVC as they produce inputs for neighbouring markets and other downstream affiliates in the same MNC' network (OECD, 2007a). Figure 3.25 shows that FDI has been a major driver of GVC's participation in NMS. This is especially emphasized in economies which attracted large amount of FDI such as core NMS, thus contributing to technology content of their exports.

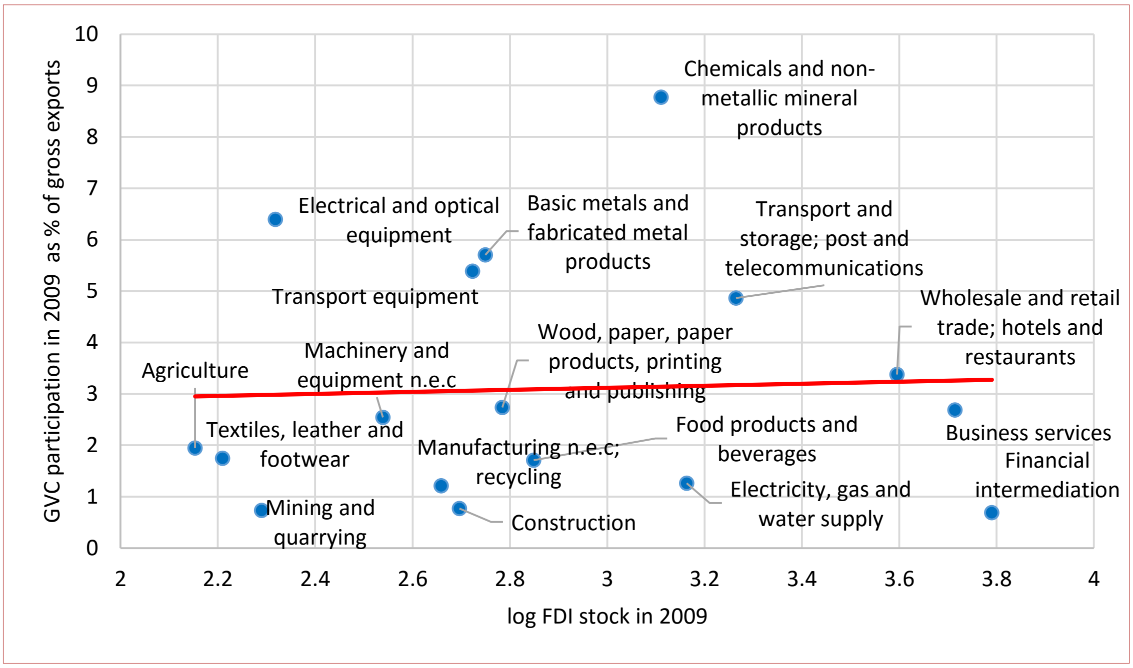
FIGURE 3.25 CORRELATION BETWEEN FDI STOCK AND GVC PARTICPATION OF NMS



Source: OECD TiVA Database and Eurostat; author's calculations

A more detailed look at the industry level presented in Figure 3.26 reveals that FDI stock in industry *j* averaged across countries has positively contributed to GVC participation of high tech and medium high tech manufacturing industries. In addition, FDI in services also positively contributed to increased GVC participation in transport and telecommunications industries and wholesale and retail trade emphasizing the increasing role of services in the export of these countries. This can be explained by improvements in ICT, infrastructure and reduced transportation costs which contributed to tradability of services and their increasing role as input to manufacturing production process.

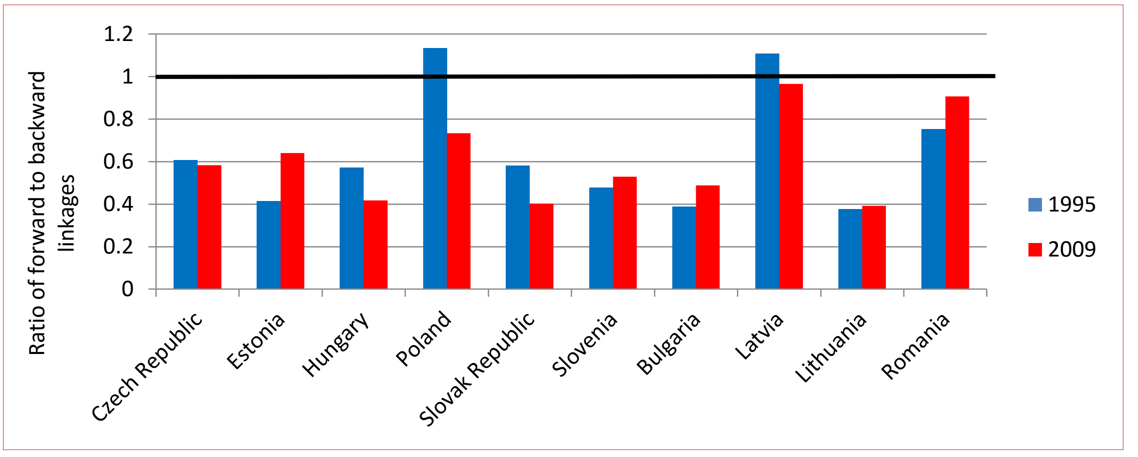
FIGURE 3.26 CORRELATION BETWEEN FDI STOCK AND GVC PARTICPATION OF INDUSTRIES, 2009



Source: OECD TiVA Database and Eurostat; author's calculations

Although previous figure shows a positive correlation between FDI stock and GVC's participation it says nothing about the gains of this participation. As already emphasized earlier in this section GVC participation can be decomposed to forward and backward linkages and higher are the forward linkages, higher are the gains from GVC. Figure 3.27 shows that most countries have gained from participation in GVC with the exception of countries which heavily relied on manufacturing sector, thus deteriorating their position in GVCs by moving even further to more downstream markets. However, in total all countries are more involved in downstream segments of the markets characterised by processing and assembly functions.

FIGURE 3.27 RELATIVE POSTION OF COUNTRIES IN GVC IN 1995 AND 2009



Source: OECD TiVA Database; author's calculations
Note: The borderline between upstream and downstream segments in GVCs is represented by thick black line at the value of 1. The thick line represents the net gains from participating in GVCs. The value larger than 1 implies that country is involved in more upstream markets characterised by high value added of exports.

A more detailed look at the industry level in Table 3.7 reveals that increase in forward/backward ratio indicating the net gains from GVCs' participation is driven by service industries, thus reflecting changes in the production phases where activities such as R&D and design of products in preproduction phase and marketing and distribution in post-production phase have increased their contribution in value added. This is in line with analysis by Francois and Worz (2008) who found that services are most important factor contributing to final exports in OECD countries.

TABLE 3.7 RELATIVE POSITION OF COUNTRIES AND INDUSTRIES IN GVC, 2009

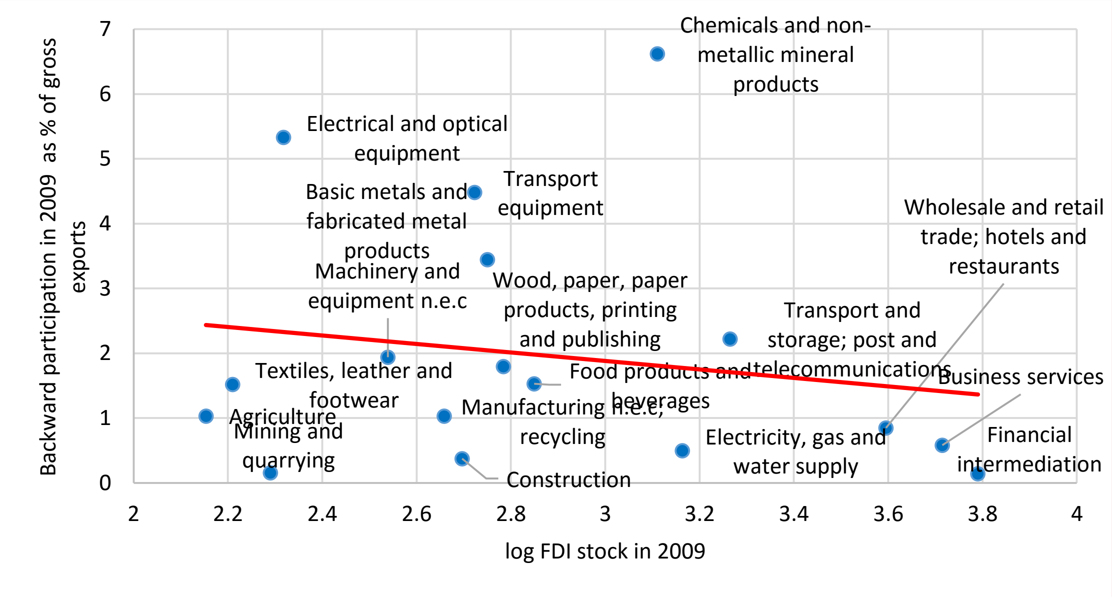
	CZ	EE	HU	PO	SK	SI	BG	LV	LT	RO
	MANUFACTURING									
Agriculture	1.16	0.96	0.68	1.15	1.18	0.92	0.78	0.99	0.52	1.67
Mining and quarrying	2.76	5.12	1.25	3.80	3.97	4.29	3.97	2.60	/	5.95
Food products and beverages	0.15	0.07	0.08	0.16	0.14	0.17	0.07	0.10	0.07	0.82
Textiles, leather and footwear	0.28	0.08	0.17	0.18	0.07	0.12	0.20	0.19	0.22	0.11
Wood, paper, paper products, printing and publishing	0.69	0.36	0.51	0.76	0.61	0.47	0.30	0.47	0.66	1.11
Chemicals and non-metallic mineral products	0.52	0.45	0.43	0.51	0.27	0.40	0.16	0.49	0.19	0.57
Basic metals and fabricated metal products	0.73	0.54	0.69	0.87	0.72	0.67	0.47	0.51	0.66	0.81
Machinery and equipment n.e.c	0.43	0.27	0.26	0.43	0.25	0.28	0.17	0.12	0.12	0.56

Electrical and optical equipment	0.13	0.41	0.13	0.27	0.04	0.28	0.29	0.18	0.34	0.84
Transport equipment	0.29	0.14	0.28	0.17	0.16	0.05	0.01	0.18	0.02	0.35
Manufacturing n.e.c; recycling	0.26	0.09	0.22	0.24	0.10	0.33	0.21	0.13	0.10	0.25
	SERVICES									
Electricity, gas and water supply	2.30	1.21	0.83	4.13	5.39	1.70	0.61	3.02	0.80	3.01
Construction	1.83	0.54	0.66	0.97	3.78	0.87	0.60	1.88	1.52	2.43
Wholesale and retail trade; hotels and restaurants	7.49	5.02	1.36	11.7	4.66	4.67	0.85	4.07	2.59	3.18
Transport and storage; post and telecommunications	2.22	0.56	1.31	1.53	1.90	0.80	0.72	1.93	1.73	2.42
Financial intermediation	6.35	2.32	8.45	5.79	4.86	5.38	4.48	2.91	17.95	8.05
Business services	2.45	3.91	2.85	4.70	5.49	3.83	7.31	2.97	11.42	2.82

Source: OECD TiVA database; author's calculation
*Note: The numbers in the table represent the ratio of forward over backward linkages. The higher is the ratio the higher is the net gain from GVC participation and therefore industry **j** is more involved in upstream markets.*

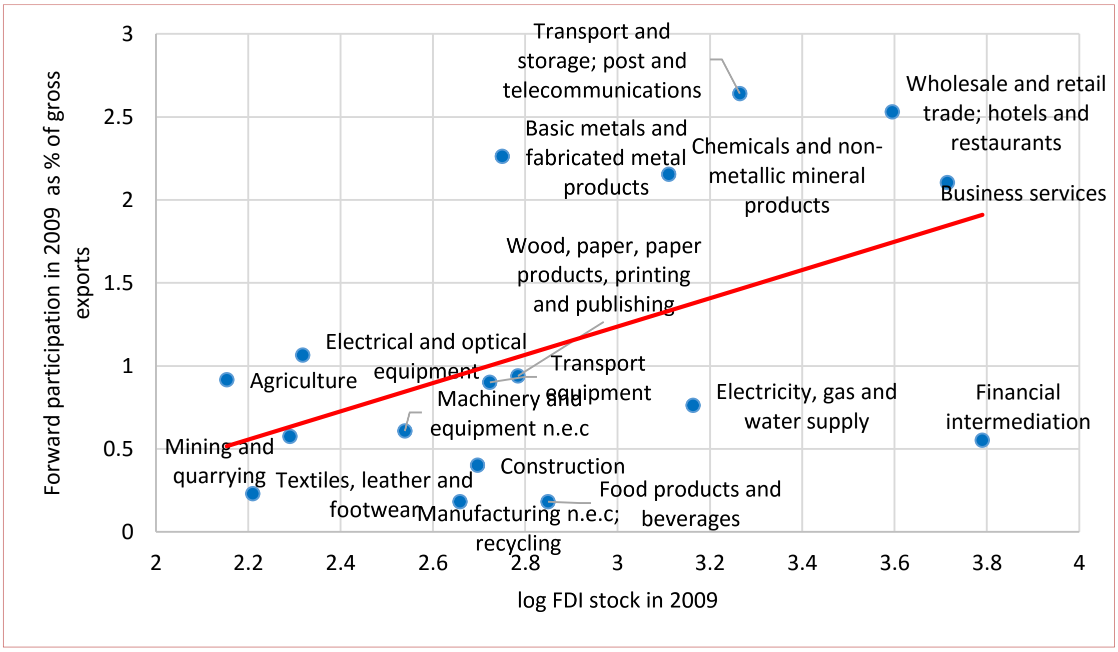
In order to share more light on the role of FDI in the participation of industries in upstream and downstream markets, Figures 3.28 and 3.29 plot the backward/forward participation index against the FDI stock in industry *j* averaged across countries, including the average fitted line. As can be seen, a positive correlation between FDI stock and forward participation and negative one with backward participation indicates that FDI is sourcing the value added from host country markets for export to third countries. However, there is a large heterogeneity among industries. In manufacturing industries such as electronics and optical industry, transport equipment, chemicals and manufacture of basic and fabricated metals, where FDI stock is relatively high, domestic industries are more downstream oriented indicating that foreign firms source most of their intermediates from abroad. Although some of these manufacturing industries also have high forward participation indicating high involvement in intermediates trade through supply chains the gains from GVC's participation are limited mostly to activities related to mid and low processing and less to high tech manufacturing. However, Ciezlik (2014) found that the Czech Republic, Hungary, Slovakia, Poland and Romania rank in top 10 countries in upstream segments of transport equipment indicating an important role played by FDI in their contribution to exports. Some of these countries also hold a strong position in upstream segment of electrical and optical equipment indicating their high technological specialisation. On the other hand, it seems that FDI has contributed more to services GVC' participation, especially in transport and telecommunications, wholesale and retail trade and business services suggesting a movement towards upstream segment of GVCs with higher value added, thus reinforcing the argument made by Gereffi and Korzeniewicz (1994) that MNCs are more likely to perform coordination and control functions where higher profits are realised.

FIGURE 3.28 CORRELATION BETWEEN FDI STOCK AND BACKWARD PARTICIPATION IN GVC PER INDUSTRY, 2009



Source: OECD TiVA Database and Eurostat; author's calculations

FIGURE 3.29 CORRELATION BETWEEN FDI STOCK AND FORWARD PARTICIPATION IN GVC PER INDUSTRY, 2009



Source: OECD TiVA Database and Eurostat; author's calculations

3.7 CONCLUSION

In this chapter the development of FDI in NMS in the course of transition to a market economy and thereafter was reviewed. The analysis showed that the fast increase in FDI in these countries is the result of coinciding favourable investor specific and host country conditions. The speed of structural reforms characterised by opening to trade and capital flows, privatisation policies and signing of EAs led to strong increase in FDI. MNCs exploited the opportunity to enter new market and satisfy local demand. Furthermore, privatisation provided a unique opportunity to acquire former SOEs which had a high quality workforce and significant market share on domestic market. All countries were in need of new capital and technology while providing market access and cheap assets to foreign investors. In the early period of transition, FDI was mainly market seeking in nature. However, when the restructuring of domestic firms acquired by foreign investors was mainly over, efficiency seeking and complex type of FDI prevailed and export demand became the major driving force of manufacturing FDI, while investors with market seeking motive started to emerge in services sector. However, there is still large heterogeneity among countries in terms of their attractiveness for FDI which is reflected in the structure of FDI across industries and contribution to economic development. Factors such as government stance towards privatisation, speed of structural reforms, expected profitability of MNCs and prospects for EU membership explain why some countries were more successful than others in their integration into world markets.

The service sector attracted the largest share of FDI in all countries due to the underdevelopment of this sector under socialism, the potential for high returns on investment and the liberalisation and privatisation of the financial industry, telecommunications and greenfield investment in wholesale and retail trade. The attractiveness of services was also influenced by the need of MNCs to outsource or offshore specific business functions in order to benefit from educated labour force, functional skills and relatively low labour costs. Manufacturing FDI is concentrated in Hungary, the Czech Republic, Estonia, Poland and Slovakia which attracted relatively large amount of FDI in high tech and medium high tech industries in comparison to other NMS. This has dramatically changed their trade patterns and led to the successful restructuring and the shift to high value added activities resulting in increased international competitiveness. The efficiency seeking FDI accompanied by more complex forms of investments in network industries enabled these countries to enter the production fragmentation process and domestic firms to enter GVCs. However, the integration in GVC has mainly been associated with processing and assembly of foreign intermediates, thus providing limited gains especially in manufacturing industries. In contrast, the service sector is involved in more upstream activities with high value added.

The analysis of the direct contribution of foreign affiliates has found their increasing role in employment, turnover and value added activities across all countries. Their contribution to these indicators is especially pronounced in manufacturing and certain service industries such as ICT, administrative and support activities and wholesale and retail trade. In general, the higher is the sophistication of industries, the larger is the contribution of foreign firms. The analysis of productivity levels between foreign firms and the rest of economy indicates the superiority of the former. Productivity gaps are pronounced in all industries, especially in services and low tech manufacturing. Hence, future productivity growth depends on the shift to knowledge based production and innovation activities some of which may be facilitated by attracting product mandate foreign subsidiaries involved in R&D.[15] Improvements in R&D policies would help foreign subsidiaries to shift towards competence creating activities and help local firms strengthen their absorptive capacity. Furthermore, a shift to more upstream activities in GVCs is conditional on the integration of domestic firms in MNCs' networks. One way to achieve this is to introduce programmes whose aim is to help domestic firms to integrate with foreign firms through supply linkages. This would help domestic firms to survive and at the same time make foreign firms less footloose.

[15] Product mandate subsidiaries possess unique local technological competence and pursue asset seeking strategies with the aim to form partnership with host country research centres or universities. They have wide geographical and functional scope and specific product scope (Filippov and Kalotay, 2009).

CHAPTER 4.
ISSUES, METHODOLOGICAL SOLUTIONS AND ESTIMATION OF TFP AT MICRO LEVEL

4.1 INTRODUCTION

In the previous chapter we have seen that countries of Central and Eastern Europe have witnessed strong productivity gains and were able to reduce the gap with more advanced economies in Europe largely due to increase in FDI. However, their GDP per capita is still below the EU-15 average and therefore the need to raise productivity levels remains an important policy goal for these countries. Since the improvement in standards of living crucially depends on the increase in productivity, the aim of this chapter is to quantify productivity as it is used as an important tool to evaluate different policies. The estimation of productivity has gained considerable attention in economic literature. The earlier work was mainly based on the quantification of the role of TFP in economic growth to explain differences in performance across countries and industries. Macro approach to TFP estimation was mainly based on growth accounting and growth regression techniques. However, with the advances in economic theory, in which firms are regarded as heterogeneous entities, and increased availability of firm level data shifted the focus on describing mechanisms and channels through which productivity can be enhanced and its role in the integration process. Estimation of firm level productivity is most commonly based on some form of production function and usually the researchers do not give serious attention to possible difficulties to the estimation of the residual. Too often empirical work *a priori* assumes that chosen empirical methodology is superior to alternatives without giving much taught on the validity of production function estimates and assumptions employed to obtain them.

The first contribution of this chapter is to point out the difficulties arising from TFP estimation at the firm level starting from explaining the major differences between parametric and non-parametric techniques, their assumptions about production technologies and problems with measurement of outputs and inputs. Second, we explain several methodological issues arising from the use of firm level Cobb Douglas production function and possible solutions. We pay specific attention to semi parametric methods which assume a flexible characterization of TFP and are less prone to different biases and measurement issues which may affect the elasticities of factor inputs. Theoretical review of semi parametric methods together with their practical implementation using typical firm level data obtained from the Amadeus database is the second contribution. While similar studies test the assumptions of data generating process and validity of factor inputs estimates using different methodologies they mainly focus on one country or narrowly defined industries. In contrast this chapter contributes by examining TFP estimates across different countries and industries.

Although different estimators make different timing assumptions about the choice of inputs, we remain agnostic about these issues as it has been shown that these assumptions make little difference on the production function and TFP estimates (Ornaghi and Van Beveren, 2012). The focus is on comparison of estimates of different semi parametric techniques and their interpretation. Specifically, we calculate TFP using OLS as a benchmark method and two structural estimators, and test their sensitivity across several dimensions. Finally, we compare different productivity distributions of foreign and domestic firms as an initial indicator of potential for generating productivity spillovers.

The remainder of this chapter is structured as follows. Section 4.2 briefly describes the origins of productivity measurement and different methodological approaches together with their advantages and drawbacks. Section 4.3 provides a detailed overview of methodological issues related to estimation of TFP using firm level data and Cobb Douglas production function, namely simultaneity bias between productivity and input choices, selection bias due to entry and exit for firms, omitted price bias and the appropriate level of analysis when firms produce multiple products. Section 4.4 provides theoretical overview of methodological solutions to some of the problems. Specific attention is paid to semi parametric techniques which have been extensively used in the literature of TFP estimation at the firm level together with more *"classical"* approaches relying on parametric technique, namely OLS and fixed effects. Section 4.5 introduces the data used in empirical estimation of TFP and subsequent empirical chapters. Specific focus is paid to representativeness of Amadeus database to official statistics, cleaning procedure to obtain the relevant sample and construction of foreign ownership variable. In section 4.6 the practical implementation of some of the estimators is applied together with comments on their relative performance. Comparison of foreign and domestic firms in terms of their TFP distribution is provided in section 4.7. Finally, section 4.8 provides concluding remarks.

Origins of productivity measurement can be traced back to seminal papers of Tinbergen (1942), Fabricant (1954), Abramovitz (1956) and Solow (1957) that decomposed output growth to input growth and productivity residual. Early studies were mainly concerned with aggregate TFP and its role in economic growth. The first empirical evidence explaining the sources of productivity growth were provided by Abramovitz (1956) by analysing U.S. economy. He was not able to identify any sources of productivity growth, which led to famous comment: *"Since we know little about the cause of productivity increase, the indicated importance of this element may be taken to be some sort of measure of our ignorance about the causes of economic growth"* (Abramovitz, 1956, p.11). Solow (1957) developed an analytical framework in which main assumption was that productivity growth is a mirror image of exogenous technological progress. Early work was mainly based on growth accounting methods which measure productivity indirectly as a residual of output growth that can not be explained by factor inputs, the former being the result of technological change. Jorgensen and Griliches (1967) continue along somewhat different line arguing that technological progress is embodied in factor inputs and therefore the residual can be completely eliminated. By taking into account differences in input quality the contribution of TFP disappears.

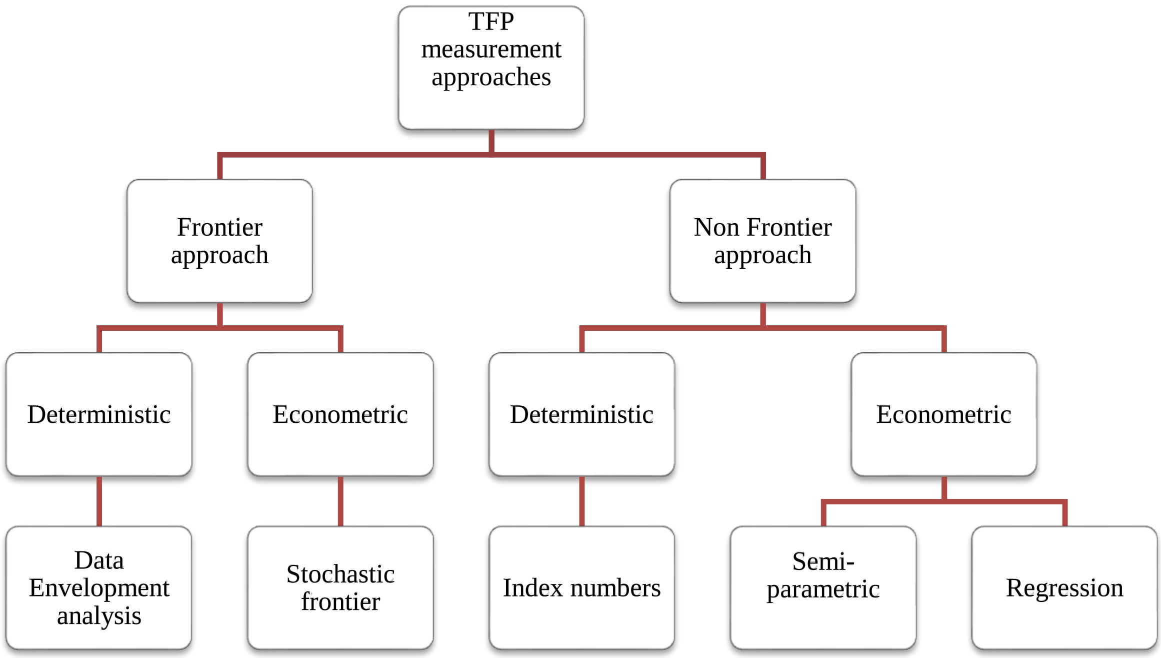
Recently, with the emergence of new growth theory which put emphasis on imperfect competition, increasing returns to scale, innovation, externalities and creative destruction process TFP is regarded as an endogenous part of the development process (Del Gatto et al., 2011). Furthermore, development of new trade models which regard firms as heterogeneous entities within industry require detailed firm level data to explore TFP distribution and integration process (e.g. Melitz, 2003; Melitz and Ottaviano; 2008; Chaney, 2008). The availability of microeconomic data has created possibilities to estimate productivity at more disaggregated levels and to explain the sources of cross country differences in economic growth. Several empirical studies have found that TFP growth can be decomposed into within and between components and the role of creative destruction process. The within component is related to innovative activities of the firms aimed to increase the efficiency of production process and choices firms make about input and output levels. Between components is the result of reallocation of inputs across firms as a result of market interactions on inputs and output markets. Finally, net entry component reflects the difference in productivity growth of new more productive firms in the market from those firms who exit. Foster et al. (2001) and Bartelsman et al. (2009) decomposed aggregate TFP growth by using firm level data and came to conclusion that within component plays the major role in productivity growth and the process of creative destruction has a significant role in the process of reallocation of inputs and outputs. Recently, Petrin and Levinsohn (2012) have challenged the existing decomposition of TFP and suggested that one should focus on measuring aggregate productivity growth as the change in aggregated final demand minus the change in the aggregated cost of primary inputs. It is an indicator of the change in potential aggregate consumption holding total primary input use constant. They show how to use plant-level data to decompose aggregate productivity into technical efficiency and reallocation terms. They were able to show that traditional measures of TFP decomposition use no information on the differences between marginal revenue products and input prices in its assessment of growth arising from reallocation.

Apart from productivity decomposition, data availability has also allowed to explore the determinants of TFP at micro level, thus enabling more specific policy recommendations. Syverson (2011) has recently summarised the determinants of TFP growth to those specific to the firms and those arising from environment in which the firms operate. Internal factors are related to managerial talent and quality of their practices, quality of labour and capital inputs, information technology, product innovation, learning by doing and firm structure decisions such as the degree of decentralisation, vertical integration and operation in multiple industries. On the other hand, external factors may not influence productivity directly, but they may influence the incentives to adopt previous practices. Also, they can influence the extent and success of internal efforts at moving producers on productivity ladder. External factors can be classified to productivity spillovers which are the aim of this thesis, intramarket and trade competition, regulation and flexible inputs markets which are closely related to flexibility in product markets.

Although the measurement of productivity has recently gained significant attention in economic literature there is yet no common methodology which allows its consistent estimates. According to Van Biesebroeck (2008) there are at least six issues related to productivity measurement. First, different estimators make different assumption about the production technology used by firms. Second, most methods require assumptions about functional form of production function. Third, one must make assumptions about firm behaviour due to technological differences. Fourth, even if the assumption of technological homogeneity is assumed, one is faced with endogeneity of input choices. Fifth, some other unobservable elements apart from productivity can affect output, and therefore some structure on stochastic evolution on the unobserved productivity difference must be imposed. Sixth, measurement errors in outputs and inputs are inherent in accounting data and therefore methodologies differ in sensitivity to such errors.

Generally, methodologies used to estimate TFP at micro level can broadly be divided in two groups as shown in Figure 4.1.

FIGURE 4.1 APPROACHES TO TFP MEASUREMENT AT MICRO LEVEL



Source: Adapted from Del Gatto et al. (2011) and Kathuria et al. (2013)

The above figure shows that TFP at the firm's level can be estimated using deterministic methodologies such as Data Envelopment Analysis (DEA) and index numbers and second, econometric methodologies which can be further divided to semi-parametric methods based on proxy variables or instrumental variables and stochastic frontier. These methodologies differ according to assumptions mentioned above. Index method assumes perfect competition in products and inputs market in order to be able to calculate TFP without resorting to estimation of a production function. Furthermore, it remains agnostic on the functional form and some index number methods allow technology to differ between firms which may be a very realistic assumption and in line with new trade models which argue that productivity differences may exist even in narrowly defined industries (Melitz, 2003). One of the main disadvantages of index methodology is that they do not allow for measurement errors which may be large due to imperfect measurement of output and input measures in accounting data. It also imposes necessary assumptions of firm behaviour and market structure which may influence productivity. DEA methodology is a non-parametric method developed by Farrell (1957) and further extended by Charnes et al. (1978). It belongs to frontier models which assume that firms are not fully efficient and in the presence of inefficiency productivity measurement is also affected. Productivity is defined as the ratio of a linear combination of outputs over a linear combination of inputs obtained using linear programming for each observation. It requires imposing specific weights on factor inputs and output in order to maximize productivity. The firm or linear combination of other firms are regarded efficient if it produces more output with the same input aggregate and the latter uses the same weights (Van Biesebroeck, 2007). The most efficient firms are located on frontier of the production and comparison is made with other less efficient firms. The distance from the frontier is termed technical inefficiency. The advantages of DEA are that it does not require any specific functional form, thus allowing technology to vary across firms. Furthermore, it is capable to disentangle two main sources of productivity growth, namely technological change which shifts production possibility frontier upwards and technical efficiency change which reflects the capability of firms to improve production with given set of input and technology. The major drawback is that this methodology does not allow for measurement errors and is very sensitive to outliers because each observation is compared to all others and therefore may affect the productivity estimates.

Turning to econometric methodologies, parametric methods require specific functional form of the type such as Cobb-Douglas (CB), translog or Constant Elasticity Substitution (CES), thus assuming same input trade-offs and returns to scale for all firms within an industry or country (Van Biesebroeck, 2007). Parametric methods are less susceptible to measurement errors due to stochastic framework of analysis and productivity estimates depend on the chosen functional form. Furthermore, econometric methods allow taking into account adjustment costs arising for example by changes in factor inputs which become costly the faster they are implemented (Schreyer and Pilat, 2001). The major drawback of such methods is endogeneity of inputs, first discussed by Marschak and

Andrews (1944). It arises due the fact that firms observe their productivity level and adjust their inputs accordingly, thus creating possible correlation between inputs and the error term which is unobserved by econometrician. In order to deal with simultaneity bias and other problems specific to TFP estimation, several solutions have been proposed, the most prominent one being structural estimators discussed in more detail in the following section and GMM estimator. The latter is explained in more detail in the next chapter.

Briefly, GMM estimator assumes a specific functional form of production function in which productivity is modelled as a firm fixed effect (ω_{it}) which evolves as AR(1) process ($\omega_{it} = \omega_{it-1} + \eta_{it}$). Given this persistence in productivity, production function is transformed from static to dynamic specification. However, transforming the production function from static to dynamic models using OLS does not solve potential simultaneity bias as factor input are still correlated with time invariant productivity level and productivity shock. Blundell and Bond (2000) estimate production function in first differences adding lagged levels of the dependent and independent variables to the right-hand side. By doing that they eliminate time invariant productivity level and the assumption that factor inputs are correlated with productivity level is made redundant (Eberhardt and Helmers, 2010). However, labour and lagged dependent variable are still correlated with productivity shock while capital is treated as predetermined. The latter assumption is based on the notion that investment in new capital is made in the *t-1* and thus capital stock does not increase until period *t.* If this assumption is dropped, capital can be treated as endogenous as well.

In practice, production function is first differenced which eliminates firm fixed effects and lagged levels of output from *t-3* and *t-2* for labour and capital can be used as instruments for equation in first differences at time *t* (Van Biesebroeck, 2007). One advantage of GMM over semi-parametric techniques discussed at length in the following section is that it its assumptions of data generating process (DGP) can be tested. Furthermore, since it uses information in both levels and first differences it can reduce measurement errors in both inputs and outputs in comparison to other methods. Moreover, the inclusion of fixed effects and lagged terms accounts for differences in production technology (Van Biesebroeck, 2007). The problem with System GMM estimation is that it is vulnerable to large downward bias if there are severe measurement errors as found in Van Biesebroeck (2008). In addition, since productivity estimation is usually conducted on industry level, the validity of assumptions must be satisfied for all industries to draw valid conclusions about parameter estimates. Finally, dynamic panel methods assume that all inputs are quasi fixed which differs from assumption of semi-parametric methods discussed below which allow more flexible use of factor inputs.

An alternative way to estimate TFP and contribution of efficiency change to change in TFP is stochastic frontier analysis originally proposed by Aigner et al. (1977), Meeusen and van den Broeck (1977) and Battesse and Corra (1977). As in the case of DEA, technical inefficiency assumption allows decomposing productivity changes due to changes in technical efficiency and technical progress. The stochastic production frontier defines maximum feasible output and the error term captures technical inefficiency. The latter can be written as:

$$TE_i = \frac{Y_i}{f(X_i;\beta)\exp(\upsilon_i)} = \exp(-\mu_i) \leq 1$$

where TE represents technical efficiency, Y_i output, $f(X_i;\beta)$ a deterministic production frontier common to all firms, υ_i is the random error term capturing external shocks to output and μ_i captures technical inefficiency. In order to calculate technical efficiency one must first estimate production function to obtain estimates of technology parameters β and composite error term. However, one of the shortcomings of this methodology is the choice of distributional and independent assumptions of the error term, especially one related to μ_i as there is no a priori justification of certain type of distribution (Del Gatto et al., 2011). Since the composite error term is negatively skewed it requires the use of maximum likelihood method. The main disadvantage is that the estimates obtained may be biased if the output is not correctly measured and it assumes that productivity is constant over the entire period.

The most common approach used in estimating productivity is based on one specific form of production function, namely Cobb-Douglas which can be written as:

$$Y_{it} = A_{it}K_{it}^{\beta k}L_{it}^{\beta l} \tag{4.1}$$

where Y_{it} is output of firm i in time t, A_{it} is total factor productivity which is unobserved by econometrician, K_{it} is capital and L_{it} is labour. β_k and β_l are intensities of capital and labour respectively. The common assumption is that A_{it} is Hicks neutral which captures disembodied technical change.[16] TFP can be the result of both internal and external factors mentioned in the previous section which are not directly related to any specific factor inputs. For example, A_{it} may not be related only to technological differences across firms, but can also include managerial ability, scope efficiency, expected machine breakdown or cyclical effect (Katay and Wolf, 2008; Konings and Vanormelingen, 2010).

By taking natural logarithms Cobb-Douglas production function can easily be transformed into linear equation suitable for empirical estimation which allows A_{it} to be additively separable from other factor inputs.

$$ln(Y_{it}) = \beta_0 + \beta_k\, ln(K_{it}) + \beta_l\, ln(L_{it}) + \varepsilon_{it} \tag{4.2}$$

and

$$ln\,(A_{it}) = \beta_0 + \varepsilon_{it}$$

where β_0 measures mean efficiency across all firms over time t and ε_{it} can be regarded as deviations from the mean capturing (i) unobserved factors affecting firm output such as managerial ability, (ii) measurement error in output and inputs, and (iii) random noise (Eberhardt and Helmers, 2010).

Error term ε_{it} in eq. (4.2) can further be decomposed in anticipated productivity Hicks neutral shock (ω_{it}^{*}) affecting firms' input choices and unanticipated productivity shock

[16] Technical change is Hicks neutral whenever marginal rate of substitution between labour and capital remains unchanged for a given capital/labour ratio. Therefore, it is assumed that any increase in output is caused by disembodied technological changes such as advances in science, blueprints, diffusion of knowledge, better marketing and organizational techniques without any changes in factor inputs.

or other sources of error (v_{it}) not observed by the firms (Eberhardt and Helmers, 2010). Unanticipated changes may include unexpected machine breakdown, workers' strike, or measurement problems in outputs and inputs. The productivity shock, unobserved productivity or TFP (ω^*_{it}) can be further divided into elements common to all firms and specific to firms expressed in the following way:

$$\omega^*_{it} = \eta_i + \gamma_t + \omega_{it} \tag{4.3}$$

where η_i represents time invariant firm specific productivity term which arises from the industry in which firms operate or geographical location and is captured by firm fixed effects. This time invariant effect represents the permanent deviation of firm i from the referene productivity level in the base year (Eberhardt and Helmers, 2010). γ_t is common technological shock such as the introduction of new technology or macroeconomic shock that affects all firms in the same way and represents the average productivity increase over time. Finally, ω_{it} is combined effect of firm specific deviation from its own TFP level in the base period and average technological progress in period t (Eberhardt and Helmers, 2010).[17]This firm and time specific effect or shock ω_{it} can be attributed to *"the technical knowledge, the will, effort and luck of a given entrepreneur"(Marschak and Andrews, 1944, p.145)* in a given time period. In other words, technological shock does not affect each firm in the same way as some benefit more that others. For example, firms with higher productivity levels experience higher rate of technical progress in comparison to firms with lower productivity levels (Eberhardt and Helmers, 2010). Therefore, firm differences in responses to shocks observed over time are captured by ω_{it}.

After incorporating these elements[18] into equation (4.2) we get:

$$ln(Y_{it}) = \beta_k\, ln(K_{it}) + \beta_l\, ln(L_{it}) + \beta_0 + \eta_i + \gamma_t + \omega_{it} + v_{it} \tag{4.4}$$

The measure of the TFP is obtained as the residual from production function, i.e.:

$$ln\,(A_{it}) = \beta_0 + \eta_i + \gamma_t + \omega_{it} = ln(Y_{it}) - \beta_k\, ln(K_{it}) - \beta_l\, ln(L_{it}) \tag{4.5}$$

[17] Since factor inputs can not affect output without taking into account ω_{it}, i.e., the later "transmit to" the input choices, this particular problem is known as the "transmission bias".

[18] *"Given that the econometrician also does not observe the common productivity γ_t and that fixed productivity effects may have a systematic relationship with the size of idiosyncratic shocks we could argue that $\beta_0 + \eta_i + \gamma_t + \omega_{it}$ are the productivity elements infuencing input choice"* (Eberhardt and Helmers, 2010, p.6).

However, the estimation of (4.4) is not straightforward as the assumption that firms operate on their production frontier may not be plausible due to different constraints arising from market conditions, financing investment and hiring of employees (Kvinge, 2008). Furthermore, the assumption of perfect competition is not realistic as firms compete selling differentiated products and charge prices above marginal costs. Also, the Cobb-Douglas production function assumes that technology is Hicks neutral meaning that it affects marginal product of labour and capital in the same way, which is a strong assumption as firms operate in different industries (Van Biesebroeck, 2007). Therefore, empirical estimation relies on relaxed assumptions by estimating production functions at a more narrowly-defined industry level rather than at total sector level. Furthermore, demand conditions are introduced in the model to capture pricing behaviour of firms.

An important issue not yet completely resolved in empirical work is the measurement of variables. As a measurement of output, some studies employ gross output while others use value added. Gross output allows to incorporate the contribution of material inputs in addition to labour and capital. Theoretically, it is preferred measure of output because it allows for substitution between materials and the other two inputs (Hall et al., 2009). Basu and Fernald (1995) show that apparent productivity spillovers are the result of specification error when using value added. They argue that in imperfect competitive industries gross output provides a better measure. Furthermore, productivity measures based on gross output specification are a valid representation of disembodied technical change if production technology is assumed to be Hicks neutral (Schreyer and Pilat, 2001).

However, when using firm level data value added specification may be more appropriate as share of materials in total output varies greatly across firms due to different degrees of vertical integration (Hall et al., 2009). Use of value added allows comparison between firms using heterogeneous intermediate inputs and allows taking into account different quality of inputs (Salim and Kalirajan, 1999). Moreover, in order to properly account the demand for intermediate inputs one should include the adjustment costs related to stocking of material (Hall et al., 2009). Finally, as we measure TFP for services sector it is difficult to define output since the latter is often intangible in nature and reflects quality improvements. In addition, since data on actual quantities sold are unavailable in firm level datasets one is able to consider only TFP based on deflated revenue. Syverson (2011) takes into account the fact that firms produce more than one product. Therefore, differences in revenues could be the result of differences of market power and this would show up as productivity differences not arising from efficiency, but from price variation. So far, empirical studies did not give a strong support to any specification suggesting a more complex working of technical change (Schreyer and Pilat, 2001).

Similar critique can be applied to measurement of inputs. Griliches (1987) argued that productivity dispersion is the result of measurement problems in inputs.[19] For labour, the most common measure is the number of employees or cost of labour instead of number of hours one actually worked. However, not all employees are equally productive and thus usual measures of labour input do not reflect time, skills and effort of the workforce. Capital is usually measured as a book value of fixed assets or constructed by using observed investment and perpetual inventory method. Appropriate measure of capital would include capital service of each asset type. However, flows of the quantity of capital services are not usually directly observable and thus they are approximated assuming that the quantity of an asset held by a firm is proportional to the usage obtained from that asset (Eberhardt and Helmers, 2010). Furthermore, components of capital equipment may be of different vintage and thus affect productivity differently (Whelan, 2002). Transition economies face substantial measurement problems with the factor capital, which arise due to the poor accounting standards and the tendency to misstate the value of capital.

In the following subsections, several methodological issues will be explained in more detail as they cause severe bias in factor elasticities and TFP estimation. Several estimation techniques are reviewed together with their advantages and drawbacks. Special attention is paid to structural estimators as they will be employed in estimation of TFP. [20]

[19] This claim disregards the fact that productivity dispersion can also be related to fixed firm characteristics. If the latter are a significant driver of productivity, than reallocation of inputs across firms and industries may be less effective and process of creative destruction may be needed to increase overall productivity, thus requiring different policy responses (Fox and Smeets, 2010).

[20] The review of potential econometric problems and solutions related to productivity estimation is based on excellent reviews by Van Beveren (2012), Del Gatto et al. (2011), Eberhardt and Helmers (2010) and Van Biesebroeck (2007).

4.3.1 SIMULTANEITY BIAS

The issue of simultaneity bias was raised by Marschak and Andrews (1944) who argued that inputs in the production function are determined by the characteristics of the firm and its reaction to external shocks. Therefore, the inherent problem in (equation 4.2) is that firms' choice of inputs is dependent on realized productivity shock which is only known to the firm, but not to econometrician. The estimation of production function using OLS requires that the inputs in the production are exogenous, i.e. determined independently from the firm's efficiency level. However, in empirical analysis it is not possible to obtain unbiased and consistent estimates of the input coefficients as we do not know how firms adjust their input choice based on productivity shocks specific to them. Since productivity term is expected to transmit to input choices, this is known as *"transmission bias"* (Griliches and Mairesse, 1995).

Hence, if there exist a positive serial correlation in firms' productivity, a positive productivity shock will lead to more variable inputs usage introducing an upward bias in coefficients of labour and materials which are regarded as more flexible inputs than capital which takes time to adjust (De Loecker, 2011). When correlation between capital and labour is positive, capital coefficient will be biased downward and the estimation of TFP will be difficult (Levinsohn and Petrin, 2003). Given that expected biases for variable and quasi fixed inputs are different it is difficult to predict the impact on TFP. For labour intensive industries and industries which use more variable inputs this implies that TFP will be biased downward if not corrected for endogeneity. The opposite holds for capital intensive industries (Van Beveren, 2012).

Traditional methods to deal with heterogeneity and endogeneity issues include fixed effects and instrumental variables estimation (Wooldridge, 2009). However, both methods are plagued by several problems discussed later. The use of Olley-Pakes (1996), Levinsohn-Petrin (2003), Ackerberg et al. (2007) and Wooldridge (2009) estimators solve these issues, although the data requirements and assumptions among the methodologies differ.

4.3.2 SELECTION BIAS

Several theoretical models of firm growth and dynamics predict that productivity differences are a major source of firm's entry and exit (Jovanovic, 1982; Hopenhayn, 1992). More recently, new trade models emphasise the importance of firms' productivity distribution and the integration process (Melitz, 2003; Melitz and Ottaviano, 2008; Bernard et al. 2007) as well as the determinants of these differences (Bernard and Jensen, 1999; Del Gatto et al., 2011). Therefore, when estimating production function one must take into account selection bias which emerges because firms do not exit the market randomly, but because of their low productivity. Decisions on the allocation of inputs in a particular period are made conditional on its survival (Van Beveren, 2012). The latter is a function of productivity shock and observed capital stock.

Firms with large capital stock are more likely to stay in the market. This holds even if they experience negative productivity shock in comparison to firms with lower capital stock which exit. This will in turn generate negative correlation between capital input and unobserved productivity. Consequently the capital coefficient will be biased downwards and TFP estimates will be biased upwards if dynamics of firms' exit process have not been taken into account (Eberhardt and Helmers, 2010). Furthermore, omitting firms' exit and use of balanced panels exert an additional upward bias in TFP. This is because exiting firms tend to have low levels of capital stock and low productivity and omitting these firms will result in lower factor elasticities and higher estimated TFP on average. The estimation algorithm developed by Olley and Pakes (1996) takes the selection bias explicitly into account.

4.3.3 OMITTED PRICE BIAS

Generally, firm price levels are not available, thus researchers are confined to use industry-level price indices to deflate firm-level sales and input expenditures in traditional production function estimates (De Loecker, 2011). The deflated values of output and inputs namely revenue, capital and materials using industry deflators, are thus typically used as proxies for their quantities. Therefore, given the data available, most studies use revenue based TFP. However, the use of the price index is only valid under the assumption of perfect competition, i.e. if all firm level prices do not deviate from deflators used, if firms produce homogeneous products and face a common and infinite price elasticity of demand (Melitz, 2001). If prices reflect market power arising from firms' size or production of differentiated products, deflated values of firms' output using single industry deflators is a second best solution to measure quality or efficiency differences. The consequence of using industry level prices is a bias in input coefficients since choice of inputs is dependent on unobserved firm level price variation (Klette and Griliches, 1996).

Standard supply demand framework assumes that inputs and outputs are positively correlated, while output and prices are negatively correlated. Thus, the correlation between (variable) inputs and firm level prices captured in error term will be negative. This will result in a negative bias for the coefficients of labour and materials (De Loecker, 2011)[21]. The presence of imperfect competition can additionally be extended to input markets as input prices are also firm specific. As with output prices, input prices usually proxied by deflated values of inputs for capital and materials since actual quantities are mostly unavailable. Again, failure to take into account firm price deviations of input prices result in upward biased estimates of TFP if firms' input prices are lower than industry prices leading to underestimation of input use (Van Beveren, 2012). De Loecker (2011) argues that if imperfect output markets are treated explicitly by including demand for output in the system, the omitted input price bias can be partially solved due to their positive correlation with output prices.

4.3.4 MULTIPRODUCT FIRMS

Bernard et al. (2009) have recently questioned the relevant level of analysis for the estimation of a production function if firms produce multiple products. Since production function assumes that firms have identical production techniques and final demand (using output deflators) across products manufactured by a single firm, TFP estimates will be biased. In practice, single firms produce multiple products which use different production techniques and face different final demand. Bernard et al. (2010) document that 41% of all firms in their sample of US manufacturing produce multiple products.

[21] For example, if firm is more efficient and is able to charge lower prices than the rest of the industry, the use of deflated sales will result in underestimation of firm's output for a given level of inputs and in underestimation of TFP and vice versa if a firm is less efficient than its competitors.

They find that two-thirds of firms alter their mix of five-digit SIC codes every five years. Consistent estimation of TFP require detailed data on product types and number, product output, inputs and prices which are almost never available to researchers. One of the possible solutions to circumvent the data unavailability proposed by Bernard et al. (2009) is to sort the firms into groups by products to obtain product level factor elasticities and TFP. However, if there are synergies in the production process of different products which raise firm efficiency, TFP may be underestimated. An alternative way to obtain consistent and unbiased estimates of TFP is to allow for variation in production parameters across firms with different product mix (Bernard et al., 2009).

4.4 SOLUTIONS TO ECONOMETRIC PROBLEMS

Several solutions to *"transmission bias"* arising from equation (4.4) have been proposed in the literature. We begin by introducing methods which dominated the empirical literature until recently. Then, Sections 4.4.1, 4.4.2 and 4.4.3 introduce structural models which are now common empirical strategy when calculating TFP at the firm level. Structural estimators explained below deal mostly with simultaneity and omitted price bias which means that estimation of TFP will still suffer from other biases. Each structural estimator has its own strengths and weaknesses, but for the purpose of this research three methods will be used. OLS will serve as robustness check for Levinsohn and Petrin (2003) and Wooldridge estimators (2009). Other econometric problems mentioned above are partially addressed. Selection bias is solved by using unbalanced panel as estimation of survival probability in Olley and Pakes (1996) structural estimator which implicitly takes into account firms entry and exit could not be employed due to lack of investment data and noisy measure of exit in Amadeus database. However, other estimators have shown that incorporation of the survival probability has small efficiency gains in comparison to use of unbalanced panel of firms (Levinsohn and Petrin, 2003; Van Beveren, 2012).

In order to tackle omitted price bias two approaches have been developed so far. First, Klette and Griliches (1996) suggest using growth in industry output as an additional variable in firm production function. De Loecker (2011) proposes to control for within industry price and demand shocks by estimating market demand. Practical implementation of solution for omitted price bias in the Olley and Pakes estimator was developed by De Loecker (2011) under the assumption of Dixit Stiglitz demand system. By estimating augmented production function one can obtain true elasticities of input coefficients by multiplying them with the relevant mark-up. The problem with this approach is that it requires explicit assumption about market structure which leads to question the plausibility of estimates (Dumont et al., 2014). The second approach is to use firm level prices to deflate firm output. For example, Foster et al. (2008) found significant differences in TFP estimates when using firm level output prices instead of industry level on data from Colombian manufacturing sector. By using industry deflated sales, the productivity is especially underestimated for young firms that usually charge lower prices for their products.

However, data on price variation are not available in most firm level datasets. Therefore, De Loecker et al. (2012) obtained product level information on prices and quantities to obtain firm price index. Using product level data for Spanish manufacturing firms, Ornaghi (2006) invalidates the correction proposed by Klette and Griliches (1996) due to existence of asymmetric biases among the input coefficients. Multiplying asymmetric coefficients with the same correction term does not yield unbiased input coefficients. Furthermore, Mairesse and Jaumandreu (2005) argue that the use of firm level prices when available has little effect on the estimated coefficients. Similarly, Dumont et al. (2014) use PRODCOM database for Belgian manufacturing firms to control for possible omitted bias when estimating firm level efficiency. They do not find many indications of systemic bias from the use of industry price deflated revenues as indicator of output.

Correction for omitted price bias is not applied in this thesis for several reasons. First, we do not have data on investment which is necessary for employing Olley and Pakes (1996) estimator. Second, correction for omitted price bias employed in this estimator only possibly corrects the omitted output bias assuming equal demand elasticities across firms, while a formal solution for the bias induced by firm-specific input prices has yet to be introduced. Finally, the correction of bias arising from multiproduct firms is not possible in the absence of product level data on inputs and outputs.

The empirical specification which forms the basis of further discussion is:

$$ln(Y_{it}) = \beta_k\, ln(K_{it}) + \beta_l\, ln(L_{it}) + \beta_0 + \eta_i + \gamma_t + \omega_{it} + v_{it} \qquad (4.6)$$

4.4.1 TRADITIONAL SOLUTIONS TO ENDOGENEITY OF INPUT CHOICE

Traditional solution to the unobserved heterogeneity and endogeneity issues is related to panel firm fixed effects (FE) by using cross sectional dummy variables or mean differencing. In order to deal with simultaneity bias the strong assumption of constant productivity differences across firms must hold.[22] Therefore, any productivity increase over time (γ_t) captured in the model by year dummies must disseminate to all firms equally and within the same period (Eberhardt and Helmers, 2010). Moreover, selection bias can be resolved since the assumption is that endogenous exit decisions are determined by time invariant productivity and not by random component. The alternative is to allow for firm specific productivity shocks, but allow inputs to be exogenous. However, as noted by Wooldridge (2009) this is a strong assumption that is not likely to hold in practice. Using fixed effects has the additional drawback of removing substantial information from the data, since only variation over time remains to identify the parameters (Eberhardt and Helmers, 2010). Finally, empirical estimation using FE on both unbalanced and balanced panel has provided unreliable coefficient estimates which is especially pronounced in very low capital coefficients leading to severely decreasing returns to scale and selection bias (Olley and Pakes, 1996; Eberhardt and Helmers, 2010).

The problem of endogeneity can also be solved using an instrumental variable (IV) approach. This method uses instrument which should be correlated with endogenous variable, do not enter production function directly and are uncorrelated with firm unobservable productivity (Greene, 2008). There are several possible instruments one can use such as input/output prices, variables that shift demand or supply for output and inputs and lagged levels of inputs (Ackelberg et al., 2007). By using lagged input prices one must assume that inputs market is perfectly competitive, the assumption being somewhat implausible. Firms with market power have more influence to set market prices in response to the input quantities and its productivity. This induces correlation between prices and productivity invalidating prices as good instruments (Van Beveren,

[22] Since fixed effect transformation wipes away firm specific effect (η_i) as it is time invariant it is necessary to assume that there are no further firm specific productivity shocks in order to tackle the endogeneity issue.

2012). Furthermore, prices need to be firm-specific and exhibit variation across firms to reflect input choices in the first stage of IV regression (Eberhardt and Helmers, 2010). Finally, most of available micro data do not report firm level prices. Using wages as instrument for labour imply exogenous labour market conditions. However, higher wages usually reflect better skills and qualifications (e.g. efficiency wage argument) and thus the latter factors are correlated with productivity making wage invalid instrument (Van Beveren, 2012).

IV deals with endogeneity of inputs, but not with selection bias. Firms facing higher input prices will be more likely to exit because of higher costs, thus leading to correlation between instruments and error term (Ackerberg et al., 2007). Turning to two other possible instrument sets mentioned above does not solve the problem. Firstly, variables that shift demand or supply are difficult to find. Second, by first differencing production function and using lagged input levels as instruments for their changes leads to downward biased, often insignificant capital coefficient and very large decreasing returns to scale due to weak correlation of input levels with its changes (Blundell and Bond, 2000).[23]

In order to solve the problems related to *"transmission bias"* and selection bias several structural models of firm behaviour were developed (Olley and Pakes, 1996; Levinsohn and Petrin, 2003; Ackerberg et al, 2007; Wooldridge, 2009). All these models rely on observed input decisions to control for unobserved productivity (ω_{it}). Since ACF and Wooldridge estimators rely heavily on the assumptions of OP and LP the latter will be briefly discussed before explanation of Wooldridge estimator as the preferred methodology used to estimate TFP.

4.4.2 OLLEY-PAKES AND LEVINSOHN-PETRIN METHODOLOGY

Olley and Pakes (1996) were the first who adopted assumptions of structural model of firm behaviour and explicitly modelled the firm's optimization problem to derive their production function estimator. The OP approach sets up a model where companies operate in discrete time and make decisions to maximize expected discounted value of

[23] As a possible solution to weak instrument problem Blundell and Bond (1999) proposed systems of equations which use first difference of the variables as instrument for their levels which yields more reasonable parameter estimates.

net cash flows. At the start of each period, incumbent firms decide either to exit the market or to continue their operations. If firms stay in the market they choose appropriate level of factor inputs and investment. They solve endogeneity problem by using information about investment I_{it} to proxy for unobserved productivity (ω_{it}) and apply control function estimator.[24] Selection issues are addressed by incorporating an exit rule into the model (Van Beveren, 2012).

In general, structural estimators discussed in this section rely on certain assumptions.

Assumption 1. Capital is assumed to be a fixed input. Capital has also dynamic implications for the next period arising from the following process:

$$K_{it} = (1-\delta)K_{it-1} + I_{it-1} \tag{4.7}$$

Where K_{it} is capital, δ is depreciation rate and I_{it} is investment of firm *i* in period *t-1*. Since present capital level was decided in previous period and it takes one period to be bought and installed it is not correlated with innovation in productivity ξ_{it} between *t-1* and *t*. In Levinsohn Petrin (2003) capital stock depends on investment in period *t.*

In contrast, labour input is assumed to be a variable input chosen at the same time the productivity shock is realized and is therefore correlated with the innovation ξ_{it}. Furthermore, labour is also a static input implying that the present levels of labour input do not affect the cost of labour in the future.

Assumption 2. The investment function (I_{it}) is fully determined by capital (K_{it}) and unobserved productivity ω_{it}. This can be represented as $I_{it} = f_t(K_{it}, \omega_{it})$. As argued by Ackerberg et al. (2006) scalar unobservable assumption implies that any unobserved heterogeneity in adjustment costs of capital, demand or labour market conditions across firms is ruled out. It also assumes perfect factor and product markets. In case of imperfect competition firm level input prices will determine the optimal level of investment and therefore they should enter inverted function f_t^{-1} defined below (Ornaghi and Van Beveren, 2012).

Assumption 3. Unobserved productivity ω_{it} can be proxied using an observable firm decision such as choice of investments. It is assumed that choice of investments is strictly

[24] Control function approach is an alternative to instrumental variable approach and consists of deriving a proxy variable that accounts for any unobserved factors which may affect endogenous variables.

increasing with state variables capital and unobserved productivity. This implies that firms with higher productivity or capital invest more. As a consequence, only non-negative values of investment can be used in the analysis. This condition needs to hold for at least some known subset of the sample (Van Beveren, 2012). Following the monotonicity assumption and provided that investment is positive, productivity can be expressed as inverted investment equation.

$$\omega_{it} = f_t^{-1} (I_{it},K_{it}) \qquad (4.8)$$

Since the f_t^{-1} would require solving complicated dynamic programming problem, its functional form is proxied by higher order polynomial terms in investment variable and state variables and estimated non-parametrically.

Assumption 4. Productivity follows a first order Markov process. This implies that future productivity is determined only by information known at current period and exogenous productivity shock which arise between time t and $t+1$. The latter is assumed to be uncorrelated with productivity (ω_{it}) and capital in $t+1$ (Ornaghi and Van Beveren, 2012). Therefore evolution of productivity can be represented as: $\omega_{it} = E[\omega_{it} \mid \omega_{it-1}] + \xi_{it} = g(\omega_{it-1}) + \xi_{it}$ where g is an unknown function and innovation term ξ_{it} is introduced which is the deviation from the expected productivity level which is mean independent of any information at $t - 1$ or before, and is thus not foreseeable by the firm.

The potential issue with Olley and Pakes estimator is that data on investment are rarely available or large number of observations report missing values or zero investment thus causing violation of monotonicity assumption. Levinsohn-Petrin (2003) suggested that monotonicity condition is more likely to hold by using intermediate inputs as a proxy variable. Using intermediate inputs increases the sample size as data on material inputs are more widely available in firm level databases. The reason for using intermediate inputs is that under assumption of perfect markets higher productivity implies higher marginal product of capital and thus firms will increase production until marginal product of capital equals its rental rate (Katay and Wolf, 2008). By increasing their output firms also increase the usage of intermediate inputs, therefore providing information about productivity of firms.[25]

[25] However, firms' productivity may be increased by better quality management or improvements in organization of production process, thus making intermediate inputs less responsive to productivity shocks.

In LP estimation labour and intermediate inputs are freely available and chosen simultaneously once that unobserved productivity is known to the firm. LP specify the demand for intermediate inputs as $M_{it} = f_t(K_{it}, \omega_{it})$. They use the same method of inverting out ω_{it} with the difference that productivity is a function of capital and materials.

$$\omega_{it} = h_t(K_{it}, M_{it}) \tag{4.9}$$

In this way, observable variables, namely capital and material costs give information about productivity. By substituting equation (4.9) in equation (4.6) one gets:[26]

$$ln(Y_{it}) = \beta_0 + \beta_k\, ln(K_{it}) + \beta_l\, ln(L_{it}) + \eta_i + \gamma_t + h_t(K_{it}, M_{it}) + v_{it} \tag{4.10}$$

In practice, LP or OP production function estimator is implemented in two steps. First, by regressing output (Y_{it}) on labour input (L_{it}) and a nonparametric function $\phi(K_{it}, M_{it})$ which act as a proxy for unobserved productivity. If labour had dynamic implications, its identification would not be possible in the first stage. This is because in the case of firing and hiring costs labour would not be perfectly adjustable, and therefore it would enter the set of state variables on which the choice of proxy variables depends (Ornaghi and Van beveren, 2012). The following equation can be estimated by Ordinary Least Square (OLS):

$$ln(Y_{it}) = \beta_l\, ln(L_{it}) + \phi(K_{it}, M_{it}) + v_{it} \tag{4.11}$$

where $\phi(K_{it}, M_{it}) = \beta_0 + \beta_k\, ln(K_{it}) + h_t\,(K_{it}, M_{it})$ (4.11a)

$\phi(K_{it}, M_{it})$ is approximated by a higher-order polynomial in M_{it} and K_{it} (including a constant term).[27] In order to account for time variation, polynomial terms are interacted with time or by including time dummies in first stage of regression.

The first stage provides an estimate of $\phi(K_{it}, M_{it})$ and unbiased and consistent estimate of labour.[28] It solves endogeneity of capital and productivity because the firm-observed

[26] Structural estimators discussed here are not able to account for time invariant firm level fixed effects (η_i) while common shocks (γ_t) are accounted for by including year dummies or interacting the polynomial function with time.
[27] LP suggest estimation based on a third-order polynomial series expansion, but any other flexible estimation approach is valid.
[28] β_0 cannot be identified as it is included in polynomial term.

productivity has been controlled for by $\phi(K_{it,}\ M_{it})$. Capital is not identified in the first stage as it is included in polynomial term and would lead to collinearity issues with non-parametric function. Second stage identifies capital coefficient using estimated ϕ under the assumption that ω_{it} follows a first order Markov process defined as $\omega_{it} = E[\omega_{it} | \omega_{it-1}] + \xi_{it} = g(\omega_{it-1}) + \xi_{it}$. As before g is an unknown function and ξ_{it} represents productivity innovation not foreseeable by firm at time $t-1$, where capital is decided, the two are orthogonal and thereby uncorrelated. This moment condition is necessary to identify capital. Given the obtained estimate of labour in the first step the production function can be expressed as:

$$Y_{it} - \beta_l L_{it} = \beta_k K_{it} + \omega_{it} + v_{it} \tag{4.12}$$

Following Markov process gives us:

$$Y_{it} - \beta_l L_{it} = \beta_k K_{it} + g(\omega_{it-1}) + \xi_{it} + v_{it} \tag{4.13}$$

$$= \beta_k K_{it} + g(\phi(M_{it-1}, K_{it-1}) - \beta_k K_{it-1}) + \xi_{it} + v_{it}$$

Finally by using $\phi(K_{it,}\ M_{it})$ and estimated labour coefficient from first stage LP/OP propose the following empirical model:

$$Y_{it} - \beta_l L_{it} = \beta_k K_{it} + \hat{g}(\phi_{\ it-1} - \beta_k K_{it-1}) + \xi_{it} + v_{it} \tag{4.14}$$

Use of non-linear least squares is required due to β_k entering the equation twice and in combination with other parameters (Eberhardt and Helmers, 2010). Due to the fact that innovation shock (ξ_{it}) and labour input are contemporaneously correlated, LP and OP subtract $\beta_l\,(L_{it})$ from the output using the coefficient obtained in the first stage regression. Capital stock is exogenous with respect to innovation shock (ξ_{it}) since its level is determined in the previous period. Therefore capital cannot be affected by change in productivity in current period (ξ_{it}) (Eberhardt and Helmers, 2010). $\hat{g}(\phi_{\ it-1} - \beta_k\ (K_{it-1})$ is found using higher order polynomials as in the first stage and its estimate is not of particular interest in the second stage.

In summary, both OP and LP achieve identification of labour coefficient through specific structural assumptions. In both estimators labour is a static input chosen in time t which does not affect cost of input in time $t+1$. This assumption is necessary as otherwise if labour is chosen before investment it will become part of state space on which the optimal amount of proxy is determined. In this case identification of labour would not be possible using inverted investment function as a proxy for unobserved productivity (Katay and Wolf, 2008). In LP labour and material costs are assumed to be perfectly variable inputs. In other words once productivity shock is observed, they adjust immediately within the same time period. In case materials are chosen before productivity shock, inverse demand function for intermediate inputs would not be possible. Identification of capital has also timing assumptions and is treated as “quasi fixed” input where its current level is determined before the occurrence of productivity shock.

It should be noted that consistency of control function depends on how closely unobserved productivity is approximated by polynomial function. If scalar unobservable assumption fails, approximation error between true productivity and those approximated by proxy variables can lead to inconsistent estimates. The failure of this assumption can happen due to omitted observables and different investment or intermediate inputs responses to permanent and transient changes in TFP (Stoyanov and Zubanov, 2014). Furthermore, as argued by Ackerberg et al. (2007) productivity is a complex function of many observables and unobservables and may not follow first order Markov process. This is especially worrisome in case of OP as investment may respond to demand factors that are independent of firm’s productivity, thus invalidating monotonicity condition (Van Beveren, 2012). In case that productivity follows a higher order Markov process, control function in the first stage is not able to capture additional lags unless additional proxy variables are available. The same holds for second stage as consistency of results relies on Assumption 4 (Stoyanov and Zubanov, 2014).

4.4.3 ACKERBERG CAVES FRAZER CRITIQUE

The main assumption in above described estimators is that at least one of the inputs is flexible. In gross output specification those are intermediate inputs and labour, while in value added specification it is only labour. As discussed in detail by Bond and Soderbom (2005) and Ackerberg et al. (2006) in order for labour coefficient to be identified in the first stage there must exist sample variability that is independent of other regressors. To illustrate this we take LP estimator as a starting point. Under the assumption of perfect competition and dynamic properties of capital coefficient, firm state variables at time t

are represented by ω_{it}, K_{it}, P_t W_t. and Z_t where output price (P_t), wages (W_t). and intermediate input price (Z_t) are assumed to be constant over firms. Ackerberg et al. (2006) point out that the first stage of OP and LP fails to identify labour coefficient because it is the function of the same state variables ω_{it} and k_{it}, i.e. it is correlated with the non-parametric terms $\phi(K_{it}, M_{it})$. The problem is more acute in the case of LP estimator as it assumes that labour and materials are chosen simultaneously and are allocated in similar ways. This implies that both materials (M_{it}) and labour (L_{it}) are chosen as a function of productivity (ω_{it}) and capital (K_{it}).

$$M_{it} = f_t\ (\omega_{it}, K_{it})$$

$$L_{it} = g_t\ (\omega_{it}, K_{it})$$

Therefore, there is no independent source of variation at the firm level which could help identify labour coefficient in the first stage. Using invertibility condition from LP, where $\omega_{it} = f_t^{-1}(M_{it}, K_{it})$, Ackerberg et al. (2006) showed the following:

$$L_{it} = g_t\ [f_t^{-1}(\omega_{it}, K_{it}), K_{it}] = h_t\ (M_{it}, K_{it}) \qquad (4.15)$$

Since labour is a function of both ω_{it} and k_{it} it is not possible to simultaneously estimate a nonparametric function of ω_{it} and k_{it} together with the labour coefficient leaving the latter unidentified. To solve the issue of collinearity, Ackerberg et al. (2006) assume that labour is chosen by the firm at time $t - b$, where $0 < b < 1$ as it is *"less variable"* than materials which is chosen at time t. This implies that firms choose labour prior to materials, but after capital stock has been determined in $t-1$. Now labour enters the demand function for intermediate inputs as a state variable which can be expressed as:

$$M_{it} = h_t\ (\omega_{it}, K_{it}, L_{it}) \qquad (4.16)$$

Maintaining the scalar unobservable assumption in practice, the first stage is implemented by regressing output on a polynomial function of labour, capital and intermediate inputs. The estimated output net of ε_{it} is then simply the residual from the first stage regression:

$$y_{it} - \varepsilon_{it} = \hat{\beta}_k K_{it} + \hat{\beta}_l L_{it} + g\ (M_{it}, K_t, L_t) \qquad (4.17)$$

First stage is used only to eliminate the part of output determined by some random component of unobservables (ε_{it}) such as measurement error of inputs or unanticipated shocks at time t from productivity shock observable by the firms (Eberhardt and Helmers, 2010). Estimation of above equation gives an estimate of $\hat{\phi}$ (polynomial function) which is used to identify input coefficients in the second stage. To do this, the assumption that productivity follows first order Markov process is defined as:

$$\omega_{it} = E[\omega_{it} \mid \omega_{it-1}] + \xi_{it} \qquad (4.18)$$

where ξ_{it} represents innovation in productivity explained earlier. Since it is assumed that capital is uncorrelated with productivity (ω_{it}) as investment decisions are made in *t-1* identification of capital coefficient is possible as $E[\xi_{it} \mid K_{it}] = 0$. The identification of labour coefficient depends on the timing assumptions. If labour is assumed to be independent of innovation in productivity because of adjustment frictions or training requirements moment conditions are defined as $E[\xi_{it} \mid L_{it}] = 0$. On the other hand, if labour is allowed to be correlated with productivity innovation than it needs to be instrumented and the moment conditions are $E[\xi_{it} \mid L_{it-1}] = 0$ (Ornaghi and Van Beveren, 2012). In practice, after obtaining $\hat{\phi}$ from the first stage regression productivity is computed as:

$$\omega_{it} = \hat{\phi} - \beta_k \ln(K_{it}) - \beta_l \ln(L_{it}) \qquad (4.19)$$

where starting values of input coefficients are obtained using OLS. After approximating ω_{it} next step is to non-parametrically regress ω_{it} on ω_{it-1} (eq. 4.18) and obtain residuals, i.e. $\widehat{\xi_{it}}$ which represent innovation in productivity. The last step is to solve optimization problem through iterative process in order to achieve a global minimum when the process stops and final values of input coefficients are obtained (Eberhardt and Helmers, 2010).

4.4.4 WOOLDRIDGE ESTIMATOR

Wooldridge (2009) proposes that instead of two step approach, inputs can be estimated in one step. He argues that two step estimators discussed above which require bootstrapping technique to obtain standard errors are inefficient because of two reasons: (i) they ignore the contemporaneous correlation in the errors across two equations and (ii) there is no correction of autocorrelation and heteroscedasticity in the errors. Furthermore, Wooldridge estimation technique also allows the inclusion of cross equation restrictions and an option to test the validity of the specifications using the Sargan-Hansen test of overidentifying restrictions.

The assumption in equation (4.10) is that materials, labour and capital are uncorrelated with the errors. Wooldridge defines a stronger form to include independence of past values of inputs:

$$E\,(v_{it} \mid L_{it}, K_{it}, M_{it}, L_{i,t-1}, K_{i,t-1}, M_{i,t-1}, \ldots L_{i1}, K_{i1}, M_{i1}) = 0 \qquad (4.20)$$

Second, productivity is assumed to follow a first order Markov process as in previously described estimators:

$$E\,[\omega_{it} \mid \omega_{i,t-1}, \ldots, \omega_{i1}] = E\,[\omega_{it} \mid \omega_{i,t-1}] + \xi_{it} \qquad (4.21)$$

where $\omega_{i,t-1} = g(K_{i,t-1}, M_{i,t-1})$ *and* $\omega_{it} = j(\omega_{i,t-1}) + \xi_{it}$

He notes that in the second stage capital coefficient can be estimated by using lagged values of intermediate inputs and labour. Therefore, to reinforce the assumption that current levels of capital are orthogonal to productivity shock, it is also assumed that productivity innovation ξ_{it} is uncorrelated with past values of the state variable K_{it} as well as L_{it-1} and the proxy variable *M.*

Replacing $\phi(K_{it}, M_{it})$ in equation (4.11) with the term in (4.11a) and plugging $\omega_{it} = f\,[g(K_{i,t-1}, M_{i,t-1})] + \xi_{it}$ into equation (4.6) gives two systems of equations with same dependent variables:

$$ln(Y_{it}) = \beta_0 + \beta_k\, ln(K_{it}) + \beta_l\, ln(L_{it}) + h(K_{i,t}, M_{i,t})] + v_{it} \qquad (4.22)$$

$$ln(Y_{it}) = \beta_0 + \beta_k\, ln(K_{it}) + \beta_l\, ln(L_{it}) + f\,[g(K_{i,t-1}, M_{i,t-1})] + \xi_{it} + v_{it} \qquad (4.23)$$

The final result is that we have two equations (4.22 and 4.23) that identify labour and capital. In order to estimate these two equations by GMM the orthogonally conditions must be satisfied. The orthogonally conditions for equation (4.22) are outlined in equation (4.20), while for equation (4.23) are:

$$E\,(u_{it} \mid K_{it}, L_{i,t-1}, K_{i,t-1}, M_{i,t-1}, \ldots L_{i1}, K_{i1}, M_{i1}) = 0 \text{ where } u_{it} = \xi_{it} + v_{it} \qquad (4.24)$$

In order to take into account the ACF critique which argues that neither of the parameters can be identified as labour is a deterministic function of polynomials of capital and proxy variable, Wooldridge proposes to estimate a single equation model similar to equation (4.23). Specifically, empirical model requires specifying the functions *f* and *g* and common practice is to include the third degree polynomials in K_{t-1} and M_{t-1}.

Central to the empirical analysis is the firm level Amadeus database. It is a commercial database provided by Bureau van Dijk updated on a regular basis and contains financial information on over 19 million private and publicly owned firms across different sectors and regions in 43 European countries (update of November 2011). The time horizon goes back to year 1996 for some European countries. However, given that the coverage was poor prior to year 2002, we limit our analysis to data between years 2002-2010. Because of its large scope it is suitable for economic analysis of firm behaviour across industries, geographical areas or firms' size. Moreover, since it collects firm level information for up to 10 years it enables creation of longitudinal data and analysis of firm behaviour and determinants. This advantage is rarely available in national business surveys in which firms are selected on the basis of a rotating sample to minimise response burdens (Ribeiro et al., 2010).[29]

A further advantage of the database is that it provides common definition and comparable information on 25 balance sheet items and 25 profit and loss account items which adhere to international standards. This enables avoiding possible errors which may arise with different sources of data, various units of measurement, uneven sector coverage and inconsistencies in inclusion criteria (Bos and Zhang, 2013). Therefore, the maximum level of comparability across countries is ensured as data quality for this type of administrative information can be easily checked using basic accounting algebra. In addition to financial information, Amadeus also provides other firm level information, such as date of incorporation, legal status, region and city, detailed industry classification and what is central to the analysis, detailed ownership information. Ownership Database permits to retrieve information on the control chain and the ownership type (foreign or domestic; industrial or individual; controlled or independent). Furthermore, an important advantage of Amadeus is that it provides the exact percentage of equity held by foreign investor. Hence, continuous measurement allows us to estimate the marginal effects of

[29] For example, Amadeus database has been widely used to explore the effects of entry regulation on business dynamics (Klapper et al., 2006), international rent sharing within MNCs (Budd et al., 2005), product market regulation (Arnold et al., 2008), the effects of employment protection legislation and financial market imperfections on investment, job reallocation and labour productivity (Cingano et al., 2010) and effects of FDI spillovers on productivity (Javorcik and Spatareanu, 2008; Javorcik and Li, 2008; Gersl et al., 2008, Damijan et al., 2013a).

foreign ownership and related heterogeneity more precisely than with the binary "yes/no" variables.

Amadeus database also has drawbacks. The quality of data is inferior to data obtained from National Statistical offices. For example, the amount and quality of data depend on accounting standards in each country and legal obligation of firms to reports certain items. This reflects the use of several national sources which have different threshold for firms to be included in the database. Therefore, the number of firms and quality of data is biased towards countries with more demanding accounting standards. Moreover, this may also create sample selection bias towards larger firms. In addition, firms which do not provide data for the last four years are removed from the database with their entire history. Hence, any variation in information retrieved from the database can be the result of sample fluctuations and not related to change in the indicators. As the aim of the chapter is to estimate and explore any differences in productivity estimates across several dimensions as well as differences between domestic and foreign firms the availability of reliable firm level data is crucial along two important dimensions: the coverage of the database and the quality of the data available for each country, issues explored in more detailed in the next subsections. Despite these drawbacks Amadeus database remains the best available database for cross country analysis (CompNet Task Force, 2014).

4.5.1 SAMPLE DESCRIPTION

The November 2011 edition of Amadeus database is used for the estimation purpose, covering the time period of 2002-2010. The data are taken from *"full"* version of Amadeus with no thresholds applied to the number and types of firms included. The sample is restricted to the following countries: Estonia, the Czech Republic, Slovakia, Slovenia, and Hungary. The choice of the countries was guided by data availability and time constraint when accessing the data. The initial sample contained 1,236,219 firms. However, after cleaning the dataset for the purposes of productivity estimations we ended up with 96,567 firms representing around 8 per cent of the original dataset.[30]

[30] Detailed cleaning procedure is explained in the Appendix II.

In order to differentiate between domestic and foreign companies Amadeus ownership database provides information along three dimensions (independence indicator, ultimate owner and shareholders) which are used to calculate percentage of shares held by foreign shareholders. [31] We use several information available to separate foreign and domestic firms. These are *"shareholder ID", "shareholder name", "shareholder direct %", "shareholder total %", and "shareholder country"* available for each year. The most recent version of Amadeus enables to track ownership changes across years which is a significant improvement over previous studies which were able to disentangle firms based on only the most recent information, thus assuming that local firm was foreign through entire period. In order to identify foreign firms we rely on direct ownership link since this is taken from original source and not amended by BvD. Firm is defined as foreign if foreign shareholder identified by *"shareholder country"* has acquired at least 10 per cent of equity stake in local company. This definition of foreign owned company is in line with OECD or IMF classification. In order to be classified as foreign, data on country of origin must be available. Therefore, private individuals are excluded since there is no information about their nationality and in such cases it is often assumed that the owner is located in the same country as acquired company (Rosen et al., 2013; Merlevede et al., 2015). Furthermore, as argued by Lesher and Miroudot (2008) private foreign individuals are less likely to have any active role in the management of company and therefore do not represent *"true foreign presence"* which is important to gauge the potential of productivity spillovers in the following chapters.

To illustrate the coverage of Amadeus database we compare the original augmented version to Eurostat Structural Business Surveys (SBS). The comparison is limited to manufacturing sector and service sector (NACE 1.1 Rev. at 2 digit codes 15-74) since productivity estimation and subsequent analysis of FDI productivity spillovers in the next chapter is based on these two broad sectors of economy. Data in Table 4.1 below are averaged over industry-time cells by country. After assigning each firm to specific cell we calculate average number of employees and average turnover as a share of corresponding aggregate from SBS. The calculations are based on entire universe of firms which report the indicated variable. As can be seen, the coverage of Amadeus in terms of employment and turnover is high in all countries except in Slovenia for both variables and Hungary for employment. Averaged over countries, our dataset covers at

[31] Detailed calculation of foreign ownership share is provided in Appendix II.

least 47 per cent of employment and 63 per cent of total turnover in the economy. In general, it seems that Amadeus includes larger firms. Since the main interest is in the sample of firms for which productivity can be estimated the last three columns in the table show that the number of firms reporting number of employees is very low with the exception of Estonia and Slovakia. Further, when we impose additional restrictions on firms reporting turnover as well, the share of firms drops slightly with the exception of Slovakia where the drop is now significant. Finally, the last column shows the share of firms for which productivity estimation is possible. As expected, the number of firms drops even further. While Slovakia and Estonia keep relatively large number of firms and may be regarded as fairly representative sample of firms, data quality for Hungary is very poor as we end up with only 0.5 per cent of firms. This representativeness is similar to CompNet database of the ECB Competitiveness Research Network (CompNet Task Force, 2014). Provider of the data, Bureau-Van-Dyke (2010) does not provide any explanation why the data on some key financial variables are missing. It may be that firms in transition countries do not meet their legal obligations of submitting reports to authorities since penalties are low. Dall'Ollio et al. (2013) also discuss that there is an overall bias towards larger firms in Amadeus which is also confirmed in our case if we look at Table 4.2 below. Overall, micro firms are underrepresented while other categories are overrepresented. This bias even increases when we limit the comparison to TFP estimation sample and is especially pronounced in Hungary.

TABLE 4.1 REPRESENTATIVENESS OF AMADEUS DATABASE VERSUS EUROSTAT SBS

	SBS 2002-2010 (average)	Amadeus as a share of SBS				
	# firms	# employees	turnover	#firms with employees	#firms with employees and turnover	#firms with employees , value added and tangible fixed assets
Czech Republic	884,842	64%	80%	7%	5.1%	3.9%
Estonia	42,463	79%	86%	60.1%	59.0%	35.5%
Hungary	556,195	28%	81%	5.5%	5.2%	0.5%
Slovakia	47,624	53%	55%	43%	20.8%	17.7%
Slovenia	98,568	12%	11%	3.9%	3.2%	3.0%

Note: Data on the number of firms and turnover in year 2010 for Czech Republic are not available for most industries in SBS, therefore the comparison is made up until 2009. Similarly, there was a large increase in the number of firms in SBS for Slovakia starting from year 2010 so in order to reduce possible misrepresentation of the data, we limit the comparison up until 2009 for shares involving the number of firms.

TABLE 4.2 COMPARISON OF FIRM SIZE DISTRIBUTION BETWEEN EUROSTAT SBS AND AMADEUS DATABASE

	SBS (2002-2010 average)					Amadeus (firms with employment) (2002-2010 average)					Amadeus (firms with TFP) (2002-2010 average)				
	1-9	10-19	20-49	50-249	>250	1-9	10-19	20-49	50-249	>250	1-9	10-19	20-49	50-249	>250
Czech Republic	95.3%	2.4%	1.4%	0.8%	0.2%	68.2%	12.9%	9.5%	7.7%	1.8%	46.2%	19.2%	16.6%	14.5%	3.5%
Estonia	84.0%	8.0%	5.1%	2.6%	0.4%	79.3%	10.2%	6.7%	3.4%	0.4%	69.5%	15.0%	10.1%	4.8%	0.6%
Hungary	94.6%	3.0%	1.5%	0.8%	0.1%	78.8%	9.6%	6.5%	4.1%	1.1%	7.0%	10.8%	24.1%	41.6%	16.5%
Slovakia	84.8%	9.4%	2.8%	2.4%	0.6%	77.8%	10.9%	4.9%	5.1%	1.4%	67.7%	14.7%	10.5%	6.1%	1.0%
Slovenia	92.9%	3.6%	2.0%	1.2%	0.3%	72.3%	13.3%	8.7%	4.9%	0.8%	41.0%	23.1%	13.3%	17.7%	5.0%

4.5.2 VARIABLES DESCRIPTION AND DESCRIPTIVE STATISTICS

The financial data obtained from Amadeus are downloaded in '000 euros at the market exchange rate in each year. Since for productivity estimation we need to obtain comparable values over time adjusted for price changes, OECD STAN database was used as a primary source to deflate nominal variables using industry price indices defined at NACE 1.1 Rev. 2 digit level for output, capital and intermediate inputs expressed at 2005 constant prices.[32] Because price deflators are expressed in national currency we used year end exchange rates from European Central Bank (ECB) to convert euros back to original currency values and applied price deflators to them. At the second stage deflated values are converted back to euros at 2005 exchange rate to avoid that exchange rate fluctuations would drive cross-country productivity comparisons (Gal, 2013).

Output is measured as total sales deflated by corresponding price deflator at NACE 1.1 Rev. 2-digit level. Value added is constructed as difference between real gross output and real intermediate inputs. The latter are defined as material costs deflated by intermediate price index. Capital is measured by stock of tangible fixed assets. Changes in capacity utilisation cannot be accounted for which is a common problem in firm level databases which may result in low capital coefficients. Labour is measured as number of employees without further breakdown of employees' characteristics or skills levels due to unavailable information.

Before turning to TFP estimation, we will shed some light on the descriptive statistics of the final dataset used for productivity estimation. The data in Table 4.3 show distribution of domestic and foreign firms across countries, technology intensive sectors and years.

[32] The exception is Slovakia for which data are not fully available and therefore we used the deflators obtained from WIOD database at more aggregated group of industries. In addition, data for year 2010 are not available for Estonia and Slovakia at 2-digit industry level, so we used total industry prices for major sectors in the economy or if not available for total economy.

TABLE 4.3 DISTRIBUTION OF FIRMS ACROSS COUNTRIES, INDUSTRIES AND YEARS

PANEL A	**Slovenia**		**Slovakia**		**Hungary**		**Estonia**		**Czech Republic**	
Number of observations per industry and country	domestic	foreign	domestic	foreign	domestic	foreign	domestic	foreign	domestic	foreign
Construction and utilities	2664	10	5871	87	880	80	14423	237	29685	350
High tech manufacturing	192	2	493	50	338	40	424	159	3439	307
Medium high tech manufacturing	869	31	2983	282	966	134	1596	296	16027	1563
Medium low tech manufacturing	2247	4	4036	286	1448	200	3784	392	20029	1517
Low tech manufacturing	1997	18	4478	236	1539	104	9228	668	19762	824
High tech knowledge intensive services	682	11	1412	80	348	37	2694	209	7319	514
Market knowledge intensive services	1847	21	7383	172	758	66	17649	584	41997	1226
Less knowledge intensive services	9050	226	20760	688	5308	497	40006	2281	85194	3692
Total	**19548**	**323**	**47416**	**1881**	**11585**	**1158**	**89804**	**4826**	**223452**	**9993**
PANEL B	**Slovenia**		**Slovakia**		**Hungary**		**Estonia**		**Czech Republic**	
Number of observations per year and country	domestic	foreign	domestic	foreign	domestic	foreign	domestic	foreign	domestic	foreign
2002	660	5	1305	33	16	-	9058	24	12588	313
2003	1060	8	2093	57	19	-	10288	332	18791	540
2004	1781	7	2724	75	162	16	11255	444	27064	732
2005	2293	16	5387	174	587	56	12090	507	29094	949
2006	3242	31	9747	230	924	64	13369	589	35899	1125
2007	3493	39	10853	254	3096	272	14874	679	39336	1266
2008	3327	63	7899	234	3402	358	13218	1210	30706	2299
2009	2867	119	7408	824	3255	355	3010	547	29974	2769
2010	825	35	-	-	124	37	2642	494	-	-
Total	**19548**	**323**	**47416**	**1881**	**11585**	**1158**	**89804**	**4826**	**223452**	**9993**

Note: The table shows the number of observations in TFP sample.

Descriptive statistics in Table 4.3 above illustrates that there is substantial heterogeneity in sample size across years and industries among countries. Majority of local firms across countries (on average 44%) is operating in less knowledge intensive services and this holds for foreign firms as well where on average 47 per cent of the latter are operating in this sector. When looking at manufacturing sector only, most of local firms operate in medium low tech or low tech manufacturing. However, foreign firms are more concentrated in medium high tech and medium low tech sectors. Further, on average, foreign firms take a larger share of total number of firms in high tech manufacturing and high tech knowledge intensive services sectors across all countries. When we separate foreign firms according to ownership type and nationality we can see that most of the firms are fully owned and originate from the EU (Table II.2 - Appendix II). This distribution of foreign firms remains similar both for the original sample and TFP sample.

Looking at the bottom panel of Table 4.3, a large heterogeneity of firms' distribution across years and countries is immediately noticeable. Overall, the number of firms in the database increased steadily over years up to 2008 which may indicate increased exit of firms due to financial crisis or change in the sample composition where firms which did not report their financials for the last four years are dropped from the sample. Moreover, the number of firms in the last years is substantially reduced and in the case of Slovakia and the Czech Republic there are no firms which satisfy the necessary condition for TFP estimation. The reason for substantial reduction in the number of firms reporting their financial indicators may be that prior to becoming available in database, the data must go through time consuming administrative procedures which can take from a couple of weeks to several years.

In table II.3 in the Appendix II we also provide in-sample data coverage. On average in each country we have four years of observations per firm. However, data coverage varies per country as less than 8 per cent of firms have 7 or 8 years of time series observations, with the exception of the Czech Republic and Estonia where this percentage rises to 12 and 23 percent respectively. The problem is most acute in Hungary where majority of firms have three years of data once again indicating data reporting problems and missing observations which may play an important role in TFP estimation in terms of differences in input coefficients estimates across different methodologies. Table 4.4 below provide basic statistics (mean values) for local and foreign firms separately across several indicators.[33]

TABLE 4.4 SUMMARY STATISTICS ON SELECTED INDICATORS

	Slovenia	Slovakia	Hungary	Estonia	Czech Republic
Variable			Domestic firms		
log TFP[34]	3.98	3.15	4.14	2.67	3.11
Sales per employee (€, '000)	134.29	155.51	183.47	56.17	98.76
LP (€, '000)	59.74	55.67	81.02	19.11	31.75
Total sales (€, '000)	2135.45	4439.00	20651.80	747.52	3650.22
No of employees	18.56	60.83	188.68	13.37	47.28
Net profit (€, '000)	50.59	103.86	470.62	49.73	111.54
Average wage (€, '000)	16.92	15.27	14.31	6.89	10.85
Total intangible asset (€, '000)	51.20	45.24	734.76	2.91	25.36
			Foreign firms		
log TFP	4.64	3.70	4.81	3.65	4.41
Sales per employee (€, '000)	263.70	222.46	288.42	119.08	187.06
LP (€, '000)	97.04	72.48	133.00	35.33	67.50
Total sales (€, '000)	11605.75	35228.99	90918.55	5754.14	33835.03
No of employees	74.63	245.77	373.44	65.22	234.01
Net profit (€, '000)	407.25	1523.20	5617.94	309.38	1830.31
Average wage (€, '000)	31.45	19.10	25.33	15.22	20.61
Total intangible asset (€, '000)	265.78	424.77	11795.07	57.83	644.44

Firstly, the size distribution of firms across countries differs substantially. In particular, firms in Hungary are much larger and more productive (measured by number of employee, total sales, labour productivity or TFP) than firms in other countries. This confirms the statistics from Table 4.2 where we found overrepresentation of large firms. Excluding Hungary, firms in Slovenia are more labour productive, have the highest sales per employee and pay the highest wage. This holds true for both local and foreign firms. On average local firms are smaller, less productive, pay lower wages, use less intangible asset and are less profitable than foreign firms. The largest gap between local and foreign firms measured as difference in mean values of TFP and LP is experienced in the Czech Republic. In addition, it seems that local firms in Estonia use far less intangible asset than their foreign counterparts.

[33] Descriptive statistics for factor inputs and output for each country are provided in the Table II.4 in Appendix II.
[34] TFP is estimated in the next section.

The estimation of TFP is based on pooled OLS with year dummies, Levinsohn-Petrin (2003) and Wooldridge (2009) techniques described in detail in Section 4.4 and applied to only domestic firms in manufacturing and market service sector.[35] The Cobb Douglas production function is estimated separately for each 2 digit industry in order to capture the heterogeneity arising from different production technologies, quality and intensity of inputs used in the production. However, to meet the requirement of at least 50 observations per industry (Gal, 2013), some industries are merged based on the grouping used in the WIOD database.[36] Productivity estimates for financial sector (NACE Rev 1.1 codes 65-67) and the rest of service sector are also calculated, but should be treated with caution due to inherent difficulties in measuring output. The Wooldridge estimator is applied in one equation framework as implemented by Petrin et al. (2011) and Petrin and Levinsohn (2012). Standard errors for both pooled OLS and Wooldridge estimator are clustered at the firm level to control for arbitrary heteroscedasticity and within panel correlation. The Wooldridge estimator is the preferred choice for several reasons. First, it provides efficient standard errors robust to both heteroscedasticity and autocorrelation which is not the case with other structural estimators which rely on bootstrapped standard errors. The latter is particularly worrisome in ACF case as it is demanding in data requirements. The problem increases in unbalanced dataset with many gaps as fewer observations are available to estimate input coefficients (Eberhardt and Helmers, 2010). Second, Wooldridge estimator is robust to ACF (2006) critique where labour may be unidentified in the first stage of LP estimator.

Both value added and gross output production function were employed in empirical analysis in order to check their suitability for data in hand. However, in the case of Levinsohn-Petrin estimation of gross output production function on 2-digit NACE Rev 1.1 level was not feasible for a number of industries and countries. The reason was the

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[35] Levinsohn and Petrin estimator is applied using STATA user written command *"levpet"* developed by Petrin et al. (2004).

[36] Due to low number of observations some industries were grouped together following the classification of WIOD database which is used to construct vertical linkages in the following chapters. Please refer to Tables II.5-II.9 in Appendix II were results by industry are reported. The first column is the NACE 1.1 2-digit code which shows which industries were grouped.

lack of variation in data for a separate identification of input coefficients. Also, in certain cases the material coefficients were equal to one due to imposed upper limit in the estimation algorithm and as suggested by Arnold (2005) these estimations should be discarded. In the case of modified Wooldridge estimator, the capital coefficient was extremely low, while labour and materials coefficients had implausible values in certain industries across countries. In addition, diagnostic tests used to gauge instrument validity were not satisfied for most industries. For these reasons, we decided to continue the analysis using value added specification.[37] The decision to use value added instead of revenue as dependent variable is also motivated by findings of Bond and Soderbom (2005) and Ackerberg et al. (2006) who suggest that identification of perfectly variable inputs (materials) is not possible without input price variation across firms in a gross revenue specification of the Cobb-Douglas production function.

In order to create internal instruments for instrumental variable regression we construct third degree polynomial approximation using first order lags of capital and intermediate inputs and labour input as instruments for equation (4.23) which allows us to obtain all production function coefficients in one step and at the same time controlling for multicollinearity of labour with polynomial function. Since first order lag of labour input is used as an external instrument for its current level, the validity of instrument is tested using Kleibergen-Paap LM statistic (2006). The latter is used to test whether the equation is identified, i.e., that the excluded instruments are correlated with the endogenous regressors. The null hypothesis is that equation is under identified which is rejected across all industries and countries. Further, since the assumption of identically and independent distributed errors (i.i.d.) is dropped we use Kleibergen-Paap Wald F statistic to test for weak identification which arises when excluded instruments are weakly correlated with the endogenous regressors. The critical values obtained from Kleibergen-Paap statistic are compared to critical values from Stock and Yogo (2005) and the null hypothesis of weak identification is rejected. Finally, we use Stock and Wright (2000) S statistic to test the null hypothesis that the coefficients of the endogenous regressors in the structural equation are jointly equal to zero and that the over identifying restrictions are valid. Again, the test rejects the null hypothesis suggesting that excluded instrument

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[37] By using value added specification we also tested dynamic implications of labour coefficient instrumenting it with longer lags starting at *t-2*. The reason for including longer lags is that labour in *t-1* is part of the polynomial term used to invert out productivity. However, diagnostic tests did not support instrument validity.

is relevant and equation is exactly identified. Overall, we can be confident that TFP estimated by Wooldridge estimator satisfy the necessary diagnostics before turning to interpretation of input coefficients.

In discussing the results special attention is paid to differences in parameter estimates across different methodologies. The results for all three estimators are shown in Tables II.5-II.9 in Appendix II. All reported estimates are based on an unbalanced sample of firms, thus allowing for implicit entry and exit of firms.[38] The results from pooled OLS model yield a labour coefficient value between 0.7 and 0.8 across industries and countries with the exception of Slovakia where parameter estimate of labour takes the value of 0.5 on average across industries for OLS estimates and even lower for estimates obtained through semi parametric methods which may be the result of collinearity with productivity term. The parameter estimates of labour are slightly higher for services which are not surprising since the latter are more labour intensive. The labour estimates drop when applying structural estimators suggesting a positive correlation between labour and productivity term leading to an upward bias of labour coefficient in the case of OLS due to possible transmission bias. In general labour coefficient obtained from all estimators is highly significant across industries and countries. In some industries such as transport or financial industries the labour coefficient falls outside unit interval being larger than one suggesting a negative relationship between labour and productivity. This is consistent with the idea that some firms within a sector are more productive and thus employ fewer workers per unit of output (Newman et al., 2015).

The estimates of capital coefficient vary across country industry pairs and are mostly insignificant in Hungary when applying structural estimators probably due to lower precision of estimates arising from smaller number of observations. Furthermore, given that large firms are overrepresented in Hungarian dataset the complexity of accounting issues when evaluating different book values and different vintages may add to sometimes negative and insignificant capital coefficient (Eberhardt and Helmers, 2010). In all countries except Slovakia, the average value of capital takes the values between 0.10 and 0.20 and the estimates of LP and Wooldridge are fairly similar. In general, it seems that structural estimators do not correct for possible downward bias of capital

[38] It has been shown that including survival probability in the second stage of Olley and Pakes algorithm did not significantly changed the value of capital estimates (Van Beveren, 2012).

coefficient as the estimates are in most cases lower than those obtained from OLS. It may also suggest that firms' use of capital is positively correlated with productivity, thus leading to an upward bias in OLS estimates. In general, this is a common finding in firm production function estimates as it is well known that measurement of capital is the most complex one (Galuscak and Lizal, 2011). The poor results for capital coefficient are possibly due to the fact that available services from this factor input are underutilised. Also, it may be that that the variables included in the polynomial approximation of the unobserved productivity hamper the identification of capital coefficient. However, it could also be the results of an attrition bias where only surviving firms are selected in the sample thus introducing a correlation between inputs and the error term which biases both input coefficients (CompNet Task Force, 2014).

To summarize, comparison of the results across sectors and countries reveals that OLS tend to produce higher coefficient for labour input pointing out the importance of correcting the *transmission bias.* Furthermore, it is found that capital coefficient in Wooldridge estimator tends to be relatively smaller or in very few cases larger than OLS counterpart depending on the industry and chosen estimation algorithm which is a usual finding in the literature (Ornaghi and Van Beveren, 2012). Similar results are also obtained when running LP estimator, thus confirming the need to correct for biased labour coefficient when using OLS. The heterogeneity of point estimates is even clearer when we test whether the obtained coefficients satisfy the constant return to scale hypothesis. In general, OLS estimates point to higher returns to scale especially in the Czech Republic's service sector and across all sectors in Estonia than structural estimators. The latter mostly predict decreasing returns to scale in almost all countries and industries. This is expected as OLS coefficient estimates tend to be upward biased. Overall, OLS seems to confirm constant returns to scale more often than Wooldridge and LP estimator. This heterogeneity may be the result of different characteristics of firms, industries and countries in terms of timing assumptions of inputs and their dynamic implications which is difficult to test form a practical point of view especially if one is interested to make comparison of estimates using the same methodology (Ornaghi and Van Beveren, 2012).

An important question is whether the estimates obtained have any significant differences on the obtained TFP from different estimation algorithms. For this purpose, we have calculated Pearson pair-wise correlation coefficients across years from three estimators provided in Tables II.11-II.15 in Appendix II. For each country there is a uniformly high correlation coefficient among different estimators (above 0.85) with the exception of Hungary where the correlation between structural estimators and OLS is 0.49. The same correlation matrix is calculated following several transformations, namely deviations from firm specific means, deviations from cross section means, growth rates of TFP and correlations in two main sectors of the economy. The correlation coefficients remain fairly robust across these different transformations. The exception is again Hungary where structural estimators are not strongly correlated across years and sectors. The latter result also holds for Slovenia where in manufacturing sector the correlation between OLS and Wooldridge/LP estimates is 0.50 and 0.57, respectively. Overall, the results indicate that different types of productivity measures are strongly correlated across several transformations, and especially their growth rates and within firm variation, are generally strongly related.

A key stylized fact from firm level productivity estimations is wide dispersion even in narrowly defined industries which drives aggregate productivity as shown theoretically within a standard model of firm heterogeneity and international trade (Melitz and Ottaviano, 2008). A large dispersion of productivity may indicate a large room for improvements in aggregate productivity by reallocating resources from less productive to more productive industries (Hsieh and Klenow, 2009). For this reason, in Table 4.5 below we report standard statistics of productivity distribution measured as the difference between the 90th (top ten percent) and the 10th (lowest ten percent) percentile of log TFP of firms for each estimation algorithm (Syverson, 2011; Gal, 2013). As can be seen, productivity dispersion is larger for OLS estimates and the differences in comparison to Wooldridge are in range of 0.04-0.49 log points.[39] It is reassuring that productivity dispersion displays very similar patterns across different structural estimators and countries. The findings imply that firms with the highest productivity within industry will produce between 1.5 and 2.5 times more output with the same amount of inputs in case of Wooldridge estimator and 1.5 and 3 in case of OLS than firms within 10th percentile of TFP distribution. The highest dispersion of productivity estimates is evident in the Czech Republic followed by Estonia. On the other hand, lowest dispersion can be

[39] In order to express the differences in percentages one needs to transform log points using this formula: $100(e^{diff} - 1)$ where *e* is exponential taking the value of 2.71 and *diff* is the difference in logpoints. In our case, the difference between OLS and WLP estimates in the Czech Republic of 0.49 log points amounts to approximately 63 percent. The lowest difference of 4 percent can be observed in Slovenia.

seen in Hungary and Slovenia. The latter results point to possible gains from reallocation of activity from low productive to high productive firms.

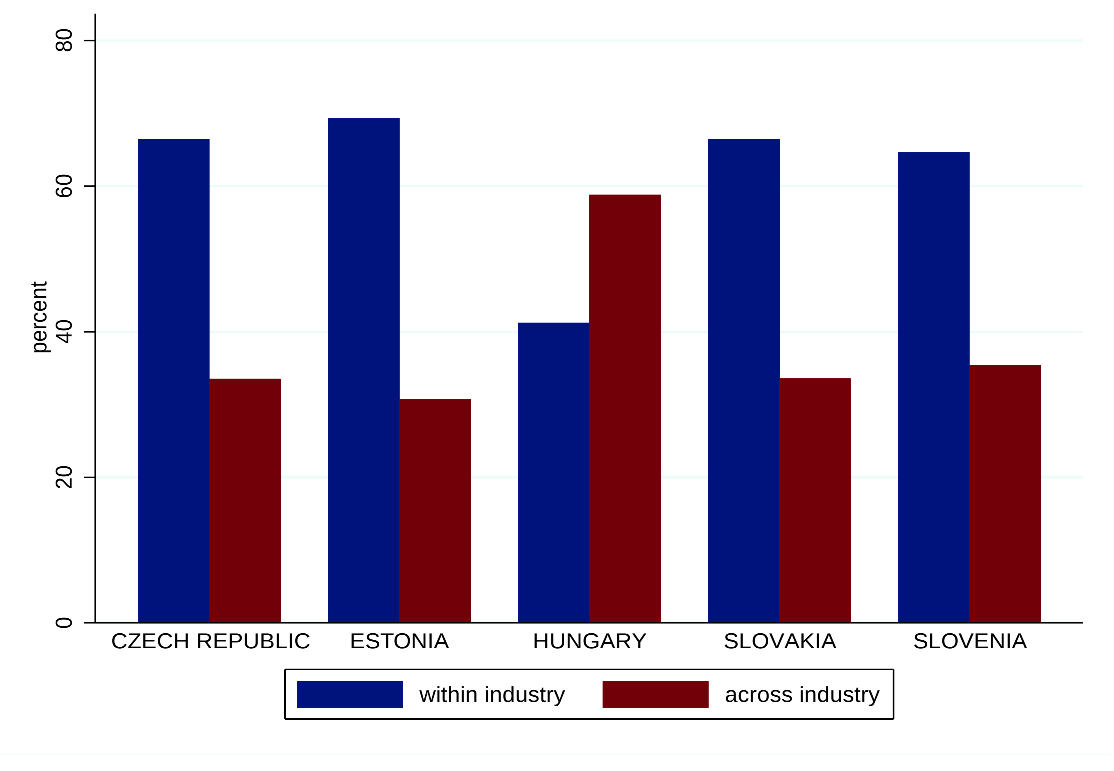
TABLE 4.5 WITHIN INDUSTRY DISPERSION OF TFP ACROSS COUNTRIES AND ESTIMATION ALGORITHMS

	CZECH REPUBLIC	ESTONIA	HUNGARY	SLOVAKIA	SLOVENIA
	Mean	Mean	Mean	Mean	Mean
Wooldridge	2.474	2.296	1.563	2.076	1.528
Levinsohn Petrin	2.460	2.283	1.555	2.040	1.532
OLS	2.973	2.550	1.654	2.163	1.532

Note: Dispersion is measured as a ratio between top and lowest ten percentiles of TFP distribution within industry

The importance of TFP dispersion can be gauged by looking at Figure 4.2 which shows that in all countries except Hungary dispersion within industries is greater than across industries.[40] These results imply that reallocation within the industry may be even more important than change in country specialization across industries, a finding similar to CompNet (2014).

FIGURE 4.2 WITHIN AND ACROSS INDUSTRY TFP DISPERSION



[40]Within-industry dispersion is computed as average standard deviations of firm-level productivity estimated by WLP within each industry. Across-industry dispersion is computed as the standard deviation of average industry-specific productivity.

To shed more light on the persistence of TFP dispersion Tables II.16-II.20 in Appendix II provide transition matrices for each country and main sectors using TFP estimates obtained from WLP estimation algorithm. Transition matrices are based on Markov chain processes which define a set of states, $S = \{s_1, s_2, \ldots s_r\}$. The process can start in any of the states and moves successively from one state to another. The basic assumption of Markov process is that its future given its present state is independent of the past. This can be expressed as $P[X_{n+1} = x \mid X_n = y] = P[X_n = x \mid X_{n-1} = y]$. Each cell in transition matrices shows the probabilities of firms moving from the first quartile of distribution to higher quartile over the period 2002-2010.[41] The striking feature emerging from transition probabilities is that diagonal elements are always higher than off diagonal elements suggesting strong persistence in TFP of local firms. In all country-industry pairs the probability to remain in the same quartile of distribution over the period is above 50 per cent. If firms move in TFP distribution, they are more likely to end up either in the higher or lower closest quartile. In summary, it seems that factors such as selection and learning by doing do not find strong support in our sample as documented by other studies (Martin, 2008; Dumont, 2011).

Finally, to evaluate whether different estimators yield similar conclusions we follow Van Beveren (2012) and Eberhardt and Helmers (2010) and evaluate sensitivity of TFP to some exogenous shock. The financial crisis that commenced in late 2007 with global repercussions on both financial and real sector represents a useful empirical exercise. Therefore, a simple regression with firm fixed effects was used to regress ln TFP on a crisis dummy taking the value of one from year 2008 until the end of period and zero otherwise. Results of this regression are reported in Table 4.6 and indicate similarities in the magnitude, sign and significance of crisis dummy across different estimation algorithms. The only notable differences can be seen in the case of Slovenia where structural estimators predict lower negative effect of crisis on TFP in comparison to OLS. Overall, it is reassuring that different estimation algorithms give comparable estimates

[41] For example, if the firm's TFP is below the median at time *t*, its probability to move to another state, i.e., above the median TFP at time *t+1* can be obtained by dividing each cell in the matrix by its row total which sums to 1. The probability is then denoted as $p_{ij.}$ known as transition probabilities. In general, if we have several possible states, the n-step probabilities to move from one state to another can be expressed as $p_{ij}^{n} = \sum_{r \in S} p_{ir}^{(k)} p_{rj}^{(n-k)}$ for any k such that $0 < k < n$ and S is the state space of Markov chain which in our case corresponds to quartiles of TFP distribution.

of TFP across countries, are highly correlated and provide the same conclusions when simple policy questions are analysed.

TABLE 4.6 EFFECTS OF EXOGENOUS SHOCK ON TFP

	Czech Republic	Estonia	Hungary	Slovakia	Slovenia
WLP	**0.0826*** **	**-0.0685*** **	**-0.134*** **	**-0.0505*** **	**-0.00925* **
	(0.00297)	*(0.00425)*	*(0.00622)*	*(0.00541)*	*(0.00566)*
LP	**0.0855*** **	**-0.0701*** **	**-0.132*** **	**-0.0457*** **	**-0.00368**
	(0.00296)	*(0.00425)*	*(0.00623)*	*(0.00532)*	*(0.00563)*
OLS	**0.0613*** **	**-0.0659*** **	**-0.134*** **	**-0.0676*** **	**-0.0386*** **
	(0.00304)	*(0.00432)*	*(0.00634)*	*(0.00562)*	*(0.00583)*
No of obs.	223,452	89,804	11,585	47,416	19,548

*Note: cluster robust standard errors in brackets where ***, ** and * denote statistical significance of variables at 1%, 5% and 10% level of significance respectively*

4.7 ARE FOREIGN FIRMS MORE PRODUCTIVE?

In the previous section we have determined that different estimation algorithms produce consistent and robust TFP estimates and that there is a substantial heterogeneity of TFP within industries. Recent theoretical and empirical literature has widely documented that firms engaged in international production or trade are more productive than purely domestic firms even in narrowly defined industries (Greenaway and Kneller 2006; Wagner 2007; Mayer and Ottaviano 2008; Arnold and Husinger, 2010). A theoretical model by Helpman et al. (2004) discussed in Chapter 1 predicts a pecking order of firms based on their productivity; least productive firms serve domestic markets, while better performers succeed in international markets and only those with the highest productivity engage in FDI. While the aim of this chapter is not to test Helpman et al.'s (2004) theory or to explore the black box of international premia, it is useful to test whether MNCs in our sample of countries are on average more productive and hence provide the potential to generate productivity spillovers to local firms.

In order to have a first look at productivity differences we plot kernel density estimation of foreign and domestic firms, shown in Figure 4.3 and Figure 4.4 for manufacturing and service sector respectively.[42] The graphs show all possible values of TFP of respective groups of firms on *x* axis and probability density function on *y* axis. We find that TFP

[42] TFP is estimated using Wooldridge (2009) methodology described in Section 4.3 and empirically estimated in Section 4.5.

distribution of foreign firms is to the right of domestic firms in each country and sector. Moreover, the TFP estimates of foreign firms are more narrowly distributed around the average and for both groups TFP is more evenly distributed in manufacturing.

FIGURE 4.3 TFP DISTRIBUTION OF FOREIGN AND DOMESTIC FIRMS IN MANUFACTURING SECTOR

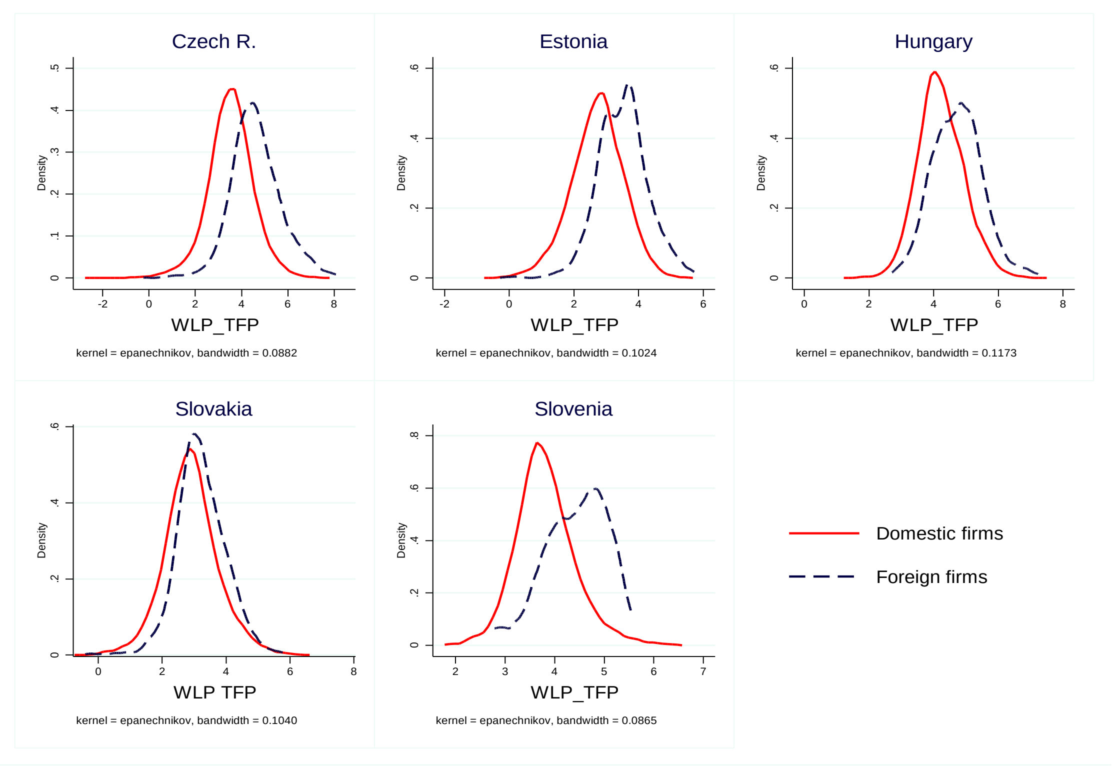
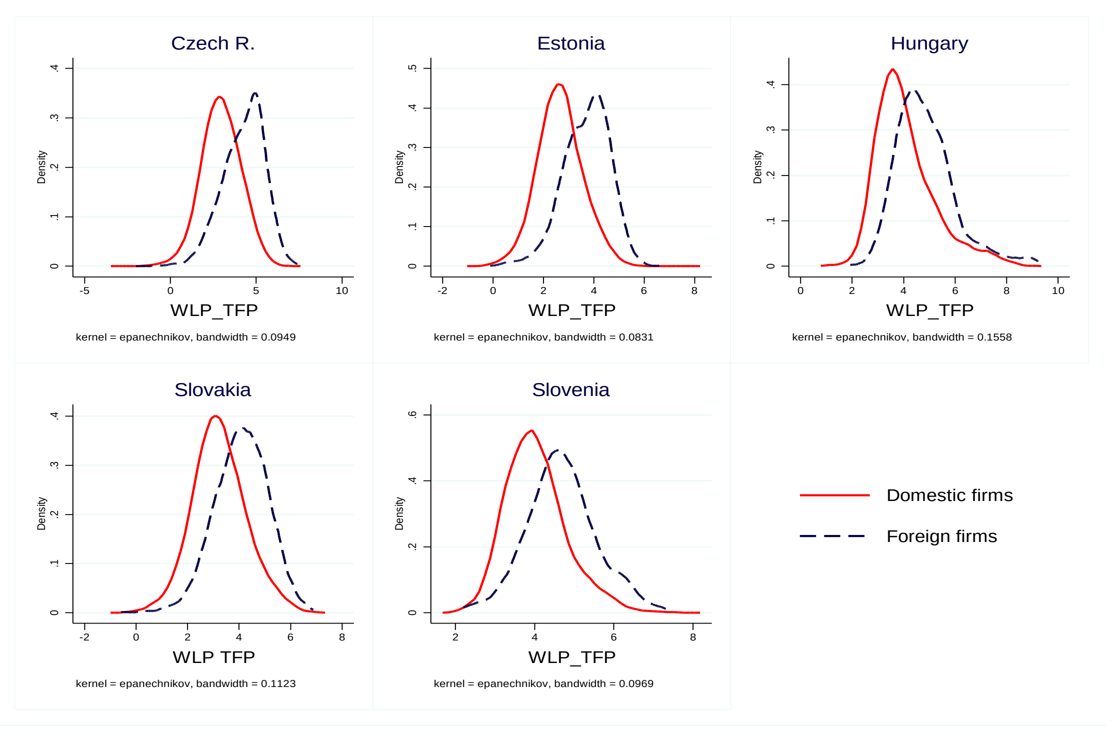


FIGURE 4.4 TFP DISTRIBUTION OF FOREIGN AND DOMESTIC FIRMS IN SERVICE SECTOR



In order to formally test the TFP difference between foreign and domestic firms, one sided and two-sided nonparametric Kolmogorov-Smirnov (K-S) statistics are used. This test allows comparison and rankings of TFP distribution based on first order stochastic dominance. The advantage of this test in comparison of mean levels is that it compares all moments of distributions. In particular, following Delgado et al. (2002) we perform tests of stochastic dominance of a given distribution F(z) (for instance, the productivity distribution of foreign firms) with respect to another distribution D(z) (for instance, the productivity distribution of domestic firms). If foreign firms' TFP distribution F(z) lies entirely right of domestic firms' distribution D(z) first order stochastic dominance is defined as $F(z) - D(z) \leq 0$. Stochastic dominance can be evaluated by testing two hypotheses:

$H_0 : F(z) - D(z) = 0 \ \forall \ z \in \mathbb{R}$ *vs.* $H_1 : F(z) - D(z) \neq 0$ for some $z \in \mathbb{R}$
$H_0 : F(z) - D(z) \leq 0 \ \forall \ z \in \mathbb{R}$ *vs.* $H_1 : F(z) - D(z) > 0$ for some $z \in \mathbb{R}$

The first hypothesis is that TFP distributions of both groups are identical. This can be tested employing two sided K-S test for which the asymptotic distribution of the test statistic has been derived by Kolmogorov (1933) and Smirnov (1939) under the assumption of independently drawn samples. If one can reject first hypothesis and at the same time accept the second hypothesis, it can be concluded that distribution of F(z) dominates D(z). Since we have panel data, the independent assumption between samples may be violated. For this reason, we use K-S test for each country-year pair shown in Table 4.7 as suggested by Arnold and Hussinger (2010).

TABLE 4.7 KOLMOGOROV SMIRNOV TEST OF EQUALITY OF TFP DISTRIBUTIONS

	Czech R.		Estonia		Hungary		Slovakia		Slovenia	
Year	One sided	Two sided	One sided	Two sided	One sided	Two sided	One sided	Two sided	One sided	Two sided
2002	0.000	0.411	-0.005	0.670	-	-	-0.041	0.233	-0.094	0.806
	1.000	***0.000***	***0.999***	***0.000***	-	-	***0.899***	***0.061***	***0.916***	***0.003***
2003	-0.002	0.475	0.000	0.517	-	-	-0.012	0.228	0.000	0.827
	0.997	***0.000***	***1.000***	***0.000***	-	-	***0.984***	***0.006***	***1.000***	***0.000***
2004	0.000	0.522	0.000	0.494	0.000	0.653	-0.002	0.300	-0.047	0.795
	1.000	***0.000***	***1.000***	***0.000***	***1.000***	***0.000***	***1.000***	***0.000***	***0.969***	***0.000***
2005	0.000	0.466	0.000	0.490	0.000	1.000	-0.008	0.236	-0.002	0.617
	1.000	***0.000***	***1.000***	***0.000***	***0.432***	***0.000***	***0.980***	***0.000***	***1.000***	***0.000***
2006	0.000	0.497	0.000	0.465	-0.007	0.340	-0.010	0.270	-0.003	0.545
	1.000	***0.000***	***1.000***	***0.000***	***0.994***	***0.000***	***0.960***	***0.000***	***1.000***	***0.000***
2007	0.000	0.487	0.000	0.470	0.000	0.326	-0.001	0.337	-0.002	0.507
	1.000	***0.000***	***1.000***	***0.000***	***1.000***	***0.000***	***1.000***	***0.000***	***1.000***	***0.000***
2008	0.000	0.437	0.000	0.400	-0.001	0.313	-0.001	0.361	-0.013	0.338
	1.000	***0.000***	***1.000***	***0.000***	***1.000***	***0.000***	***1.000***	***0.000***	***0.980***	***0.000***
2009	0.000	0.409	-0.001	0.328	0.000	0.318	-0.002	0.194	-0.003	0.354

	1.000	***0.000***	***0.999***	***0.000***	***1.000***	***0.000***	***0.994***	***0.000***	***0.998***	***0.000***
2010	-	-	0.000	0.392	-0.016	0.304	-	-	-0.047	0.299
	-	***-***	***1.000***	***0.000***	***0.985***	***0.010***	***-***	***-***	***0.861***	***0.005***

Note: The largest difference in TFP between two groups is presented in the first row, while corresponding asymptotic p-values are marked in bold and italics. Due to insufficient number of observations in certain years, KS test was not calculated.

As can be seen, the asymptotic p-values for two sided test are almost always zero for each country year pair suggesting that the equality of distributions can be rejected. The null hypothesis for one sided test stating that foreign firms have larger TFP than domestic firms cannot be rejected. From both tests it can be concluded that foreign firms are more productive than local firms as predicted by theory. In order to shed more light on these results we also run an OLS regression as in Bernard and Jensen (2007) to quantify the productivity premia of MNCs. The analysis is fairly straightforward and consist of the following model:

$$ln\,TFP_{ijt} = \alpha + \beta\, Foreign_{ijt} + \delta\, l.size_{ijt} + y_t + \gamma_j + \gamma_r + \epsilon_{ijt} \qquad (4.25)$$

In equation (4.25) firm TFP is regressed on a dummy variable indicating foreign ownership interpreted as average percentage difference between foreign and domestic firms, lagged size of the firm measured in terms of number of employees to eliminate the size effect and a set of time, industry and region dummies. Table 4.8 contains the estimated values of foreign ownership dummy across seven different specifications as indicated by names in the rows of the table.

TABLE 4.8 TFP PREMIUM OF FOREIGN OVER DOMESTIC FIRMS

	Czech R.	Estonia	Hungary	Slovakia	Slovenia
MNCs	**0.684*****	**0.476*****	**0.509*****	**0.526*****	**0.415*****
	(0.018)	*(0.0218)*	*(0.0396)*	*(0.0335)*	*(0.0678)*
Fully owned	**0.717*****	**0.530*****	**0.561*****	**0.536*****	**0.476*****
	(0.0198)	*(0.0277)*	*(0.0455)*	*(0.0393)*	*(0.0767)*
Partially owned	**0.486*****	**0.299*****	**0.279*****	**0.415*****	**0.236***
	(0.0340)	*(0.0291)*	*(0.0644)*	*(0.0545)*	*(0.130)*
MNCs from the EU	**0.692*****	**0.488*****	**0.517*****	**0.555*****	**0.430*****
	(0.0183)	*(0.0225)*	*(0.0402)*	*(0.0350)*	*(0.0687)*
MNCs from non EU	**0.399*****	**0.215*****	**0.111**	**0.265*****	**0.0109**
	(0.0890)	*(0.0764)*	*(0.190)*	*(0.0948)*	*(0.368)*
MNCs in manufacturing	**0.540*****	**0.295*****	**0.418*****	**0.400*****	**0.324*****
	(0.0254)	*(0.0383)*	*(0.0562)*	*(0.0450)*	*(0.109)*
MNCs in services	**0.764*****	**0.538*****	**0.546*****	**0.645*****	**0.414*****
	(0.0249)	*(0.0262)*	*(0.0543)*	*(0.0463)*	*(0.0816)*
Observations	163,326	70,850	8,004	32,136	14,534

*Note: cluster robust standard errors in brackets.***, ** and * denote statistical significance of variables at 1%, 5% and 10% level of significance respectively.*

Results point to significant foreign ownership premium across all countries, the highest being in the Czech Republic and lowest in Slovenia where foreign firms are on average 98 per cent and 51 per cent more productive, respectively.[43] Looking in more detail, fully owned foreign firms seem to be more productive in comparison to partially owned firms, but both groups outperform purely domestic firms. In terms of FDI origin, the TFP premium of EU firms is two to three times higher in comparison to non EU firms. However, one must bear in mind that there is a very low number of non-EU firms in TFP sample, which is also indicated with insignificant coefficient in Slovenia and Hungary. Finally, when we split the sample, we can see that MNCs in service sector are on average 70 per cent, while those in manufacturing are 48 per cent more productive than domestic firms which is in line with Figures 4.2. and 4.3.

As a robustness check we have also compared TFP distribution of foreign and domestic firms in manufacturing and service sector as well as the difference between foreign firms themselves according to ownership type using K-S test. Again, the results suggest that foreign firms' TFP distribution stochastically dominates their counterpart in both sectors.[44] In addition, fully owned foreign firms are more productive than partially owned foreign firms which is in line with theoretical propositions discussed more thoroughly in the next chapter. The results hold for each country and sector, except for foreign firms in manufacturing sector in Slovenia. Finally, we have estimated productivity difference between domestic and foreign firms using OLS estimates of TFP and found almost identical results except in Slovakia for the first two years of data. The estimation results for OLS estimates are shown in the Tables II.26-II.30 in Appendix II.

Although there is evidence that foreign firms have higher productivity levels than purely domestic firms it may be that foreign firms self-select into more productive sectors or regions or "cherry pick" most productive domestic firms thus causing endogeneity problem. The later can be properly addressed only if one creates a missing counterfactual on how domestic firms would have performed in the absence of foreign investment. One method commonly employed is a combination of propensity score matching with difference in difference approach to control for both observable and unobservable

[43] In order to get the exact percentage effects of dummy variable on ln TFP we need to apply the following formula: 100[exp(dummy coefficient) - 1].

[44] Please take note that this comparison is made on pooled sample of firms over the entire period available so they should be taken as indicative. The results of this exercise are shown in Tables II.21-II.25 in Appendix II.

characteristics, something that we leave for further research as the aim of this thesis is the estimation of indirect effects of FDI.

4.8 CONCLUSION

In this chapter we have provided a review of different methodologies used to estimate TFP together with their basic assumptions about functional form, production technology used and the impact of measurement errors on the parameter estimates. The aim was not to test all available techniques, but to show the strengths and weaknesses of each method as guidance for empirical work taking into account data specificities, research interests and assumptions one is making about DGP. Since our analysis is focused on publicly available information obtained from Amadeus database it is necessary to recognize that although the sample of analysed countries is fairly representative in terms of total employment and turnover when compared to official statistics it is less ideal for TFP estimation due to large number of missing observations on input and output data. This is especially pronounced in Hungary which also differs from other countries in above average representativeness of large firms in the sample. Furthermore, the accounting data do not provide detailed enough information about different products nor their composition changes over time which may affect the measurement of output. Similarly we are not able to control for bias arising from using industry deflators to gauge firms' physical output. Data on factor inputs are presented in very crude form which may additionally exacerbate measurement in inputs. These and other issues related to TFP estimation discussed in the text affected our choice of methodology.

Several reviews have shown that semi parametric techniques are robust to measurement issues and provide accurate productivity estimates. It assumes that productivity evolves as Markov process which enables its flexible characterization in comparison to other techniques. Furthermore, the problem of simultaneity bias between inputs and unobserved productivity term is resolved without the need to use GMM estimation techniques which require validity of instruments used for each set of regressions. However, structural estimators are not without drawbacks as the assumption of monotonicity between proxy variable and productivity conditional on capital has to hold.

Furthermore, scalar unobservable assumption may not hold if there are any other omitted variables affecting unobserved productivity. Since TFP is used as a dependent variable in the following empirical chapters we have used three methodologies (OLS, LP and WLP) to test whether TFP estimates differ in several aspects. The reliance on semi parametric methods has become very popular in recent years, however little attention has been paid to estimates of input coefficients and TFP obtained through such procedure in comparison to other *"classical"* approaches such as OLS. The result of our analysis suggests that OLS indeed leads to overestimation of labour coefficient giving support to the structural estimators as a possible solution to *"transmission bias"*. Similarity of coefficients is also partially confirmed when comparing returns to scale. In most cases all three estimators suggest decreasing returns to scale although the magnitude is somewhat higher for OLS estimates. Several robustness checks such as correlation coefficients across several dimensions, within industry dispersion of TFP and simple regressions have indicated that productivity estimates are very robust across different methodologies, a finding similar to other studies (Van Beveren, 2012).. In summary, if one is interested in non-deterministic part of production function the choice of estimation methodology is of lesser importance as shown in other studies (Van Biesebroeck, 2006; Van Beveren, 2012). Given the advantages of Wooldridge estimator over other estimations techniques it is chosen as our preferred method for TFP estimation and used as dependent variable in subsequent chapters.

The main findings related to TFP estimation can be summarised as follows. Firms in Hungary are on average the most productive while firms in Estonia are the least productive, which is not surprising given the average size of the firms in the sample, thus providing support to heterogenous trade models which recognized firm size as an important determinant of productivity (Melitz, 2003) and is in accordance with some previous empirical analysis (e.g. Mayer and Ottaviano, 2007). During the period of analysis, domestic firms in all countries have experienced improvements in productivity as indicated by interquartile movements, especially firms whose TFP is below median levels in both services and manufacturing sector. However, majority of firms still experience a strong persistence in TFP.

In terms of productivity differences between domestic and foreign firms, the empirical findings suggest that productivity distribution of foreign firms is significantly different from purely domestic firms across years and sectors using WLP and OLS methodology.

In addition, regression results point that on average foreign firms are more productive as implied by both non parametric tests across manufacturing and services sector. This is also confirmed in regression analysis taking into account foreign firms' ownership characteristics and origin as well as their sector of operation. Since potential for productivity spillovers estimated in the next chapters relies on the assumption of superior performance of foreign over domestic firms we may be confident that domestic firms may benefit from indirect effects of FDI.

CHAPTER 5.
PRODUCTIVITY SPILLOVERS OF FDI IN SELECTED TRANSITION COUNTRIES – THE ROLE OF MNC'S HETEROGENEITY

5.1 INTRODUCTION

The endogenous growth theory suggests that technological progress is a key factor to economic growth of countries (Romer, 1990; Grossman and Helpman, 1991; Aghion and Howitt, 1997). In this context FDI is seen as bundle of intangible assets, codified and tacit knowledge and technology which are transferred either directly or indirectly to host economy. Through technology transfer and spillovers, endogenous growth theory suggests that FDI can increase the development of intermediate product variety, improve the quality of products, increase the intensity of R&D and bring new forms of human capital (UNECE, 2001). Therefore, transition countries have made considerable efforts in attracting FDI through various financial, fiscal and other forms of investment incentives such as subsidies for infrastructure, regulatory concessions and certain exemptions from labour laws. The investment policies and various incentives offered to MNCs are based on the premise that FDI delivers important contributions to economic development of countries through technology transfer and productivity improvements resulting from knowledge diffusion to local firms. Although the theoretical arguments provide strong positive relationship between FDI and economic growth, the empirical studies on both macro and micro level are less clear cut.

As is discussed in Chapter 2 the main reason for such an ambiguity is related to the employment of firm level data - which appear to be the most appropriate level of analysis of FDI spillovers. Furthermore, different methodologies, data sources, and firm, industry, country and geographical heterogeneity are mentioned as possible sources of the failure to corroborate the expected positive effects. Recently, several improvements have been made to alleviate these problems, the most important ones being the differentiation between horizontal and vertical spillover channels, the incorporation of firm heterogeneity and moderating factors such as absorptive capacity. Substantial research in the area has found that vertical linkages are a major source of FDI productivity spillovers and that absorptive capacity of firms and host countries also matter for these spillovers. Furthermore, the heterogeneity of MNCs has been recognized as an important factor for spillover potential. However, many questions still remain, especially those related to exact mechanisms of knowledge transfer.

In order to shed more light on the inconclusive results of FDI spillovers found in the transition literature, this chapter makes several contributions. First, the existing studies of FDI spillovers reviewed in Chapter 2 have provided partial analyses of spillover effects focusing on foreign presence in a manufacturing industry (e.g. Vahter, 2006; Halpern and Murakozy, 2007; Nicolini and Resmini, 2010; Damijan et al., 2013a) or in case they include all firms in the economy only horizontal spillovers is investigated (Djankov and Hoekman, 2000; Konings, 2001; Sinani and Meyer, 2004; Vahter and Masso, 2007; Kosova, 2010) with the exception of Kolasa (2008). The volume of FDI in service sector has gained significant share and overpassed that in manufacturing sector, thus influencing the changes in economic structure. The motives and strategic objectives of such investment are inherently different and thus provide diverse knowledge spillover potential.

The second contribution is related to MNC heterogeneity, specifically the role of partially and fully foreign owned enterprises in generating knowledge spillovers and creation of vertical linkages. Furthermore, the theory suggests that FDI origin brings different managerial practices and technologies which may benefit local firms to the extent that the latter are able to synthesize various sources of knowledge and result in higher productivity. Therefore, we deviate from the contemporary literature which has focused on issues such as absorptive capacity and other factors influencing the demand side of FDI spillovers. Third, the time period of investigation is in most cases confined to the end of 1990s or the beginning of 2000s. However, changes in macroeconomic and business environment as well as the progress in institutions further influenced the entry, type and motive of foreign firms at the onset of transition and integration of these countries into international and supranational organizations. As was discussed in Chapter 3, these countries experienced a significant institutional restructuring characterised by a slow and complex process of creating informal network of government agencies, suppliers and research centres (Narula and Guimon, 2010). Studies investigating IDP found significant differences across CEECs due to socio-political and economic histories, absorptive capacity, industrial policies and legal frameworks (Bourdier, 2008; Chobanova, 2009). Significant changes in the mode of entry, internal organisations and motives of MNCs towards efficiency seeking and strategic assets seeking followed by fragmentation of their activities across countries and industries are likely to have different developmental impact on host countries.

Fourth, methodological and data issues as well as the model specification have contributed to ambiguity and diversity of results among countries. The current static approach to FDI spillovers is inadequate as it does not correspond to theoretical transmission channels suggesting short and long run effects of MNC entry and effects on local firms. This also has important policy implications as the incentives are warranted only if FDI brings long term benefits to local firms. With that in mind, we use dynamic panel estimation which enables us to control for various specification issues such as simultaneity bias, measurement errors in foreign presence due to incomplete datasets and possible selection issues inherent in some of the previous empirical work which did not include small firms. Since previous research has shown that small firms lack the capacity to benefit from FDI spillovers (Altomonte and Pennings, 2009; Blalock and Simon, 2009), excluding them leads to overestimation of true spillover effect (Eapen, 2013). Finally, the use of a comprehensive firm level database which covers the more recent period and the use of common methodology enable us to make cross country comparisons of FDI spillover effects, thus partially contributing to explanation of ambiguous empirical results witnessed so far.

The chapter is organized as follows. Section 5.2 describes the empirical model and estimation strategy used, followed by data description and methodological approach in Section 5.3 and 5.4 respectively. Section 5.5 provides the discussion of results from FDI spillovers effects and their heterogeneous effects due to MNCs' characteristics. Finally, Section 5.6 concludes.

5.2 MODEL SPECIFICATION

The most common assumption in international business and international trade literature discussed in Chapter 1 is that firms engaged in cross border transactions possess specific advantages that enable them to transfer technology across borders while reaping the benefits of host locations. Ethier and Markusen (1996) and Markusen and Venables (1998) argue that FDI is chosen as the optimal entry strategy because it minimises the probability of imitation, especially under imperfect state of intellectual property rights in the host-country. In these models, productivity spillovers are less likely to arise. Organizational choices, economies of scope stemming from product specific R&D, trade secrecy and efficiency wages are means which MNCs use to protect their knowledge (Kugler, 2006). However, as discussed in Chapter 2, a large literature has developed over the last three decades which argue that FDI spillovers can still occur due to market failure and the public good nature of firm specific assets (Koizumi and Kopecki, 1977; Findlay, 1978; Das, 1987; Wang and Bloomstrom, 1992; and Fosfuri et al., 2001). The major shortcoming of this literature is that they only provide a partial picture of spillover channels focusing on the homogenous effects of FDI within a specific industry or country.

More recent research on FDI spillovers has focused on the role of domestic firms in the Global Value Chains (GVC) which encompass specific activities in the production process where individual firms and even countries are involved in just one stage of product's value chain (Baldwin, 2012). Since the MNC can benefit from knowledge diffusion when it establishes connection with downstream clients and upstream suppliers, it will cooperate with domestic firms by signing supply contracts or licensing agreements. The creation of linkages benefits suppliers directly due to transfer of generic knowledge increasing their specialisation and efficiency. This in turn creates pecuniary externalities to MNCs and local firms as they are able to source intermediate inputs at lower prices. This set of models, concerned with dynamic vertical linkages between MNCs and local firms as well as the outcome of their interaction, is discussed more thoroughly in Chapter 2 (Rodriguez-Clare, 1996; Markusen and Venables, 1999). Although vertical linkages involve market transactions, they also generate technological externalities as local firms absorb, adapt and replicate the knowledge and technology of foreign firms, receive training and financial support, engage in joint product and process development and share business information.

The empirical model developed in this chapter is built upon transmission channels of FDI spillovers discussed in Chapter 2, namely horizontal spillovers and vertical linkages, linked with the insights discussed in Section 2.5.1 in Chapter 2 emphasising MNCs' heterogeneity. Horizontal channel of FDI spillovers in our case includes net effects of technology or knowledge spillovers arising from a combination of demonstration, imitation and competition effects while potential effects arising from worker mobility are not explored due to unavailable data on worker flows. The other type of knowledge spillovers arise from vertical linkages between MNCs and local firms. They can be divided between backward and forward linkages. They include both pecuniary spillovers arising from changes in relative prices and costs and technological spillovers such as informal knowledge transfer (e.g. technical assistance, quality control, employee training). Empirically it is difficult to disentangle pecuniary from technological spillovers and thus the former are usually captured in productivity estimates. Therefore, in this case term *"spillovers"* refers to FDI externalities that capture both knowledge spillovers and voluntary technology transfer occurring through buyer supplier linkages. Since we do not have data which would enable us to identify direct linkages between domestic and foreign firms, it is not possible to estimate direct effects of knowledge transfer such as technical assistance or quality assurance systems provided by foreign firms.

As the main objective of this chapter is the analysis of economic effects of FDI spillovers, we rely on a production function framework commonly used in the literature. In line with endogenous growth theory productivity is not only determined by firm specific technologies, but also by various external factors available in the economy. Therefore, total factor productivity (TFP) estimated in Chapter 4 is related to various factors that are internal and external to the firm. Since the main interest lies in technology shock T_{it} induced by FDI, this can be expressed in the following way:

$$T_{it} = f^{i}\,(I_{it}, E_{jt}) \qquad (5.1)$$

where $(F_{it}, AC_{it}) \in I_{it}$
$(HS_{jt}, VT_{jt}, IT_{jt}) \in E_{jt}$

Internal factors (I_{it}) are foreign ownership (F_{it}) and absorptive capacity (AC_{it}) of firm i at time t expressed in terms of intangible assets (Marroccu et al., 2012), human capital (Blalock and Gertler, 2009), size and age. Main external factors (E_{it}) include various measures of horizontal spillovers (HS_{jt}) and vertical linkages (VT_{jt}) together with variables controlling for competition effects and demand conditions (IT_{jt}) expressed at industry level j. The basic idea underlying equation (5.1) is that firms can increase their technology level internally through investment in human capital and intangible assets or by changing their ownership structure. Since the main interest of this thesis lies in the estimation of indirect effects of FDI on purely domestic firms, the term F_{it} indicating direct foreign equity participation is dropped from the empirical model. An alternative way to boost its technology is to rely on external sources of knowledge, namely those generated by presence of MNCs in industry in which domestic firms operate or in upstream or downstream industries acting as suppliers or customers.

Formally, the empirical model has the following form:

$$\boldsymbol{ln\,TFP_{it} = \beta_0 + \rho\, ln\left(TFP_{i,t-1}\right) + \delta_1 HS_{jt} + \varphi_2 VT_{jt} + \theta_3 AC_{it} + \sigma_4 IT_{jt} + \gamma_j + \gamma_r + \gamma_t + \varepsilon_{ijt}} \quad \textbf{(5.2)}$$

Where $\ln TFP_{it}$ is the logarithm of TFP of firm *i* at time *t* that is estimated in Chapter 4 and $ln\left(TFP_{i,t-1}\right)$ is lagged level of TFP. HS_{jt} and VT_{jt} are defined at the industry level and stand for horizontal spillovers and vertical linkages respectively defined below in more detail. AC_{it} denotes the vector of firm level variables, namely the stock of human capital and intangible assets. In addition, we control for firm's age and size. Vector IT_{jt} includes variables controlling for competition in the market and demand from downstream sectors defined at the industry level *j* at time *t*. Finally γ_j represents industry dummies (defined at NACE 1.1 Rev. level) controlling for unobserved time invariant industry specific factors that may influence both the level of FDI and productivity of local firms. Region (defined at NUTS 3 level) dummies γ_r control for spatial differences in the pattern of FDI and differences in regional performance. Year dummies γ_t take into account changes in economic environment that could lead to changes in MNCs' presence and improvements in TFP. In the following paragraphs we present the description of these variables and explain the rationale of including them in the empirical model.

The specification is derived from theoretical propositions, the most relevant of which is the "partial adjustment" model. In that model, the dependent variable responds sluggishly to changes in the explanatory variables, with geometrically declining lag weights. In this context responses in productivity may be delayed, for example because technological externalities take time to materialise as they depend on the formation of business links with domestic firms in case of vertical linkages or reactions of indigenous firms to increased competition. Since TFP follows a first order Markov process in structural estimators discussed in more detail in the Chapter 4 it is lagged one year to capture the dynamic process of learning by doing occurring within the firm. Furthermore, TFP is a highly persistent variable indicating autocorrelation problems which are best addressed in a dynamic framework.

In the literature, the methodology for calculating spillover variables is drawn from the works of Caves (1974) and Javorcik (2004a) and it is based on an input output framework. In the absence of detailed data on inter firm relationship, which are only available if one conducts a survey, input-output tables provide the best possible option to gauge the relationship between firms in different industries. In principle it provides information on interconnections between industries and relies on the assumption that sectoral R&D and technology or knowledge is embodied in output. We begin by constructing a measure of intra-industry or horizontal spillovers calculated as following:

$$Horizontal_{jt}(HS) = \frac{\sum_{i \epsilon j} Foreign_{ijt} * Y_{ijt}}{\sum_{i \epsilon j} Y_{ijt}} \qquad (5.3)$$

where Y_{ijt} is the output (measured as revenue) produced by foreign firm *i* in industry *j* in year *t*. $Foreign_{ijt}$ is a dummy variable indicating if the firm is foreign owned. It takes the value of one if the sum of shares of foreign investors exceeds 10% of a firm's equity and zero otherwise. As common in the literature intra industry spillovers are calculated at NACE (Rev. 1.1) 2-digit industry group level defined in World Input Output Database (WIOD) given that input output tables used to construct vertical linkages defined below are based on this classification. Horizontal measure captures the output produced by foreign firms *i* in industry *j* in time *t* and is a measure of both demonstration and imitation effects.[45]

In order to calculate vertical linkages the data from WIOD is used (Timmer, 2012).[46] This database has been published only recently and provides yearly input output tables aggregated over 35 NACE Rev. 1.1 2-digit level sectors covering 27 EU countries and 13 other major countries. Yearly data allow us to estimate time varying Input-Output coefficients which is a significant improvement over previous studies which used I-O tables from early/mid 2000s, thus ignoring the changing economic structure of countries over years.

The impact of foreign suppliers or customers is assessed using the proportion of foreign firms in upstream and downstream sectors respectively. In order to compute technical coefficients that are used for calculating vertical linkages, we depart from the work of Javorcik (2004a) and include inputs supplied within the same industry.[47] The reason for

[45] When calculating horizontal measure the total number of firms available in the database was used regardless of whether these firms had data on all production function variables for TFP estimation.

[46] This project is funded by the European Commission, Research Directorate General as part of the 7th Framework Programme, Theme 8: Socio-Economic Sciences and Humanities. The details on how WIOD has been constructed and sources of data can be found in Timmer (2012).

[47] Measure of backward linkages employed by Javorcik (2004a) typically exclude inputs supplied within the same industry as these are captured by horizontal spillovers. It is calculated as $Backward_{jt} = \sum_{k \neq j}^{K} \alpha_{jkt} \, Horz_{kt}$.

this lies in the fact that is unrealistic to assume no inter-industry linkages in highly aggregated industries. For example, when calculating input/output coefficients among industries we were constrained to use the same I-O coefficients for four NACE Rev. 1.1 sectors (30, 31, 32 and 33). Therefore, if buyer supplier linkages between those four sectors are higher than competitive pressures measured by horizontal spillovers backward or forward linkages will be underestimated. If we exclude inputs supplied within the same industry we imply that productivity spillovers occurring at lower levels of aggregation are captured by horizontal spillovers and vertical spillovers will not be identified (Barbosa and Eiriz, 2009). Therefore, excluding/including inputs supplied within the same industry might affect empirical results as shown by Lenaerts and Merlevede (2012). Backward linkages at two-digit industry level are calculated as following:

$$Backward_{jt}\ (VT) \ = \sum_{k=1}^{K} \alpha_{jkt}\, Horizontal_{kt} \qquad (5.4)$$

where α_{jkt} measures the proportion of industry j's output supplied to industry k at time t and $Horizontal_{kt}$ is share of foreign owned firms in downstream sector k. The technical coefficients α_{jkt} are calculated for domestic intermediate consumption, therefore excluding final uses, export and imports.[48] By concentrating on domestic intermediate consumption we are able to relax the common and wrong assumption that MNCs use domestic inputs in the same proportion as imported inputs. Although both types of inputs can increase TFP of domestic firms, MNCs may source different inputs in host country according to literature on international outsourcing of intermediate inputs (Barrios et al., 2011). The backward linkage captures spillovers between MNCs and local suppliers and it has two sources of changes. The first is related to changes in customer-supplier relationship at the industry level, thus rejecting a restrictive assumption of stable inter-industry relationship in transition countries. The second source of variation comes from changes in foreign presence in downstream industry and as the latter increases so does the extent of vertical linkages.

[48] To compute technical coefficients, the inputs in the domestic intermediate IO table are used to find the row and column totals and then each input is divided by the appropriate total (the column total for forward spillovers, the row total for backward spillovers). No adaptations are made to the coefficients in the input-output table.

Similarly, forward linkages are calculated as:

$$Forward_{jt}(VT) = \sum_{l=1}^{L} \gamma_{jlt}\, Horizontal_{lt} \qquad (5.5)$$

In this case technical coefficient γ_{jlt} the proportion of industry j's inputs purchased from industry l at time t. The forward linkage is a proxy for spillovers between MNCs and their local clients in industry j. The larger the presence of MNCs in upstream sectors l and the larger the output sold to local firms the higher is the value of the variable.

Since we are interested in examining the supply side of spillover process, the above measures are corrected to take into account MNCs' heterogeneity, namely their geographical origin and the extent of foreign ownership. This enables us to partially address the critique put forward by Barrios et al. (2011) that MNCs of different origin do not have the same input sourcing behaviour[49]. Foreign firms are therefore divided among two groups reflecting investors from EU and rest of the world. Vertical linkages and horizontal spillovers are recalculated accordingly taking into account MNCs' different origins. Similarly, we recalculate vertical linkages and horizontal spillovers to capture the heterogeneous effects of different degree of foreign ownership according to fully owned (>99%) and partially owned foreign firms (>10% & <99%).

Most of the studies surveyed in Chapter 2 have shown the importance of firm absorptive capacity to reap the benefits of foreign presence. Therefore, two measures of absorptive capacity are developed and are captured within AC vector. First, *human capital* is recognized as an important determinant in the context of FDI-growth effects (Romer, 1990; Barro and Sala-i-Martin, 1995; Borensztein et al., 1998) and in innovation and learning process (Meyer and Sinani, 2009). Human capital affects TFP growth by facilitating the adoption and implementation of new technology developed exogenously (Nelson and Phelps, 1966), and/or by promoting the domestic production of technological innovations (Aghion and Howitt, 1997). By incorporating the quality of labour inputs into a production function, O'Mahony and Timmer (2009) were able to explain the large part of the TFP growth. Haltiwanger et al. (1999) used a matched

[49] Barrios et al. (2011) in addition to separate horizontal spillover according to nationality of foreign investors also use investors' home country IO tables to calculate IO technical coefficients.

employer-employee dataset and found that labour productivity is positively associated with higher proportion of educated workers.

Apart from its direct effects on TFP, human capital is important in the context of FDI spillovers through its multifaceted moderating role. First, firms with high levels of human capital are more likely to benefit from direct entry of MNCs since imitation of foreign technology, operational and management skills required to cope with increased competition require some level of human capital. Second, in order to become a supplier of MNCs, domestic firms need to increase their efficiency and supply quality. MNCs provide domestic firms with information about products, prices, markets; they also provide technical, financial, management and procurement assistance (Giroud et al., 2012). Therefore, the higher the level of human capital, the more likely it is that firms will meet quality standards and become suppliers of MNCs. Merlevede and Schoors (2005) argue that domestic firms with lower levels of human capital can experience negative backward linkages due to their inability to compete. However, higher levels of human capital may also be detrimental as firms with skilled labour may charge higher prices for their products. This might be the case if MNCs are more oriented to cost savings and prevention of knowledge transfer. If cost savings are the main reason for engaging in backward linkages, firms with lower levels of human capital are more likely to be hired as suppliers as they are engaged in low valued added activities (Giroud et al., 2012).

In the case of forward spillover, firms with skilled labour are more likely to benefit from high quality inputs in their production process, thus increasing their productivity. On the contrary, firms with lower levels of human capital are less likely to benefit from foreign firms' inputs and may even experience negative competition effects from both foreign subsidiaries and local firms. Since the Amadeus database does not provide information on skill structure of employees, another measure of the quality of human capital is constructed for this study. Following Becker (1964), it is assumed wage rates reflect the employee's general human capital. Accordingly, we use average wages paid within the firm as a measure of labour quality. Wagner (2012) demonstrated that the average wage in a firm is a useful proxy variable for the qualification of the employees, although it does not account for the heterogeneity of the labour force.

The second variable used as a determinant of firm TFP and as a measure of absorptive capacity is *intangible assets.* Studies investigating FDI productivity spillovers have found that technologically advanced industries and firms with high R&D intensity are in a better position to benefit from the presence of MNCs (Keller and Yeaple, 2009; Aghion et al., 2009). Recent research has recognised that a range of intangible assets grouped in digitized information (IT capital), innovative property (scientific and non-scientific R&D) and economic competences (brand names, firms' specific human capital and organizational structure) is conducive to innovation based growth and productivity improvements (Andrews and de Serres, 2012; Corrado et al., 2009). The widespread heterogeneity and asymmetry in the distribution of firm performance has been related to different within-firm factors such as varying use of intangibles (Syverson, 2011). This is in line with Resource Based Models (RBM) which views firms as distinctive bundles of resources and capabilities (Teece, 1988) and capability based theory of the firm in which firm's decisions are determined mainly by the capabilities of the firm accumulated over time (Dosi et al., 2000).

At the macro level, research has shown that intangible assets explain a larger share of labour productivity growth than tangible assets in a number of countries (Corrado et al., 2009; Marrano et al., 2009; Borgo et al., 2013). Similarly, micro level studies have found a positive relationship between firm investment in intangibles and productivity level (Bontempi and Mairesse, 2008; Marrocu et al., 2012; Hall et al., 2013; Battistini et al., 2014). In order to include a broader measure of firms' capabilities, intangible asset will be used in this study. The choice of using intangible asset is driven both by the unavailability of data on R&D expenditure in the Amadeus database and empirical motivation. The latter can be explained by the fact that TFP estimation discussed in the previous chapter is based on the revenue approach. Since R&D expenditure is only one of the many variables that can influence firms' revenue, Battistini et al. (2014) argue that intangible assets provide more comprehensive measure of effort that firms incur in order to improve their market position and revenues as they include R&D costs, absorptive capability and marketing, design and technical expenditure with the goal of increasing revenues. However, as intangibles include a broad range of factors, measuring them is a challenging task from the accounting perspective as some items can be considered as both current expenditure or capital accumulation (Marrocu et al., 2012). Since Amadeus database does not provide detailed information on different factors comprising intangibles the latter is proxied by the 'share of intangible asset in total fixed assets' and measures firms' endowment with specific advantages.[50] It should be noted that a large number of firms do not report intangible asset. Since the variable is expressed in logarithms, observations with zero values of intangible asset have been transformed to half of the smallest observable value as it is highly likely that these are not true zeros but very small values which are reported as such in the database. The expected effect of intangible asset as a moderating factor of FDI spillovers is the same as in the case of human capital. Therefore, both variables measuring absorptive capacity will simultaneously be included in the model as they measure knowledge capital which is expected to positively affect productivity.

Other firm specific variables include firm size and age and their quadratic terms to control for possible nonlinear effects. It is expected that *firm size* measured as natural logarithm of total assets play an important role in absorption of spillovers and productivity enhancing process. Passive learning model of firm dynamics predicts that larger firms are more productive due to a selection process in which more efficient firms grow and survive (Jovanovic, 1982). New trade theory suggests that differences in firms' performance can be attributed to heterogeneity in terms of productivity and size (Melitz, 2003). The empirical evidence has shown that the average productivity of countries is driven by large firms (Mayer and Ottaviano, 2008, CompNet, 2014). Besides direct effects such as learning by doing and scale and scope economies there are also indirect effects through other variables affecting productivity which are related to firm's size (Barbosa and Eiriz, 2009). Larger firms usually invest more in R&D, have large number of trained and skilled people, more competent management, and pay higher wages increasing the probability to introduce innovation and enhance their efficiency (Huergo and Jaumandreu, 2004; Farole and Winkler, 2012). They are also more adaptable and flexible, thus are more likely to be selected as suppliers and become clients of MNCs (Alfaro and Rodriguez-Clare, 2004). Therefore, the sign of this variable is expected to be positive. However, small and medium sized firms are also likely to benefit from spillovers, as they are more innovative and can adapt their business processes more quickly. The inclusion of a quadratic term is motivated by the fact that size of the firm may be relevant to TFP, i.e. there might be an optimal firm size which enables firms to benefit from low unit costs and organizational structure. Similarly, *age* can also be an

[50] Definition of intangible asset in Amadeus database include R&D expenditures, patents, copyrights, software, employee training, trademarks and other similar costs and as such comprises only those intangible assets that have been capitalized.

important determinant of productivity as it reflects business experience, ability to adapt and familiarity with customer needs. Thus, it is expected that older firms have more specific knowledge that enables them to benefit from foreign entry since they have accumulated experience and knowledge through learning by doing. However, younger firms may be more productive as they may use more advanced technology and innovative business practices. By including quadratic term of age we control for the possibility that young firms may have lower TFP due to limited access to finance and time to accommodate to industry conditions while older firms may experience a decrease in their productivity due to vintage capital effect.

Since a measure of horizontal spillovers may also capture the effect of competition, it is necessary to isolate these two effects. Foreign entry may induce more competition, thus forcing local firms to become more efficient and productive. By not incorporating a specific variable measuring competition, increased productivity may be wrongly attributed to spillovers. The *Herfindahl-Hirshman concentration index* is used to calculate the intensity of competition. It is defined as the sum of the squares of sales shares of all firms in industry *j* (defined at 2 digit NACE Rev. 1.1 level) and time *t*. The sign of this variable is expected to be negative, at least in the short run. Besides competition which may affect horizontal spillovers, we also include a *demand* variable for two reasons. First, foreign firm entry may increase demand for local inputs which may favour economies of scale. On the other hand, if MNCs import most of their intermediates, local firms will face a decrease in productivity since fixed costs of production will be spread to fewer units. The second reason of including the demand variable is the fact that most firms operate in monopolistic competition or in other imperfect market structures, thus having enough market power to influence the price. As our measure of output in Chapter 4 is not expressed in physical quantities but as deflated sales using industry price deflators, it may be subject to omitted price bias and therefore not reflect the true level of productivity. Therefore, it is necessary to separate the variation in quantities which are a measure of true efficiency from variation in prices due to market power by including the demand variable (Van Biesebroeck, 2007). Hence, the demand variable is calculated as:

$$Demand_{jt} = \sum_{k=1}^{K} \alpha_{jkt} Y_{kt} \tag{5.6}$$

Where α_{kj} represents quantity of good *j* needed to produce one unit of good *k* at time *t* while Y_{kt} represents the total real output of industry *k*. The definitions of all variables are provided in Table 5.1.

TABLE 5.1 DESCRIPTION OF VARIABLES

Variable	***Definition***
TFP	*Logarithm of total factor productivity estimated using WLP (2011) method* $TFP_{it} = y_{it} - \beta_K k_{it} - \beta_L l_{it}$
Proxy for horizontal spillovers	$Horizontal_{jt} = \frac{\sum_{i\epsilon j} Foreign_{it} * Y_{it}}{\sum_{i\epsilon j} Y_{it}}$
Proxy for backward linkages	$Backward_{jt} = \sum_{k=1}^{K} \alpha_{jkt} Horz_{kt}$
Proxy for forward linkages	$Forward_{jt} = \sum_{l=1}^{L} \gamma_{jlt} Horz_{lt}$
Proxy for horizontal spillovers arising from EU countries	$Horizontal\_EU_{jt} = \frac{\sum_{i\epsilon j} Foreign_{it}EU * Y_{it}}{\sum_{i\epsilon j} Y_{it}}$
Proxy for horizontal spillovers arising from non-EU countries	$Horizontal\_nonEU_{jt} = \frac{\sum_{i\epsilon j} Foreign_{it}nonEU * Y_{it}}{\sum_{i\epsilon j} Y_{it}}$
Proxy for horizontal spillovers arising from fully owned foreign firms	$Horizontal\_full_{jt} = \frac{\sum_{i\epsilon j} Foreign_{it}full * Y_{it}}{\sum_{i\epsilon j} Y_{it}}$
Proxy for horizontal spillovers arising from partially owned foreign firms	$Horizontal\_part_{jt} = \frac{\sum_{i\epsilon j} Foreign_{it}part * Y_{it}}{\sum_{i\epsilon j} Y_{it}}$
Proxy for backward linkages arising from EU countries	$Backward\_EU_{jt} = \sum_{k=1}^{K} \alpha_{jkt} Horizontal_{kt}EU$
Proxy for backward linkages arising from non-EU countries	$Backward\_nonEU_{jt} = \sum_{k=1}^{K} \alpha_{jkt} Horzizontal_{kt}nonEU$
Proxy for backward linkages arising from fully owned foreign firms	$Backward\_full_{jt} = \sum_{k=1}^{K} \alpha_{jkt} Horizontal_{kt}full$
Proxy for backward linkages arising from partially owned foreign firms	$Backward\_part_{jt} = \sum_{k=1}^{K} \alpha_{jkt} Horizontal_{kt}part$

Proxy for forward linkages arising from EU countries	$Forward\_EU_{jt} = \sum_{l=1}^{L} \gamma_{jlt}\, Horizontal_{lt}EU$
Proxy for forward linkages arising from non-EU countries	$Forward\_nonEU_{jt} = \sum_{l=1}^{L} \gamma_{jlt}\, Horizontal_{lt}nonEU$
Proxy for forward linkages arising from fully owned foreign firms	$Forward\_full_{jt} = \sum_{l=1}^{L} \gamma_{jlt}\, Horizontal_{lt}full$
Proxy for forward linkages arising from partially owned foreign firms	$Forward\_part_{jt} = \sum_{l=1}^{L} \gamma_{jlt}\, Horizontal_{lt}part$
Ln Size	$\ln(Total\_Assets_{ijt})$
Ln Size squared	$\ln(Total\_Assets_{ijt})^2$
Age	Time T – date of incorporation
Age squared	(Time T – date of incorporation)^2
Ln Human capital	ln (cost of employees / number of employees)
Ln Intangibles	ln (intangible fixed assets / tangible fixed asset)
Hirschman-Herfindahl index of industry concentration	$\sum_{j} (Sales_{ijt} / \sum_{j} Sales_{jt})^2$
Ln Demand	$\ln Demand_{jt} = \sum_{k=1}^{K} \alpha_{jkt}\, Y_{kt}$

5.3 DATA AND DESCRIPTIVE STATISTICS

Central to the analysis of FDI productivity spillovers is the firm-level Amadeus database which has already been described in detail in Chapter 4. The investigation is limited to manufacturing and services firms for the period from 2002 until 2010. The sample is restricted to the following five countries: the Czech Republic, Estonia, Hungary, Slovakia and Slovenia. Since country, industry and firm heterogeneity play an important role in demand and supply process of spillovers five countries in the sample are treated as distinct samples throughout to fully benefit from the scale of the database. This allows all the coefficients to vary freely across the countries, which would not be achieved by using country fixed effects. Perhaps more importantly, an additional advantage of country specific estimations is the higher degree of robustness of the analysis by eliminating potential differences in the sample composition across countries. Previous studies (Damijan et al., 2003, 2013a; Gersl et al., 2007; Nicolini and Resmini, 2010) which also focused on examining FDI spillovers in several transition countries were based on incomplete coverage of Amadeus database and mainly focused on the period before the EU accession and only on manufacturing sector. The observed period of analysis coincides with large volume of FDI in the last decade partially induced by substantial investment incentives. Therefore, it is important to analyse whether MNCs brought the expected increase in productivity of domestic firms across the two most important sectors of economy.

Before turning to empirical analysis investigating the effects on TFP of domestic firms associated with observed heterogeneity of foreign subsidiaries, a short preview FDI spillover and other control variables is provided in Table 5.2.

TABLE 5.2 DESCRIPTIVE STATISTICS

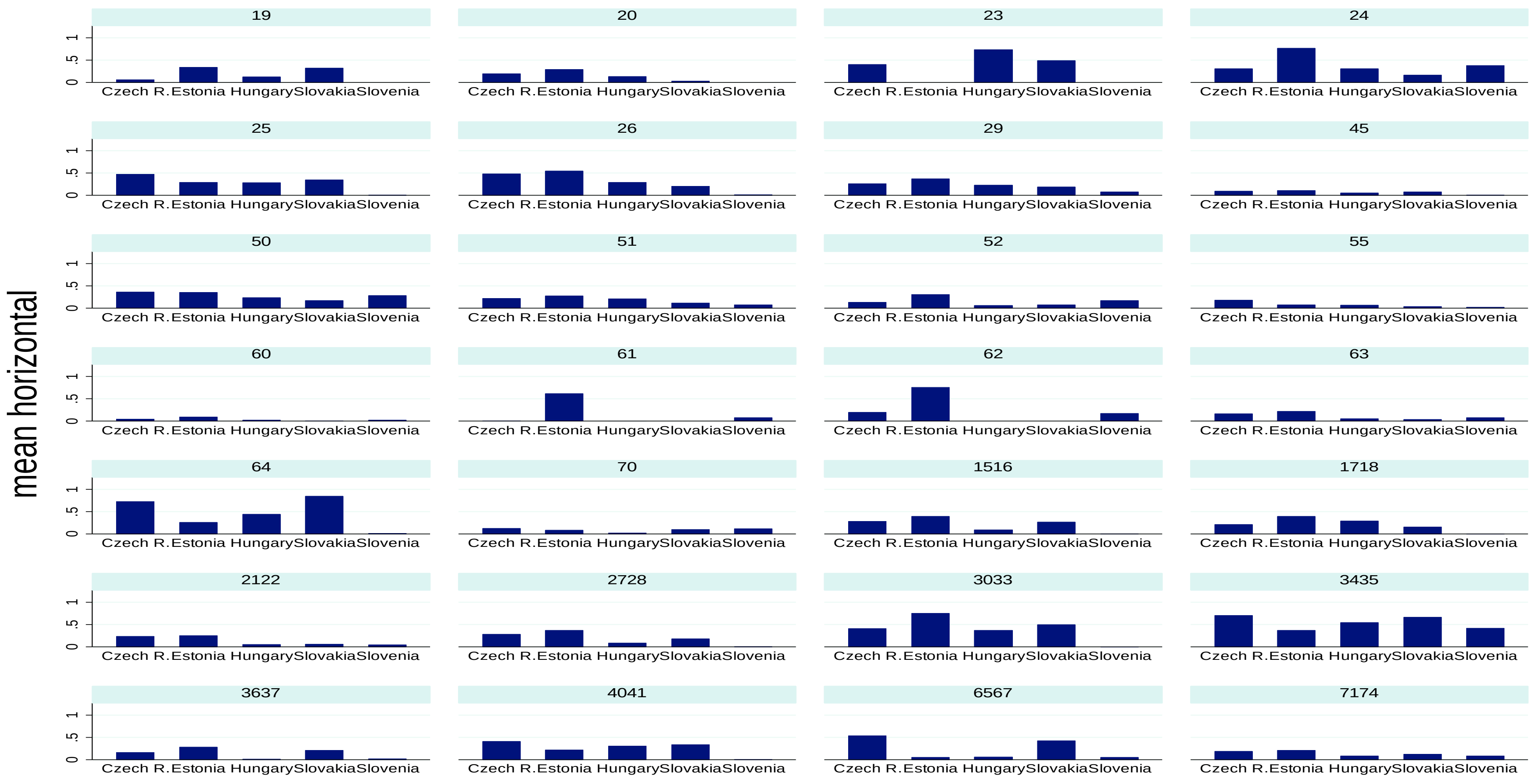
	Czech Republic		Estonia		Hungary		Slovakia		Slovenia	
Variable	*Mean*	*St.dev.*	*Mean*	*St.dev.*	*Mean*	*St.dev.*	*Mean*	*St.dev.*	*Mean*	*St.dev.*
ln TFP	3.108	1.148	2.667	0.898	4.549	1.383	3.525	1.072	3.923	0.765
Horizontal	0.208	0.141	0.220	0.148	0.204	0.123	0.144	0.154	0.069	0.105
Horizontal EU	0.196	0.134	0.200	0.135	0.180	0.105	0.123	0.126	0.057	0.091
Horizontal non-EU	0.012	0.015	0.021	0.027	0.024	0.040	0.021	0.074	0.013	0.040
Horizontal full	0.167	0.126	0.164	0.121	0.160	0.112	0.107	0.134	0.049	0.085
Horizontal part	0.041	0.055	0.056	0.048	0.044	0.057	0.037	0.074	0.021	0.055
Backward	0.180	0.085	0.088	0.043	0.180	0.057	0.175	0.091	0.060	0.043
Backward EU	0.170	0.078	0.176	0.073	0.154	0.049	0.133	0.060	0.054	0.042
Backward non-EU	0.010	0.009	0.022	0.010	0.026	0.012	0.042	0.039	0.006	0.003
Backward full	0.143	0.077	0.134	0.062	0.126	0.045	0.138	0.083	0.029	0.023
Backward part	0.038	0.017	0.065	0.026	0.054	0.024	0.037	0.017	0.031	0.029
Forward	0.170	0.062	0.123	0.059	0.138	0.043	0.130	0.059	0.052	0.035
Forward EU	0.162	0.058	0.157	0.065	0.120	0.035	0.115	0.052	0.040	0.033
Forward non-EU	0.008	0.005	0.019	0.010	0.018	0.014	0.016	0.010	0.012	0.007
Forward full	0.124	0.057	0.126	0.062	0.076	0.026	0.079	0.047	0.033	0.027
Forward part	0.046	0.019	0.051	0.019	0.062	0.034	0.051	0.027	0.019	0.016
ln Wage	2.146	0.768	1.710	0.755	2.537	0.594	2.177	0.854	2.740	0.447
ln Intangibles	-4.235	2.075	-3.717	1.925	-4.569	2.182	-4.812	1.992	-4.134	2.099
Hirschman Herfindahl index	0.024	0.044	0.036	0.075	0.084	0.122	0.042	0.074	0.085	0.114
ln Demand	9.077	1.092	7.676	1.246	9.911	1.278	9.912	1.441	8.036	0.992
Age	9.230	4.843	8.051	6.690	11.977	5.647	9.076	5.912	11.089	6.480
ln Size	6.176	1.767	4.774	1.696	8.584	1.427	6.558	1.771	6.148	1.568

In general, one fifth of industry output is produced by foreign firms with the exception of Slovakia and Slovenia, indicating the importance of foreign firms across industries and relatively high potential for productivity spillovers. A more detailed look at the descriptive statistics indicates that fully foreign owned firms and those coming from the EU have the highest potential for generating spillovers, but also inducing competitive pressure on domestic firms. Turning to vertical linkages, firms in the Czech Republic, Hungary and Slovakia have the highest potential for becoming suppliers of MNCs judging by the mean value of backward linkages. This is somewhat expected as those countries have strong manufacturing base and attracted a significant number of MNCs in manufacturing industries which are thought to have strong backward linkages. The lowest potential for development of backward linkages is evident in Slovenia. Again, fully foreign owned firms coming from the EU have the highest potential for developing supplier linkages with local firms. Forward linkages are most likely to occur in the Czech Republic, especially from EU MNCs and those which are fully owned. Firms in Slovenia and Hungary pay the highest average wages while the share of intangible asset as a proxy for knowledge capital is highest in Slovenia, followed by Hungary and the Czech Republic. The competitive environment measured by HHI indicates high competition in all countries. The mean age of firms ranges between 8 and 12 years suggesting that the sample includes relatively young firms formed after the first few years of the transition period. The size of firms is largest in Hungary as expected due to sample structure and smallest in Estonia.

Since FDI is not only country specific, but also industry specific the Figures 5.1, 5.2 and 5.3 below provide a more detailed picture of the development potential of FDI spillovers related to entry and presence of foreign firms across different industries and countries. One can immediately notice the significant heterogeneity in all measures of FDI spillovers across countries and industries. The largest share of foreign firms' output is accounted in Post and Telecommunications industry (64) in all countries except Slovenia, followed by Electrical and Optical equipment industry (30_33), Transport equipment (34_35), Chemical industry (25) and Rubber and Plastics (26). Overall, it seems that foreign firms in the database still have a significant influence in manufacturing industries despite the large amount of FDI in the service sector. However, the potential for backward linkages development shown in Figure 5.2 is more pronounced in services, especially in Retail (51), Wholesale and commission trade (52) and Water Transport (61).

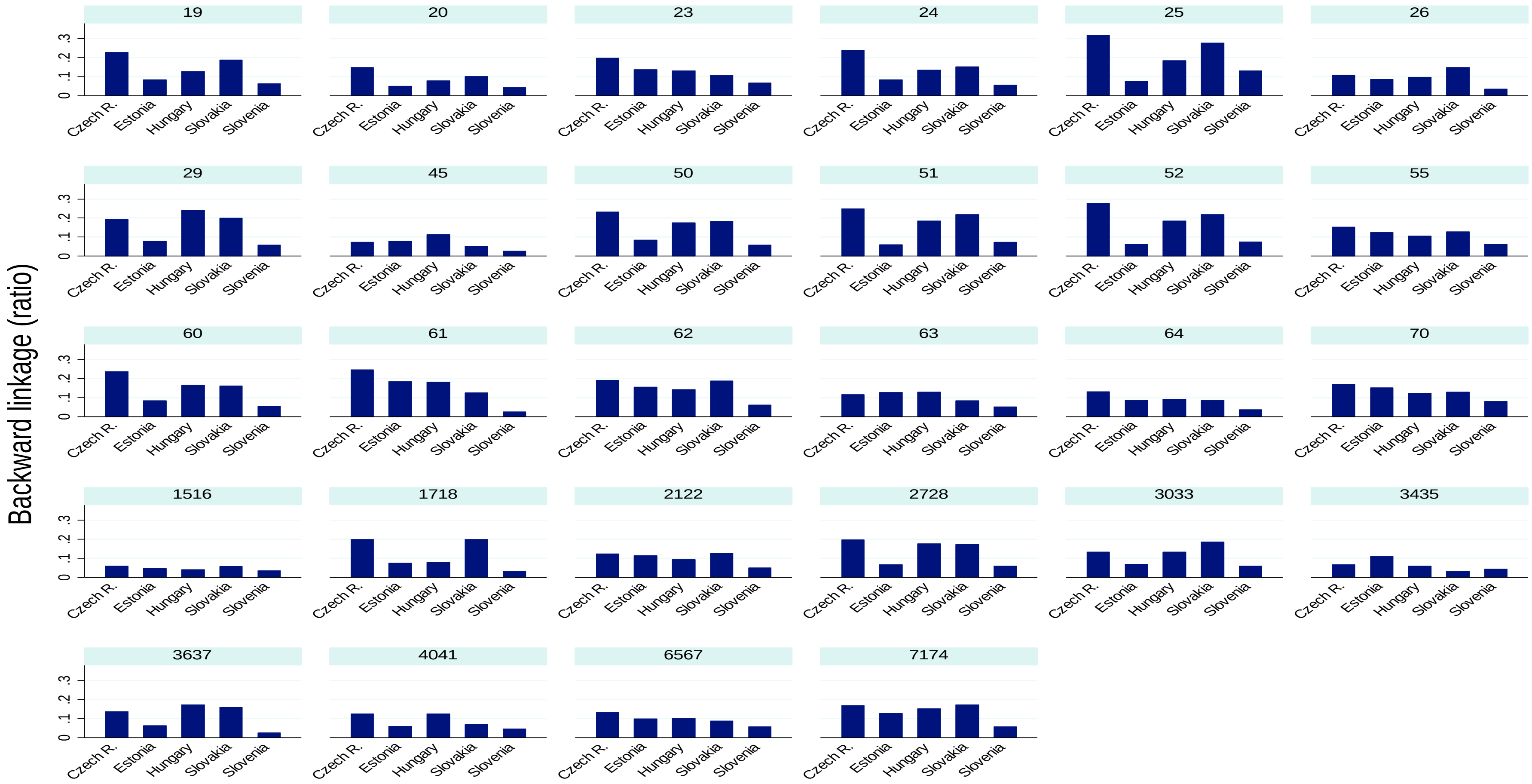
However, it must be noted that these averages are pulled up mainly by the Czech Republic, Hungary and Slovakia. Within the manufacturing industries, the higher potential for supplier development and inclusion in GVC is evident in production of Rubber and plastics industry (25), Machinery (29) and Basic and Fabricated metals (27_28). Finally, in terms of forward linkages shown in Figure 5.3 there is a clear indication of the importance of transport industries (60_62) for downstream clients followed by Chemical industry (24) and Sale, maintenance and repair of motor vehicles (50).

FIGURE 5.1 HORIZONTAL SPILLOVERS ACROSS INDUSTRIES AND COUNTRIES



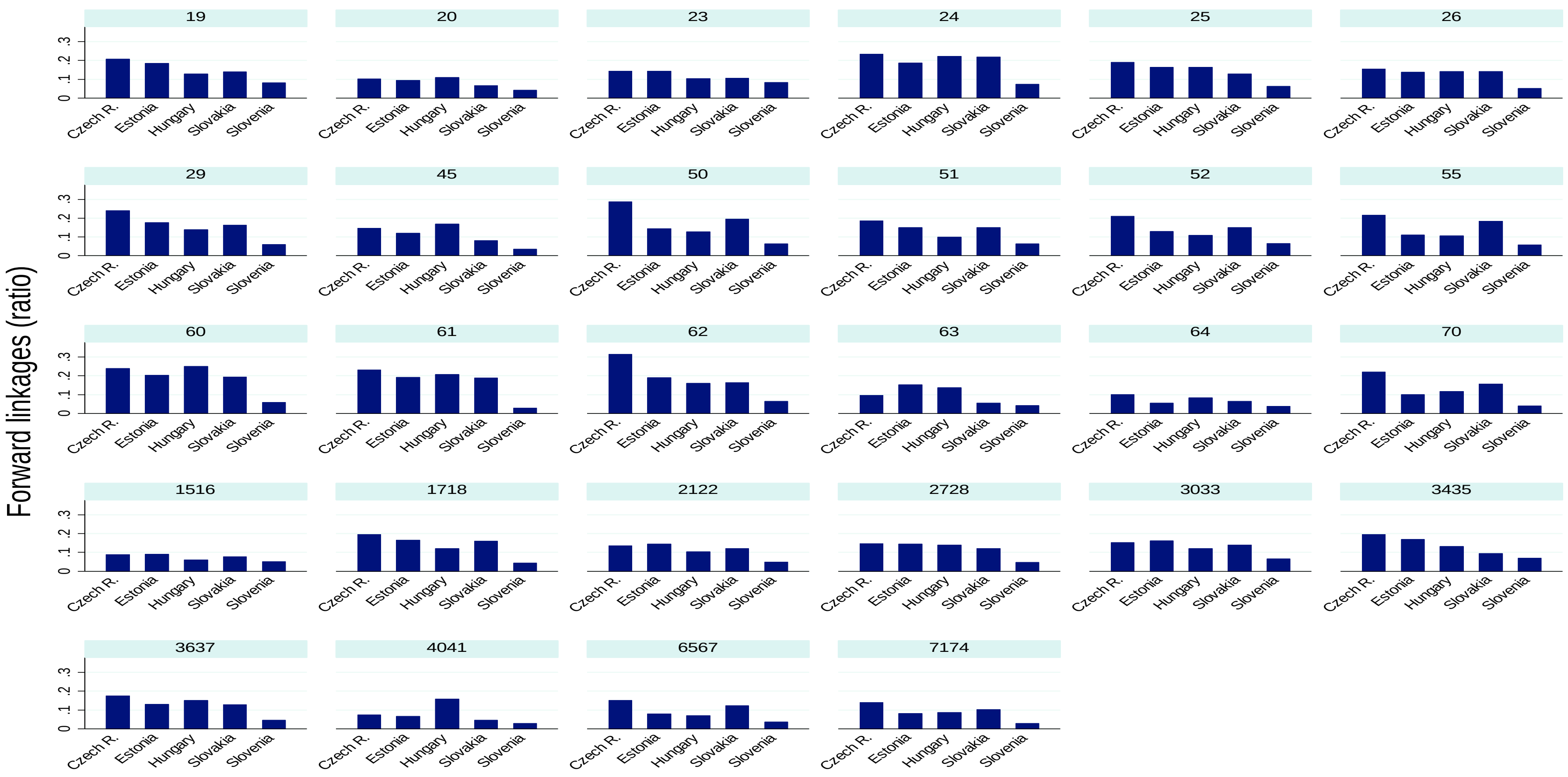
Note: Industry codes correspond to industry classification in WIOD database and are based on 2-digit NACE Rev. 1.1 group

FIGURE 5.2 BACKWARD LINKAGES ACROSS INDUSTRIES AND COUNTRIES



Note: Industry codes correspond to industry classification in WIOD database and are based on 2-digit NACE Rev. 1.1 group

FIGURE 5.3 FORWARD LINKAGES ACROSS INDUSTRIES AND COUNTRIES



Note: Industry codes correspond to industry classification in WIOD database and are based on 2-digit NACE Rev. 1.1 Rev. group

5.4 METHODOLOGY

Since we are dealing with longitudinal data, several possible estimators such as pooled OLS, standard fixed effects estimation or corrected least square are potentially available. However, given the possible endogeneity and the fact that the main interest is to estimate dynamic effects of FDI spillovers, the fixed effects model or pooled OLS, which are most commonly used in empirical literature on FDI spillovers, are prone to several drawbacks. First, both dependent variable and FDI spillovers are measured with errors thus making regression coefficients biased and inefficient and worsen identification difficulties (Eapen, 2013). Second, fixed effects correct for the possible correlation between unobserved effects and some of the independent variables, by taking deviations from time-averaged sample means. This approach may be inappropriate in our case since the dependent variable is stripped of its long run variation and hence any conclusion about dynamic nature is precluded (Doytch and Uctum, 2011). Third, the most severe problem with OLS estimation, especially when firms' specific effects are not controlled for is endogeneity. Since FDI is more likely to go to industries or regions which exhibit higher productivity *ex ante* the positive correlation between FDI and productivity of domestic firms might simply reflect the location decision by foreign investors rather than the positive spillover productivity effects (Hale and Long, 2011). This may lead to upward bias in the estimates of productivity spillovers. Fourth, since the model discussed in Section 4.2 includes lagged dependent variable, the estimation by OLS or fixed effects would lead to a dynamic panel bias. Nickell (1981) established that OLS estimates of the lagged dependent variable's coefficient in a dynamic panel model are biased due to the correlation between the lagged dependent variable and the error term. This bias is inversely related to panel length. Since firms in the dataset have 3 to 4 years of data on average, the possible bias cannot be regarded as negligible. Recently, Kiviet (1995) and Bruno (2005) proposed a bias-corrected least squares dummy variable estimator (LSDVC) which corrects for *"Nickell bias"* using an estimate of the short-panel bias computed from each firm's data. However, this procedure assumes that the independent variables are exogenous.

A common strategy to deal with above mentioned problems is to use a difference or system GMM estimator (Arellano and Bond 1991; Arellano and Bover 1995; Blundell and Bond 1998). Furthermore, Roodman (2009) suggests that the GMM estimator is the proper methodological approach in cases where the number of time periods (T) is small relative to the number of groups (N), independent variables are not strictly exogenous, there is heteroscedasticity and autocorrelation within groups, and variables are not normally distributed. A necessary moment condition which needs to be satisfied is the restriction on the covariance between the error term and independent variable, i.e. (ε_t,) = 0. If this is not the case, coefficient estimates will be biased and inconsistent. The problem is usually overcome by using instruments which are uncorrelated with the error term, but correlated with endogenous variables. GMM is specifically designed to capture the endogeneity of some explanatory variables through the creation of a matrix of internal instruments. The latter is important for this study as it is very difficult to find external instruments for FDI at industry level for countries under analysis. The number of instruments can be very large, and by defining more than one moment condition per parameter to be estimated, the information available to the estimation process is maximised.

Using Arellano and Bond (1991), we can transform our baseline model (eq. 5.2) into first-differences to eliminate firm-specific effects as follows:

$$\boldsymbol{ln\,TFP_{it} - lnTFP_{i,t-1} = \beta_0 + \rho\, ln\left(TFP_{it-1} - TFP_{i,t-2}\right) + \delta_1(HS_{jt} - HS_{j,t-1}) + \varphi_2(VT_{jt} - VT_{j,t-1}) + \theta_3(AC_{it} - AC_{i,t-1}) + \sigma_4(IT_{jt} - IT_{j,t-1})} + (\varepsilon_{it} - \varepsilon_{i,t-1}) \quad (5.7)$$

Although time invariant effects are removed, simultaneity bias still remains since differenced lagged dependent variable and differenced error term are correlated. Arellano and Bond (1991) proposed that the lagged difference ($y_{it-2} - y_{it-3}$) or lagged levels y_{it-2} of the regressors should be used as instruments. This is valid under the assumptions: (i) the error term is not serially correlated, and (ii) the lag of the explanatory variables are weakly exogenous.

A potential problem of the Arellano-Bond difference GMM estimator is that (i) coefficient estimates may be biased, making lagged levels weak instruments for their differences if variables follow a random walk, (ii) the explanatory variables are persistent over time, and (iii) the time dimension of the sample is small (Blundell and Bond, 1998). In order to alleviate these problems a system GMM estimator was developed which combines the equation in first differences with the equation in levels (Arellano and Bover, 1995; Blundell and Bond, 1998). The introduction of levels equation in the model is explained by the argument that past changes may be more predictive of current levels than the levels can be of future changes when the series are close to random walk (Roodman, 2009). System GMM allows for the inclusion and estimation of slowly changing variables or time invariant variables. Finally, Roodman (2009) suggests that system GMM performs better in the case of unbalanced panels since difference estimation magnifies gaps in the data. An additional requirement for the efficiency in system GMM is that unobserved firm specific effect is uncorrelated with first difference of variables (Windmeijer, 2005). In other words, the condition implies that deviations of the initial values of the explanatory variables from their long-run values are not systematically related to the firm-specific effects. The major shortcoming with GMM models is the possible instrument proliferation since it may overfit endogenous variables, weaken diagnostics used to test instrument validity and provide imprecise estimates of the covariance matrix of the moments. The general rule of thumb suggested by Roodman (2009) is that the number of instruments should not exceed the number of groups. One of the ways to reduce the instrument matrix is to restrict the lag ranges that are used in generating these instrument sets. This is done by including different instruments for each lag, but for all time periods. Mehrhoff (2009) and Roodman (2009) suggest that collapsing the instrument sets is an efficient way of dealing with possible instrument proliferation. By collapsing, an instrument for each lag distance is created rather than for each time period and each lag. It has the advantage over the truncation of the lag depth that it retains much more information as it does not involve dropping of any lag.

Given the shortcomings of difference GMM, we decided to apply system GMM and, since both estimators can be estimated in one or two step procedure, we decided to opt for the second one as it is robust to heteroscedasticity and cross-correlation. The problem with two step procedure is that standard errors are known to be downward biased when the number of instruments is large. Therefore, Windmeijer (2005) correction, which is found to be superior to the cluster-robust one-step standard errors (Roodman, 2009) is applied. Furthermore, all specifications include time dummies to control for possible cross-sectional dependencies arising from spatial dependence, economic distance or common shocks (Sarafidis et al., 2009).

In order to verify that the moment conditions or assumptions of System GMM are satisfied we rely on several diagnostic tests. The instrument validity is tested with the Hansen test which is robust to heteroscedasticity. The null hypothesis of Hansen test is that overidentifying restrictions are valid. Roodman (2009) suggests that p-values of Hansen test of overidentifying restrictions lower than 0.25 and those approaching unity should be viewed with concern. However, Blundell et al. (2000) have shown that using system GMM on a large panel may weaken Sargan/Hansen test and over reject the null hypothesis. Consistent with this, several studies employing system GMM on a large panel found statistically significant Hansen test (Benito 2005; Becker and Sivadasan, 2010; Chen and Guariglia, 2013). We also rely on the difference in Hansen test to test the subset of instruments as it can affect the overall Hansen statistics, and the choice considerably alters the coefficients obtained for the independent variables.

The Arellano-Bond test for autocorrelation examines the hypothesis of no second-order serial correlation in the error term of the difference equation (i.e., cov ($\Delta\varepsilon_{it}$, $\Delta\varepsilon_{it-k}$)=0 for k≥2). In the presence of serial correlation of order *n* in the differenced residuals, the instrument set for the equation in first-differences needs to be restricted to lags n + 1 and deeper (Roodman, 2009). The GMM estimator requires that there is first-order serial correlation (m1 test) but that there is no second-order serial correlation (m2 test) in the residuals. Since there is no formal test of weak instrument in system GMM, Bun and Windmeijer (2010) maintain that the both GMM estimators may suffer from small-sample bias, but the bias for the system GMM estimator is rather small when the variance of unobserved heterogeneity (σ_η^2) is equal to the variance of the idiosyncratic disturbance term(σ_ε^2). Hence if two variances have roughly similar values it could provide a hint that instrument are not too weak. Similarly, Bond et al. (2001) suggest that the coefficient of lagged dependent variable can be compared to those obtained from OLS which is upward biased and fixed effects which are downward biased. A consistent GMM estimator should lie between two values and if not, it may be due to weak instrument problem.

Another benefit of the dynamic analysis is that it allows us to distinguish between short and long run effects. In our case, this is important as policy makers need to be aware whether the entry of MNCs provides long term benefits to the host country firms in order to devise policy recommendations towards FDI. The estimated coefficients provide short term effects which represents only a fraction of the desired change (Baltagi, 2008). Hence, long run effects are calculated as a product of estimated coefficients and long run multiplier $\frac{1}{1-\beta_1}$ (where β is the estimated coefficient on the lagged dependent variable).

The statistical significance of such obtained coefficients can be calculated using the so-called 'delta' method (Papke and Wooldridge, 2005).[51]

5.5 DISCUSSION OF FINDINGS

Starting from the basic model discussed in Section 5.2, the empirical estimation is conducted in statistical software Stata 12 using *xtabond2* command developed by Roodman (2009). As a starting point, the model is estimated for domestic firms only in order to avoid aggregation bias which might arise due to inclusion of foreign firms. The consequences of such bias are exaggerated positive productivity spillovers since foreign firms are more productive. The lagged dependent variable and variables measuring FDI spillovers (horizontal, backward and forward) are treated as endogenous and as such are instrumented with their own lags and lagged differences. As suggested by Roodman (2009) in the levels equation instruments are found among the one and more periods lagged differences of endogenous variables. In the difference equation the endogenous variables are instrumented with their own levels lagged two or more periods. The choice of lags was determined by model diagnostics. The initial specifications included a minimum number of lags, i.e. the number of instruments came from restriction to start with one lag for levels and differences in case of lagged dependent variable and two lags for FDI spillover variables (Roodman, 2009). However, in certain cases model diagnostics with minimum number of lags were not satisfied and therefore the instrumentation matrix included higher order lags (three or four) of the regressors as instruments. Consequently we also report the AR(3)/AR(4) tests for third/fourth order serial correlation of the differenced residuals in our tables. Furthermore, if specification tests rejected no second order autocorrelation tests or validity of instruments, a second lag of dependent variable was added to the right hand side of the model (Sarafidis et al., 2009; Merikull and Room, 2014).

In this section only the result of variables of interest are presented, while coefficients of year, industry and region dummies are excluded for presentation purposes. However, the

[51] This method is based on deriving linear function that approximates non-linear combination of estimators using Taylor's series expansion. Stata command "nlcom" is used to transform non-linear equation and to calculate standard error.

latter can be found in Appendix III together with the original printouts and syntaxes. The following subsections explain in more detail model diagnostics and results for the baseline model and its extensions.

5.5.1 RESULTS FOR BASELINE MODEL

As discussed in Section 5.5 system GMM uses internal instruments to correct for endogeneity. Since there is no clear rule on the optimal number of instruments, we follow Roodman (2009) suggestions and use lag limits and collapse option to limit the number of instruments and obtain a more parsimonious model.[52] Hansen J test of overidentifying restrictions is valid for each regression taking the p-values between 0.15 and 0.43. The null hypothesis of no autocorrelation in differences of errors is rejected for the autocorrelation of first order but there is no sufficient evidence to reject the null hypothesis of no autocorrelation of second order in differences of errors. It is also important to check the validity of subsets of instruments. For this purpose, one can use a difference-in-Hansen test, also known as the C-test (Baum, 2006). The null hypothesis of the C-test is that the specified variables are proper instruments, i.e. that the set of examined instruments is exogenous. As can be seen from Tables III.1-III.5 in Appendix III, we do not have sufficient evidence to reject this hypothesis.

In order to test for cross sectional dependence, the difference-in-Hansen test statistic for the lagged dependent variable is examined. The corresponding p-values suggest that there is not sufficient evidence to reject the null hypothesis that the instruments for lagged dependent variable are valid. To check whether the steady-state assumption which states that convergence process of TFP is independent from unobserved time invariant firm specific effects holds, difference-in-Hansen test for level equation is used. The latter implies that there is not sufficient evidence to reject the null hypothesis of valid instruments. Therefore, system estimator can be preferred over the difference one. Moreover, the value of lagged dependent variable indicates convergence as, in all cases, it is less than unity (Roodman, 2009). Finally, following the suggestion of Bond et al. (2001) an additional test of validity of dynamic panel estimates is performed by checking whether the value of lagged dependent variable lies between lower bound of FE and

[52] In all regressions presented below, the number of instruments is far below the number of cross sectional units as expected due to large number of firms.

upper bound of OLS estimates. As can be seen from Table III.16 in Appendix III, all specifications satisfy this condition. Having satisfied all diagnostic tests, we can conclude that our model is well specified and allows us to proceed with the interpretation of results of the baseline model, presented in Table 5.3.

TABLE 5.3 DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVER EFFECTS ON PRODUCTIVITY (LN TFP) OF DOMESTIC FIRMS, 2002-2010 (ALL SECTORS)

VARIABLES	Czech Republic	Estonia	Hungary	Slovakia	Slovenia
L. ln TFP	**0.400*** **	**0.402*** **	**0.463*** **	**0.658*** **	**0.572*** **
	(0.0121)	*(0.0144)*	*(0.0636)*	*(0.0648)*	*(0.102)*
Horizontal	**0.304**	**4.118*** **	**3.835*** **	**-3.082*** **	**-1.208*** **
	(0.225)	*(1.009)*	*(0.722)*	*(0.614)*	*(0.433)*
Backward	**0.459*** **	**-0.945*** **	**1.908* **	**0.203** **	**-0.0694**
	(0.0784)	*(0.200)*	*(1.063)*	*(0.0937)*	*(0.107)*
Forward	**-3.883*** **	**-4.918*** **	**-5.465**	**5.599*** **	**4.864*** **
	(0.450)	*(1.257)*	*(5.023)*	*(1.279)*	*(1.629)*
Ln Human capital	**0.427*** **	**0.368*** **	**0.348*** **	**0.283*** **	**0.317*** **
	(0.00837)	*(0.0105)*	*(0.0307)*	*(0.0153)*	*(0.0430)*
Ln Intangibles	**0.0512*** **	**0.0929*** **	**0.0117*** **	**0.0592*** **	**0.0320*** **
	(0.00175)	*(0.00402)*	*(0.00359)*	*(0.00672)*	*(0.00590)*
Age	**-0.0106*** **	**-0.00744*** **	**-0.0109*** **	**-0.0104*** **	**0.0316** **
	(0.00103)	*(0.00146)*	*(0.00203)*	*(0.00148)*	*(0.0130)*
Age^2	**8.47e-05** **	**9.39e-05*** **	**4.29e-05*** **	**0.000209*** **	**-0.00179*** **
	(3.36e-05)	*(1.26e-05)*	*(1.56e-05)*	*(2.86e-05)*	*(0.000604)*
Ln Size	**0.201*** **	**0.361*** **	**0.111* **	**0.159*** **	**0.0910*** **
	(0.0129)	*(0.0401)*	*(0.0686)*	*(0.0388)*	*(0.0277)*
Ln Size^2	**-0.00494*** **	**-0.0191*** **	**0.00117**	**-0.00632*** **	**0.000395**
	(0.000827)	*(0.00386)*	*(0.00419)*	*(0.00183)*	*(0.00153)*
HHI	**-0.326*** **	**-4.382*** **	**-0.172**	**0.774*** **	**-0.259** **
	(0.0662)	*(1.057)*	*(0.111)*	*(0.224)*	*(0.116)*
Ln Demand	**-0.00706**	**-0.105*** **	**0.101**	**-0.0868*** **	**-0.388**
	(0.0141)	*(0.0349)*	*(0.108)*	*(0.0228)*	*(0.271)*
Model diagnostics					
Observations	97,891	46,368	6,910	30,490	12,884
Number of groups	36,700	13,978	3,635	13,595	4,335
No. of Instruments	62	57	86	59	69
Year effects	yes	yes	yes	yes	yes
Region effects	yes	yes	yes	yes	yes
Industry effects	yes	yes	yes	yes	yes
AR(1) p-value	0	0	1.21e-06	0	4.66e-09
AR(2) p-value	0.261	0.298	0.173	0.827	0.0847
AR(3) p-value	0.382	0.421	0.344	0.00187	0.953
AR(4) p-value	0.469	0.367	0.918	0.0437	0.287
Hansen Test p-value	0.193	0.155	0.431	0.236	0.154

Note: robust standard errors in brackets
****, ** and * denote statistical significance of variables at 1%, 5% and 10% level of significance respectively.*

The model includes domestic firms in both manufacturing and market service sector (at NACE Rev. 1.1 classification, codes 15-74). The dynamic specification, through the lagged dependent variable, contains the entire history of the independent variables and their influence on the current level of productivity. Therefore, we are able to identify the additional short-run effects on local firm's productivity of recent changes in the FDI spillover variables, absorptive capacity and industry conditions. The coefficient on lagged dependent variable is positive and highly significant in every country. A one percent increase in TFP in previous period implies an increase in TFP in current period between 0.40 and 0.66 percent. In other words, the speed of adjustment to desired level of TFP ranges between 0.34 and 0.60. The results suggest that learning by doing has an effect in all countries, the smallest being in the Czech Republic and the largest in Slovakia.

Turning to our greatest concern about the relationship between FDI spillovers and TFP, the results provide a mixed picture for horizontal and vertical spillovers. The findings with respect to knowledge capital indicate that both human capital and intangibles have a significant and positive role in increasing the level of productivity of domestic firms. Turning to industry level variables, it seems that concentration and demand effects have a negative and significant effect in most cases. Finally, a firm's size and age exhibit nonlinear effects in most cases indicating that there might be a turning point where the firm's productivity starts to rise after it accumulates experience and adapt to market and organizational structure which impeded firms to achieve efficiency at certain point during their business life.

In order to shed more light on the mixed effects in the case of FDI spillover, we start by examining the effects of horizontal spillovers. These are positive and significant in the case of Hungary and Estonia where the share of foreign firms' output is the highest, and negative in the case of Slovakia and Slovenia. The results suggest that a one percentage point increase in the share of foreign owned output in an industry increases productivity of domestic firms by 3.83 and 4.11 percent in Hungary and Estonia, respectively. The effects are larger in the long run where horizontal spillovers increase the domestic firms' TFP by 6.88 and 7.13 per cent respectively. It seems that domestic firms in these two countries are able to cope with increased competition induced by increased foreign entry either by imitating foreign firm practices or by increasing their efficiency – they are in line with empirical work of Bekes et al. (2009) for Hungary, Sinani and Meyer (2004) for Estonia and Stancik (2007), Kosova (2010) and Javorcik and Spatarenau (2011) for the Czech Republic.[53] On the other hand, it seems that domestic firms in Slovakia and Slovenia are not able to benefit from increased foreign presence in their sectors. A one percentage point increase in foreign owned output in a sector is associated with a decrease in productivity between 1.20 and 3.08 percent. This finding is consistent with the literature arguing that domestic firms which do not have a certain level of absorptive capacity are crowded out from the market as some of their markets is captured by foreign firms. This is also confirmed in a multi country study by Damijan et al. (2013a) who initially found negative horizontal effects, but positive after controlling for absorptive capacity. By reducing their market share, domestic firms in Slovakia and Slovenia seem to be operating at less efficient scale and face increased costs which may affect their profits and result in less investment in training and technology. Furthermore, negative horizontal effects may arise from negative effect of worker mobility as foreign firms pay higher wages than domestic firms (Heyman et al. 2007; Earle and Telegdy, 2008), thus leaving domestic firms with less skilled workforce affecting their ability to benefit from potential imitation or demonstration effects.

Turning the discussion to backward linkages, the results imply that foreign presence in downstream sector is associated with positive productivity effects in upstream sector in the Czech Republic, Hungary and Slovakia. The positive effects of backward linkages is highest in Hungary where a one percentage point increase of foreign firms' output in a downstream industry increases the demand for local inputs resulting in increase of TFP of local firms by almost 2 percent in short run and 3.55 per cent in the long run, the latter effects being reported in Tables III.1-III.5 in Appendix III. Similarly, in the Czech Republic and Slovakia, this positive effect amounts to 0.45 percent and 0.20 percent in short run and 0.76 percent and 0.59 percent in the long run, respectively. However, it seems that foreign firms in Estonia have negative effects on upstream local suppliers. The negative effects of backward linkages are in contrast to studies by Javorcik (2004a), Halpern and Murakozy (2007), Gersl et al. (2007) and Kolasa (2008), but in line with Merlevede and Schoors (2007), Stancik (2007, 2009) and Damijan et al. (2013a).[54] It seems that total negative effect of backward linkages is driven by the inability of

[53] Bear in mind that these studies are based on manufacturing sector only.

[54] In Damijan et al.' (2013a) study backward linkages become positive when controlling for absorptive capacity and domestic firms' heterogeneity in terms of their size, productivity levels and technological gap.

domestic firms to establish vertical linkages and enter supply chain of MNCs, but it is still unclear which foreign firms are driving these results.

Forward linkages exhibit positive and statistically significant effect on productivity of domestic firms in Slovakia and Slovenia, while for the Czech Republic and Estonia we find a significant negative relationship. The large negative effects of forward spillovers in the latter two countries outweigh the positive effects arising from backward linkages in the Czech Republic and horizontal spillovers in Estonia in both short and long run. In contrast to these two countries, the results suggest that forward spillovers are a source of net positive productivity spillovers in Slovakia and Slovenia, a finding similar to Gorodnichenko et al. (2014), Zajc and Kumar (2006) and Merlevede and Schoors (2009).[55] This finding is again in contrast to majority of other studies which focused on productivity spillovers within manufacturing sector (Gersl et al., 2007). However, given the large amount of FDI in the service sector which is almost entirely motivated by market seeking behaviour of MNCs and their concentration in sectors such as financial services, telecommunications, transport and business services domestic firms may be able to benefit from high quality inputs provided by foreign service firms. This has provided strong incentives for domestic firms to switch from imports or to cope with import competition and procure high quality inputs from local market, especially those inputs coming from service sector as the latter have important implications for manufacturing productivity. A more detailed analysis of these effects will be analysed in the next chapter.

Turning to variables measuring absorptive capacity of domestic firms, namely human capital and share of intangible assets in total fixed assets we find positive and significant effects of knowledge capital across all specifications. The findings suggest that one percent increase in average wage which act as a proxy for quality of human capital increase productivity of local firms between 0.28 percent in Slovakia and 0.42 percent in the Czech Republic. The effects are even stronger in the long run where a one percent increase in the average wage leads to 0.62 percent increase in TFP in Estonia and 0.82 per cent in Slovakia. The magnitude of coefficient indicates that the level of human capital is relatively high and may significantly influence the increase in productivity and realisation of potential positive productivity spillovers coming from FDI. Since MNCs

[55] A study by Gorodnichenko et al. (2014) find partially positive forward spillovers in case of older firms; firm facing high import competition; and linkages arising with domestic oriented MNCs.

often require trained staff and product upgrading in order to develop linkages, it is of utmost importance that domestic companies further invest in their human capital which will enable them to benefit from the presence of MNCs in their sector as well as entering the GVC of MNCs.

In the main model (eq. 5.2) presented in Table 5.3, the effects of intangibles are in line with previous empirical estimates (Marroccu et al., 2012; Bontempi and Mairesse, 2014). It enables domestic firms to increase their productivity between 0.01 per cent in Hungary and 0.09 percent in Estonia in the short run. In the long run, the effects are almost doubled. The finding may be the consequence of increased competition induced by both domestic and foreign firms which force firms to increase investment in marketing, design and technical expenditure with the goal of increasing market share but also to become supplier of MNCs. Javorcik and Spatareanu (2009) found that the Czech suppliers increased their investment in product upgrading and that vast majority of such development came from their own effort and developed in house.

The effect of concentration measured by Hirschman-Herfindahl index is mostly negative with the exception of Slovakia. A one percentage point increase in industry concentration leads to a decrease in productivity between 0.25 in Slovenia and 4.38 per cent in Estonia. The large coefficient in the case of Estonia accompanied with positive horizontal spillovers suggests that surviving domestic firms have high absorptive capacity that enables them to benefit from imitation or demonstration effects and at the same time outweigh any crowding out effects. On the other hand positive productivity effects of higher concentration of firms in Slovakia seem to be accompanied by negative market stealing effect. The findings imply that remaining domestic firms do not have the ability to benefit from MNC entry either because of lack of absorptive capacity, foreign firms' successful prevention of knowledge leakage or MNCs poaching the best workers from domestic firms.

The variable measuring increased demand for inputs suggests that both domestic and foreign firms decrease the intermediate inputs purchase which does not allow domestic suppliers to reap the benefits of scale economies. Demand effects is negative and significant in Estonia and Slovakia suggesting that a one percent increase in the purchase of intermediate inputs lead to a decrease in productivity between 0.08 percent in Slovakia and 0.11 percent in Estonia. The negative effect of demand may explain the negative backward linkages in Estonia as local firms are not able to achieve increasing returns to scale in the production of inputs which may enable them to lower the prices of intermediate goods and transfer the benefits to downstream firms.

The findings for firms' age are consistent across countries (negative on age and positive on the squared term), except in the case of Slovenia where the coefficient is positive for the linear term and negative for the squared term. Since age is an interaction variable it is necessary to interpret both coefficients at the same time. An additional year of experience for an average firm leads to a decrease in TFP of 0.01 percent across all countries.[56] However, in case of Slovenia the effect is positive, indicating an increase in productivity of 0.02 percent. Younger firms typically need to accommodate to market conditions and therefore their performance is below existing firms in the first years of operation. This finding is consistent with those of Jensen et al. (2001) examining the effect of age on TFP of US firms and Harris and Moffat (2015) for UK firms, although the former study found that the negative vintage effect of older plants is offset by positive learning effect. Negative age effect can also be correlated with changes in organizational structure as it influences the way firms operate and may result in decrease in TFP (Van Witteloostuijn, 2003). The turning point after which the age of firms starts to negatively affect TFP is around 9 years in Slovenia and given that more than 50 percent of firms are older we can conclude that age has a decreasing effects on domestic firms' productivity. The opposite effect is experienced in other countries where turning point starts at 25 years in Slovakia up to 127 years in Hungary.[57] Given that there are a small number of firms which are older than the turning point in other countries we can conclude that there is a negative selection effect due to the inability of domestic firms to learn, acquire more advanced technology, or achieve economies of scale in the medium term.

Turning to other control variables, the results suggest that there is a strong and positive effect of firm size in all countries. This relationship however takes the concave form in all countries except Slovenia where the effect of quadratic term is not significant, indicating that size has diminishing effects on the productivity levels. The positive effects of size on TFP range from 0.09 percent in Slovenia to 0.32 percent in Estonia. The findings are broadly consistent with theoretical models of industrial dynamics and

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[56] A common interpretation of coefficients in case of nonlinear variables is by taking the first partial derivative with respect to dependent variable. In this case, the effects of age can be expressed as: $\frac{\partial TFP}{\partial age} = \beta_1 + 2\beta_2 age$.

[57] Quadratic function $ax^2 + bx$has its minimum or maximum at: $x = -b/2a$, therefore this is the point of inflection where function changes its direction.

heterogeneous trade models which predict that larger firms are more productive (Jovanovic, 1982; Melitz 2003). These are also corroborated by the findings of Van Biesebroeck (2005b) who found significant differences between small and large firms in nine African countries. Furthermore, Garcia-Santana and Ramos (2013) found a significant relationship between size and labour productivity at the micro and size and TFP at aggregate level across 104 developing countries controlling for standard determinants of plant efficiency while Castany et al (2007) found that large firms are more productive due to differences in endowments and returns to innovation and skilled labour. Nonlinear effects suggest that after a certain point becoming too large has a negative effect on productivity due to inefficiencies in coordination, management and supervision resulting in diseconomies of scale (Fernandes, 2008).

5.5.2 THE EFFECT OF OWNERSHIP STRUCTURE

The second part of the analysis is concerned with ownership structure of foreign firms and their effects on the extent of spillovers. Existing empirical studies disentangling the effects of different degrees of foreign ownership on productivity of domestic firms are mostly focused on developing countries (Almeida and Fernandes, 2008; Abraham et al., 2010) with the exception of Javorcik and Spatareanu (2008), Merlevede and Shoors (2007), Kolasa (2008), Merlevede et al. (2014) and Gorodnichenko et al. (2014) who analysed the effects of ownership in Romania, Poland and Eastern European countries, respectively. As mentioned in Chapter 2, the supply side of FDI spillover process has gained little attention so far in empirical literature. One of the possible reasons is that the data to conduct such analysis is not widely available. However, since the Amadeus database provides detailed ownership information on foreign equity stakes in each firm, we decided to investigate the effect of ownership structure on the results presented in Section 5.6.1.

As mentioned in Section 2.5.1 the equity stake of foreign firms can reveal something about their market entry preferences and technology they bring with them (Blomstrom and Sjoholm, 1999). The results obtained in Section 5.6.1 can hide significant and contrasting effects and magnitude of spillovers. To shed more light on different spillover effects arising from different ownership structures, the total spillovers are decomposed according to those arising from partially foreign owned firms (where the share of foreign owners ranges from 10 to 99%) and fully owned foreign firms (where the share of foreign owners is greater than 99%). Therefore, we have two horizontal measures of spillovers, two backward and two forward measures of vertical spillovers defined as follows:

$$Horizontal\_full_{\ jt} = \frac{\sum_{i\epsilon j} Foreign_{it}full * Y_{it}}{\sum_{i\epsilon j} Y_{it}} \tag{5.8}$$

$$Horizontal\_part_{\ jt} = \frac{\sum_{i\epsilon j} Foreign_{it}part * Y_{it}}{\sum_{i\epsilon j} Y_{it}} \tag{5.9}$$

$$Backward\_full_{jt} = \sum_{k=1}^{K} \alpha_{jkt}\, Horizontal_{kt}full \tag{5.10}$$

$$Backward_{part\,jt} = \sum_{k=1}^{K} \alpha_{jkt}\, Horizontal_{kt}part \tag{5.11}$$

$$Forward_{full\,jt} = \sum_{l=1}^{L} \gamma_{jlt}\, Horizontal_{lt}full \tag{5.12}$$

$$Forward\_part_{jt} = \sum_{l=1}^{L} \gamma_{jlt}\, Horizontal_{lt}part \tag{5.13}$$

where α_{jkt} and γ_{jlt} are input and output coefficients from annual IO tables measuring the proportion of industry *j'*s output supplied to or purchased from industries *k* or *l* at time *t* weighted by the share of foreign firms with full or partial ownership in industry *k* or *l*.

Before turning to the explanation of results, which are presented in Table 5.4 below, it is useful to discuss the diagnostics of the econometric models. In all regressions, the Hansen J test of overidentifying restrictions is valid for all models while the null hypothesis of no autocorrelation in differences of errors is rejected for the autocorrelation of first order but there is insufficient evidence to reject the null hypothesis of no autocorrelation of second order in differences of errors.[58] The C-test of the instrument subset also confirms that specified variables are valid instruments, i.e. exogenous. Moreover, the value of lagged dependent variable indicates convergence as in all cases it is less than unity

[58] Since AR(n) test rejected null hypothesis of no second and higher order autocorrelation in the case of Czech Republic, a second lag of dependent variable was added to the specification. Similarly, in case of Estonia, the second order autocorrelation is rejected at conventional levels of significance, however, given that all variables are instrumented with three or four lags or regressors, AR(3) and AR(4) cannot be rejected.

(Roodman, 2009). The additional test of the validity of dynamic panel estimates confirms that the value of lagged dependent variables lies between the lower (FE) and the upper (OLS) bound values. Finally, the difference-in-Hansen test for the level equation implies that there is insufficient evidence to reject the null hypothesis of valid instruments and therefore system GMM is preferred over difference GMM.

TABLE 5.4 DYNAMIC SYSTEM GMM ESTIMATION OF FDI SPILLOVER EFFECTS ON DOMESTIC FIRMS' PRODUCTIVITY (LN TFP) - EXTENT OF MNC'S OWNERSHIP, 2002-2010 (ALL SECTORS)

VARIABLES	Czech Republic	Estonia	Hungary	Slovakia	Slovenia
L. ln TFP	**0.389*** **	**0.530*** **	**0.559*** **	**0.435*** **	**0.523*** **
	(0.0126)	*(0.0364)*	*(0.0826)*	*(0.0242)*	*(0.101)*
Horizontal_full	**-0.356**	**0.721**	**-0.480**	**-1.113*** **	**-0.785** **
	(0.347)	*(0.570)*	*(0.383)*	*(0.274)*	*(0.320)*
Horizontal_partial	**0.568*** **	**1.438** **	**1.620* **	**-2.580*** **	**0.549**
	(0.192)	*(0.727)*	*(0.879)*	*(0.776)*	*(0.441)*
Backward_full	**0.0591**	**0.523** **	**1.558* **	**0.287** **	**-0.240* **
	(0.0919)	*(0.241)*	*(0.854)*	*(0.113)*	*(0.148)*
Backward_partial	**1.868** **	**-2.383*** **	**-3.801** **	**-3.070*** **	**1.036*** **
	(0.866)	*(0.643)*	*(1.546)*	*(0.855)*	*(0.393)*
Forward_full	**-1.785*** **	**-4.767*** **	**-7.679*** **	**2.223*** **	**4.724*** **
	(0.553)	*(1.253)*	*(2.090)*	*(0.836)*	*(1.565)*
Forward_partial	**-6.071*** **	**7.145*** **	**-5.630** **	**5.509* **	**2.712* **
	(2.067)	*(2.193)*	*(2.515)*	*(3.129)*	*(1.384)*
Ln Human capital	**0.435*** **	**0.335*** **	**0.307*** **	**0.324*** **	**0.369*** **
	(0.00852)	*(0.0134)*	*(0.0381)*	*(0.00848)*	*(0.0401)*
Ln Intangibles	**0.0524*** **	**0.0826*** **	**0.0104*** **	**0.0817*** **	**0.0356*** **
	(0.00180)	*(0.00348)*	*(0.00337)*	*(0.00352)*	*(0.00555)*
Age	**-0.0108*** **	**-0.0125*** **	**-0.00954*** **	**-0.0132*** **	**0.0252*** **
	(0.00104)	*(0.00106)*	*(0.00194)*	*(0.00142)*	*(0.00938)*
Age^2	**8.43e-05** **	**0.000139*** **	**3.69e-05*** **	**0.000214*** **	**-0.00149*** **
	(3.38e-05)	*(1.09e-05)*	*(1.32e-05)*	*(3.02e-05)*	*(0.000436)*
Ln Size	**0.209*** **	**0.236*** **	**0.132** **	**0.283*** **	**0.0805*** **
	(0.0133)	*(0.0215)*	*(0.0581)*	*(0.0227)*	*(0.0287)*
Ln Size^2	**-0.00520*** **	**-0.00872*** **	**-0.00145**	**-0.0112*** **	**0.00230**
	(0.000840)	*(0.00206)*	*(0.00322)*	*(0.00146)*	*(0.00153)*
HHI	**-0.253*** **	**-1.298** **	**-0.131**	**0.196**	**0.0101**
	(0.0744)	*(0.564)*	*(0.0998)*	*(0.139)*	*(0.0993)*
Ln Demand	**-0.0597**	**-0.0339**	**0.113* **	**-0.0581** **	**-0.954*** **
	(0.0382)	*(0.0411)*	*(0.0673)*	*(0.0229)*	*(0.237)*
Model diagnostics					
Observations	97,891	66,194	6,910	30,490	12,884
Number of groups	36,700	18,684	3,635	13,595	4,335
No. of Instruments	67	61	119	65	71
Year effects	yes	yes	yes	yes	yes
Region effects	yes	yes	yes	yes	yes
Industry effects	yes	yes	yes	yes	yes
AR(1) p-value	0	0	4.35e-05	0	1.51e-08
AR(2) p-value	0.399	0.0419	0.161	0.229	0.333
AR(3) p-value	0.382	0.441	0.364	0.155	0.990
AR(4) p-value	0.360	0.141	0.926	0.217	0.0438
Hansen Test p-value	0.114	0.153	0.317	0.316	0.223

hor_part=hor_full	0.00636	0.136	0.0173	0.0183	0.00179
back_part=back_full	0.0385	0.000610	0.0149	0.000297	0.00895
for_part=for_full	0.0378	2.26e-06	0.550	0.263	0.0436

Note: robust standard errors in brackets
****, ** and * denote statistical significance of variables at 1%, 5% and 10% level of significance respectively.*

The lagged dependent variable is highly significant and positive in all cases, ranging from 0.39 in the Czech Republic to 0.56 in Hungary, again indicating high persistence of past productivity improvements and learning effects. Increased concentration in industries has negative and significant effect only in Estonia and the Czech Republic, although the magnitude of the coefficient in the former country is now lower. The demand variable again indicates that the bulk of firms in Slovakia and Slovenia are not buying inputs from domestic suppliers, thus negatively affecting productivity by 0.05 and 0.95 percent, respectively. In comparison to the baseline model, the effect of demand is now positive in Hungary. It seems that firms benefit from increased economies of scale as a 10 percent increase in purchased inputs leads to improvement of local firm’s productivity by one percent.

Firm level variables, namely age and size kept the same sign, with similar magnitude and significance levels as in the baseline model. Again, the turning point after which the effect of the age of firms becomes positive and outweighs initial negative effects is too large to have any significant effect in the medium term. The results suggest that older firms in all countries except Slovenia are not capable of increasing their productivity probably due to obsolete capital equipment or do not have the necessary knowledge or level of investment to keep pace with advances in technology. Findings for the firm size corroborate those from the baseline model indicating inverse U shaped effects in the case of the Czech Republic, Estonia and Slovakia and positive linear effects throughout the sample period for Hungary and Slovenia.

Findings related to variables measuring absorptive capacity are in line with those obtained in the baseline model suggesting that human capital and the share of intangible assets play a positive and significant role in increasing TFP. The effect of human capital on TFP is largest in the Czech Republic, where a one percent increase in average wage leads to an increase in TFP by 0.43 percent, followed by Slovenia (0.36 percent) and being smallest in Hungary (0.30 percent). Similarly, the effect of intangible assets confirms the positive findings from the baseline model although the magnitude of the coefficient is slightly smaller. If the share of intangibles increases by 10 percentage points the effect on TFP ranges from 0.1 percent in Hungary to 0.8 percent in Estonia and Slovakia, whilst for other countries the effect is moderate (between 0.3 and 0.5 percent). It seems that domestic firms have either invested in the process or product innovation or increased their stock of knowledge by adopting the fruits of other firms' innovation efforts embodied in intangible asset purchased on the market.

Turning to FDI spillover variables, it is noticeable that the average coefficient in the baseline model hides important information. Although the results are robust to change in specification in terms of significance and signs, the magnitude of coefficients vary. Partially foreign owned firms have stronger effect on productivity within the sector, while the opposite holds for backward vertical linkages. Starting from horizontal spillovers it seems that the percentage of foreign ownership does matter for productivity as partially foreign owned firms seem to generate positive horizontal spillovers in the Czech Republic, Estonia and Hungary, while fully foreign owned firms generate negative spillovers within the industry in Slovenia and Slovakia. In the latter country, total negative effects are driven by both types of foreign firms. The difference between partially and fully foreign owned firms is statistically significant in all countries except in Estonia. Overall, the productivity effects range from 0.56 percent in the Czech Republic up to 1.6 percent in Hungary for every one percentage point increase in the output of partially foreign owned firms in the industry. Negative effects of fully foreign owned firms are in line with the hypothesis suggesting that these firms are bringing more advanced technology in order to obtain higher market share. Furthermore, the full control of operation enables them to prevent knowledge dissipation and to cope with the liability of foreignness. At the same time, local firms are not equipped to capture potential technology spillovers due to their higher technological gap. However, foreign firms entering the local market through joint ventures or as a part of partial acquisitions have beneficial effect as the technology and productivity levels are more likely to be similar to local firms which enable them to benefit from demonstration or imitation effects. Furthermore, as argued by Smeets and de Vaal (2006), a tacit component of knowledge requires frequent communication and interaction providing another reason why shared ownership is more likely to result in greater knowledge spillovers. Finally, it is more likely that in firms with shared ownership the local partner is mostly involved in hiring decisions of local staff and increased labour mobility may lead to technology transfer.

The heterogeneous effects of ownership is also evident in the case of backward linkages where positive effects in the baseline model for the Czech Republic, Hungary and Slovakia are driven by two different types of firms. In the former, the positive effects on local firms' productivity are driven by partially foreign owned firms corroborating the findings by Javorcik and Spatereanu (2008) who hypothesize that firms with partial foreign ownership are more likely to source their intermediate inputs from local markets due to the knowledge of local conditions and quality of suppliers. An increase in demand for inputs from these firms in the Czech Republic and Slovenia may also arise due to the less stringent requirements for quality and production process which benefit domestic suppliers who otherwise would not be able to provide inputs to more technologically advanced foreign firms. On the other hand, the negative effect of fully foreign owned firms in Slovenia may be attributed to the time necessary to familiarise with domestic suppliers and provide them with training and support. In addition, greenfield investments are usually undertaken by large firms with high bargaining power and usually require large discounts for their inputs as a prerequisite to become supplier.

A different picture emerges in the case of other countries. In Hungary, a one percentage point increase in the backward linkage from fully foreign owned firms is associated with 1.5 percent increase in productivity, while for the other two countries the effect is smaller in magnitude and in the range between 0.28 in Slovakia and 0.52 percent in Estonia. On the other hand, the positive effects from fully foreign owned firms are offset by negative productivity effects on local suppliers from partially foreign owned firms which are larger in magnitude and possibly explain total negative effects of backward linkages in Estonia. In all cases, the difference between coefficients is statistically significant. The positive effects of fully foreign owned enterprises in these countries can be explained by the large number of these firms being established through either greenfield investment or full acquisitions in both manufacturing and service sectors. Since fully foreign owned investments are in general more productive and bring more advanced technology into the host market they are more likely to induce technological improvements in existing suppliers such as higher standards on product features, delivery schedules, quality control, inventory holding (Godart and Gorg, 2013). In their theoretical model, Carluccio and Fally (2013) have demonstrated that the entry of more advanced foreign firms induces reconfiguration of the supply chain and forces technology adoption by domestic firms that are willing to supply to MNCs. Those firms that do not adopt foreign technology suffer from increased competition from foreign suppliers, while firms in downstream sector are faced with less availability of inputs compatible with domestic technology and are forced out of the market.

In Hungary acquired companies retained their original suppliers while other local firms have also been successful in joining the international network of MNCs mainly established through greenfield investment (Sass, 2008). Since fully foreign owned enterprises, especially those that are smaller and privatised, are more independent in their decisions about which supplier to choose and most of them exist for a certain period of time, the positive effects reflect the increasing familiarity with domestic supply capacity (Vince, 2001; Sass, 2007). Finally, the overall improvement in institutional progress and especially in the protection of intellectual property rights might have induced more entry in high tech and knowledge intensive industries through wholly owned subsidiaries requiring more advanced inputs (Javorcik and Saggi, 2010). [59]

The strong negative effect of partially foreign owned enterprises can be explained by higher import ratio of components which may result in a loss of customers for suppliers, reduction in profit and a decline in their productivity (Newman et al., 2015). In addition, it is well documented that joint ventures or M&A bring less advanced technology to local market (Mansfield, 1980). Therefore, the incentive to improve the quality and efficiency may be weaker when domestic firms supply partially foreign owned firms with less valuable technology and know-how which could be transferred to their local suppliers. Alternatively, firms with shared ownership may be operating in less knowledge intensive sectors with low value added and obsolete technology which do not require technologically advanced inputs or may be involved more in distribution activities which require less intermediate inputs.

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[59] In order to shed more light on the role of intellectual property rights in moderating the relationship between FDI spillovers and firms' TFP we interacted the former with Legal System and Property Right index obtained from Fraser Institute. The expectation was that an improvement in IPR will have negative moderating effects on horizontal spillovers due to increased competitive edge of MNCs, especially from fully owned foreign firms which are more likely to appropriate the benefits of their advanced technology. In case of vertical linkages the moderating effect is more ambiguous. On the one hand, stroger IPR are likely to increase productivity enhancing effects of FDI spillovers as it enhance the enforcement mechanism that foreign firms can utilize in case of expropriation of the obtained knowledge or encourage MNCs to transfer more advanced technology and thus provide inputs of superior quality to local customers (Smeets and de Vaal, 2015). On the other hand, foreign firms can gain monopoly or monopsony power, thus requiring local suppliers reduce their prices or charge higher prices to local customers. However, the obtained data had very little variation over time and the corresponding empirical results did not satisfy the necessary model diagnostics or when they did the results were to mixed to shed more light on the already heterogenous results.

Forward spillovers are significant and positive in Slovakia and Slovenia for both types of foreign firms. The productivity effects on local firms are especially beneficial when inputs come from partially foreign owned firms in Slovakia and fully foreign owned firms in Slovenia. A one percentage point increase in output of foreign firms with shared ownership in upstream sectors is associated with 5.50 and 2.71 percent increase in TFP of downstream firms in Slovakia and Slovenia, respectively. This effect may stem from domestic market orientation of these companies which are more familiar with the needs and capabilities of domestic firms. Similarly, a one percentage point increase in output of fully foreign owned firms is associated with 2.2 and 4.7 percent increase in TFP in Slovakia and Slovenia, respectively, indicating that local firms in both countries have the ability to benefit from high quality inputs. In both Slovakia and Slovenia, the net effects of vertical linkages are positive arising mainly from the ability of local firms to benefit from increased quality of intermediate inputs purchased from MNCs. The F test of equality of both types of forward spillovers is rejected in all countries expect in Slovakia and Hungary as indicated at the bottom of Table 5.4.

In the case of Estonia, the average negative effect of forward linkages is driven by fully foreign owned firms. However, this detrimental effect is offset by the significant and economically meaningful effects of firms with shared ownership which, by selling their output to local firms, increase their TFP by 7.1 percent. In other countries, local firms are not able to reap the benefits of better intermediate inputs probably due to insufficient absorptive capacity or differences arising from sourcing behaviour of domestic firms in different sectors. The negative effect is mostly pronounced in Hungary where both type of foreign firms have a combined negative effect of 13.2 percent while in the Czech Republic this negative effect amount to 7.85 percent reduction in the productivity levels of local firms.

5.5.3 THE EFFECTS OF MNC'S ORIGIN

The third part of this chapter is concerned with the analysis of MNC's country of origin. As mentioned in Chapter 2 origin of MNCs can have differential impact on local firms' productivity and their inclusion in GVCs. It has been shown that foreign affiliates from emerging economies generate fewer positive spillovers to local firms since they rely more on non-technological assets, mature technology, and production capabilities, networks and relationships (UNCTAD, 2006; Buckley et al., 2007b). Related to this, recent research has found that these affiliates engage in asset seeking strategies relying on host country technology with the aim to improve the performance of its parent company thus limiting spillovers to local firms (Driffield and Love, 2007; Chen et al., 2012). However, Javorcik and Spatareanou (2011) drawing on theoretical model of vertical linkages (Rodriguez-Clare, 1996) argue that geographical distance can have a positive impact on the creation of linkages as MNCs have incentives to source more from local companies to reduce transportation and communication costs.[60]

Similarly, it has been shown that services MNCs follow their clients in foreign markets due to strong need for geographical proximity with users of business services inputs (Nefussi and Schwellnus, 2010). Therefore, the variety of services inputs brought by MNCs of different origin can also benefit local customers in both manufacturing and service sectors. However, the expected sign of forward linkages is ambiguous and depends on the level of technology brought by foreign firms and the ability of local firms to absorb different inputs. Furthermore, free trade area within the EU can encourage export platform FDI from MNCs located outside of the EU that are attracted by improved market access to countries within the trading bloc. Since local firms are often not direct competitors, export oriented MNCs do not need to worry about potential technology leakage. Also, non-EU MNCs have to comply with the rule of origin which requires that sufficient share of value in their product is added within the host country (Javorcik and Spatareanou, 2011). Since our sample consist of EU member states the assumption of increased domestic sourcing of non-EU MNCs is likely to hold in order to avoid import tariffs.

In the case of foreign affiliates from EU political, economic, cultural and institutional proximity induced by EU integration process facilitate the cooperation and creation of linkages (Monastiriotis, 2014). For example, cultural and institutional similarity evident in business laws, customs, ways of doing business and possibly familial links may induce trust and mitigate misunderstanding (Johanson and Vahlne, 2009; Conti et al., 2014). This in turn may result in reduction of transactions costs between suppliers and customers, thus facilitating vertical linkages. However, EU investors are exempt from rule of origin requirement and thus are more likely to import their intermediate inputs

[60] Services may not be affected to the same extent as manufacturing goods due to improvements in ICT.

from their home countries or third countries using global sourcing network. If this is the case, one would expect lower or even negative backward linkages from investments with EU origin. At the same time, increasing fragmentation of production process may generate coordination costs. Therefore, as noted by Markusen (2005) co-location of services functions such as R&D, logistics, sales and marketing may complement existing production activities within the country potentially leading to forward spillovers.

In order to investigate the importance of country of origin the FDI spillover variables are separated and recalculated according to MNC's home country. The Amadeus database identifies large shareholders of companies by country of origin. Thus this information is used to group firms according to whether their owners are of EU or non-EU origin. The former include 28 EU member states plus Switzerland and Norway while non-EU investors include those from other countries.[61] Therefore, horizontal and vertical spillovers are recalculated in the following way:

$$Horizontal\_EU_{\ jt} = \frac{\sum_{i\epsilon j} Foreign_{it}EU * \ Y_{it}}{\sum_{i\epsilon j} Y_{it}} \tag{5.14}$$

$$Horizontal\_nonEU_{\ jt} = \frac{\sum_{i\epsilon j} Foreign_{it}nonEU * \ Y_{it}}{\sum_{i\epsilon j} Y_{it}} \tag{5.15}$$

where *Foreign EU* and *Foreign nonEU* are dummy variables indicating the origin of foreign investors, while Y_{it} indicate total output of firm *i* at time *t*.

$$Backward_{jt}EU = \sum_{k=1}^{K} \alpha_{jkt}\, Horizontal_{kt}EU \tag{5.16}$$

$$Backward_{jt}non_{EU} = \sum_{k=1}^{K} \alpha_{jkt}\, Horizontal_{kt}nonEU \tag{5.17}$$

[61] Since we are interested in investigating geographical, institutional and cultural proximity of different FDI origin the sample is split into two main groups of countries. Furthermore, our sample is consistent with official statistics where majority of MNCs come from within the EU. Therefore, we are interested in whether sourcing behaviour of firms from EU is different from those with non-EU origin. Although combining high income countries such as US with less developed countries such as China or Ukraine may have different spillovers effects due to technology differences, scale and motives of investment, splitting the sample in more non-EU groups would result in very few firms from certain countries of origin which could bias the results. In addition, literature does not clearly distinguish between different groups of affiliates from emerging economies. Some authors include only low and middle income countries (Chen et al., 2012), others include only large emerging countries (Athreye and Kapur, 2009) while the third group of scholars include companies from high income countries in Asia (Mathews, 2002). In our sample, majority of non-EU investors come from Russia, Ukraine, US, China and in case of Slovenia from Western Balkan countries.

$$Forward_{jt}EU = \sum_{l=1}^{L} \gamma_{jlt}\, Horizontal_{lt}EU \quad (5.18)$$

$$Forward_{jt}non_{EU} = \sum_{l=1}^{L} \gamma_{jlt}\, Horizontal_{lt}nonEU \quad (5.19)$$

where $\alpha_{jkt}(\gamma_{jlt})$ are input (output) coefficients from annual IO tables measuring the proportion of industry *j'*s output (input) supplied (purchased) to (from) industries *k(l)* at time *t*.

Table 5.5 below provides empirical results of the combined effects of strategic, geographical, institutional and technological diversity that MNCs from different origin bring into host countries. Before turning to the explanation of results, the diagnostics of the models are discussed. The Hansen J statistics of over identifying restrictions indicates that the probability of making Type I error if rejecting the null hypothesis of the validity of instrument ranges from 18 to 94 percent, thus providing sufficient evidence of instrument exogeneity in all countries except the Czech Republic. In the latter country, over identifying restrictions are not satisfied, thus casting some doubt on the validity of results. A more detailed analysis can reveal that the difference in the Hansen test for exogenous variables, more specifically the variable age is most likely the cause for rejection of the test for the overall validity of the instrument. We tried different specifications by including higher order lags of the dependent variables in the instrument set or treating intangible assets and human capital as endogenous variables, but the diagnostics of the model did not improve and in some cases even worsened. Second order serial correlation cannot be rejected thus satisfying the necessary condition for the validity of estimates. Only in the case of Estonia, the test indicates the presence of autocorrelation in second and fourth lags at 5% significance level. However, in specifications when second order autocorrelation is satisfied this comes at the expense of rejecting the Hansen J test, but the signs and significance of coefficients remains similar across different specifications providing a certain degree of confidence in the results obtained. Overall, the results for the Czech Republic and Estonia must be taken with these caveats in mind. The coefficient of the lagged dependent variable in all countries lies between lower (FE) and upper (OLS) estimates, thus we can be confident that dynamic specification satisfies Bond et al. (2001) informal test for a good estimator.

Difference-in-Hansen test for level equation cannot be rejected, hence we can conclude that there is sufficient evidence that system GMM is a proper estimator.

TABLE 5.5 DYNAMIC SYSTEM GMM ESTIMATION OF FDI SPILLOVER EFFECTS ON DOMESTIC FIRMS' PRODUCTIVITY (LN TFP) – THE ROLE OF MNC'S ORIGIN, 2002-2010 (ALL SECTORS)

VARIABLES	Czech Republic	Estonia	Hungary	Slovakia	Slovenia
L.ln TFP	**0.387*** **	**0.540*** **	**0.362*** **	**0.546*** **	**0.556*** **
	(0.0123)	*(0.0358)*	*(0.0671)*	*(0.0290)*	*(0.102)*
Horizontal_EU	**0.464*** **	**2.123*** **	**1.565*** **	**-0.190**	**-1.299*** **
	(0.103)	*(0.419)*	*(0.456)*	*(0.320)*	*(0.269)*
Horizontal non_EU	**-2.959*** **	**6.977*** **	**0.701**	**-1.047** **	**2.977** **
	(0.506)	*(1.084)*	*(0.621)*	*(0.517)*	*(1.443)*
Backward_EU	**-1.964*** **	**-1.510*** **	**2.500** **	**2.048*** **	**-1.816*** **
	(0.282)	*(0.212)*	*(1.251)*	*(0.582)*	*(0.502)*
Backward_nonEU	**11.14*** **	**6.131*** **	**3.369**	**-5.133*** **	**3.015*** **
	(1.604)	*(0.945)*	*(3.195)*	*(1.536)*	*(0.925)*
Forward_EU	**1.910*** **	**0.668**	**6.218*** **	**2.562*** **	**4.173*** **
	(0.528)	*(0.945)*	*(1.708)*	*(0.480)*	*(1.256)*
Forward_nonEU	**-12.04*** **	**-22.32*** **	**-7.255** **	**1.037**	**7.675**
	(1.971)	*(5.530)*	*(3.578)*	*(0.993)*	*(20.27)*
Ln Human capital	**0.438*** **	**0.332*** **	**0.384*** **	**0.282*** **	**0.384*** **
	(0.00836)	*(0.0132)*	*(0.0314)*	*(0.0144)*	*(0.0504)*
Ln Intangibles	**0.0525*** **	**0.0856*** **	**0.0138*** **	**0.0548*** **	**0.0324*** **
	(0.00177)	*(0.00352)*	*(0.00362)*	*(0.00471)*	*(0.00522)*
Age	**-0.0106*** **	**-0.0112*** **	**-0.0126*** **	**-0.00875*** **	**0.0128**
	(0.00107)	*(0.00108)*	*(0.00200)*	*(0.00192)*	*(0.00946)*
Age^2	**8.48e-05** **	**0.000128*** **	**5.23e-05*** **	**0.000160*** **	**-0.000901** **
	(3.51e-05)	*(1.09e-05)*	*(1.51e-05)*	*(3.17e-05)*	*(0.000434)*
Ln Size	**0.208*** **	**0.279*** **	**0.136** **	**0.148*** **	**0.0718*** **
	(0.0132)	*(0.0239)*	*(0.0596)*	*(0.0334)*	*(0.0269)*
Ln Size^2	**-0.00500*** **	**-0.0135*** **	**0.00138**	**-0.00471** **	**0.00207**
	(0.000840)	*(0.00237)*	*(0.00363)*	*(0.00185)*	*(0.00133)*
HHI	**-0.317*** **	**-3.074*** **	**-0.328*** **	**0.0289**	**0.338** **
	(0.0626)	*(0.671)*	*(0.112)*	*(0.159)*	*(0.160)*
Ln Demand	**0.0840*** **	**-0.0835*** **	**0.0744**	**0.00197**	**-0.836*** **
	(0.0192)	*(0.0273)*	*(0.123)*	*(0.0108)*	*(0.236)*
Model diagnostics					
Observations	97,891	66,194	6,910	16,440	12,884
Number of groups	36,700	18,684	3,635	7,326	4,335
No. of Instruments	68	65	104	67	75
Year effects	yes	yes	yes	yes	yes
Region effects	yes	yes	yes	yes	yes
Industry effects	yes	yes	yes	yes	yes
AR(1) p-value	0	0	9.76e-06	0	7.04e-09
AR(2) p-value	0.198	0.0435	0.125	0.132	0.167
AR(3) p-value	0.475	0.167	0.215	0.442	0.974
AR(4) p-value	0.102	0.0324	0.928	0.875	0.128
Hansen Test p-value	0.00971	0.233	0.948	0.198	0.189
hor_EU=hor_nonEU	1.63e-10	9.03e-07	0.212	0.0128	0.00608
back_EU=back_nonEU	0	0	0.707	0.000668	0.000465

for_EU=for_nonEU	1.28e-08	0.000176	0.000159	0.119	0.861

Note: robust standard errors in brackets;
****, ** and * denote statistical significance of variables at 1%, 5% and 10% level of significance respectively.*

The coefficient of lagged TFP is positive and significant indicating the persistence or inertia effect from past levels of TFP and suggest that learning by doing and both observed and unobserved influences from the past have a strong impact on current levels of TFP. However, the magnitude of lagged dependent variable is somewhat lower in comparison to the baseline model or the model investigating the effects of ownership levels. As was the case with previous specification, the effects of FDI spillovers across countries are heterogeneous. The investments from EU in general provide potential for domestic firms to benefit from demonstration or imitation effects except in Slovenia where the effect from the EU is negative leading to a decrease in domestic firms' productivity by 1.2 percent in response to one percentage point increase in foreign firm's output. In Estonia the average positive effect from foreign presence within industry is driven by both EU and non-EU firms, however the effect of the latter is more than three times larger in magnitude. Since the non-EU variable captures different dimensions of institutional, geographical, strategic and technological context, domestic firms benefit from increased diversity of management practices and technologies which can be used to increase their own productivity and competitive advantage (Zhang et al, 2010). Alternatively, the level of technology used by these foreign firms is more suited and less advanced which enables domestic firms to imitate the practices of foreign firms and compete with them. The positive effects of FDI can also be seen in countries which attracted considerable amount of EU investments such as the Czech Republic and Hungary. In both countries, increase in foreign output from EU firms by one percentage point leads to productivity improvements by 0.46 and 1.56 percent, respectively. These positive effects can be attributed to technological, social, cultural and institutional proximity between EU investors and domestic firms creating local synergies and advance learning capabilities (Monastiriotis, 2014). On the other hand, negative effects from non-EU investors in the Czech Republic can arise for example from the size of investments from Russia or Ukraine which enable them to capture higher market share and lead to market stealing effects. The negative effects in Slovakia can be attributed to more advanced technology brought from US investors potentially explaining negative effects of horizontal spillovers in the baseline model due to inability of local firms to imitate foreign technology and therefore improve their efficiency in the wake of increased competition.

Turning the attention to backward linkages, the effect of EU MNCs are negative and statistically significant in three out of five countries. Negative effects in the Czech Republic, Estonia and Slovenia indicate that presence of EU firms in downstream industries hurts productivity of domestic suppliers as they are not able to join global production networks. Furthermore, MNCs from EU are in better position to source their inputs from their home country supplier due to their vicinity and may be more technologically advanced than MNCs coming from rest of the world, thus requiring higher quality of inputs which may act as a barrier for domestic supplier to enter GSC.[62] As suggested by Rodriguez and Clare (1996) the negative effect of backward linkages may also stem from dissimilarities in terms of variety of inputs between host and home countries. On the other hand, positive effects are experienced by local suppliers in Hungary and Slovakia where a majority of EU investment went to industries with high potential for developing local linkages, such as automobile and electronics, due to long history, tradition and intense cooperation in the field of production and/or trade with foreign partners (Sass, 2008). The magnitude of coefficients are economically meaningful suggesting that a one percentage point increase of foreign firms' output of EU MNCs in downstream sectors leads to increase in TFP of domestic suppliers by 2 percent in Slovakia and 2.5 percent in Hungary.

On the other hand, non-EU investors seem to source inputs from local markets as suggested by positive coefficients in each country except Slovakia where the effect is negative and statistically significant indicating a decrease in TFP of 5.1 percent. Positive effects of non-EU investors are highest in the Czech Republic where a one percentage point increase of foreign firms' output from outside EU in downstream sector leads to 11.1 percent increase in TFP, followed by 6.1 increase in Estonia and 3 percent increase in Slovenia while in Hungary the effect is not significant. The difference between coefficients is statistically significant in all countries except Hungary. The effects of non-EU investment are in line with the proposition that distance plays a role in the extent of

[62] When log TFP of foreign firms is regressed on a dummy variable taking the value of one for non-EU and zero for EU investors controlling for industry, region and time effects the result point out that there is a negative and statistically significant relationship between TFP and the presence of foreign firms outside the EU in the Czech R. and Estonia. Hence, we can take this result as an indication of lower productivity levels of non-EU MNCs. This in turn may benefit domestic firms as non-EU MNCs are able to transfer knowledge to their local suppliers.

backward linkages. Most of foreign investors outside the EU were established to benefit from relatively cheap location and at the same time enjoy access to the EU market using countries under analysis as export platforms. In order to qualify for preferential tariff these foreign subsidiaries are more likely to be actively involved with local suppliers. However, as suggested by Javorcik and Spatareanu (2011), to confirm the role of distance it is necessary to test if knowledge transfer from non- EU MNCs is larger in sectors with high transport costs, something that is difficult to test given the data and space limitations of this thesis and the fact that our focus is on manufacturing and service industries, the latter being mostly a non-tradable sector for which transport costs is difficult to obtain. Furthermore, given recent advances in ICT, the transport costs are less relevant for services.

In the case of forward linkages EU investment seem to have a positive and significant effects in all countries except Estonia indicating increased market seeking motives of EU subsidiaries and at the same time a possible increase in absorptive capacity of local firms which are able to use better quality and variety of intermediate inputs. Moreover, given that in most cases foreign suppliers within the EU followed their customers acting as a Tier 1[63] suppliers or providers of business services, the increased presence of foreign firms in upstream sectors may have resulted in cheaper inputs which benefit local downstream firms (Markusen and Venables, 1999).

In general, the effects of positive forward linkages from the baseline model in Slovakia and Slovenia are driven by EU investors entirely although there is no statistically significant difference between the effects of EU and non-EU MNCs. In other countries, the effect of non-EU investors is negative, being the highest in Estonia where an increase in foreign firms' output in upstream sector by one percentage point leads to decrease in productivity of domestic firms in downstream sector by 22 percent. Similarly, in the Czech Republic this negative effect amount to 12 percent and in Hungary to 7.2 percent. The possible reason for negative forward linkages from non-EU MNCs may stem from their motive of investment. It is likely that non-EU firms engage in export platform FDI to circumvent the trade costs related to distance. However, such investment motive is more oriented to supplying other neighbouring countries, thus reducing the spillovers

[63] Tier 1 are more technologically capable companies which act as direct suppliers to original equipment manufacturers (OEM) in automotive or aerospace industry which require complex and specialized components.

potential for domestic firms and even crowd out existing domestic suppliers. If this is the case, domestic firms buying inputs from foreign MNCs may be faced with higher quality inputs and higher costs, thus resulting in decreased TFP. The difference in coefficients is statistically significant implying that positive effects brought by EU MNCs are entirely offset by negative effect from non-EU MNCs.

The effects of concentration ratio are significant and positive in case of Slovenia, non-significant in Slovakia and negative in other countries confirming previous findings suggesting that increased competition benefit productivity of domestic firms. The results are in line with selection effects of heterogeneous producers in which competition induce existing firms to become more efficient and force less efficient firms to exit (Syverson, 2011). However, the exact mechanism through which competition is postulated to increase productivity cannot be discerned from the variable used in this analysis. The effects of a one percent increase in demand for intermediate inputs in the economy leads to diseconomies of scale resulting in decrease of TFP between 0.08 in Estonia and 0.83 percent in Slovenia confirming findings from previous models. It seems that increased demand for inputs have positive albeit small effects on local firms' productivity in the Czech Republic.

Age and size kept the same signs and significance levels as in the ownership and baseline model with the exception of age which is now insignificant at conventional levels in the case of Slovenia. Nonlinear effects of firms' size are again found only in the case of the Czech Republic, Estonia and Slovakia where TFP starts to decline after firms cross certain threshold. Firm specific variables measuring absorptive capacity are in line with those obtained in other models suggesting that human capital and the share of intangible assets play a positive and significant role in increasing TFP.

5.6 CONCLUSION

The literature on productivity spillovers has made significant advances in the last ten years. A large body of empirical evidence based on micro level data has been produced focusing predominantly on factors that condition the spillover process. Despite these advances, the heterogeneity of MNCs has largely been ignored – except for some theoretical work on the extent of technology transfer arising from differences in MNCs' country of origin, ownership structure and heterogeneous role of subsidiaries in MNCs' network. The aim of this chapter was to examine the size and direction of productivity spillovers to local firms accruing from MNCs' heterogeneity in a sample of five CEE countries controlling for firms' absorptive capacity, market competition and demand effects. The novelty of this chapter is the introduction of new methodology which controls for the potential endogeneity of FDI spillovers and dynamic effects. In addition, unlike most other studies, the investigation takes into account not just the manufacturing but also the service sector, shedding new light on the role of MNCs and providing comparable results across countries by using the same data source and empirical model.

The results of the baseline model show that previous findings related to horizontal spillovers may be misleading as in several cases it is found that local firms may benefit from increased presence of foreign firms and that these spillovers may become even more important than vertical linkages. In countries where MNCs reduce the TFP of local firms due to negative competition effects or labour poaching, the results are driven by both fully and partially foreign owned firms indicating the lack of absorptive capacity of the average firm in the sample. On the other hand, in all countries the positive effects of MNCs within sector can be explained by beneficial effects of partially foreign owned firms due to their lower technological sophistication which enable local firms to obtain technology at lower costs. It can be argued that local firms improve their productivity relying on well diffused technology brought by partially owned foreign firms. The findings related to the origin of foreign investment suggest that EU investment tend to generate greater productivity spillovers within their sector except in Slovenia and Slovakia. Overall, it appears that at least part of these increased knowledge spillovers is related to socio-cultural and institutional proximity which facilitates the process of learning and knowledge diffusion.

The findings for vertical linkages partially confirm the previous findings for backward linkages. The latter are found to be significant and positive in the Czech Republic, Hungary and Slovakia and negative in Estonia. A closer look reveals that partially foreign owned firms are driving the total negative effects in Estonia and partially offset the positive effects of full foreign ownership in other countries. Interestingly, it seems that fully foreign owned firms contribute to the development of supplier linkages - the reason for this may lie in the time period under investigation. The latter factor is related to time and effort of both local firms to satisfy quality requirements and increase their absorptive capacity and of foreign firms to become more familiar with the capabilities of local firms. On the other hand, local firms in the Czech Republic and Slovenia seem to benefit more from partially foreign owned firms as they are more likely to transfer less advanced technology and be more involved in local economy, thus facilitating knowledge absorption by local firms.

Similarly, we find that MNCs from the EU are more likely to source inputs from local markets in Hungary and Slovakia, thus confirming the hypothesis that cultural and institutional proximity are more likely to lead to more cooperation with local economy. On the other hand, in other countries the productivity advantage of EU firms has detrimental effects on local firms' productivity which is offset by greater sourcing of local inputs by MNCs from distant countries due to higher trade costs and motives of investments oriented to serve local markets and neighbouring countries.

Finally, perhaps the more interesting findings is related to forward linkages where in all countries except Hungary, the effects are statistically significant and economically larger than backward linkages shedding new light on the role of MNCs. This result may be driven by firms in the service sector which may explain insignificant findings in earlier studies investigating manufacturing firms only. It seems that overall forward spillovers follow a common pattern across countries, being negative in the Czech Republic and Estonia and positive in Slovakia and Slovenia. This is also confirmed when considering differences in ownership characteristics of foreign firms where the positive effects in Slovakia and Slovenia are driven by both fully and partially foreign owned firms while in Czech Republic and Hungary the opposite effects are observed.

However, when considering geographic heterogeneity, the effects are less clear cut. It seems that EU investments have a positive and significant effect in all countries except Estonia. On the other hand, non-EU investments exhibit negative effects on productivity of local firms in downstream industries possibly due to their orientation towards supplying third countries in the EU trading bloc. Hence, potential for forward spillovers may be limited. The magnitude of negative effects from non-EU MNCs offset any positive effects in the Czech Republic and Estonia, thus contributing to total negative effects. The results for the Czech Republic, Hungary and Estonia in augmented models suggest the importance of disentangling linkages as the average effects of forward spillovers hide the important implications of MNCs' heterogeneity on productivity of local firms. Hence, governments should question their laissez-faire view that advocates inflow of FDI without paying close attention to heterogeneity of MNCs and the benefits they bring to local firms in different sectors.

Summarizing the empirical results from this chapter, we can identify several findings. First, there is large heterogeneity across countries and any further attempt to analyse the mechanism of FDI spillovers should take into account the country's specificities. Second, the MNC heterogeneity should also be taken into account as firm's ownership and origin have important implication for productivity spillovers. Third, forward spillovers are more likely to influence the net benefits or costs of the foreign presence in the local economy. Finally, local firms should continue to invest in building their human capital, innovation capital, scientific and creative property and organizational capital incorporated in the firms' intangible assets as these are found to be important determinants of productivity.

CHAPTER 6. THE IMPACT OF SERVICES FDI ON PRODUCTIVITY OF DOWNSTREAM MANUFACTURING FIRMS

6.1 INTRODUCTION

Motivated by recent theoretical modelling suggesting differential effects of FDI arising from heterogeneity within and across MNCs, previous chapter focused on examining productivity spillovers in manufacturing and service sectors combined. Given the inherent differences between these two sectors arising from type of products and services offered, entry barriers, productivity levels of both domestic and foreign firms, mode of entry, motives and strategies of MNCs, this chapter aims to shed more light on the effects of services and manufacturing FDI on productivity of local firms in these two sectors.

It is shown that productivity differences across countries can be largely attributed to differences in services productivity (Bosworth and Triplett, 2003; Inklaar et al., 2008; Maroto and Rubalacaba, 2008). Recent liberalisation of services due to improvements in ICT, decreasing entry barriers and deregulation has fostered not only domestic competition but also entry of foreign firms with the aim to benefit from increased market opportunities arising from underdeveloped service sector in transition countries. The large share of service sector in employment and value added increased the need to raise the efficiency, improve availability and variety of services inputs. Better services also contribute to manufacturing competitiveness through reduction in costs and improvements in manufacturer's ability to differentiate from competitors. Nordas and Kim (2013) argue that removing restrictions on FDI in services leads to more differentiated products for which consumers are willing to pay a premium and enables manufacturers to obtain higher export prices in sectors with comparative advantages.

As witnessed by industry level data in Chapter 3 and firm level data in Chapter 4, main recipients of FDI have been services, a trend which is common to majority of middle and high income countries. Therefore, the aim of this chapter is to investigate inter-industry linkages beyond those occurring within manufacturing sector. Although a bulk of empirical work investigated the effects of vertical linkages with domestic firms and externalities associated with MNC entry, little empirical work was done incorporating MNCs in services. The area of investigation includes total spillovers accruing to domestic firms in manufacturing and service sectors. Furthermore, the effects of vertical linkages resulting from MNC operating in manufacturing and service sector on local firms' productivity in manufacturing sector is investigated in order to shed more light on the customer supplier relationship between domestic and foreign firms in two main sectors of economy.

Previous work has focused on services forward linkages with the rationale that entry of MNCs in service sector provides more variety, better quality and reduced prices of intermediate inputs, thus enabling domestic firms to upgrade their technological capabilities resulting in increased TFP. This chapter adds and expands on existing work investigating the effects of services liberalisation on both upstream and downstream manufacturing firms by examining four possible channels of vertical linkages simultaneously. In addition, we examine whether the scope and scale of FDI spillovers depends on firms' absorptive capacity.

The reminder of chapter is structured as follows. Section 6.2 presents conceptual framework and empirical evidence related to the role of services in economy and their interrelationship with manufacturing sector. Section 6.3 describes the data used to construct manufacturing and services vertical linkages and explains the methodology adopted for empirical investigation and how the possible endogeneity of FDI is dealt with. Section 6.4 discusses the findings for baseline and augmented models applied to manufacturing sector and the role of absorptive capacity. Finally, section 6.5 concludes.

6.2 CONCEPTUAL FRAMEWORK AND RELATED RESEARCH

The previous chapter emphasized the limitation of existing studies examining the FDI spillovers in transition economies which focused mainly on homogenous effects of foreign firms within manufacturing sector. Recent research has started to include vertical linkages and horizontal spillovers simultaneously, but they only refer to manufacturing sector (e.g. Javorcik, 2004a; Nicolini and Resmini, 2010; Damijan et al., 2013). Despite the increases in FDI in services, which now account for almost 65 per cent of total worldwide FDI inward stock (UNCTAD, 2014), and development of corresponding theoretical literature on the importance of linkages between services and manufacturing sectors and their effects on productivity and exports, empirical literature is scarce. Even scarcer is the literature on the effects of FDI spillovers on service sector TFP or the impact of services MNCs on productivity of downstream manufacturing firms. Given the large inflows of foreign investment in services in transition countries, it is important to separately examine the impact of MNC's entry in services and manufacturing sectors on productivity of manufacturing firms. This will shed new light on the effects of vertical linkages on local firms.

6.2.1 THE IMPORTANCE OF SERVICE SECTOR AND IMPLICATIONS FOR MNC'S ENTRY

The rising importance of service sector can be attributed to two main factors. First, rise in income per capita increases the demand for more elastic final goods and thus increases the need to shift resources into the sector explaining the rise in services employment (Clark, 1940; Fourastie, 1949). In addition, Raa and Wolff (2001) and Fixler and Siegel (1999) argue that shift to services is caused by structural changes in the economy which moves the demand curve for services outward. They explain this by increased outsourcing of manufacturing activities to the providers of specialist external services and increased female participation in the labour market, hence increasing the demand for services which were previously produced and consumed within household.

On the other hand, Baumol and Bowen (1966) and Baumol (1967) argued that increase in share of final or consumer services in total output is the result of productivity gap between two main sectors of the economy. Therefore, this shift would have detrimental effects on aggregate productivity growth as services are less productive and less technologically advanced. The increased share of services on current price basis is thus the result of fall in relative prices of manufacturing and increased costs and prices in stagnant sectors which rise by magnitude of productivity differential. However, the major critique to Baumol is his focus on consumer services while ignoring the importance of producer services (Katouzian, 1970; Francois, 1990a).

This leads to second factor emphasized by Oulton (2001). He pointed out that not all services are demanded for final consumption. Therefore, as long as some services are an important source of intermediate inputs to other industries and their productivity is positive the shift to services can increase overall productivity. Wolfl (2003) emphasized several channels through which increased share of producer services can contribute to overall growth and productivity. The first one is related to outsourcing of certain activities previously performed within manufacturing firms' boundary which increases the productivity of the latter. Second, the rise of producer services can help realize economies of scale in those activities. Lastly, increased demand for intermediate services also spurs new entry and competition, leading to increased productivity. In addition, urban and regional economics has recognized the importance of producer services for downstream users as an important source of agglomeration externalities (Greenfield, 1966; Jacobs, 1969; Chinitz 1961; Vernon 1960; Stanback, 1979). Recently, new economic geography literature emphasized the role of agglomeration externalities as a source of differences in economic performance across regions (Krugman, 1991a; Fujita et al., 1999). As argued by Markusen et al. (2005) the source of such externalities are producer services since the lack of tradability and higher costs due to imports from distant markets create disadvantages for its users.

However, second unbundling has reduced the relative production, transport, trade and coordination costs enabling the service sector to increase its share in overall economic output and trade acting as a main impetus to structural changes within and across economies (Baldwin, 2012). Even before the full impact of information technology on services trade, Bhagwati (1984) argued that trade in services will expand as there is an incentive to "splinter" the value chain geographically. The advances in information and communication technology (ICT) allowed slicing up the value chain into different stages where functions became more geographically and organizationally dispersed (Nordas and Kim, 2013). The advances in ICT industry have enabled the reduction of coordination costs leading to outsourcing and offshoring of services which are no longer produced in house (Amiti and Wei, 2005). As a consequence, trade in intermediate goods and services has gained momentum and now surpass the trade in final goods. Furthermore, if trade is measured as value which is added by processing imported components into final goods for export, the share of global services trade rises to almost 50 per cent (Francois and Hoekman, 2010). This further increases if one accounts for sales of OECD foreign subsidiaries which were estimated at $1.5 trillion (WTO, 2008). The expansion of outsourcing and offshoring activities led to emergence of services MNCs which provide organisational, managerial and information processing/analysis skills and knowledge (Miozzo and Grimshaw, 2008).

Second, unbundling has enabled MNCs to bring services into international markets and to specialize in more upstream (R&D and design) and downstream (marketing and after sale service) activities while shifting low value added activities to low cost locations. Although improvements in ICT suggest that proximity and geographical concentration no longer matter, knowledge intensive business services (KBIS) heavily rely on tacit or combination of codified and tacit knowledge, high complementarity of in house knowledge base and frequent interaction between services provider and manufacturing firms (Landry et al., 2012). Therefore, it is expected that nature of KIBS requires physical presence of MNCs in host country. In general, services often have an element of *"jointness in production"* suggesting that other services are also needed in order for trade to occur (Francois and Hoekman, 2010).

The reason for this is the nature of services which are characterised by intangibility, inseparability, heterogeneity, ownership, perishability. Also, their exchange requires the proximity of supplier and customer (Rodriguez and Nieto, 2012). The proximity burden was the main factor inhibiting the exchange of services (Christen and Francois, 2009). In theoretical model of Brainard (1993) discussed in Chapter 1, firms face *"proximity concentration trade-off"* between fixed costs related to outward FDI and transportation costs related to exports. In subsequent extension by Helpman et al. (2004) the model predicts a pecking order of firms' international activity where the most productive firms will decide to engage in OFDI as they are able to overcome fixed costs of setting up a new production facility while less productive firms will export or serve to home market. Bhattacharya et al. (2010) note that in a world with tradable services, Helpman et al's model differ in two key aspects. First, transportation costs are irrelevant for services offshoring as long as they are not higher than set up costs abroad. Second, the characteristics of services mentioned above create uncertainty about the true quality of services provided. This uncertainty dimension creates incentives for OFDI, while the lack of transportation costs discourages it. Furthermore, services are difficult to export since they are non-storable and require interaction between provider and customer. The consequence of this is that a large bulk of trade in services is carried out via FDI which is also acknowledged in Article I:2 of the General Agreement on Trade in Services (GATS) where mode 3 is related to *"commercial presence",* whereby the service is rendered by a foreign subsidiary (Kelle et al, 2012).[64]

[64] Other three modes are: 1. "Cross border trade" where services is produced at home and delivered to a foreign country through ICT; 2. "Consumption abroad" where foreign customers travel to home country to consume the services; 3. "Temporary movement of natural persons" where employee of home country temporarily travels abroad to provide a service to a foreign customer.

Until recently entry of MNCs in service sector was regarded to have less potential for provision of advanced technology, development of linkages or access to export markets in comparison to manufacturing. However, this perception has now changed. Services MNCs often bring both hard (equipment) and soft technology (expertise, marketing, organizational, management and information processing and other skills). They can also provide vital intermediate inputs to manufacturing and information about international markets (UNCTAD, 2004). Foreign firms in host countries are more skill intensive than those in manufacturing and rely less on labour cost difference between alternative locations. This has implications for technology transfer as services employ a larger share of local staff in high skilled occupations with better salaries, thus leading to potential spillovers through worker mobility. The example of such skills are specialised skills in risk management, management and marketing skills in banking and insurance industry. Furthermore, local service firms may adopt similar information and systems and electronic banking techniques leading to imitation effects (UNCTAD, 2004). Services MNCs can easily add supply capacity in complex, capital intensive services such as telecommunications, transport or utilities due to better access to finance and ability to manage complex systems.

However, increased presence of services MNCs can also lead to crowding out effects in certain industries such as hotel industry with entry of international hotel chains and retail industry due to better pricing structures, better access to finance, firm level economies of scale and negotiating power (UNCTAD, 2004). Since MNCs' entry in telecommunications industry and utilities was mostly motivated by privatisation in case that previous domestic suppliers do not satisfy quality requirements, foreign firms can resort to foreign supplier thus indirectly contribute to crowding out effect. In addition, the second unbundling enabled MNCs to increase the range of their strategic options and rank locations hierarchically depending on the character of global value chains (GVC) within which the multinational is embedded (Gereffi and Korzeniewicz, 1994) and availability of favourable local conditions in terms of cheap labour, infrastructure and institutional framework (Thomas, 1997). Furthermore, there is evidence that service MNCs are more "footloose" as investment in services is less capital intensive and involves lower sunk costs, creating weaker linkages with local firms (UNCTAD, 2004). As already discussed in Chapters 1 and 3 the emergence of GVCs has important implications for technological upgrading and productivity improvements of transition economies as it depends on successful integration into specific production stages of global or regional MNCs. So far, these countries have been involved in vertical specialization based on wage differences which enable them to restructure their industries, improve export performance and increase their productivity (Damijan et al., 2013b). However, as noted by Baldwin (2012) increasing internationalization and fragmentation of GVCs mean that MNCs can easily switch to other locations to benefit from favourable local conditions. Moreover, only specific know how of MNCs' headquarters has been transferred leading to technology lending not transfer which is more likely to have productivity enhancements properties in the long term.

6.2.2 INTERACTIONS BETWEEN SERVICES AND MANUFACTURING

The importance of services for manufacturing sector is manifold and has been extensively studied. The extent of services use depends on the competitive pressure and the need to increase efficiency, the availability of high quality services and the relative costs of in house provision of services against outsourcing or offshoring (Banga and Goldar, 2007). Guerrieri and Meliciani (2005) noted that application and use of new technology has contributed to increased complexity of manufacturing production and distribution. Therefore, increased role of producer services is attributed to coordination problems and the need for control of specialised operations within the firm (Greenfield, 1966; Miozzo and Soete, 2001). Similar arguments are put forward by Jones and Kierzkowski (1990) and Francois (1990a) who noted that demand for employees in producer services increases with changes in specialization and scale of production in order to ensure better functioning of specialized and interdependent operations.

Services are also direct inputs into economic activities, and determine the productivity of factors of production (Hoekman and Mattoo, 2008). For example, Antonelli (1998) found that output elasticities of business services have comparable values to more traditional inputs and conclude that services are the engine of competencies and knowledge accumulation. Similar results are found in Drejer (2002) and Crespi (2007). Melvin (1989) emphasized the role of producer services as input to manufacturing as some services facilitate transactions through space (transport and telecommunications) and time (financial services).

More recently, the focus shifted on the effects of services liberalization and deregulation and the benefits it can bring to manufacturing sector in terms of cost reduction, increased variety, availability and better quality of inputs. Horn and Wolinsky (1988) explored the role of entry barriers in upstream sector and concluded that input prices are often determined in bargaining between suppliers and customers. Therefore, downstream firms may be locked in bilateral monopoly relations with providers. They showed that increased competition leads to lower input prices. Recently, Barone and Cingano (2011) develop a simple framework relating services regulation to the costs of production of downstream firms. They showed that the share of services inputs whose price is determined under perfect competition increases while opposite holds in the case where the price is determined by a monopolist. The consequence of deregulation is the shift in equilibrium allocation of production and trade to those industries which use services more intensively. Bourles et al. (2013) highlighted two main channels through which lack of competition in service sector can have detrimental effects on manufacturing users. First, imperfect competition in upstream sectors incurs costs for new manufacturing firms downstream as search for intermediate inputs is costly and time consuming, thus curbing new entry and firm growth. Second, the existence of regulation in upstream sectors can create a hold up problem. By increasing the market power of suppliers and curbing the incentives to improve efficiency in downstream sectors the latter is forced to share the rents with upstream supplier.

A related literature investigated the role of producer services and the presence of MNCs in service sector on downstream industry productivity. Markusen (1989) demonstrated that trade in producer services has more beneficial effects than trade in final goods only, due to the complementarity between domestic and foreign producer services. Francois (1990b) showed that costs and availability of producer services are important to realize the increasing returns due to specialization and that disintegration of production chain depends on the scale and supply of producer services. Liberalisation of trade in services either by trade or FDI can have significant productivity and growth effects and enable less developed countries to become a part of international production chain. Rivera-Batiz and Rivera-Batiz (1992) argued that FDI in the business service sector encourages specialization and increases the productivity of the downstream firms. Markusen et al. (2005) developed a theoretical model to quantitatively assess the impact of FDI liberalisation in services and argue that foreign producer services may act as a complement to domestic services. Furthermore, imported inputs may allow transition economies to obtain the inputs which are not available or require substantial time and resource to develop. As the entry of foreign firms increases the costs of intermediate inputs may decrease leading to better competitiveness of manufacturers.

Apart from increased competition, which results in input price reductions, FDI can lead to improvements in quality due to superior technology of MNCs (Mirodout, 2006). Knowledge intensive services provide input upon which manufacturing firms can increase their innovation and productivity (Kox and Rubalcaba, 2007). It has been found that producer services are important vehicles for transmission of knowledge spillovers and induce changes in production process resulting in increased productivity (ECSIP, 2014). Besides quantitative effects the development of producer services, particularity business services is also likely to stimulate the innovation capacity of their clients by enhancing their ability to design, develop and introduce new products and organizational models (Evangelista et al., 2013). Moreover, use of services, such as logistics, transport and wholesale and retail trade ease the flow of goods between different geographical locations. R&D improve the quality and technological content of products, financial services facilitate transaction within and across borders while telecommunications and reliable electricity are crucial for modern use of capital equipment and software (Nordås, 2010). Transactions costs associated with the operation of financial markets and the enforcement of contracts are greatly reduced with developed business services such as accounting, engineering, consulting and legal service (Hoekman and Mattoo, 2008).

Availability of financial instruments, transport and telecommunication services are necessary for productivity improvement of manufacturing firms as they increase access to finance, limit disruption in production, reduce costs and make provision of service more reliable (Arnold et al., 2011; Fernandes and Paunov, 2012). This is especially relevant for transition countries in which business services played a minor role before liberalization. The increasing variety and availability of services enable firms to exploit international division of labour and benefit from splitting production in low cost locations. This is also supported by Ethier (1982) who theoretically showed that greater variety of services is beneficial for downstream manufacturing productivity. FDI can therefore bring new and technologically advanced services and may induce domestic provider to increase their quality.

Lastly, the productivity potential of services and manufacturing interactions is dependent on information asymmetries between services provider and users. This warrants the increased presence of MNCs in services sector. Markusen (1989) specifically focused on producer services and argued that they are knowledge intensive and differentiated and therefore require a big initial investment and existence of scale economies. This knowledge intensity creates an impediment to cross border trade as local customer has difficulties to assess their quality. Similarly, Raff and von der Ruhr (2007) developed a model where they test information asymmetries between foreign provider and local customer in terms of quality of services. They argue that since provision of services often includes experience their provision entails moral hazard problem where foreign providers misrepresent the quality of their products to capture the higher prices. Recognizing the problem, local firms continue to purchase lower quality services from local providers. They show that the information barrier is likely to be overcomed when there is a significant presence of downstream foreign firms using MNC's inputs from foreign services provider since the former are more familiar with the quality of inputs. This creates incentives for foreign services provider to deliver high quality inputs and increases the likelihood that local customers will also start buying foreign services inputs. This may have implications on the occurrence of spillovers from services FDI as the quality of services is difficult to measure and it is often more suited for downstream foreign firms. Only with the passage of time local firms may start to recognize the quality and use foreign inputs more intensively or foreign firms may become more responsive to local needs.

6.2.3 REVIEW OF EMPIRICAL LITERATURE

The existing empirical work investigating service sector and its impact on firm performance is relatively scarce and started to emerge only recently due to increased availability of databases including services companies. One strand of literature is related to the process of servitization where manufacturing firms shift into production and sale of services with the aim to increase productivity and move up the value chain. The major impetus to such process is increased import competition and the process of offshoring which enabled manufacturer to move some of their tasks abroad to benefit from cheap labour. The empirical evidence largely confirms the increased use of services in manufacturing production in both developed and developing countries (e.g. Pilat and Wolfl, 2005; Nordas, 2010; Neely et al., 2011; Falk and Peng, 2012; Fernandes and Paunov, 2012; USITC, 2013). Similarly, studies investigating the role of services export in manufacturing found an increasing share of services such as in the export of R&D and engineering services (Kelle, 2013). Crozet and Miller (2014) found increasing share of services in production sales of French manufacturing firms. The authors mainly attribute the trend to within-firm increases in sales of services although the entry and exit of firms also contributes.

Another strand of empirical literature which is more closely related to our objective is the role of services and FDI liberalisation and its effect on downstream manufacturing productivity. On macro level, Eschenbach and Hoelkman (2006) utilizing EBRD indicators of progress in banking, non-bank financial services and infrastructure liberalization investigated the impact of changes in services policy on economic performance for a sample of 20 transition economies. They found that changes in policies towards services liberalisation are strongly correlated with FDI and that measures of services policy reform are statistically significant explanatory variables for the post-1990 economic performance of the transition economies in the sample. Fernandes (2009) found that liberalization of services in transition countries had a positive and significant effect on labour productivity growth for most services subsectors. However, the author found large disparities across countries and sectors. The effects were stronger for countries joining the EU in 2004 and for the ICT sector. Finally, they found a positive and significant effect of service liberalisation in finance and infrastructure on downstream manufacturing productivity. Camacho and Rodriguez (2007) looked at the effects of Knowledge Intensive Services (KIS) on 11 EU-15 countries and found in general positive impact on productivity, although there are important differences across countries and time.

Studies based on firm level data are relatively scarce and only few of them are related to transition countries. Arnold et al. (2011) analysed the impact of privatization, services liberalization, FDI penetration and the extent of competition in services industry in the Czech Republic and found a strong positive association between liberalization in services industries and performance of Czech firms in downstream manufacturing. They found that FDI in services is a key channel, which affects productivity of manufacturing firms through increased availability, quality and range of services inputs. In related research using enterprise survey data from over 1,000 firms in 10 sub-Saharan African economies, Arnold et al. (2008) also found a statistically significant positive relationship between firm productivity and the performance of three service input industries (access to communications, electricity and financial services). Similarly, Fernades and Paunov (2012) using firm level data from Chile find that forward linkages from FDI in services to downstream manufacturing industries had increased the productivity of Chilean manufacturing firms by five percent. The novelty of their approach is the use of plant level time varying intensity of services usage as weight for FDI penetration. Recently, Arnold et al. (2015) found that services reforms in the telecommunications, insurance and transport sectors significantly increased productivity of manufacturing firms in India. The effect is stronger for foreign firms which experience a 7.5 percent increase in productivity for one standard deviation increase in aggregate index of service liberalisation. They also found an independent positive effect on productivity of overall FDI and foreign presence in banking and transport, but not for telecommunications.

Using data from over 40,000 firms in Ukraine over period 2001-2007, Shepotylo and Vakhitov (2015) analysed the impact of services liberalization on productivity. They find that one standard deviation increase in services liberalization, taken from EBRD indicators, leads to a 9 percent increase in TFP of Ukrainian manufacturing firms. The authors argue that such a large increase can be attributed to initially protected services sector. They also find that beneficial effect of services liberalisation is more pronounced for domestic and small firms. As an important methodological innovation, this study controls for market structure and demand shocks and also takes into account the dynamic effect of the liberalization on investment and exit decisions, and consequently on future productivity. Although their results may be plagued by endogeneity problem as services reform are often followed by other economic reforms or may be induced by increased manufacturing productivity authors argue that services liberalisation was exogenously imposed. This is also confirmed by Copenhagen Economics (2005) which argue that WTO accession explicitly demanded the liberalisation of services. Furthermore, they note that FDI liberalisation would have significant welfare gains and development stimulus to manufacturing sector.

Two papers which are closest to our empirical model and estimation are those by Klishchuk and Zelenyuk (2012) and Mariotti et al. (2013). The first uses data from EBRD transition indicators to examine the impact of services liberalisation on labour productivity in 21 transition countries. They use firm level data on 19,912 firms obtained from Orbis database. This is the first study that uses data from several countries using longitudinal data. Although Arnold et al. (2008) also used data from multiple countries they studied service sector performance as opposed to liberalisation and relied on enterprise surveys. Klishchuk and Zelenyuk found that firm TFP is positively related to services liberalisation of transportation services and negatively related to banking. Second paper by Mariotti et al. (2013) examined the impact of FDI in services on downstream manufacturing productivity using data from Italy. Their approach is different from other papers as they investigate the impact of services MNCs on both upstream and downstream manufacturing firms. Their results point out to both backward and forward linkage effects, the latter being the main channel for the transmission of knowledge to manufacturing firms. They also find that manufacturing suppliers benefit from increased demand in downstream sectors and customers from increased competition and absorptive capacity in upstream sectors.

6.3 EMPIRICAL STRATEGY

Following the discussion in previous section the baseline model from Chapter 5 is replicated and applied to manufacturing and service sectors separately. The reason for this is the expected heterogeneity of both foreign and domestic firms arising from different productivity levels, nature of linkages and type of knowledge transferred to local firms, motives and strategic objectives of investment. Despite increasing importance of services in overall economic output and international trade, policy makers do not yet have a clear understanding of potential benefits or costs of services FDI. For example, Inklaar et al. (2008) found that cross country differences in aggregate productivity levels and growth are entirely attributable to service sector. They found that TFP in services is a key element explaining cross country differences. Given that a bulk of international trade in services is still occurring through Mode 3 (Lejour and Smith, 2008), that is via commercial presence of foreign firms in host country it is of interest to investigate linkages and knowledge spillovers to local firms in service sector. The divergent productivity dynamics between manufacturing and service sector could be better explained by exploring the effects of FDI spillovers comparatively. Therefore, this chapter will add to the literature by examining the effects of FDI spillovers separately for manufacturing and services firms.

In addition, only few studies disentangle vertical linkages according to industry source. To the best of our knowledge most studies investigate backward and forward linkages within manufacturing sector (Javorcik, 2004a; Blalock and Gertler, 2009; Nicolini and Resmini, 2010). However, recent liberalisation of services in transition countries characterised by second wave of privatisation of large companies in banking and telecommunications industry, subsequent greenfield investments and foreign acquisitions in other service sectors provide an opportunity to investigate inter-industry linkages. Previous studies focused only on either forward services spillovers (Miozzo and Grimshaw, 2008; Arnold et al., 2011; Fernandes and Paunov, 2012), backward services spillovers (Javorcik and Li, 2013) or their combined effects (Mariotti et al., 2013) on manufacturing firms' productivity. We take a somewhat different approach and investigate the impact of MNC's entry in service and manufacturing sector on productivity of local manufacturing firms which are at the same time supplier and customer of foreign firms. In addition, the analysis is conducted on several countries thus providing a comparative view of the effects of FDI spillovers arising from different sectors.

6.3.1 EMPIRICAL MODEL AND METHODOLOGY

As in Chapter 5 we start our analysis by employing the baseline model which in this case is applied separately to manufacturing and services firms. Empirical model has the following form:

$$\boldsymbol{ln\,TFP_{it} = \beta_0 + \rho\; ln\left(TFP_{i,t-1}\right) + \delta_1 HS_{jt} + \varphi_2 VT_{jt} + \theta_3 AC_{it} + \sigma_4 IT_{jt} + \gamma_j + \gamma_r + \gamma_t} + \varepsilon_{ijt} \qquad \textbf{(6.1)}$$

where TFP is total factor productivity of firm *i* in industry *j* at time *t*, which is estimated in Chapter 4 using Wooldridge estimator adapted by Petrin et al. (2011) and Petrin and

Levinsohn (2012). As in the previous chapter, HS_{jt} and VT_{jt} stand for horizontal spillovers and vertical linkages respectively defined at the industry level; AC_{it} includes firm level determinants of TFP, namely human capital, intangible assets, size and age and their squared terms. Vector IT_{jt} controls for industry competition and demand effects. Finally $\gamma_j, \gamma_r, \gamma_t$ denote industry, region and time dummies to control for any unobserved effects such as economy wide technological progress, changes in specialisation of certain industries or changes in their market and agglomeration economies.

In order to examine the link between FDI in service sector and downstream manufacturing productivity we need information on linkages between different sectors of economy. Since Amadeus database does not provide information on individual firms' reliance on services inputs our services FDI linkage draws upon measures based on input output coefficients obtained from WIOD database that is discussed in the previous chapter. This approach is applied in several papers (Arnold et al., 2011, Mariotti et al., 2013) and provides information about the average inter industry sourcing behaviour of firms within a sector. As already emphasized in the previous chapter some precision is lost when using input output coefficients. However, using data on firm level sourcing behaviour would lead to endogeneity as significant use of services inputs may be correlated with firm performance (Arnold et al., 2015). An additional advantage of time varying IO table is the ability to capture the sourcing behaviour of manufacturing and service industries over time as the process of outsourcing and offshoring as well as splintering the value chain has increased dramatically reflecting the ability and incentives of firms to benefit from favourable conditions across different geographical regions (Baldwin and Lopez-Gonzalez, 2014).

Since FDI in services can be regarded as outcome of policy reforms and some services are more important for manufacturing it is necessary to properly measure the intensity of which services inputs are used by manufacturing sector. Therefore, information on inter-industry sourcing from WIOD database are combined with information on sales of foreign firms in each sector obtained from Amadeus database. Similar reasoning applies to the intensity of manufacturing inputs used by service industry which are constructed in a similar fashion. In summary, total backward and total forward linkages that are applied to manufacturing and service sectors separately in the baseline model are disentangled to four types of vertical linkages (manufacturing backward/forward and services backward/forward). This allows us to assess the importance of MNCs' presence in manufacturing and service sectors on downstream manufacturing productivity.

Specifically, if sector k is the sector in which MNCs are present and sector j is the manufacturing sector, backward linkages from manufacturing and service sectors are calculated as follows:

$$Manufacturing\ Backward_{jt} = \sum_{k=1}^{K} \alpha_{jkt}\, Horz_t^{man} \quad (6.2)$$

$$Services\ Backward_{jt} = \sum_{k=1}^{K} \alpha_{jkt}\ Horz_t^{serv} \quad (6.3)$$

The coefficient α_{jk} measures the share of manufacturing sector j's output that is sold to downstream industry k and is reported in the rows of IO table. Variables $Horz_t^{man}$ and $Horz_t^{serv}$ measure the share of foreign firm's output in manufacturing and service industry respectively in time t, expressed as the share of foreign sales in total sales within an industry k.

Similarly, to quantify the intensity of exchanges between downstream manufacturing industries *(j)* and upstream service and manufacturing industries *(l)* where MNC is located we rely on technical coefficients obtained from the columns of IO tables. Thus, forward linkages arising from manufacturing and service sector are calculated as follows:

$$Manufacturing\ Forward_{jt} = \sum_{l=1}^{L} \gamma_{jlt}\ Horz_t^{man} \quad (6.4)$$

$$Services\ Forward_{jt} = \sum_{l=1}^{L} \gamma_{jlt}\ Horz_t^{serv} \quad (6.5)$$

The coefficient γ_{jlt} is the amount of inputs sourced from sector l, expressed as a fraction of the total inputs used by manufacturing sector j weighted by foreign firm's output in manufacturing ($Horz_t^{man}$) and service ($Horz_t^{serv}$) industry l in time t.

Our augmented empirical model allows us to simultaneously quantify the intensity of vertical linkages by distinguishing different channels of spillovers. The final augmented model investigating differential impact of manufacturing and services FDI on productivity of manufacturing firms has the following form:

$$\boldsymbol{ln\,TFP_{it} = \beta_0 + \rho\, ln\left(TFP_{ij,t-1}\right) + \delta_1 horizontal_{jt} + \delta_2 manufacturing\_backward_{jt} + \delta_3 manufacturing\_forward_{jt} + \delta_4 services\_backward_{jt} + \delta_5 services\_forward_{jt} + \theta_6 AC_{it} + \lambda_7 IT_{jt} + \gamma_j + \gamma_r + \gamma_t} + \varepsilon_{ijt} \qquad \textbf{(6.6)}$$

where ln TFP is the logarithm of total factor productivity of manufacturing firm i operating in manufacturing industry j at time t. Imitation and demonstration effects are captured within vector $horizontal_{jt}$ while vertical linkages arising from manufacturing and service sector are captured with above defined variables. As is the baseline model, firm level determinants of productivity are represented within AC_{it} vector, while vector IT_{jt} controls for industry concentration and demand effects. The measure of concentration is especially relevant for horizontal and forward spillovers as it is expected that increased entry of MNCs would lead to lower prices due to increased competition and increased efficiency of firms. To isolate the effects of increased competition and knowledge spillover or transfer, it is important to separate these two effects (Javorcik, 2004a). Demand variable on the other hand controls for increased demand in downstream sectors due to entry of MNCs. Since increased demand may induce scale economies which may be translated into higher TFP of local supplying firms, we need to control for market size.

As already explained in Chapter 5 since both the baseline and augmented model contain lagged dependent variable and FDI spillover variables and TFP are measured with errors we resort to system GMM estimation. Additional reasons for dynamic panel estimation are dynamic nature of TFP which in structural estimators based on proxy variables is assumed to evolve as first order Markov process, thus making static model of FDI spillovers currently employed in the literature misspecifed. An additional concern of augmented empirical model is potential endogeneity of FDI services linkage with respect to manufacturing productivity. As argued by Shepotylo and Vakhitov (2015) large and more productive manufacturing firms may lobby the government for liberalization of particular service subsectors leading to reverse causality. However, FDI regime in analysed countries was liberal before our sample period and as argued by Arnold et al.

(2011) policy reform was under tight supervision of EU Commission as a part of preparation for EU accession. Nevertheless, strong productivity growth of manufacturing firms may have attracted services MNCs due to strong demand. Also, there is ample empirical evidence that MNCs providing services are locating near major manufacturing locations, thus positive effects of FDI may simply reflect location decision of MNCs in certain industries or regions (Nefussi and Schwellnus, 2010; Meliciani and Savona, 2011; Castellani and Meliciani, 2014). The same reasoning applies to service sector itself where successful privatisation of financial industry and telecoms may have induced other MNCs to invest in certain location due to increased use of services by manufacturing firms. Given the above mentioned problems system GMM based on exploitation of internal instruments is thought to provide more efficient and unbiased estimates of FDI spillovers. The initial specifications included minimum number of lags, i.e. the number of instruments came from restriction to start with one lag for levels and differences in case of predetermined variable (ln TFP) and two lags for endogenous variables, namely FDI spillover variables (Roodman, 2009). However, in certain cases model diagnostics with minimum number of lags were not satisfied and therefore the instrumentation matrix included higher order lags (three or four) of the regressors as instruments.

6.3.2 DATA

The empirical analysis is based on Amadeus and WIOD databases described in Chapters 4 and 5. Since the baseline model in Chapter 5 is estimated using firm level data from both manufacturing and service sector we continue along the same line in order to provide a comparative view of the effects of FDI spillovers on local firms in manufacturing and service sector. Therefore, the data applied to the models defined in Section 6.3.1 pertain to 23 manufacturing and 20 service sector. However, due to low number of observations in some industries WIOD industry classification is applied which groups 2-digit industries producing similar goods or providing a similar service based on NACE Rev 1.1 classification.[65] The same grouping is applied in the previous chapters in estimation of TFP and construction of vertical linkages, thus resulting in 14

[65] NACE Rev 1.1 is used as input output tables are constructed using this classification.

manufacturing sectors and 13 service sectors. Namely, the presence of foreign firms in service sector focus on the following broad NACE Rev 1.1. 2 digit categories:

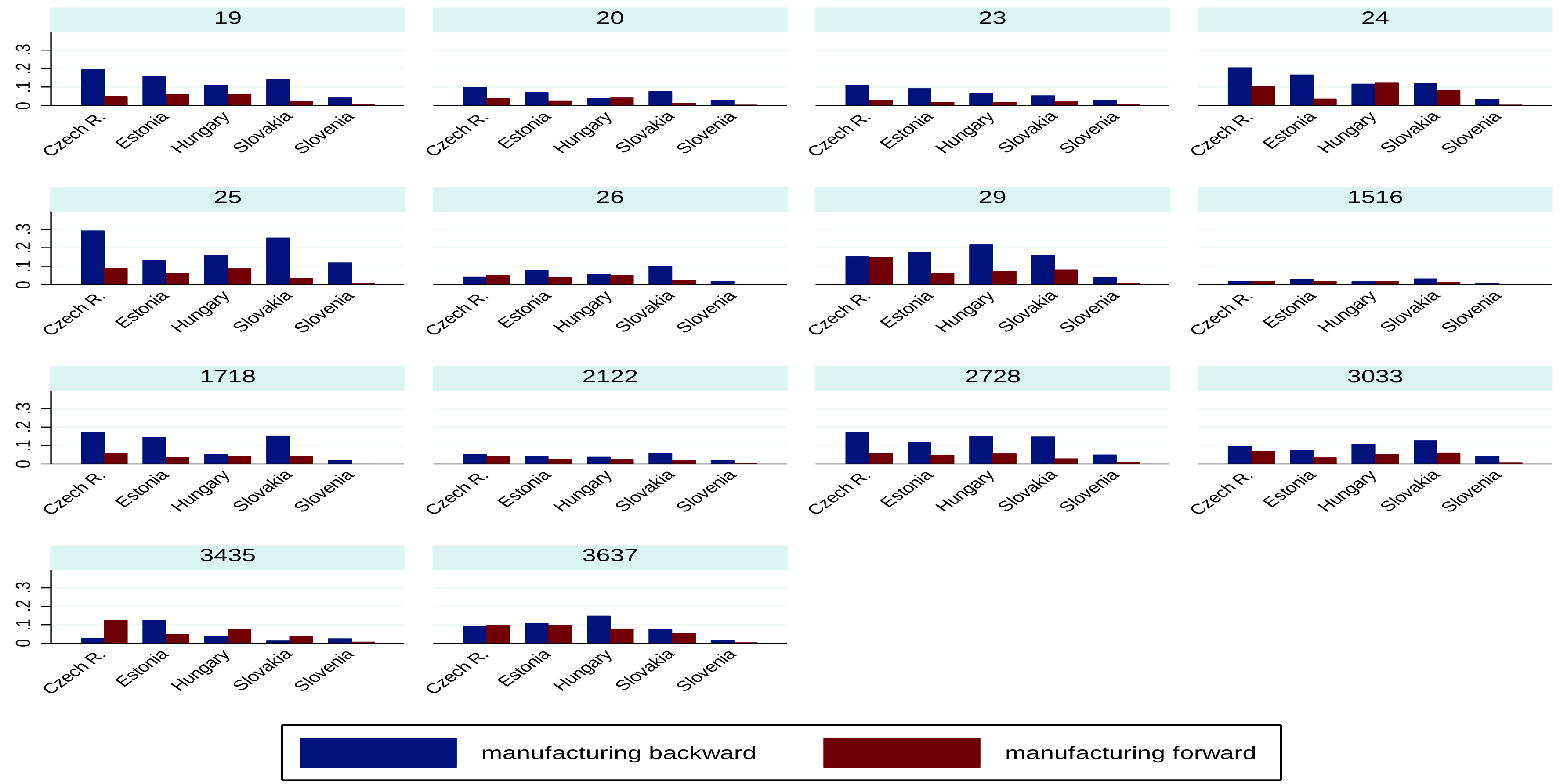
- Electricity, gas and water supply (NACE 1.1-E)
- Construction (NACE 1.1-F)
- Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods (NACE 1.1-G)
- Hotels and restaurants (NACE 1.1-H)
- Transport, storage and communication (NACE 1.1-I)
- Financial intermediation (NACE 1.1-J)
- Real estate, renting and business activities (NACE 1.1-K)

The data period under investigation is the same as in previous chapters and covers period 2002-2010. In order to shed more light on the intensity of vertical linkages, Figures 6.1 and 6.2 provide mean values of manufacturing and service linkages within manufacturing sector. A closer look at Figure 6.1 reveals that foreign firm presence in manufacturing of rubber and plastics (25) provide the strongest potential for manufacturing backward linkages followed by manufacture of machinery and equipment (29), manufacture of metals and fabricated metals (27_28) and leather related products (19). On the other hand, as expected forward manufacturing linkages provide a lower potential for spillover development in almost all industries. The highest forward linkages are evident in manufacture of machinery and equipment (29), chemical products (24) and other manufacturing industries (36_37). Regardin the countries, suppliers and customers of foreign firms within manufacturing sector in the Czech Republic, Hungary and Slovakia are more likely to benefit from manufacturing backward and forward linkages. Given that these countries experienced a higher productivity growth in comparison to growth in unit labour costs (ESCIP, 2014) they were able to attract significant amount of FDI and enter MNCs' production networks.

Similarly, Figure 6.2 provide information on services linkages. It seems that manufacturing suppliers in coke, refined petroleum and nuclear fuel industry (23) and paper, publishing and printing industry (21_22) are more likely to benefit from supplying downstream services firms over the analysed period. Similar conclusion can be made for suppliers in other non-metallic mineral industry (26) and electrical and optical equipment industry (30_33). Turning to forward services linkages we can notice the relatively high share of services inputs, partially reflecting the increased manufacturing specialization of analysed countries (ESCIP, 2014). This is especially the case in the Czech Republic, Slovakia and Hungary where high quality inputs are necessary to increase the quality of export goods and in Estonia where increased specialisation in service sector contributed to large productivity gains in business services and manufacturing productivity (ESCIP, 2014).

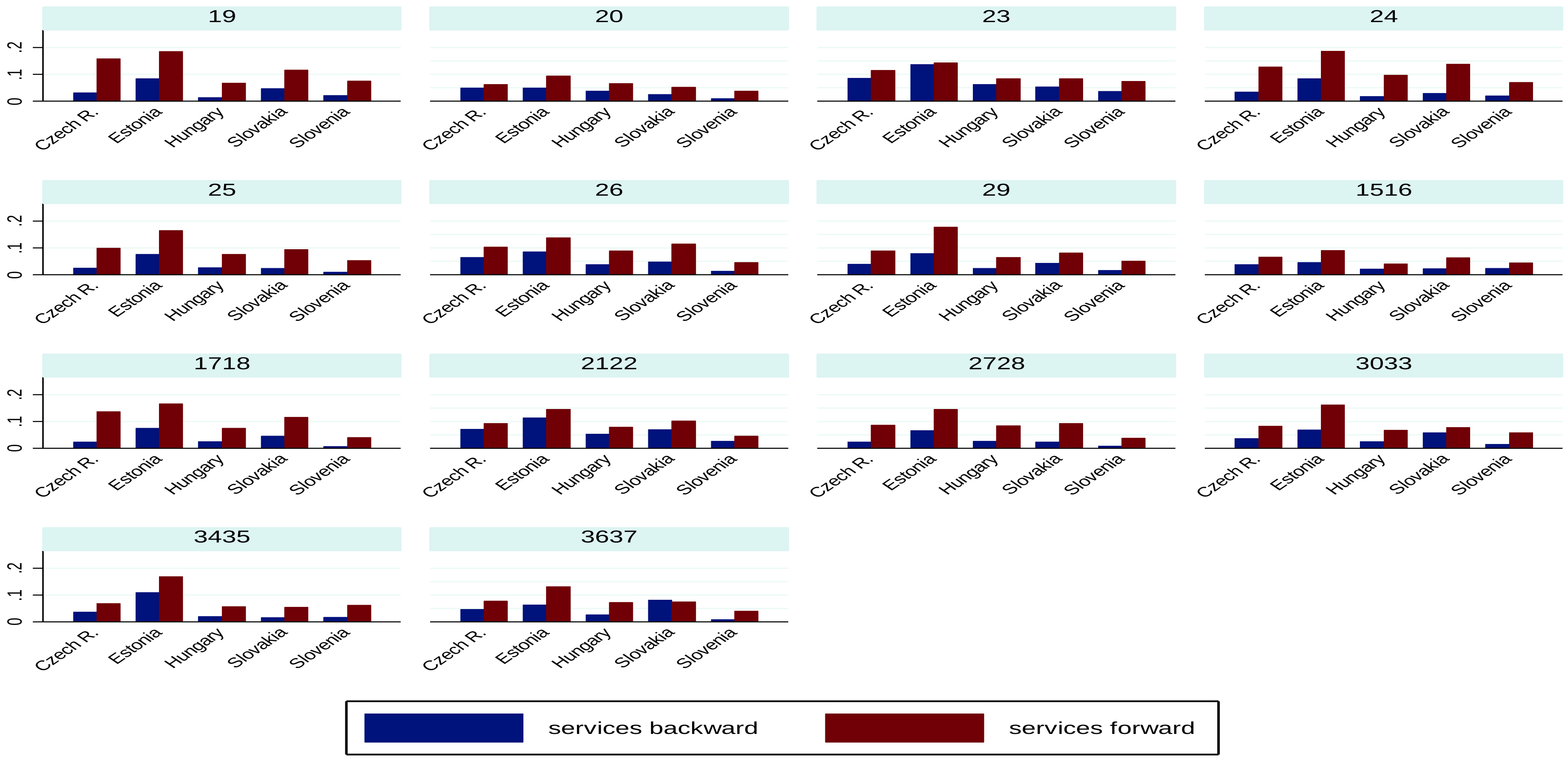
The increased reliance of manufacturing industries on services inputs also reflects the rising share of foreign output in services which increased from 8 per cent in 2002 to 30 per cent in 2010 on average (Appendix IV, Figure IV.1). The largest increase can be observed in Slovakia where the share of foreign output increased from only 12 per cent in year 2002 to over 33 per cent in 2010. The service sector in the Czech Republic (20 to 40 per cent) and Slovenia (4 to 25 per cent) was also characterised by large increase in foreign output. During the same time period, the average share of foreign services inputs rose from 4 per cent to 17 per cent due to strong increase in recent years partially reflecting better coverage of firms in the database (Appendix IV, Figure IV.2). The largest increase was evident in Slovakia and Estonia, where the share increased by 16 and 20 percentage point, respectively. A more detailed analysis across industries and countries provided in Figure 6.2 illustrates that manufacturing industries in Estonia are most reliant on foreign services inputs followed by Slovakia and the Czech Republic. However, our measure of direct cost share of services in manufacturing total costs measured using technical coefficients from IO tables is somewhat imperfect as some services such as telecommunications may capture relatively small share of total cost, but are very important for normal functioning of business. Industries with highest usage of foreign services inputs are chemical industry (24), leather and leather products (19) and textile and textile products (17_18) closely followed by other manufacturing industries. Thus, these figures illustrate the increasing relevance of services FDI and diverse impact of foreign firms in manufacturing industries in our sample, and thereby provide a compelling motivation to investigate separately the impact of services and manufacturing FDI linkages on the performance of manufacturing firms.

FIGURE 6.1 MANUFACTURING LINKAGES ACROSS INDUSTRIES AND COUNTRIES



Note: Industry codes correspond to industry classification in WIOD database and are based on 2-digit NACE Rev. 1.1 group

FIGURE 6.2 SERVICES LINKAGES ACROSS INDUSTRIES AND COUNTRIES



Note: Industry codes correspond to industry classification in WIOD database and are based on 2-digit NACE Rev. 1.1 group

Before turning to explanation of results, a brief comment on the model diagnostics is made. As System GMM relies on internal instruments to deal with possible endogeneity, Hansen J test together with autocorrelation test is reported in the model diagnostics (Table 6-1). Further diagnostics tests for all models along with the syntax for each are enclosed in Appendix IV (Tables IV.1-IV.10). As shown below, in both baseline models used to estimate FDI spillovers in manufacturing and service sector, overall Hansen test cannot be rejected providing confidence that employed instruments are valid. In all models the p-values are always larger than the 0.25 threshold that was proposed by Roodman (2009), except for service sector in Slovakia. Even it that case Hansen test cannot be rejected at 10 per cent significance level. The null hypothesis of no second order autocorrelation in the error term of differenced equation is rejected only in the case of Estonia for baseline model applied to services. We tried to increase the lag order of the lagged dependent variable or even add a second lag of dependent variables on the right hand side of the model, but the diagnostics did not improve.[66] However, the sign and significance of coefficients remain robust across different specifications, though some caution is still warranted when interpreting the results.

Next important step is to check for steady state assumption. Difference in Hansen test for levels equation does not provide sufficient evidence to reject the null hypothesis, therefore we can conclude that system GMM is preferred estimator. Time dummies are included to control for time universal shocks such as financial crisis, which is expected to affect productivity levels. However, as argued by Sarafidis et al. (2009) some cross sectional dependence may still remain, therefore we also use difference in Hansen test to test the validity of instruments for lagged dependent variable. The difference in Hansen test for lagged dependent variable cannot be rejected at conventional level of significance in most models. Some concerns can be raised in the case of Slovakia where both difference in Hansen test for levels equation and for lagged dependent variable in services model are rejected at 10 per cent significance. However, overall Hansen test,

[66] In the case of the Czech Republic and Slovenia, inclusion of second lag of dependent variable on the right hand side improved the model diagnostics.

autocorrelation tests and difference in Hansen test for endogenous variables are satisfied, thus supporting our specification. Finally, the estimated coefficient of lagged dependent variable is compared to those obtained by OLS which is known to be upward biased and fixed effects which provides a lower bound of estimated coefficient. In all models the coefficient of lagged dependent variable lies between lower and upper bound providing sufficient evidence that system GMM estimator is a true dynamic estimator.

6.4.1 RESULTS OF BASELINE MODEL ACROSS SECTORS

Table 6.1 presents the results for both manufacturing and service sectors to allow for an easier comparison. Starting with the lagged dependent variable (TFP), we can see that in all models there exist a partial adjustment to the desired level of productivity. On average, across countries a one per cent increase in past productivity leads to 0.42 per cent increase in current productivity in manufacturing sector and 0.55 per cent increase in service sector. This implies that past determinants of productivity have positive and significant effects on their current levels.

Turning to our main variables of interest, we start by examining the effects of horizontal spillovers. The latter are negative and significant across manufacturing sector, with the exception of Slovenia, which points to a possible crowding out effect of foreign firms within the industry. This is in line with meta regression results investigating indirect effects of FDI in transition countries (Iwasaki and Tokunaga, 2014). Additionally, as found by Smeets and de Vaal (2015) stronger intellectual property rights will reduce positive knowledge spillovers and enhance negative competition effects by increasing MNCs' competitive position. Negative horizontal spillovers are even stronger in the long run suggesting inability of local firms to learn (see Appendix IV, Tables IV.1-IV.5). These results imply that local firms are not able to increase the efficiency to cope with increased competition. The negative effect on local firms' productivity in the short run range from 0.40 per cent in Slovakia to 1.77 per cent in Estonia for every percentage point increase in foreign firms' output in the same industry. On the other hand, in service sector the presence of foreign firms has positive effects evident in the case of the Czech Republic, Hungary and Estonia. However, the effect is not significant in the latter case. The results are similar to Ayyagari and Kosova (2010) investigating the impact of FDI spillovers across services and manufacturing on domestic firms' entry. As in manufacturing sector, long run positive effects are more pronounced and lead to an increase in TFP of services firms by 2.09 and 2.86 per cent in Hungary and the Czech Republic, respectively (see Appendix IV, Tables IV.5-IV.10). There are several possible explanations of beneficial effects in services. First, our sample contain more firms in services. Second, as argued by Kugler (2006) firms in manufacturing have higher incentives to minimize technology leakage. Third, these results suggest that local firms are more likely to benefit from demonstration and imitation in service sectors due to inseparability of production and consumption and where methods of production are transferable (Gorodnichenko et al., 2014). In case of Slovakia and Slovenia, the results suggest that MNCs in service sector are putting competitive pressure on local firms which are not able to cope with better technology, managerial and organizational know how of foreign firms resulting in their reduced productivity. Furthermore, since entry of MNCs bring reduction in prices and increase the variety of services, previous monopoly rents are reduced, thus negatively affecting revenues and TFP. These negative effects range from 0.83 per cent in Slovenia to 1.77 per cent in Slovakia. Overall, these results suggest that total effects of horizontal spillovers estimated in the previous chapter are largely driven by the service sector thus shedding new light on the role of services FDI in respective economies.

TABLE 6.1 DYNAMIC PANEL SYSTEM GMM ESTIMATIONS OF FDI SPILLOVER EFFECTS ON PRODUCTIVITY (LN TFP) OF DOMESTIC FIRMS (MANUFACTURING VS. SERVICES), 2002-2010

VARIABLES	**Czech Republic**		**Estonia**		**Hungary**		**Slovakia**		**Slovenia**	
	manufacturing	services	manufacturing	services	manufacturing	services	manufacturing	services	manufacturing	services
L.ln TFP	**0.393*** **	**0.410*** **	**0.345*** **	**0.590*** **	**0.547*** **	**0.486*** **	**0.381*** **	**0.325*** **	**0.443*** **	**0.601*** **
	(0.0219)	*(0.0144)*	*(0.109)*	*(0.0415)*	*(0.103)*	*(0.0821)*	*(0.0407)*	*(0.106)*	*(0.0591)*	*(0.0336)*
Horizontal	**-0.671*** **	**1.690*** **	**-1.774** **	**0.160**	**-1.145*** **	**1.075* **	**-0.401** **	**-1.771*** **	**1.948** **	**-0.833*** **
	(0.186)	*(0.215)*	*(0.834)*	*(0.320)*	*(0.388)*	*(0.594)*	*(0.179)*	*(0.258)*	*(0.945)*	*(0.311)*
Backward	**-0.276**	**-0.774*** **	**-1.936** **	**-0.350*** **	**-2.414*** **	**1.565** **	**0.874**	**0.758*** **	**1.731* **	**-0.113**
	(0.371)	*(0.130)*	*(0.882)*	*(0.121)*	*(0.854)*	*(0.624)*	*(0.819)*	*(0.120)*	*(0.898)*	*(0.144)*
Forward	**-2.792*** **	**-5.042*** **	**-1.374**	**-5.724*** **	**-2.037**	**-23.13*** **	**0.247**	**0.712* **	**0.763**	**4.985* **
	(0.623)	*(0.542)*	*(1.057)*	*(1.240)*	*(1.838)*	*(4.903)*	*(0.382)*	*(0.430)*	*(1.168)*	*(2.818)*
Ln Human capital	**0.478*** **	**0.414*** **	**0.420*** **	**0.308*** **	**0.311*** **	**0.328*** **	**0.339*** **	**0.347*** **	**0.517*** **	**0.296*** **
	(0.0140)	*(0.0101)*	*(0.0394)*	*(0.0148)*	*(0.0526)*	*(0.0385)*	*(0.0144)*	*(0.0244)*	*(0.0495)*	*(0.0278)*
Ln Intangibles	**0.0449*** **	**0.0526*** **	**0.101*** **	**0.0801*** **	**0.00956** **	**0.0103** **	**0.0608*** **	**0.103*** **	**0.0290*** **	**0.0186*** **
	(0.00256)	*(0.00224)*	*(0.0148)*	*(0.00385)*	*(0.00462)*	*(0.00441)*	*(0.00517)*	*(0.0118)*	*(0.00572)*	*(0.00322)*
Age	**-0.00915*** **	**-0.00977*** **	**-0.00167**	**-0.0126*** **	**-0.00725* **	**-0.0110*** **	**-0.00921*** **	**-0.0183*** **	**-0.0103*** **	**-0.00328* **
	(0.00147)	*(0.00155)*	*(0.00438)*	*(0.000968)*	*(0.00415)*	*(0.00249)*	*(0.00257)*	*(0.00234)*	*(0.00283)*	*(0.00198)*
Age^2	**8.05e-05** **	**3.38e-05**	**5.65e-05**	**0.000132*** **	**-1.59e-05**	**3.51e-05* **	**8.76e-05* **	**0.000337*** **	**4.50e-05**	**-3.75e-05**
	(3.98e-05)	*(6.16e-05)*	*(4.26e-05)*	*(1.04e-05)*	*(0.000132)*	*(1.81e-05)*	*(4.76e-05)*	*(4.46e-05)*	*(8.47e-05)*	*(6.59e-05)*
Ln Size	**0.213*** **	**0.209*** **	**0.638*** **	**0.169*** **	**0.0865**	**0.121**	**0.142*** **	**0.386*** **	**-0.0185**	**0.0906*** **
	(0.0182)	*(0.0173)*	*(0.147)*	*(0.0160)*	*(0.0601)*	*(0.0957)*	*(0.0315)*	*(0.0688)*	*(0.0607)*	*(0.0265)*
Ln Size^2	**-0.00446*** **	**-0.00627*** **	**-0.0457*** **	**-0.00307*** **	**0.000997**	**0.000660**	**-0.00244**	**-0.0158*** **	**0.00972** **	**-0.00259**
	(0.000929)	*(0.00117)*	*(0.0136)*	*(0.00111)*	*(0.00349)*	*(0.00574)*	*(0.00199)*	*(0.00335)*	*(0.00495)*	*(0.00167)*
HHI	**-0.191*** **	**-1.327*** **	**-3.524*** **	**0.489*** **	**-0.203* **	**-0.123**	**-0.0943**	**-0.306** **	**-0.135**	**0.0904**
	(0.0587)	*(0.237)*	*(1.298)*	*(0.157)*	*(0.114)*	*(0.193)*	*(0.109)*	*(0.144)*	*(0.153)*	*(0.130)*
Ln Demand	**-0.00930**	**0.198*** **	**0.0626**	**0.223*** **	**0.0925* **	**0.447* **	**-0.0115**	**-0.172*** **	**-0.0779**	**-0.0858**
	(0.0267)	*(0.0291)*	*(0.0694)*	*(0.0754)*	*(0.0530)*	*(0.232)*	*(0.0151)*	*(0.0333)*	*(0.178)*	*(0.308)*

Model diagnostics

No. of observations	29,263	68,628	11,451	54,743	2,499	4,411	8,140	22,350	3,584	6,016
Number of groups	9,712	26,988	2,870	15,814	1,278	2,357	3,074	10,521	1,136	2,394
No. of instruments	47	47	42	46	63	86	60	53	68	71
Year effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Region effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Industry effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
AR(1) p-value	0	0	3.36e-07	0	0.00107	0.000144	0	5.08e-08	0	0
AR(2) p-value	0.570	0.588	0.718	0.0106	0.869	0.0925	0.742	0.591	0.228	0.546
AR(3) p-value	0.411	0.189	0.684	0.418	0.342	0.474	0.0575	0.484	0.663	0.106
AR(4) p-value	0.925	0.979	0.771	0.361	0.196	0.178	0.756	0.852	0.977	0.913
Hansen Test p-value	0.277	0.412	0.307	0.286	0.278	0.402	0.883	0.110	0.481	0.555

Note: robust standard errors in brackets;
****, ** and * denote statistical significance of variables at 1%, 5% and 10% level of significance respectively.*

In case of backward linkages, the results suggest negative and significant relationship between increase in foreign firm's output in downstream sectors and productivity of local manufacturing suppliers in Hungary and Estonia in both short and long run, thus contradicting the findings in meta regression analysis (Havranek and Irsova, 2011). A possible explanation of negative effects in manufacturing sector may arise from competition effects in downstream sectors which outweigh any positive backward linkage effects from increased sourcing of inputs from foreign firms as suggested in theoretical model by Markusen and Venables (1999) discussed in Chapter 2. Also, it may be that domestic linkage effect is lower for MNCs due to differences in technology and variety of inputs available in the economy or may reflect differences in sourcing behaviour where MNCs use only a fraction of the intermediates with respect to the domestic firms they displace. Furthermore, foreign suppliers may enter the industry following their major customer, thus exacerbating an additional pressure on existing domestic suppliers and result in full crowding out effect in both downstream and upstream industry (Altomonte and Resmini, 2002). In addition, the construction of backward linkages is such that includes both manufacturing and services MNCs and thus may simply reflect negative effects arising from services FDI which is known to have fewer linkages with the local economy, partly because they are more footloose and require less sunk costs (UNCTAD, 2004). The only country which seems to benefit from entering supply chains of MNCs is Slovenia where one percentage point increase of foreign firm's output in downstream sectors leads to 1.7 per cent increase in productivity in the short run and 3.1 per cent in the long run.

Similar effect of backward linkages can be seen in service sector where suppliers in the Czech Republic and Estonia experience a decline in productivity between 0.77 and 0.35 per cent in the short run and between 1.31 and 0.85 in the long run, respectively. The effect in Slovenia is not significant. On the other hand, for every percentage point increase in downstream foreign firm's output, domestic services suppliers in Slovakia and Hungary increase their productivity by 0.75 and 1.56 per cent, respectively. The long run positive effects are stronger and range from 1.12 to 3.04 per cent. These findings suggest that FDI has heterogeneous effects across and within countries as evident in the case of Hungary. Furthermore, a close inspection on the sign of backward linkages suggests that total positive effects in Hungary and Slovakia estimated in previous chapter are driven by beneficial effects of MNCs on suppliers in service industry, a finding similar to Lesher and Mirodout (2008), while opposite holds for the Czech Republic and Estonia. It seems that increased presence of foreign firms in former two countries has forced domestic suppliers in services to reduce their costs, become more efficient and improve the quality of their products. Furthermore, services have strong backward linkages with all industries which is less of a case for manufacturing industries.

Turning to forward linkages, the findings suggest a negative and significant relationship in all countries and industries except Slovakia and Slovenia where positive short term effects on local firms' productivity are evident only in service sector and range from 0.71 per cent in former and 4.9 per cent in the latter country. Negative effects of using foreign inputs are more pronounced in service sector which may reflect the lack of absorptive capacity of average firms in the sample or the increased costs of inputs due to higher quality. The strong negative effect of forward linkages in service sector may also reflect the fact that services inputs are less tradable and therefore MNCs are exploiting their strong bargaining position to charge higher prices which negatively affects domestic firms' profit function.

In terms of variables measuring absorptive capacity, the empirical finding suggests a positive and significant relationship between measure of human capital and TFP across all countries and sectors. In manufacturing sector ten percent increase in average wage leads to 3.1 per cent increase in productivity in Hungary and up to 5.1 per cent in Slovenia. Similarly, in service sector positive effect is smallest in Slovenia where ten percent increase in average wage leads to 2.9 per cent rise in productivity while strongest effect is experienced by services firms in the Czech Republic whose TFP increases by 4.1 per cent. The effect is even stronger in the long run where expected increase in productivity of manufacturing firms range from 5.4 and 9.2 per cent in Slovakia and Slovenia, respectively. In service sector, long run effect is strongest in Estonia (7.5 per cent) and weakest in Slovakia (5.1 per cent) for every 10 percent increase in average wage.

Similarly, the intensive use of intangible asset has positive and significant effects on both manufacturing and services firms in all countries, which is in line with other empirical studies examining the impact of intangibles on productivity (Marrocu et al., 2012; Hall et al., 2013; Battistini et al., 2014). Short term effects of intangible asset are strongest in the Czech Republic in both manufacturing and service sector where ten percent increase leads to 0.4 and 0.5 per cent increase in productivity, respectively. On the other hand, weakest effects are noticeable in Hungary in both sectors where ten percent increase in use of intangibles leads to only 0.01 per cent increase in TFP.

The effects of other firm level variable, namely age suggest a nonlinear relationship in almost all countries and sectors with the exception of manufacturing firms in Estonia and Hungary. In Slovenia there seems to be a negative linear effect of age in both sectors which is somewhat surprising given the results in the previous chapter. The findings for both sectors suggest that either very young or very old firms have positive effects on productivity. It seems that majority of firms need to accommodate to market conditions and are still in the learning process which negatively affects their productivity levels and only after a very long period of operation they are able to increase their productivity. Firm's size has a positive and significant effect in all countries and sectors except Hungary which may be due to this country having a very large proportion of large firms in the sample. Inverse U shape effects can be found in both sectors in the Czech Republic and Estonia and in service sector for Slovakia suggesting that after firms achieve a certain size their effects on productivity starts to diminish.

Competition has mostly positive effects on firm's productivity in manufacturing sectors in the Czech Republic, Estonia and Hungary. The effect is less pronounced in service sector where increased competition has beneficial effects only in the Czech Republic and Slovakia, while increased industry concentration negatively affects TFP of services firms in Estonia. This suggests that manufacturing firms are more responsive to changes in market conditions. Finally, when we look at the effects of demand the findings suggest a positive and significant effect on productivity of firms in service sector in the Czech Republic, Estonia and Hungary and negative effects in Slovakia. It seems that increased purchase of intermediate inputs by domestic firms partially offset negative effects of MNCs' backward linkages in service sector in these countries. Similar reasoning can be applied to manufacturing firms in Hungary.

6.4.2 EFFECTS OF SERVICES FDI ON DOWNSTREAM MANUFACTURING FIRMS

Following the discussion in Section 6.2.2 on the role of FDI in service sector and its possible channels of influence on manufacturing firms the aim of this section is to shed more light on the effects of MNCs on domestic firms' TFP in manufacturing sector. To explore this alternative, we have split the total backward and forward linkages into two groups. First group consist of manufacturing backward and forward linkages defined in eq. (6.2 and 6.4) while the second group is related to services backward and forward linkages defined in eq. (6.3 and 6.5). In this way we are able to shed more light on the customer supplier relationship between domestic and foreign firms in two main sectors of economy. Furthermore, given the different timing of investments in these two sectors of economy as well as heterogeneous motives, strategies and sourcing behaviour the effects of vertical linkages may be different than one found in the previous section. The specific focus on manufacturing sector is important as successful integration of local manufacturing firms in GVCs provide opportunities to increase their competitiveness by upgrading their production. By entering MNCs' network local firms may engage in production of high value added products, employ more efficient production strategies or increase the skill content (Humphrey and Schmitz, 2002; Kaplinsky, 2000, Gereffi et al., 2005). Therefore, it is important to analyse whether the presence of MNCs in different sectors provide local manufacturing suppliers and customers an opportunity to increase their productivity. The results of augmented baseline model (6.6) are presented in Table 6.2 below.

Starting with the diagnostics, Hansen test suggests that instruments and their subsets for each model are valid, i.e. exogenous. Arellano and Bond test for autocorrelation confirms the absence of autocorrelation in second differences while rejecting null hypothesis of no first order autocorrelation. Furthermore, the assumptions of no cross sectional dependence and steady state hold which provide us with confidence that the models are correctly specified and that we can proceed with the explanation of results.

TABLE 6.2 DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVER EFFECTS ON PRODUCTIVITY (LN TFP) OF DOMESTIC FIRMS IN MANUFACTURING ACCORDING TO INDUSTRY SOURCE, 2002-2010

VARIABLES	Czech Republic	Estonia	Hungary	Slovakia	Slovenia
l.lnTFP	**0.385*** **	**0.267*** **	**0.600*** **	**0.385*** **	**0.431*** **
	(0.0219)	*(0.0274)*	*(0.114)*	*(0.0432)*	*(0.0571)*
Horizontal	**-0.167** **	**-0.635*** **	**-0.701** **	**-0.383** **	**0.206**
	(0.0829)	*(0.158)*	*(0.343)*	*(0.198)*	*(0.356)*
Backward_man	**1.740*** **	**-0.597* **	**2.765** **	**1.815* **	**1.841** **
	(0.599)	*(0.339)*	*(1.355)*	*(1.100)*	*(0.933)*
Forward_man	**-2.573*** **	**-1.331*** **	**-3.082** **	**-0.257**	**-0.333**
	(0.485)	*(0.409)*	*(1.373)*	*(0.495)*	*(1.430)*
Backward_serv	**-7.576*** **	**1.286* **	**-20.66*** **	**5.331* **	**-9.719** **
	(2.158)	*(0.674)*	*(6.324)*	*(2.801)*	*(4.698)*
Forward_serv	**4.417*** **	**3.110*** **	**6.913* **	**6.150*** **	**13.60*** **
	(1.492)	*(0.710)*	*(4.147)*	*(1.752)*	*(5.205)*
Ln Human capital	**0.482*** **	**0.488*** **	**0.295*** **	**0.332*** **	**0.526*** **
	(0.0141)	*(0.0163)*	*(0.0609)*	*(0.0145)*	*(0.0450)*
Ln Intangibles	**0.0453*** **	**0.0766*** **	**0.00774* **	**0.0597*** **	**0.0289*** **
	(0.00254)	*(0.00585)*	*(0.00410)*	*(0.00521)*	*(0.00552)*
Age	**-0.00877*** **	**-0.0150*** **	**-0.00491**	**-0.00930*** **	**-0.0103*** **
	(0.00152)	*(0.00158)*	*(0.00423)*	*(0.00260)*	*(0.00247)*
Age^2	**7.68e-05* **	**0.000172*** **	**-8.37e-05**	**9.16e-05* **	**6.29e-05**
	(4.13e-05)	*(2.51e-05)*	*(0.000139)*	*(4.83e-05)*	*(6.01e-05)*
Ln Size	**0.213*** **	**0.270*** **	**0.0800* **	**0.146*** **	**-0.0265**
	(0.0183)	*(0.0243)*	*(0.0485)*	*(0.0321)*	*(0.0590)*
Ln Size^2	**-0.00427*** **	**-0.00725*** **	**0.000436**	**-0.00269**	**0.0105** **
	(0.000934)	*(0.00203)*	*(0.00297)*	*(0.00203)*	*(0.00474)*
HHI	**-0.232*** **	**0.241* **	**-0.142**	**-0.159**	**-0.189**
	(0.0619)	*(0.136)*	*(0.116)*	*(0.106)*	*(0.132)*
Ln Demand	**-0.0332**	**-0.0456**	**0.0655**	**-0.0204**	**0.0293**
	(0.0240)	*(0.0335)*	*(0.0471)*	*(0.0161)*	(0.100)
Model diagnostics					
Observations	29,263	11,451	2,499	8,140	3,584
Number of groups	9,712	2,870	1,278	3,074	1,136
No. of Instruments	55	86	107	60	81
Year effects	yes	yes	yes	yes	yes
Region effects	yes	yes	yes	yes	yes
Industry effects	yes	yes	yes	yes	yes
AR(1) p-value	0	0	0.000564	0	0
AR(2) p-value	0.562	0.788	0.569	0.722	0.343
AR(3) p-value	0.850	0.983	0.455	0.0689	0.289
AR(4) p-value	0.879	0.803	0.456	0.924	0.394
Hansen Test p-value	0.106	0.107	0.682	0.755	0.353

Note: robust standard errors in brackets;
****, ** and * denote statistical significance of variables at 1%, 5% and 10% level of significance respectively.*

For brevity, we will focus our attention on vertical linkages since horizontal spillovers and other control variables are fairly robust to changes in specification except the effects of industry concentration which now suggest that manufacturing firms in Estonia benefit from less competition. As far as backward linkages are concerned we can observe that presence of foreign firms in downstream manufacturing sectors with the exception of Estonia benefit domestic suppliers as the effects on local firms' productivity range from 1.7 per cent in the Czech Republic to 2.7 per cent in Hungary. The effects are even stronger in the long run where one percentage point increase of foreign firm's output in downstream manufacturing sector leads to 3.23 per cent and 6.9 per cent increase in TFP in Slovenia and Hungary, respectively. These results are now more in line with most empirical studies (Havranek and Irsova, 2011) suggesting that countries which attracted large amount of FDI in tradable sectors such as the Czech Republic, Hungary and Slovakia are able to benefit from entering MNCs' production network. However, one must be careful in interpreting these results as our measure of backward linkages simply measure the extent of inputs bought by MNCs and its effects on local firm's TFP. As shown by several studies focusing on automotive industry in CEE region which attracted significant amount of FDI, the transfer of knowledge is somewhat limited. For example, studies by Pavlinek and Zenka (2011) and Rugraff (2010) showed that the Czech automotive industry is almost entirely dominated by foreign firms which act as a Tier 1 supplier whilst local firms are engaged in a system of "price-driven subcontracting" failing to develop and produce innovative products. Furthermore, it is found that local suppliers are mostly engaged in assembly of low to medium value-added parts finding it difficult to increase their value added. However, there is also evidence that interaction with MNCs lead to process and product upgrading (Domanski and Gwosdz, 2009; Pavlinek et al., 2009) and increased knowledge transfer by autonomous foreign subsidiaries and those which have longer presence in host economy (Gentile-Ludecke and Giroud, 2012; Jindra et al., 2009).

Turning to backward services linkages, positive effects on local firm's productivity are evident only in Estonia and Slovakia and are larger in magnitude in comparison to manufacturing backward linkages. These positive effects may reflect the change in economic structure of these economies where service sector share in economic activities is rising (ESCIP, 2014) which provide domestic suppliers an opportunity to increase their productivity. As shown by Javorcik and Li (2013) in the case of global retail chains increased presence of MNCs create a strong competitive pressure which results in crowding out of local firms in service sector and at the same time increase the bargaining power of MNCs *vis a vis* local suppliers. Moreover, due to their global sourcing and increased use of ICT foreign firms have the ability to import some of their products thus creating incentives for local firms to increase the quality of products, reduce prices and improve efficiency. Furthermore, MNCs in certain service industries may help domestic suppliers to reduce their distribution costs and provide access to other regional or national markets stimulating economies of scale (Javorcik and Li, 2013).

On the other hand, negative services backward linkages are experienced by manufacturing firms in the Czech Republic, Hungary and Slovenia, offsetting any positive effect arising from increased domestic sourcing of MNCs in manufacturing sector. In addition, large negative effects of services backward linkages may explain negative backward linkages in Hungary presented in Table 6.1. These findings are in line with those obtained by Mariotti et al. (2013) who found that four service sectors exhibit negative effects on upstream manufacturing firms unless entry of MNCs in is able to increase demand for intermediate manufacturing inputs. Similar result is found in Ayyagari and Kosova (2010) when investigating the effects of services backward linkages on domestic firm' entry. They explain this by the fact manufacturing firms usually supply only limited amount of intermediate inputs to services in form of communication and information technology and office automation equipment. Since in these industries barriers to entry may be high and foreign presence is significant services firms may be more inclined to source from their foreign suppliers. In addition, backward linkages are usually stronger within service sector as found in Nordas and Kim (2013) due to less reliance on inputs from other sectors. Inability of domestic suppliers to satisfy stringent quality requirements may pose certain difficulties to local suppliers in terms of input adaptation. As argued by Mariotti et al. (2013) adaptation requires additional costs evident in costs of training and investments which may negatively impact TFP.

Furthermore, some services are characterised by buyer driven GSCs. The example of latter are large retailers or marketers of final products which require meeting high quality standards at reduced costs (Gereffi and Lee, 2012). In certain cases, that can only be satisfied by large MNCs in manufacturing sector which have the ability to meet stringent and costly requirements. Iacovone et al. (2015), for example, showed that large retailers require substantial price reductions if suppliers do not come up with product innovation in a given year. Only firms with very high performance and ability to invest in innovation become suppliers, while other firms face declining sales, productivity or even exit from the market. Recently, there has been a trend of consolidation in supply chain (Cattaneo et al., 2010). This has led to outsourcing being carried through a supplier tiering model where in most cases foreign supplier is a first tier supplier managing its own production or sourcing network (Farole and Winkler, 2014). This may explain the limited role of domestic manufacturing firms to enter GVC of MNCs in service sector either because they are involved in low value added activities with limited knowledge transfer or first tier supplier follows a more internalised process.

The findings with respect to manufacturing client firms suggest that inputs supplied by MNCs in manufacturing sector have detrimental effects on TFP in all countries, but are only significant in the Czech Republic, Estonia and Hungary. One percentage point increase in foreign firms' output in upstream sector leads to decline in TFP levels between 1.3 per cent and 3 per cent in Estonia and Slovakia, respectively. This suggests that domestic firms do not have the capabilities to benefit from high quality inputs either due to their higher prices or inability to effectively use them in production process.

Turning to forward spillovers from service sector the results indicate a strong positive and significant effect of foreign services inputs on downstream manufacturing productivity thus confirming previous findings on the beneficial effects of services FDI (Arnold et al., 2011; Fernandes and Paunov, 2012; Mariotti et al., 2013). The short run effects range from 3.1 per cent in Estonia to 13.6 per cent in Slovenia. Long run effects are even stronger being smallest in Estonia (4.24 per cent) and largest in Hungary (17.3 per cent) and Slovenia (23.9 per cent). Such large semi-elasticities may reflect the FDI penetration ratios in service sector due to recent liberalisation where effects are expected to be larger for an increase in foreign presence from small levels than in sectors where levels of FDI are already saturated (Gersl et al., 2007). The evidence suggests that productivity spillovers are more easily captured by manufacturing customers which buy inputs with high technological content from services MNCs than through backward linkages. This may be the results of stringent quality requirements imposed by MNCs in services which put pressure to lower the production costs and prices resulting in fewer financial resources to finance the necessary investment in technology and product upgrading. Positive effects of services forward linkages may also reflect market seeking motives of MNCs which initially followed their clients, but eventually expanded their operation to local manufacturing firms which are in need of high quality inputs in order to be able to maintain and increase their international competitiveness.[67]

6.4.3 THE MODERATING EFFECTS OF ABSORPTIVE CAPACITY

As argued in Chapter 2, the occurrence of FDI spillovers is not an automatic process and not all firms benefit equally from FDI. As noted by Cohen and Levinthal (1990) and later on by Zahra and George (2002) absorptive capacity helps firms identify, assimilate, transform and apply knowledge from external environment. Therefore, it is expected that the benefits from FDI spillovers are more likely to occur in firms which are better able to evaluate the technology which comes with MNCs. Assimilation of external knowledge depends on firm's prior knowledge base which can encourage or hinder knowledge absorption. As argued by Rosenkopf and Nerkar (2001) prior experience can facilitate knowledge absorption by defining the locus of knowledge search, but at the same time it can hinder firm's search activities to familiar and proximate areas (Stuart and Podolny, 1996), thus ignoring other sources of knowledge (Cohen and Levintahl, 1990). Finally, absorptive capacity enables firms to transform and apply the new technology. This in turn depends on organizational capabilities and routines which provide an opportunity to internally disseminate external information and incorporate technology into existing processes and routines (Nelson and Winter, 1982; Dosi et al., 2000; Blalock and Simon, 2009).

Since absorptive capacity is a multidimensional concept its measurement in empirical research is somewhat difficult. Various measures of absorptive capacity have been used such as input indicators represented by R&D expenditure, R&D intensity or R&D human capital measured as R&D employees divided by total employees (Gao et al., 2008), percentage of higher-educated workforce (Kleinknecht and Reijnen, 1992), number of doctorates in the R&D department (Veugelers,1997). The shortcoming of such indicators lies in their narrow focus which cannot explain the complex nature of absorptive capacity

[67] Given the large heterogeneity of manufacturing and especially service sectors, we have run two additional models: (i) interacting FDI spillover variables in model 6.6 with a dummy variable indicating low and high tech manufacturing sectors; (ii) separating the effects of service linkages according to less and high knowledge intensive services using Eurostat classification. In both cases, the additional results confirmed the extreme heterogeneity of empirical results, thus no general pattern could be found across countries.

which relies on several capabilities that build on one another (Duchek, 2013). In addition, high R&D expenditure or intensity does not necessarily imply higher output or increased TFP as transformation from input to output depends on other variables as well. Similarly, output measures such as the number of patents filed by firms are used since they represent evolution or emergence of new knowledge within the firm (Duchek, 2013). Finally, some studies use technological gap measured as distance between the level of a local firm TFP and that of foreign firms (Girma, 2005; Nicolini and Resmini, 2010; Abraham et al., 2010). However, the problem with technological gap is measurement error arising with TFP estimation and the fact that TFP reflects other factors besides technology. In addition, TFP gap may be affected by temporary shocks which do not affect absorptive capacity (Girma and Gorg, 2007).

Keeping in mind these shortcomings of single quantitative measures of absorptive capacity and data availability, we test whether intensity of intangible asset use has a moderating effect on the occurrence of FDI spillovers within the manufacturing sector. The use of intangible asset has potentially several advantages over other measures of absorptive capacity. First, intangible capital is found to be a strong determinant of firm productivity in many studies hence it helps to explain large productivity differences (Syverson, 2011). Second, intangible capital is a broader measure of absorptive capacity as it includes both innovation inputs and outputs developed either in house or acquired in arms-length transactions. For example, knowledge capital of the firm incorporated in intangible assets include R&D expenditure, software, patents, trademarks, organizational processes and firm specific skills that provide competitive advantages (Ragoussis, 2014). Third, in order to be classified as intangible asset, three criteria are used to classify expenses identified in International Accounting Standards (IAS).[68] Intangible asset reported in Amadeus database conform to these criteria and empirical evidence have found that capitalized intangible asset is more productivity enhancing than intangible capital based on current expenses (Bontempi and Mairesse, 2015).

However, our measure of absorptive capacity is not without drawbacks. First, we are not able to distinguish between different types of intangible capital. Second, only externally acquired assets can be capitalized and therefore recognized as intangible asset while

[68] (i) identifiability: arising from ability of firms to separate, rent, licence and exchange the asset or the assets need to arise from legal right regardless if they are transferable or separable;
(ii) control: arising from firm power to obtain the benefits from those assets;
(iii) asset must bring future economic benefits (IFRS, 2012)

those assets generated internally is often expensed (Ragoussis, 2014). Furthermore, innovative capabilities and computerised information are reported in firm's balance sheet while economic competencies such as marketing expenditure or costs related to employee training are often expensed. Bearing in mind these shortcomings we proceed with our estimation as our analysis is conducted within countries and any asymmetries in accounting standards and treatment of intangible asset are controlled for.

The model presented by equation 6.2 is now augmented by the interaction terms between each FDI spillover measure and the log ratio of intangible over tangible asset:

$$\boldsymbol{ln\,TFP_{it} = \beta_0 + \rho\, ln\left(TFP_{ij,t-1}\right) + \delta_1 horizontal_{jt} + \delta_2 horizontal_{jt} * IA_{it} + \delta_3 manufacturing\_backward_{jt} + \delta_4 manufacturing\_backward_{jt} * IA_{it} + \delta_5 manufacturing\_forward_{jt} + \delta_6 manufacturing\_forward_{jt} * IA_{it} + \delta_7 services\_backward_{jt} + \delta_8 services\_backward_{jt} * IA_{it} + \delta_9 services\_forward_{jt} + \delta_{10} services\_forward_{jt} * IA_{it} + \theta_{11} AC_{it} + \lambda_{12} IT_{jt} + \gamma_j + \gamma_r + \gamma_t + \varepsilon_{ijt}} \quad \textbf{(6.7)}$$

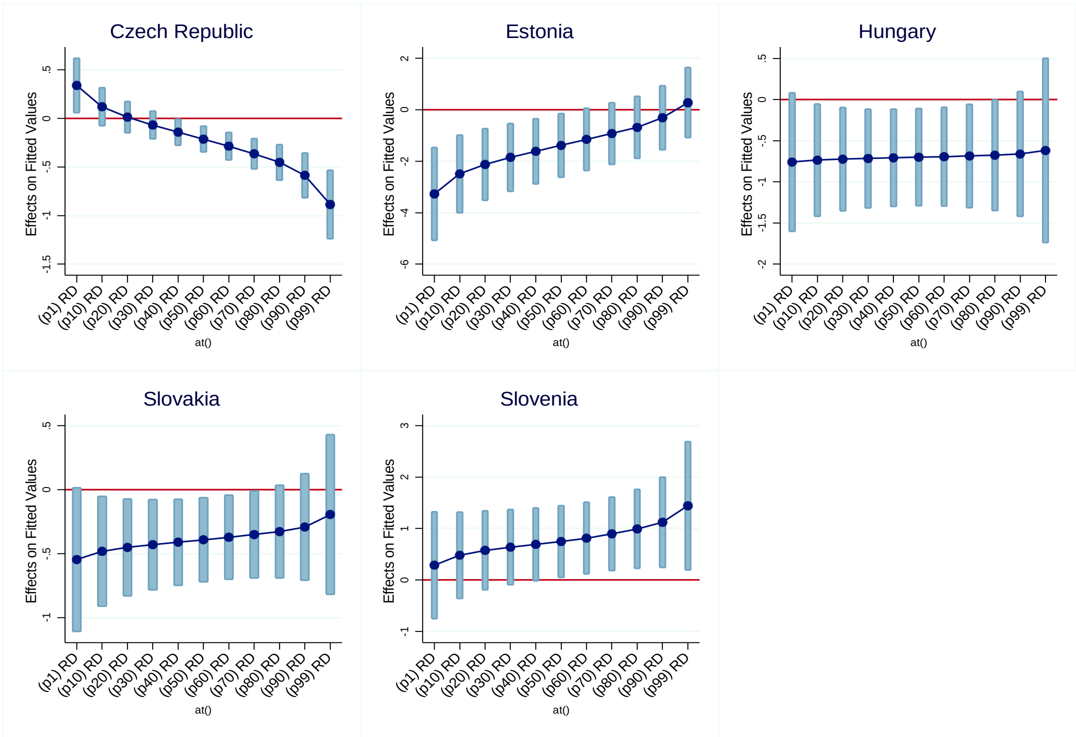
where definition of variables is the same as in eq. (6.6). However, the interpretation of individual spillover terms is different due to presence of interaction terms. For example, $\boldsymbol{\delta_1}$ reflects the effect of horizontal spillovers when intangible asset ratio is zero (IA_{it} =0) and the sum $\boldsymbol{\delta_1 + \delta_2} * (IA_{it})$ reflects the effect of horizontal spillovers for different values of IA_{it} included in the interaction terms (individual coefficient of IA is also included in AC vector).

The estimation technique is the same as in the previous models. The number of instruments is higher due to inclusion of interaction terms in the instrument matrix. Turning to model diagnostics which are reported in full in Appendix IV (Tables IV.16-IV.20), there is no sufficient evidence to reject the null hypothesis for validity of over identifying restrictions. In addition, there is insufficient evidence to reject second order autocorrelation in differences of residuals while first order autocorrelation is rejected in all cases. Difference in Hansen test for the exogeneity of instruments subset suggest instruments for endogenous variables are valid. Finally, difference in Hansen for levels equation and lagged dependent variable suggest that steady state assumption holds and there is no evidence of cross sectional dependence.

Detailed interpretation of alternative model is not provided given that the main interest is to explain the effects of FDI spillovers on local firms' TFP moderated by the measure of absorptive capacity. However, we are confident in the robustness of results as the coefficients from model 6.2 and augmented model 6.6 are similar in sign and size while significance is now improved for variables controlling for competition and demand effects. Since interaction terms include two continuous variables we present marginal effects of FDI spillovers on TFP conditional on different values of intangible asset ratio. The values of intangible asset ratio taken are 1st and 99th percentile and deciles of respective distribution.

Starting with interpretation of horizontal spillovers presented in Figure 6.3 we find that higher intensity of intangible asset ratio has beneficial effects on TFP of firms within manufacturing sectors as initial negative effects are attenuated in almost all countries. The beneficial effects are especially pronounced in Estonia and to a lesser extent in Slovakia where negative effects are diminishing with higher levels of intangible assets. Looking at more detail, beneficial effects of investment in intangible asset start at different levels in Estonia and Slovenia. In the former country, manufacturing firms with high levels of intangible asset are less likely to benefit from horizontal spillovers. They may already possess high levels of technology and therefore have limited capacity to learn from MNCs (Grunfeld, 2006). In case of Slovenia investment in intangible asset has increasing positive effects on domestic firms' ability to benefit from horizontal knowledge spillovers. Finally, it seems that moderating effects of absorptive capacity further increase the negative horizontal effects of manufacturing firms in the Czech Republic, but only for firms which have above median levels of intangible assets. One of the possible explanation of negative moderating effects of intangible asset is capability gap in which firms have the resources but not the capability to use them effectively (Teece, 1998). As argued by Teece and Pisano (1998) competences and capabilities are crucial for creation of new products and processes and enable firms to react to changes in market conditions. Since economic competencies (e.g. human capital and organizational structure) are regarded as the most important part of intangible asset which are most difficult to measure and therefore are not included in the balance sheet negative effect of other components may arise. This is because investment in R&D, digitized information technology and similar intangible asset increase the costs of firms which is not translated into higher revenue.

FIGURE 6.3 AVERAGE MARGINAL EFFECTS OF INTANGIBLE ASSET RATIO AND HORIZONTAL SPILLOVERS WITH 90% CI

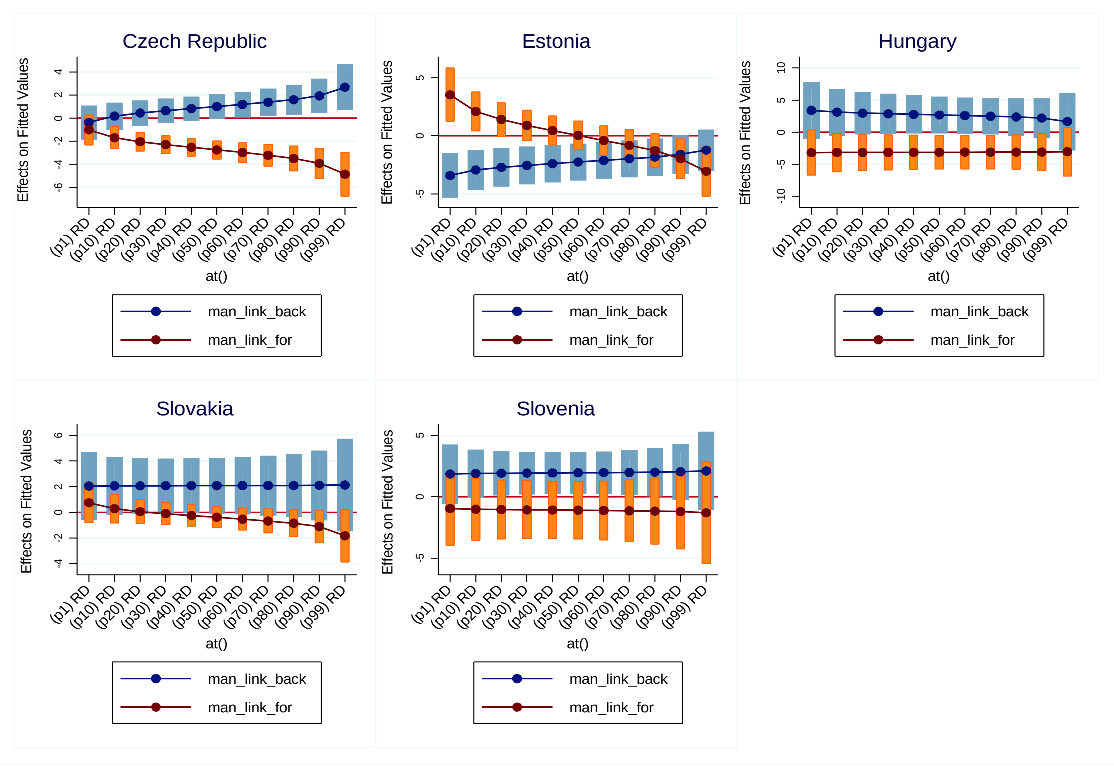


Turning to linkages arising from manufacturing sectors presented in Figure 6.4, empirical findings suggest that domestic suppliers with higher absorptive capacity benefit from backward linkages in almost all countries by either further increasing their TFP like in the Czech Republic and Slovenia or attenuating negative effects in Estonia, thus confirming the role of firm's absorptive capacity as enabling factor for FDI spillovers (Crespo and Fontoura, 2007; Blalock and Gertler, 2009; Damijan et al., 2013a). In Hungary and Slovakia marginal effects are significant but have very little increasing effects on TFP. In the former country, domestic suppliers with higher absorptive capacity even experience a decline in TFP possibly indicating that firms are involved in low value added activities based on standardized processes and components. Hence any investment in intangible asset to increase the quality of inputs contribute to increased costs since MNCs mostly source their high quality inputs from first-tier suppliers (Rugraff, 2010).

In case of forward linkages, the results suggest that firms in the Czech Republic experience a decline in TFP with higher levels of intangible asset possibly because of complexity of inputs and inability of firms to transform and implement the knowledge embodied in acquired inputs (Zahra and George, 2002). Similar finding is found in

Estonia where firms with very high levels of intangible asset ratio experience negative effects, while those with very low ratio are able to increase their productivity. In other countries the effects of manufacturing forward linkages are insignificant with the exception of Hungary where negative effects are slightly attenuated with higher levels of intangible asset.

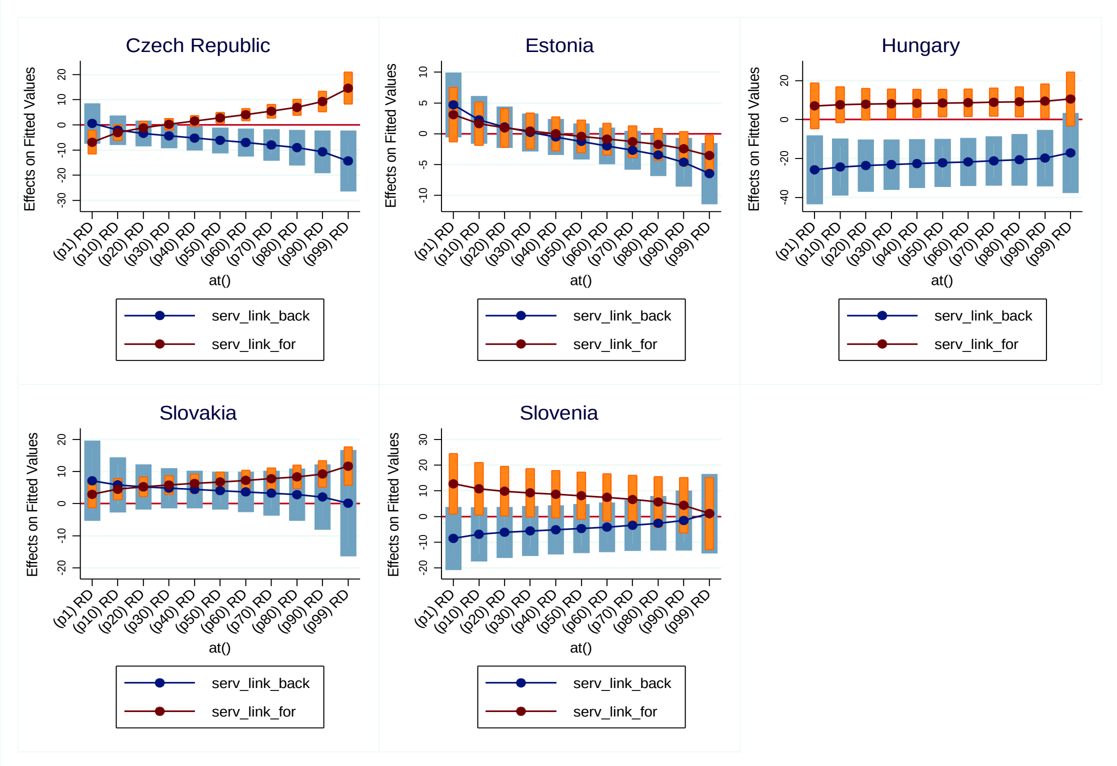
FIGURE 6.4 AVERAGE MARGINAL EFFECTS OF INTANGIBLE ASSET RATIO AND MANUFACTURING LINKAGES WITH 90% CI



Turning to backward linkages arising from service sector presented in Figure 6.5, one can notice a significant negative moderating effect of absorptive capacity in the Czech Republic and Estonia. In these two countries domestic manufacturing suppliers with medium or higher levels of intangible asset ratios are not able to benefit from vertical linkages with services MNCs. Possible reason is inability of domestic firms to combine an existing knowledge to increase their technological capabilities which would result in new processes, products and services that would partially replace imported components of MNCs. On the other hand, moderating effects of absorptive capacity seem to slightly attenuate large negative effects of services backward linkages in Hungary.

Finally, it seems that positive effects of services forward linkages found in previous section are reinforced and become larger for higher levels of intangible asset ratios in the Czech Republic, Hungary and Slovakia while for firms in Estonia and Slovenia the moderating effects are mostly insignificant. These results are in line with those obtained by Mariotti et al. (2013) and once again confirm the importance of services liberalization as newly available inputs with higher technological content favour the technological upgrading of the production process resulting in increased manufacturing productivity.

FIGURE 6.5 AVERAGE MARGINAL EFFECTS OF INTANGIBLE ASSET RATIO AND SERVICES LINKAGES WITH 90% CI



6.5 CONCLUSION

This chapter explored the effects of FDI spillovers on manufacturing and service sector. To the best of our knowledge no empirical analysis has been undertaken to this date on whether the increased presence of MNCs in service sector, encouraged by recent services liberalisation, lead to productivity improvements of domestic firms. Although, research on FDI spillovers in transition countries is vast it is mostly based on manufacturing sector alone. Given that services play an important role as a creator of value added and employment within country and promote the development of other sectors indirectly through intermediate inputs to manufacturing industries it is of great concern whether MNCs entry contribute to economy wide benefits such as improvements in productivity through provision of low costs and high quality inputs, increased competition and knowledge spillovers.

Starting with the baseline model applied separately to manufacturing and service sectors, the empirical findings suggest negative horizontal effects of manufacturing FDI which are partially offset by positive knowledge spillovers in service sector in the Czech Republic and Hungary. In case of backward linkages positive effects of FDI spillovers are found only in Hungary and Slovakia for service sector and in manufacturing sector in Slovenia casting some doubt on previous findings from the literature. Regarding forward linkages the results suggest negative effects of foreign suppliers on local firms' productivity which are especially pronounced in service sector with the exception of Slovakia and Slovenia.

In order to shed more light on the impact of vertical linkages we employed an empirical model disentangling backward and forward linkages according to industry source and measure their impact on productivity of domestic firms in manufacturing industries which are at the same time supplier and customer. The results suggest positive effects of backward manufacturing linkages in all countries except Estonia, thus confirming previous empirical findings which suggest that MNCs have a strong incentive to share the knowledge with their suppliers. Negative effect in Estonia may reflect declining share of manufacturing industries and increasing reliance on services. In addition, it seems that local manufacturing supplier firms do not benefit from increased presence of services MNCs acting as customers with the exception of firms in Slovakia and Estonia. The positive results for the latter two countries may be explained by increased specialisation in services and increased activity of MNCs which moved some of the headquarters and therefore require information and communication technology or office automation equipment.

A closer investigation on the source of forward linkages effects within manufacturing sector reveal that presence of MNCs has dual effects on local firms' productivity. On one side MNCs in manufacturing have negative effects on their local customers which outweigh positive effects on their suppliers. On the other hand, those inputs provided by services MNCs have strong and positive effects. The findings are consistent with the view that services liberalisation and their outcome such as increased MNCs' presence is associated with improved availability, range and quality of services resulting in improved performance of downstream manufacturing firms. It is worth noticing that total effects of vertical linkages calculated as the linear combination of four different channels is positive except in the Czech Republic and Hungary due to large negative effects from services MNCs in downstream markets. Finally, findings suggest that gains from MNCs presence do not accrue equally to all firms. Those firms which have higher intensity of intangible asset ratio as a proxy for absorptive capacity are more likely to benefit from manufacturing backward and forward services linkages while negative effects of intra industry spillovers are attenuated.

In summary, given the positive correlation between services FDI and downstream manufacturing productivity policy makers should encourage entry of MNCs in service sector which could constitute an important means to improve the productivity of local firms and their competitiveness on international markets. Furthermore, the effects of direct or indirect technology transfer by MNCs are moderated by high levels of absorptive capacity which is crucial for assimilation and transformation of external knowledge. This is especially pronounced in case of backward manufacturing and forward services linkages, two channels of FDI spillovers with the highest potential for productivity spillovers. Therefore, policy makers should put more emphasis on improving the absorptive capacity of firms by encouraging and facilitating firms' R&D investment, employee training, new software applications and organizational innovations. Finally, as FDI is the outcome of services liberalisation any remaining barriers limiting competition, conduct regulation or FDI restrictions should be reduced. Regarding the latter restriction, government should require that MNCs engage in supplier development programs given current large negative effects of services MNCs on local suppliers in some countries.

CHAPTER 7.
CONCLUSIONS

7.1 INTRODUCTION

The aim of this thesis, was to examine the potential spillover effects of FDI on productivity of domestic firms in five transition economies (the Czech Republic, Estonia, Hungary, Slovakia and Slovenia) which are among the most developed New Member States of the EU. The inflow of foreign direct investment at the beginning of transition from centrally planned to market economies was one of the main impetuses to economic and institutional restructuring in these countries. MNCs played an important role in the privatisation process, the subsequent firm restructuring, changes in export and market structures, the development of service sector and technological upgrading. Apart from direct effects, MNCs are also a major source of technology spillovers to indigenous firms. These indirect effects are seen as an important factor for productivity catch up of domestic firms, their participation in Global Value Chains (GVC) and ultimately their survival in national and international markets.

Although the investigation of FDI spillovers has gained momentum in the last two decades, empirical studies have still not reached a consensus on the indirect effects of foreign firm's entry on productivity of local firms. Hence, this thesis has focused on several questions which are crucial for understanding the current ambiguous findings in the literature. How, and through which channels, are domestic firms expected to benefit from technology spillovers from MNCs? What is the most appropriate method for measuring firm level productivity? What is the level of productivity of local and foreign firms? Are there any differences between the productivity of firms in the two major sectors of economy (manufacturing and services)? How FDI spillovers are measured and what is their effect on productivity of domestic firms? What is the role of MNCs' geographic origin and the extent of foreign ownership on productivity of domestic firms? What are the factors influencing the ability of domestic firms to benefit from technology spillovers according to the channel through which they occur? Is there any systematic variation in FDI spillover effects across manufacturing and service sectors? Are there any intersectoral spillovers?

The surge of FDI after World War II resulted in various theories attempting to explain why firms decide to go abroad and incur sunk costs. An initial review of determinants of FDI in Chapter 1 has shown that the concept can be explained using insights from international trade and international production theory and its variants. Although many strands of the literature are concerned with the explanation of FDI and the emergence of MNCs, they differ in their underlying assumptions. The majority of theoretical concepts reviewed in Chapter 1 have failed to account for the complexity of MNCs' decision to engage in cross border investments. OLI paradigm combined several strands of literature in an attempt to provide an explanation for internationalisation of production and hence provide a general framework for analysis of the effects of FDI. Recently, the network based theory of MNCs has emphasized the technological accumulation, firm specific learning and roles of MNCs' subsidiaries and their embeddedness in local environment as a source of competitive advantages. An alternative approach explaining FDI has been adopted by scholars in the field of international economics which combined ownership and location advantages with technology, firm and country characteristics in explaining different forms of FDI.

By evaluating the complementarities between different theories and incorporating recent advances in international business and international economics literature and having in mind data limitations, the investigation of FDI spillovers adopted in this study relied on a production function framework in order to be able to derive changes in firm level productivity as a proxy for technology spillovers. We argued that theoretical models of FDI spillovers developed by scholars in the field of international economics, growth theory and international business emphasizing both MNCs and local firms' heterogeneity are best suited for our research needs. This is because the focus of our research is on the ability of local firms to benefit from variety of technologies and linkages made available by different MNCs located across the manufacturing and service sectors. Heterogeneity of MNCs can lead to different FDI spillovers potential and effect and thus productivity catch up of domestic firms and ultimately their success in international markets.

Once the conceptual framework for investigating FDI spillovers was established in Chapter 2, our analysis moved on to investigate the role of FDI in the transition process.

We found that the entry of MNCs was facilitated by, and became part and parcel of, the wide ranging structural reforms pursued by transition countries. The structure of FDI across countries and industries, and the success of countries in attracting MNCs closely followed the government stance towards privatisation, speed of structural reforms and prospects for EU membership. While manufacturing sector was the initial focus of foreign investors, subsequent investments were more oriented towards underdeveloped service sectors and hence the share of manufacturing FDI started to decline. The exceptions were countries with strong manufacturing base such as the Czech Republic, Hungary and Slovakia which continued to attract significant amounts of FDI in automotive and electronics sectors.

NMS in general have witnessed strong income and productivity convergence towards the EU-15 and we argued that FDI has played an important role in this process. The contribution of foreign affiliates in total turnover, value added and employment, and the levels of technological sophistication have been increasing over time. As a consequence, FDI contributed to industry restructuring and increase in productivity, enabled the shift from low to high value added activities and intensified NMS's integration in GVCs. Motivated by findings in Chapter 3 which suggested the importance of foreign firms for economic activity of NMS and their superior performance over domestic firms, the second part of the thesis was concerned with empirical analysis of FDI spillovers at micro level.

The empirical part of the thesis is divided into three Chapters.

Chapter 4 was concerned with the estimation of TFP at firm level as a first step in the investigation of FDI productivity spillovers. Given data limitations we focused on five NMS (the Czech Republic, Estonia, Hungary, Slovakia and Slovenia) during the 2002-2010 period, the most recent year for which data were available at the time of writing the thesis. Although the concept of total factor productivity is well known in the literature, its estimation is far from simple due to its unobservable nature. Our starting point was a critical review of the various approaches available for the estimation of productivity. We argued that a semi-parametric methods based on control functions containing observable firm characteristics are the most appropriate when a researcher is interested in exploring the characteristics of factors of production such as ease of adjustment and observability of all factors affecting output. In addition, they are able to control for simultaneity bias between factor inputs and unobserved productivity.

Having in mind several methodological issues explained in Chapter 4, we resorted to estimation of TFP using OLS, Levinsohn-Petrin (2003) and Wooldridge (2009) estimators in order to test the data properties and compare empirical results across different estimators. After applying Cobb Douglas production framework for each country-industry pair and comparing the obtained TFP estimates across different estimators, we decided to choose Wooldridge TFP model as the preferred estimator as it is able to control for identification problems mentioned in Ackerberg et al. (2006) and are fairly similar when compared to other two estimation techniques. Our results are in line with similar studies comparing TFP estimates across different estimators and we may conclude that the choice of estimator is less crucial when one is interested in the non-deterministic part of the production function. These TFP estimates were then used as the dependent variable in the subsequent chapters.

In Chapter 4 we also tested the necessary assumptions for the occurrence of FDI spillovers related to the productivity premium of foreign over domestic firms. We found that foreign firms in every country and main sectors of activity were more productive. These results hold both for non-parametric Kolmogorov-Smirnov test and parametric estimation. We also found that MNCs' heterogeneity in terms of their geographic origin and the extent of foreign ownership has important implications for potential productivity spillovers. Namely, fully owned foreign firms and firms coming from the EU were the most productive. We also found that domestic firms have experienced an improvement in their productivity levels over time, especially those firms whose TFP is below median levels. However, there is a strong persistence in the position of domestic firms in TFP distribution which is the main feature of this sample.

In Chapter 5, we developed an empirical model of FDI spillovers based on the conceptual framework and identified shortcomings of the current empirical studies applied to transition countries. The model was based on endogenous growth theory in which the main interest lies in the estimation of technology shock induced by factors internal and external to the firm. In this thesis the latter factors are represented by FDI spillover variables. The main aim was to investigate whether the heterogeneous nature of MNCs has different productivity spillovers effects on domestic firms in manufacturing and service sectors. Rich micro panel data applied to the five countries under consideration allowed us to incorporate variables controlling for absorptive capacity of local firms such as the share of intangible assets in total fixed assets and a measure of human capital proxied by average firm-level wage. We also controlled for firm age and size and the squared terms of these factors, demand in downstream sectors and the level of competition in the industry. The main variables of interest were related to the construction of FDI spillovers within and across industries. For that purpose we relied on a combination of firm level data available from Amadeus database and yearly input output tables available from World Input Output tables thus providing us the opportunity to examine changes in economic structure and input sourcing behaviour of foreign firms over time.

It should be noted that our main variables of interest, namely horizontal spillovers and vertical linkages capture different mechanisms of knowledge diffusion. In case of horizontal spillovers we capture the net effects of pure technological externalities such as imitation and reverse engineering reffered to as demonstration effects and competition effects arising from changes in market structure due to MNCs' entry. In addition, knowledge spillovers may also arise due to worker mobility which can only be gauged by tracing the movement of workers between companies. In comparison to unintentional knowledge diffusion measured by demonstration effects and worker mobility, vertical linkages involve intentional knowledge transfer and pecuniary externalities. Although, we may find positive correlation between productivity of domestic firms in upstream sectors with the presence of MNCs in downstream sectors or vice versa, the exisiting measures based on industry level proxies for vertical spillovers do not pinpoint which mechanisms are at play.

For example, positive backward spillovers which influence domestic firms' productivity may arise due to the direct linkage with foreign customers along the supply chain through various forms of assistance and knowledge transfer provided by foreign firms after the contract has been signed. Alternatively, domestic firms not direcly involved with foreign firms in downstream sectors may also experience productivity improvements due to the interest of foreign firms in improving the quality of sourced inputs and therefore provide help to local suppliers before they enter into contractual relationship. Alternatively, positive productivity shock may be the result of own firm effort motivated by lucrative contracts with MNCs or scale economies reflecting greater demand for domestically produced inputs (Javorcik, 2004; Javorcik and Spatareanu, 2009). All of these scenarios can broadly be regarded as spillovers, however, disentagling the exact mechanisms at play using industry level proxies is not possible.The result from dynamic panel model used to control for potential endogeneity of FDI spillover variables and TFP suggested that horizontal FDI spillovers have become more important over time, thus shedding new light on the role of MNCs in host countries. A closer investigation revealed that the positive effects were mainly driven by partially owned foreign firms indicating that domestic firms are well equipped to benefit from well diffused technology. On the other hand, the presence of fully owned foreign firms placed considerable pressure on local firms as they were not able to effectively imitate foreign technology causing reduction in their productivity levels. Alternatively, foreign firms may have been more successful in preventing the leakage of knowledge and technology to their potential competitors. When taking into account geographic heterogeneity of MNCs, we found that there was positive spillovers from European MNCs in all countries except Slovenia, thus supporting the premise that institutional and socio cultural proximity facilitated knowledge sharing, technology diffusion and learning by domestic firms. Non-European investors, the majority of which came from USA and China, also provided knowledge which was used by domestic competitors to increase their productivity. However, these results hold only for firms in Estonia and Slovenia.

The findings for backward linkages confirmed previous findings in the literature suggesting that MNCs are more likely to share their knowledge with local suppliers. They imply increasing impact in the Czech Republic, Hungary and Slovakia and decreasing impact in Estonia. A new finding is that fully owned foreign firms are driving the positive effects. On the other hand, these positive effects were offset by negative effects from partially owned foreign firms. The exceptions were the Czech Republic and Slovenia. When accounting for geographic heterogeneity of MNCs, the results were more heterogeneous. While in Hungary and Slovakia EU investors were more inclined to engage in vertical linkages, the opposite was found in other countries, thus partially confirming the hypothesis that investors from distant countries were likely to source inputs locally to save on transport and trade costs, thus confirming theoretical model of Rodriguez-Clare (1996).

Perhaps, the most interesting findings were related to forward linkages. Over time these linkages have gained more importance than backward linkages, exhibiting large productivity gains/losses for domestic firms. Based on our results, forward linkages are more likely to influence the net benefits or costs of foreign presence in the local economy. Firms in Slovakia and Slovenia were able to benefit from increased variety and quality of inputs, thus increasing their productivity. These positive effects hold across different ownership structures of foreign firms and are mainly driven by EU investors. Firms in other countries experienced a decline in their productivity and these negative effects were driven by both partially and fully owned foreign firms with the exception of Estonia where partially owned foreign firms have a beneficial effect on local firms' productivity. In addition, non-EU investors were responsible for large negative effects on productivity which completely offset any positive effects from EU MNCs.

The empirical findings showed that other factors, such as the level of intangibles and human capital to positively influence local firms' productivity in all countries. Increased competition in the industry was also found to positively influence TFP in all countries with the exception of Slovakia, while increased demand in downstream sectors exhibited mostly negative effects. We also found that productivity is negatively affected by firms' age. Although after a certain period, the variable age becomes positive, the proportion of firms in our sample that were older than estimated turning point was negligible. Also, the findings suggested that larger firms were more likely to experience positive productivity gains.

In Chapter 6 we explored further the different nature of FDI spillovers in firms in manufacturing and service sectors. We divided the sample and re-estimated the baseline model developed in Chapter 5. Furthermore, we investigated the intersectoral spillovers between manufacturing and services. The aim was to shed more light on the direction of vertical linkages between these two sectors and to explore their heterogeneity by constructing four types of vertical linkages. This included splitting total backward and forward linkages according to the main sector of MNCs' activities. The empirical analysis then estimated the effects of manufacturing (services) linkages on local firms' productivity in manufacturing sector which are at the same time supplier and customer of foreign firms located in the two main sectors of the economy. Since we found significant positive effects of knowledge capital variables in Chapter 5, we also tested their moderating effects by interacting them with FDI spillover variables.

Empirical analysis was based on a dynamic system GMM estimator as in Chapter 5 to make results comparable. Findings from the baseline model applied separately to firms in manufacturing and services suggested that the positive horizontal spillovers found in Chapter 5 were mostly driven by firms in services. The negative effects of horizontal spillovers in manufacturing sector are in line with the empirical results from other studies indicating that local firms do not have sufficient level of absorptive capacity. On the other hand, foreign firms in services require close interaction and communication thus giving domestic firms the opportunity to learn and imitate some of the best practices of MNCs. These positive effects were however observed only in Hungary and the Czech Republic. The findings suggested the importance for separating firms from different sectors.

In the case of backward linkages, our findings suggested that MNCs in services were more likely to source inputs from local firms in Hungary and Slovakia while the opposite holds for firms in the Czech Republic and Estonia. The findings related to local manufacturing firms suggested that they were not able to enter the supply chain of MNCs expect those in Slovenia. The heterogeneity of findings across countries was further supported when analysing forward linkages. These have been found to be positive only in the service sector in Slovakia and Slovenia. On the other hand MNCs in services have large negative productivity effects as suppliers of inputs to local firms in the Czech Republic, Estonia and Hungary.

By employing an augmented empirical model and disentangling vertical linkages according to industry source we found that our results for backward manufacturing linkages are in line with the current literature. In other words, local manufacturing suppliers were able to join the global supply chains of MNCs and increase their productivity through voluntary and involuntary knowledge transfer from foreign firms. We also found that MNCs in services were less keen to source their inputs from local manufacturing suppliers and more likely to resort to inputs sourced from abroad or from other foreign firms in upstream manufacturing sectors. Only local manufacturing firms in Slovakia and Hungary were able to benefit from engaging in backward linkages with MNCs in services. The most interesting findings are again related to forward linkages. Local manufacturing firms were not able to benefit from inputs bought from MNCs in the manufacturing sector. However, we have found significant and positive effects of services inputs for manufacturing productivity across all countries thus further corroborating the notion that the liberalisation of services followed by increased foreign entry was expected to bring substantial positive effects to downstream clients.

Further we investigated the interaction between firms' investment in intangible asset and FDI spillover variables. This analysis was motivated by the notion that a minimum level of absorptive capacity is necessary for firms to identify, assimilate, transform and apply the knowledge from external environment. According to the findings, the moderating effects of firms' absorptive capacity had beneficial impact on TFP of firms within the manufacturing sector as the initial negative horizontal effects were attenuated in almost all countries. Similar findings were found in the case of backward manufacturing linkages where firms in the Czech Republic and Slovenia were able to increase their TFP with higher levels of intangibles while firms in Estonia were able to attenuate initial negative effects. However, in case of backward services linkages, the moderating effects do not hold as manufacturing firms were not able to combine an existing knowledge to increase their technological capabilities which would result in new or improved intermediate inputs.

The findings related to forward linkages implied that investing in intangible assets matter for manufacturing firms in the Czech Republic, Hungary and Slovakia seeking to improve their productivity by buying services inputs. On the other hand, the moderating effect of absorptive capacity does not matter for forward linkages in manufacturing. For firms in the Czech Republic and Estonia higher levels of intangible asset have detrimental effects on their ability to benefit from manufacturing inputs. This may be due to the complexity of inputs and their prices, or the inability of manufacturing firms to transform and implement the knowledge embodied in acquired inputs.

In order to summarize our empirical findings on spillover effects of FDI explored in Chapters 5 and 6 and to better present the heterogeneity of results across countries, we have constructed a table showing all empirical models and associated signs and statistical significance (at least 10%) of FDI spilllover variables across countries. As can be seen from Table 7.1 below the findings for horizontal spillovers are mostly ambiguous which is in line with current empirical literature, further highlighting the need for better data which would allow researchers to disentangle different mechanisms of knowledge spillovers within industry. In general, horizontal spillovers across countries are mostly negative in the manufacturing sector and those from fully owned foreign firms while positive effects are limited to partially owned foreign firms and those coming from the EU.

In case of backward linkages, the empirical results are in line with the exisiting literature suggesting positive effects of MNCs on domestic suppliers' TFP. The effect seems to be strongest in manufacturing sector and only when domestic suppliers are supplied by foreign firms from manufacturing sectors. Similarly, in the majority of cases positive effects of backward linkages across countries and two major sectors are found for non-EU MNCs and fully owned foreign firms.

Finally, the major finding in the thesis is related to positive and significant effects of forward linkages from the service sector to domestic clients in manufacturing, thus shedding new light on the role of MNCs in the service sector on indigenous firms' productivity. In addition, the origin of foreign investors matters for forward spillovers as foreign firms from the EU have unambiguous positive effects on productivity of downstream clients while opposite holds for non-EU investors.

TABLE 7.1 SUMMARY OF FINDINGS ACROSS COUNTRIES AND EMPIRICAL MODELS

	SLOVENIA	SLOVAKIA	HUNGARY	ESTONIA	CZECH REPUBLIC	Overall empirical sign	Theoretical prediction
	Baseline model all industries						
Horizontal	**negative**	**negative**	**positive**	**positive**	positive	**Mixed**	**positive**
Backward	negative	**positive**	**positive**	**negative**	**positive**	**Mainly positive**	**positive**
Forward	**positive**	**positive**	negative	**negative**	**negative**	**Mixed**	**positive**
	Manufacturing industries						
Horizontal	**positive**	**negative**	**negative**	**negative**	**negative**	**Mainly negative**	**positive**
Backward	**positive**	positive	**negative**	**negative**	negative	**Mixed**	**positive**
Forward	positive	positive	negative	negative	**negative**	**Mainly negative**	**positive**
	Service industries						
Horizontal	**negative**	**negative**	**positive**	positive	**positive**	**Mixed**	**positive**
Backward	negative	**positive**	**positive**	**negative**	**negative**	**Mixed**	**positive**
Forward	**positive**	**positive**	**negative**	**negative**	**negative**	**Mixed**	**positive**
	Ownership model						
Horizontal partial	positive	**negative**	**positive**	**positive**	**positive**	**Mainly positive**	**positive**
Horizontal full	**negative**	**negative**	negative	positive	negative	**Mainly negative**	**negative**
Backward partial	**positive**	**negative**	**negative**	**negative**	**positive**	**Mixed**	**positive**
Backward full	**negative**	**positive**	**positive**	**positive**	positive	**Mainly positive**	**ambiguous**
Forward partial	**positive**	**positive**	**negative**	**positive**	**negative**	**Mixed**	**positive**
Forward full	**positive**	**positive**	**negative**	**negative**	**negative**	**Mixed**	**ambiguous**
	Origin model						
	Slovenia	Slovakia	Hungary	Estonia	Czech Republic		
Horizontal EU	**negative**	negative	**positive**	**positive**	**positive**	**Mainly positive**	**positive**
Horizontal nonEU	**positive**	**negative**	positive	**positive**	**negative**	**Mixed**	**ambiguous**
Backward EU	**negative**	**positive**	**positive**	**negative**	**negative**	**Mixed**	**ambiguous**

Backward nonEU	**positive**	**negative**	positive	**positive**	**positive**	**Mainly positive**	**positive**
Forward EU	**positive**	**positive**	**positive**	positive	**positive**	**Strongly positive**	**ambiguous**
Forward nonEU	positive	positive	**negative**	**negative**	**negative**	**Mainly negative**	**ambiguous**
	Cross sectoral-manufacturing						
	Slovenia	Slovakia	Hungary	Estonia	Czech Republic		
Horizontal	positive	**negative**	**negative**	**negative**	**negative**	**Strongly negative**	**positive**
Backward manufacturing	**positive**	**positive**	**positive**	**negative**	**positive**	**Mainly positive**	**positive**
Backward services	**negative**	**positive**	**negative**	**positive**	**negative**	**Mixed**	**ambiguous**
Forward manufacturing	negative	negative	**negative**	**negative**	**negative**	**Strongly negative**	**positive**
Forward services	**positive**	**positive**	**positive**	**positive**	**positive**	**Strongly positive**	**positive**
	Absorptive capacity						
	Slovenia	Slovakia	Hungary	Estonia	Czech Republic		
Horizontal	**positive and increasing from median levels**	**negative and decreasing with higher levels**	**mostly negative with very little change**	**negative and decreasing up to median level**	**negative and increasing with higher levels**	**Mixed**	**positive**
Backward manufacturing	**positive and increasing with higher levels**	**positive with very little change**	**positive and decreasing with higher levels**	**negative and decreasing up to median level**	**positive for above median levels**	**Mixed**	**positive**
Backward services	**insignificant**	insignificant	**negative and decreasin with higher values**	**negative at high levels**	**negative and increasing with higher levels**	**Mostly negative**	**positive**

Forward manufacturing	insignificant	insignificant	**mostly negative with very little change**	**positive at very low and negative at very high levels**	**negative and increasing with higher levels**	**Mostly negative**	**positive**
Forward services	**positive and decreasing up to median levels**	**positive with higher levels**	**positive for above median levels**	insignificant	**positive for above median levels**	**Mostly positive**	**positive**

Note: words marked in bold indicate effect at least at 10 percent significance level. Cells marked in green indicate empirical findings in line with theoretical prediction while those marked in red indicate the opposite.

This thesis has made several contributions to existing theoretical and empirical body of knowledge on FDI spillovers. Based on review of the literature on determinants of FDI we argued that varieties of theoretical concepts are not able to fully explain the complex and multidimensional nature of FDI. While international business literature assumes that MNCs possess superior firm specific advantages in comparison to domestic firms, early studies failed to explain MNCs' heterogeneous nature in terms of investment motives, mode of entry, technology, knowledge or productivity. The early models of FDI spillovers were based on the neoclassical theory assuming that the intensity of MNCs' activities is a measure of potential for FDI spillovers to host country firms. Therefore, to revise the assumption of MNCs' homogeneity, commonly made in FDI spillovers studies conducted on transition economies, we have combined recent insights from international business and international economics literature emphasizing the heterogeneity of MNCs and their affiliates. We have proposed that the effects of FDI spillovers may differ according to MNCs' observable characteristics available in the dataset and other non-observable heterogeneities. Our conceptual framework emphasized that FDI spillovers are determined by both demand and supply side factors and shaped by external environment such as industry characteristics and institutional framework in which firms operate.

We have also argued that existing theoretical models of vertical linkages between MNCs and local firms place too much emphasis on backward linkages occurring within manufacturing sector. Notwithstanding the importance of backward linkages for local firms' development in manufacturing sector, forward linkages have received less attention. We have argued that liberalisation and deregulation of services followed by entry of MNCs in services are an important conduit to better quality and variety of inputs available at lower price, hence contributing to manufacturing productivity and better functioning of specialised and interdependent operations. Since services are often characterized by intangibility, inseparability and require frequent interaction and proximity between supplier and customer due to information asymmetries about quality, we argued that MNCs are the main conduit for technology spillovers to downstream clients thus shedding new light on the role of forward linkages.

Our first empirical contribution is related to the estimation of TFP at firm level. Most studies employing semi-parametric techniques lacked a critical examination of the data generating process of different estimators, the robustness checks for TFP estimates across different estimators was rarely performed, the elasticity of factor inputs was almost never discussed and the potential pitfalls arising from the violation of timing assumptions of inputs were ignored. In cases when authors extensively tested the assumptions of certain estimators they used data from only few industries in one country framework. Therefore, our contribution lies in the application of semi-parametric methods to a broad set of industries and countries. Another contribution to knowledge is related to the method employed when estimating TFP. We used Wooldridge (2009) application of semi-parametric methods which corrects some of the problems discussed in Ackerberg et al. (2006) not previously addressed in estimation of TFP in transition countries.

We also estimated both value added and gross output in a Cobb Douglas production function framework and tested the timing assumptions of labour input. We have found that value added production function treating labour as static input is suitable for our dataset. However, none of the existing studies using TFP as a dependent variable to evaluate the impact of policy measures such as FDI spillovers have acknowledged potential issues in TFP estimates arising from different timing assumptions of labour input. Thus, our findings may point to possible publication bias and be considered as additional contribution to knowledge.

Our estimation of FDI spillovers has made several contributions to the existing literature. First, we expand our knowledge on the effects of MNCs on their local competitors, their suppliers and clients in transition countries by applying an empirical model to a set of advanced NMS, simultaneously taking into account both types of vertical linkages and horizontal spillovers. In addition, we add to the literature by employing the same dependent variable estimated by using the unique method previously not explored in the context of transition countries. Furthermore, by using time varying input-output tables we were able to take into account dynamic structural changes and differences in sourcing behaviour of MNCs in transition countries which has not been done in previous empirical work. Second, this is the first study which treats FDI spillovers in a dynamic framework thus taking into account theoretical transmission channels of knowledge spillovers which differentiate between short and long run effects. With this in mind we used dynamic system GMM estimation which accounts for potential endogeneity of FDI spillover variables and the dynamics of firms' productivity as implied by the control function approach used to derive it. Third, our study is the first one to include the service sector of these countries which has largely been ignored in the investigation of FDI spillovers. Fourth, we depart from the contemporary literature which has focused on issues such as the role of local firms' absorptive capacity and demand size of FDI spillovers. Our augmented empirical model is the first study which takes into account the supply side of FDI spillovers by examining the geographic and ownership heterogeneity of MNCs in this set of countries.

We have also separately examined FDI spillovers in manufacturing and services, adding to the current literature which has mainly focused on the manufacturing sector. Given the large inflows of FDI in services and the importance of its inputs for downstream clients this thesis addressed and clarified some of the misunderstandings related to the role of forward vertical linkages and their impact on productivity of downstream manufacturing firms. We showed that the current measurement of vertical linkages does not permit the measurement of overall spillover effects according to the channels through which they occur. Construction of four types of vertical linkages enabled us to shed more light on the customer-supplier relationship between domestic and foreign firms in the two main sectors of economy.

The final contribution of this thesis is its temporal, sectoral and geographical coverage. Through a critical review of the literature in Chapter 2 we came to conclusion that existing studies investigating FDI spillovers in transition countries are mainly focused on the manufacturing sector. Moreover, most of these studies are conducted using data from the first decade of transition or early 2000s while the bulk of FDI inflow took place in the later period of transition. Our empirical analysis covers the period which coincided with the large inflows of FDI in services and changes in macroeconomic and business environment as well as the progress in institutions which further influenced the entry, type and motives of MNCs. Furthermore, it can be argued that in the second decade of transition domestic firms improved their absorptive capacity and the quality of their products. Finally, we were able to estimate the effects of FDI spillovers using common data, methodology and empirical model for the five leading NMS, thus enabling us to provide more valid and comparable results across countries.

7.4 POLICY IMPLICATIONS

Throughout this thesis we have emphasized the relationship between heterogeneous nature of MNCs, sectoral heterogeneity and the differential impact of vertical linkages on the one hand and the ability of indigenous firms to increase their productivity and increase their competitiveness in national and international markets on the other. It was stressed that NMS have been successful in attracting FDI in medium high and high technology sectors which has enabled them to reduce the productivity gap *vis-a-vis* more advanced market economies and become more specialised in production of products with higher value added. By choosing export led strategies, NMS have successfully integrated in international trade and stimulated their economic growth (Rugraff, 2008). However, given the rising importance of GVCs and the prominent role played by MNCs in world production and distribution, further development and growth of NMS depends on their successful integration in MNCs' networks and their orientation toward knowledge based economy.

The main source of productivity improvements in the analysed countries emerged from vertical linkages with MNCs accompanied by high stock of knowledge capital, namely the share of intangible assets and high levels of human capital. However, the productivity effects largely depend on the type of vertical linkages and the heterogeneity of MNCs. Therefore, one of the most important issues for analysed countries is the identification of channels through which heterogeneous MNCs contribute to indigenous firms' productivity and measures which can facilitate the inclusion of local firms in MNCs' supply network. In devising policy recommendations which can serve as a guideline to governments for raising prospects for indigenous firms' integration in GVCs, we will primarily rely on findings from the empirical chapters. The set of policy recommendations are organized in three areas: (i) attracting the "right" type of foreign investors; (ii) establishing the right kind FDI incentives to promote linkages with MNCs; and (iii) increasing the capacity of local firms to benefit from FDI spillover potential.

7.4.1 ATTRACTING THE RIGHT TYPE OF FOREIGN INVESTORS

One of the key messages of this thesis is that not all foreign investors are the same. Therefore, given the importance of spillovers, FDI promotion should be designed to allocate incentives depending on the motive and type of foreign investment as well as the sector of operation. So far, NMS have adopted the so-called 'Irish model', offering generous fiscal and financial incentives in order to attract large scale FDI with almost no performance requirements and without formulating sufficient incentives for the foreign firms to interact with the local environment (Rugraff, 2008; Jindra and Rojec, 2014). Therefore, further promotion and incentives should be based on active promotion of specific sectors and activities within the sector which can increase local firms' participation in GVCs so as to emphasise the fragmentation of tasks and activities and not industries anymore. Incentives offered to foreign investors should be based on the promotion of R&D activities and the attraction of technologically more advanced, fully owned MNCs and those engaged in activities with high value added such as services. Although still limited, backward linkages in services are gaining importance suggesting that besides positive effects of efficiency seeking investors on local manufacturing suppliers, policy makers should put more emphasis on attracting market seeking investors in services as they are less sensitive to costs consideration than efficiency seeking investors. This is also suggested by findings in Chapter 6 where local firms were shown to benefit from backward linkages with MNCs in services in Estonia, Hungary and Slovakia.

Furthermore, investment promotion strategies coordinated and implemented by investment promotion agencies should put emphasis not only on employment effects or the amount of investment, but also on potential for technology transfer, R&D activities and development of linkages. By attracting MNCs in services especially those in the energy sector, telecommunications, transport, logistics and ICT, the potential for spillovers is likely to be of cross-sectoral nature, thus improving productivity of downstream manufacturing clients by providing high quality inputs as suggested by findings in Chapter 6. The evaluation criteria for granting fiscal, financial or other type of incentives should include the strategy and commitment for technology transfer and creation of linkages with local firms. Investment incentives could take into account the degree of foreign ownership and the country of origin of MNCs given their differential impact on productivity of local firms across countries.

With increasing fragmentation of GVCs, Tier 1 suppliers followed their main customers to host countries, thus making it very difficult for local suppliers to directly supply MNCs, especially those in the service sector. Hence, promotion efforts should also be targeted at Tier 2 or Tier 3 suppliers with lower quality requirements and those who have already established contracts with Tier 1 suppliers. Although this may reduce the potential for technology transfer due to their lower knowledge capacity, their cooperation with local suppliers would enable the latter to learn and gradually improve the quality of their inputs and efficiency of operations (Farole and Winkler, 2014). To the extent that development of supplier linkages is important in a country, they should attract foreign investors from distant countries given their reliance on localised inputs.

7.4.2 PROMOTION OF LINKAGES

Another set of FDI promotion policies is related to the integration of MNCs into host country. The basic premise here is that the high integration of MNCs with local firms would result in higher potential for knowledge spillovers, transfer of technology and management know-how. One way in which the government can promote the development of linkages with MNCs is the provision of timely information to local firms about the technology characteristics and encouraging worker mobility in order to benefit from the potential tacit knowledge. As argued by Farole and Winkler (2014) one way of reducing information asymmetries is to encourage the establishment of Special Economic Zones (SEZ) in which both foreign and local firms can engage in mutual information sharing, exchange technology and facilitate greater integration of MNCs in the local economy. This in turn would lead to an increase in productivity of local firms through external economies of scale, assistance effects and knowledge diffusion. Given the findings in Chapter 5 which pointed out the beneficial effects of well diffused technology brought by partially owned foreign firms for local competitors and suppliers in some of the analysed countries, closer interaction between foreign and domestic firms in SEZ would be more likely to result in more intensive collaboration. This would enable some local supplier firms to offset some of negative productivity effects from partially owned foreign firms and learn about their requirements in order to establish deeper linkages with them. Similar reasoning applies to fully-owned foreign firms which in general are less keen to share knowledge with their competitors. However, the creation of clusters which connect competitors and local suppliers or clients would be an important step towards more intensive knowledge sharing activities.

The exchange of information aimed at matching investors' needs with the absorptive capacity of domestic firms is an important role for governments. For example, investor promotion agencies could establish a database of MNCs' requirements in terms of quality, delivery time, scale of production and required quality certificates and at the same time could offer to foreign investors information about domestic suppliers or clients. The organization of exhibitions in which domestic and foreign firms can present their product range or input and skill requirements is an alternative way of promoting active linkages (Farole and Winkler, 2014).

Also, fiscal and financial incentives offered to MNCs could be linked to their sourcing strategies, the scale of their R&D investments and technology brought to host countries. In this regard, if the promotion of linkages is high on government agenda, attracting MNCs from distant countries in general brings more benefits for local suppliers while investors from the EU region are more likely to provide valuable inputs to downstream firms. In addition, governments should develop supplier programmes which should encourage the development and upgrading of domestic firms in the medium and long term. One way to achieve this is to help domestic suppliers meet international quality standards such as ISO which are usually the first requirement of MNCs before engaging in vertical linkages. In addition, the government should provide information about any industry specific requirements needed by MNCs in order to facilitate the creation of vertical linkages and entry of indigenous firms into GVCs (Farole and Winkler, 2014).

As suggested by findings in Chapter 6, the higher intensity of the use of intangible assets is more likely to benefit local customers in manufacturing sector buying more specialized and advanced inputs from MNCs in services and attenuate negative productivity effects from direct foreign competitors. Therefore, investing in R&D institutions and attracting R&D intensive MNCs, which could become embedded in national innovation system, would facilitate the creation of vertical linkages. As mentioned above, by focusing more on the creation of specialized clusters and by offering incentives to foreign subsidiaries to stimulate technological activities and cooperation between domestic and foreign firms, knowledge spillovers from FDI can be maximised. This would at the same time reduce the likelihood of disinvestment by MNCs and their reallocation to next low cost location and encourage them to engage in asset augmenting activities characterised by higher technological content and deeper local embeddedness.

Finally, an important role for the government is to establish the institutional framework with emphasis on the rule of law, contract enforcement to reduce hold-up problems, better protection of intellectual property rights and improvements in the bureaucratic apparatus. Furthermore, given beneficial effects of intermediate input from services, any remaining barriers limiting competition, conduct regulation or FDI restrictions in services should be reduced.

7.4.3 INCREASING THE ABSOPRTIVE CAPACITY OF LOCAL FIRMS

The degree to which local firms benefit from foreign investors and MNCs' integration in host countries crucially depends on the absorptive capacity of local competitors, suppliers and customers. The empirical analysis demonstrated large heterogeneity among countries in terms of benefits they receive from MNCs. These findings raise several suggestions. Given the negative effects of horizontal spillovers in general, especially those arising in the manufacturing sector and fully owned foreign firms, governments should actively promote investment in absorptive capacity. While there is a potentially broad range of interventions that government may take to improve absorptive capacity they should primarily aim to build firms' and workers' ability to capture foreign technology and access opportunities arising from the presence of foreign firms.

As suggested by the findings in Chapter 6, local firms will be more likely to benefit from joint cooperation with MNCs in the same sector. FDI in services may be particularly important in this regard as the latter often involves frequent interaction and exchange of ideas and generate high paid jobs, thus enabling local firms to benefit from worker mobility and improve their human capital.

Improvements in absorptive capacity would result in the reduction of technology gap and in turn help indigenous firms to adopt state of the art technology brought by fully owned firms and MNCs located in high tech sectors. Provision of additional research grants to invest in new technology and management and technical training through various government programmes is one way to improve absorptive capacity (Farole and Winkler, 2014). In addition, supplier development programmes mentioned above should take into account the heterogeneity of MNCs and local firms since successful matching programmes require compatibility in technology, skills and ability of local firms to upgrade in high-value added activities. Hence, any linkage promotion should be based on programmes with clearly defined criteria that participating firms must satisfy in terms of quality of human capital, the share of innovative products and services and the level of productivity.

In addition, the successful adoption of foreign technologies depends on firms' access to finance since investments in absorptive capacity usually entail sunk costs. Therefore, the government should put more efforts to promote affordable access to credit through financial sector reforms. One way to achieve this would be to offer better credit terms to local firms through loans available from private and state development banks and guarantees backed by either MNCs engaged in vertical linkages with local supplier or the state (Farole and Winkler, 2014).

The findings from Chapters 5 and 6 uniformly confirmed the importance of knowledge capital for productivity and the ability of firms to attenuate possible negative FDI spillovers or further increase positive effects. We identified two channels through which local firms can increase their productivity. The first one is related to investments in human capital. While governments can in general improve the quality of human capital by improving the education system, raise the overall level of highly educated persons and pay attention to future skill requirements when devising national curriculum, increasing firms' productivity also requires specific investments. One way to attract and keep highly qualified personnel is to offer them efficiency wages or similar pay incentives as they positively affect firms' productivity. Additional attention should be paid to on the job training especially in the light of increased complexity of the technology brought in by more advanced MNCs. In order to benefit from FDI knowledge spillovers, local firms need to be able to retain their highly qualified employees and invest in training. One way to achieve this is through co-financing the salaries and various forms of training of employees working on the introduction of new technology or the provision of subsidies for requalification of employees (Jindra and Rojec, 2014). In addition, the organization of specific training courses by industry associations should be encouraged.

The second channel through which local firms are able to increase their productivity is related to investment in intangible asset. The relative importance of physical endowments has received less attention due to their relative abundance. However, the quality and availability of "soft" production factors such as intangible asset is becoming the driving force of firms' productivity and economic growth (Corrado et al., 2009; Dettori et al., 2009; Marrocu et al., 2010; Borgo et al., 2013). This has important implications for fiscal and financial incentives which should be designed to stimulate local firms to accumulate intangible assets such as software, R&D, patents, employee training and economic competences. In this regard, collaboration with research institutes and universities is crucial as the creation of research funds, promotion of high quality research and availability of grants can promote collaborative activities resulting in new products and processes, skill developments, new curriculum and technology transfer.

In the long run policies should aim at improving financial markets, quality of education system and vocational training and infrastructure which should lay the foundations for a knowledge based economy. Improvements in physical infrastructure such as railways or roads would also lead to more even distribution of FDI across regions and encourage worker mobility, thus enabling employees to easily switch their jobs and employ the knowledge gained in foreign firms. Moreover, given the goal of NMS to become knowledge based economies, more emphasis should be placed on improvements in energy, telecommunications and ICT infrastructure in order to attract high technological MNCs.

7.5 LIMITATIONS OF RESEARCH

This thesis made several contributions to the existing body of knowledge on FDI spillovers in general and in transition countries in particular. However, the research faced several constraints and limitations which deserve further discussion. Most of the limitations have resulted from the lack of appropriate data which had implications for the analysis in different chapters. Our initial goal was to include two additional Baltic countries but, because of the poor quality of output and employment data, it was not possible to estimate TFP and, therefore, Lithuania and Latvia had to be dropped from the sample. Although the Amadeus database is an ideal, and much used, source of firm level information, it contains a large number of missing observations on input and output data - which makes it is less ideal for TFP estimation. This is especially pronounced in the data for Hungary. We also faced another problem in Hungarian sample: the above average representation of large firms and the small number of observations in early years. The latter fact raises a question about the validity of results.

It is important to note that our measure of TFP includes inputs which are not explicitly included in the production function such as management skills and human capital skills, capacity utilisation and intangible assets and thus is overestimated. Furthermore, our TFP measure is estimated using monetary values and does not control for other potential biases arising from using industry deflators to measure firm's physical output and assumption that firms produce only one product.

Throughout the thesis we have emphasized the importance of technology spillovers as they are the main conduit for economic growth according to new growth theories. Since technology is difficult to measure, we resorted to the second best solution and estimated TFP-raising spillovers which are basically the effects of technology.

The quantitative analysis of FDI spillovers relied heavily on industry level data obtained from input-output tables to measure the inter-industry linkages between foreign and domestic firms- instead of the more accurate, but not available, firm level sourcing data. Although we have contributed to the literature by using time varying input-output coefficients, this came at the expense of using somewhat aggregated industry classification. A consequence of this is that vertical linkages may not be fully identified if they occur at lower levels of aggregation and thus the effects of horizontal spillovers may be overestimated. There are two other limitations with regard to how FDI spillovers are estimated. We adopted a conventional approach based on production function. However, this approach did not allow us to distinguish gains from technology spillovers and potential losses arising from increased competitive pressure, and thus what we observed is a net effect. In addition, the effects of FDI spillovers are limited to only one variable. However, it may be argued that FDI spillovers may affect the innovative activities of firms as well.

In Chapter 5, in order to identify MNCs' heterogeneity we took a headquarter-centred perspective in which foreign firms' superior advantage arises from the exploitation of existing ownership advantages. This conceptual view ignores strategic and technological developments where foreign subsidiaries play an important role in MNCs' network by increasing their capabilities, innovation activities and functional scope over time, creating new knowledge and contributing to diversification of products and market. As a consequence of frequent interaction with local partners and greater local embeddedness in host economies, the potential for technology spillovers may be higher. However, the Amadeus data did not allow us to distinguish between different types of MNCs' subsidiaries and to incorporate the recent theoretical development in international business literature. Due to space constraints of this thesis, the heterogeneity of service and manufacturing sectors in Chapter 6 was not further explored to find out if the results for vertical linkages were driven by specific service or manufacturing sectors. Furthermore, additional heterogeneity in terms of firms' size, technology intensity of industries, productivity levels of both foreign and domestic firms was not explored.

Finally, limitations were also present in modelling other firm characteristics. This was particularly true for variables controlling for absorptive capacity. The latter is a multidimensional concept which can hardly be captured with only two variables measured in a rather crude way. First, human capital is proxied by average wage which may not reflect the level of education, occupational structure, the number of workers that received training or the level of cognitive skills. Second, intangibles comprise a variety of assets grouped as digitalized information, innovative property and economic competences. Again, the Amadeus database does not provide detailed information on these different groups. Furthermore, innovative capabilities and computerised information are reported in firm's balance sheet while economic competencies such as costs related to employee training are not.

7.6 DIRECTIONS FOR FURTHER RESEARCH

Although this research has addressed some specific research questions related to the effects of FDI spillovers on productivity of local firms in transition countries, it also raises new questions for research. Some important areas together with limitations discussed in the previous section worth considering for future research are discussed below.

First, future research may explore scenarios in which foreign subsidiaries are an important part of the mechanism for transferring knowledge from MNCs' headquarters. A subsidiary adopts different roles within MNCs' network and has been argued that their autonomy on production and technology decisions enables them to develop their independence, use a wider range of local inputs and generate higher levels of linkages with their host economy (Birkinshaw and Hood, 1998; Cantwell and Mudambi, 2005; Blomkvist et al., 2010; Marin and Sasidsharan, 2010; Giroud et al., 2012). Specially designed firm level surveys could be used as a basis for this type of research. In addition, this type of data could better describe the quality of linkages in terms of transferred technology, products and skills; duration of such linkages; extent of learning which occurs due to interactions between foreign and local firms and their employees (Giroud and Scott-Kennel, 2009).

Second, very few studies have focused on the effects of knowledge spillovers and vertical linkages on the export propensity and intensity of local firms and possible factors within the transmission channels which may influence export spillovers from FDI. Although the Amadeus database contains data on the share of export in total sales they are confined only to two countries from our sample. However, more detailed data could be obtained from the Business Environment and Enterprise Performance Surveys (BEEPS)[69] which also has the advantage of providing additional factors influencing the transmission channels.

Third, our empirical analysis investigated the net effects arising from benefits of technology spillovers and potential losses arising from increased competitive pressure.

[69] BEEPS is a firm level survey carried out by European Bank for Reconstruction and Development (EBRD) whose aim is to gain understanding of firm's perception of the environment in which they operate. It includes questions from several broad areas such as access to finance, innovation, competition, infrastructure and firms' financial data.

One way to disentangle these two effects is to resort to estimation of entrepreneurial spillovers usually measured by entry of new and exit of existing firms from the market.

Finally, future research on FDI spillovers may take more direct approach to trace the flow of knowledge and technology across firms instead of relying on industry level proxies (Driffield et al., 2010). In this regard, the use of Community Innovation Surveys (CIS)[70] data can be exploited to a greater extent by using survey questions concerning knowledge spillovers and flows between various firms in the economy. In addition, one may investigate different stages of innovation process. Using the model developed by Crepon et al. (1998), future research will be able to examine the impact of FDI spillovers on the decision of firms to innovate and the amount of innovation expenditure, the transformation of innovation input to innovation output and document the detailed mechanism through which FDI spillovers affect performance of firms.

[70] CIS is a survey of innovation activities of enterprises carried out by EU member states' statistical offices every two years. Its main aim is to collect detailed information on different types of innovation and other various aspect related to development of an innovation.

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APPENDICES

APPENDIX I.
SUPPLEMENT TO CHAPTER THREE

1.1 INCOME AND PRODUCTIVITY CONVERGENCE IN NMS

TABLE I.1 GDP PER CAPITA (PPP) GROWTH RATES IN NMS AND EU 15

GEO/TIME	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average 1996-2013
EU 15	**4.71**	**5.62**	**4.26**	**4.59**	**7.32**	**3.18**	**3.08**	**0.43**	**4.26**	**3.67**	**4.72**	**4.89**	**-0.72**	**-6.50**	**3.86**	**2.23**	**1.45**	**0.36**	**2.86**
Bulgaria	-15.22	5.13	14.63	4.26	10.20	9.26	10.17	6.15	8.70	9.33	9.76	11.11	9.00	-5.50	4.85	8.33	3.42	-0.83	**5.71**
Czech Republic	8.04	1.65	0.00	4.07	5.47	6.67	4.17	5.33	6.96	5.33	6.18	8.99	-1.94	-3.96	1.55	3.05	1.97	-0.48	**3.50**
Estonia	9.43	17.24	5.88	5.56	13.16	6.98	10.87	10.78	9.73	11.29	13.04	12.18	-1.71	-13.37	6.04	9.49	5.78	2.73	**7.51**
Croatia	13.43	7.89	4.88	0.00	10.47	5.26	11.00	5.41	6.84	5.60	6.82	10.64	3.85	-8.02	-1.34	3.40	2.63	0.00	**4.93**
Latvia	8.70	12.00	10.71	3.23	7.81	10.14	10.53	8.33	10.99	9.90	12.61	14.40	2.10	-13.01	6.30	11.11	9.33	5.49	**7.82**
Lithuania	7.69	10.71	9.68	1.47	8.70	10.67	9.64	13.19	7.77	10.81	10.57	13.97	3.87	-15.53	11.03	11.92	8.28	4.37	**7.71**
Hungary	5.33	7.59	7.06	4.40	8.42	11.65	8.70	3.20	5.43	4.41	4.93	2.68	3.92	-3.77	5.23	4.97	0.59	1.18	**4.77**
Poland	9.52	10.14	6.58	6.17	6.98	2.17	5.32	2.02	7.92	5.50	6.96	10.57	3.68	0.71	8.45	6.49	4.27	2.34	**5.88**
Romania	6.25	-7.84	-4.26	4.44	6.38	10.00	9.09	8.33	15.38	6.67	15.00	16.30	14.02	-4.10	5.98	4.03	5.43	2.21	**6.30**
Slovenia	7.34	8.55	5.51	7.46	5.56	3.95	6.33	2.98	8.09	4.81	5.61	6.76	2.71	-11.01	1.98	2.91	0.94	-0.47	**3.89**
Slovakia	8.57	9.21	6.02	2.27	5.56	8.42	7.77	3.60	6.96	9.76	10.37	13.42	7.10	-6.08	6.47	4.42	2.65	1.03	**5.97**
Average NMS	**5.95**	**7.12**	**5.68**	**4.10**	**7.90**	**6.84**	**7.41**	**5.12**	**7.76**	**6.75**	**8.38**	**9.81**	**3.31**	**-7.30**	**4.86**	**5.58**	**3.57**	**1.39**	**5.23**

Source: Eurostat; author's calculations

TABLE I.2 GDP PER CAPITA (PPP) GAP, PERCENTAGE OF EU 15

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average 1995-2013
Bulgaria	27	22	22	24	24	25	26	28	29	31	32	34	36	39	40	40	43	43	43	**32**
Czech Republic	66	68	65	63	62	61	63	64	67	69	70	71	74	73	75	73	74	74	74	**69**
Estonia	31	33	36	37	37	39	41	44	48	51	54	59	63	62	58	59	63	66	67	**50**
Croatia	39	43	44	44	42	43	44	47	50	51	52	53	56	58	58	55	55	56	56	**50**
Latvia	27	28	30	32	31	31	33	36	39	41	44	47	51	53	49	50	55	59	62	**42**
Lithuania	31	31	33	35	34	34	37	39	44	45	48	51	56	58	53	56	61	66	68	**46**
Hungary	44	44	45	46	46	47	51	53	55	56	56	56	55	57	59	60	61	61	61	**53**
Poland	37	39	40	41	42	42	41	42	43	44	45	46	49	51	55	57	60	61	63	**47**
Romania	28	29	25	23	23	23	24	26	28	31	31	35	38	44	45	46	47	49	50	**34**
Slovenia	64	66	68	68	70	69	70	72	74	76	77	78	79	82	78	77	77	77	76	**74**
Slovakia	41	43	44	45	44	43	45	47	49	50	53	56	61	65	66	67	69	70	70	**54**
Average NMS	**40**	**40**	**41**	**42**	**41**	**42**	**43**	**45**	**48**	**50**	**51**	**53**	**56**	**58**	**58**	**58**	**60**	**62**	**63**	**50**

Source: Eurostat; author's calculations

TABLE I.3 LABOUR PRODUCTIVITY GROWTH PER PERSON EMPLOYED (CONVERTED TO 2013 PRICE LEVEL WITH 2005 PPP, 1995=100)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average 1996-2013
EU 15	**1.72**	**2.42**	**1.39**	**1.91**	**2.42**	**0.41**	**0.99**	**1.20**	**2.13**	**1.13**	**1.69**	**1.39**	**-1.28**	**-2.62**	**2.25**	**0.87**	**-0.08**	**0.45**	**1.02**
Lithuania	4.29	7.49	8.49	1.25	7.90	10.92	3.11	7.88	7.39	5.19	5.87	6.82	3.59	-8.61	15.31	5.55	1.85	1.99	5.35
Estonia	8.44	11.68	8.85	4.39	11.35	5.42	5.12	6.29	6.36	6.71	4.48	6.64	-4.31	-4.54	7.70	2.42	1.66	0.98	4.98
Latvia	5.99	5.04	5.93	4.77	8.81	6.07	4.09	5.60	7.53	8.40	5.77	6.18	-3.66	-5.23	3.65	14.65	3.36	2.03	4.94
Poland	4.98	5.58	3.77	8.81	5.93	3.50	4.60	5.09	4.07	1.43	2.95	2.19	1.23	1.22	3.40	3.49	5.56	1.22	3.83
Slovakia	4.76	5.53	4.85	2.64	3.39	2.89	4.49	3.65	5.30	4.96	6.14	8.23	2.45	-3.04	6.03	1.19	1.75	0.85	3.67
Romania	5.26	-5.89	-0.23	0.33	3.21	6.81	16.97	5.29	10.32	5.76	7.14	5.93	7.34	-4.69	-0.88	2.99	-0.58	1.67	3.71
Bulgaria	-11.46	1.47	5.95	6.57	8.30	4.95	4.41	2.47	4.05	3.56	3.07	3.17	3.74	-3.83	4.44	4.13	3.36	0.65	2.72
Croatia	5.92	23.10	-7.43	0.34	4.33	3.14	4.03	1.44	2.61	3.54	1.04	1.55	1.00	-5.21	3.00	2.36	1.98	0.14	2.60
Czech Republic	3.99	-0.14	1.56	3.95	5.04	3.41	1.51	4.60	5.08	4.57	5.61	3.54	0.77	-2.78	3.53	1.85	-1.41	-0.37	2.46
Slovenia	5.76	6.91	3.62	3.74	2.69	2.36	2.22	3.24	3.99	4.49	4.24	3.51	0.78	-6.24	3.49	2.37	-1.73	-1.04	2.47
Hungary	0.08	2.97	2.48	0.38	3.21	3.88	4.59	3.85	5.81	4.27	3.45	-0.60	2.74	-4.39	0.21	1.26	-1.80	0.19	1.81
Average NMS	**3.46**	**5.80**	**3.44**	**3.38**	**5.83**	**4.85**	**5.01**	**4.49**	**5.68**	**4.81**	**4.52**	**4.29**	**1.42**	**-4.30**	**4.53**	**3.84**	**1.27**	**0.76**	**3.50**

Source: Total Economy Database™; authors' calculations.

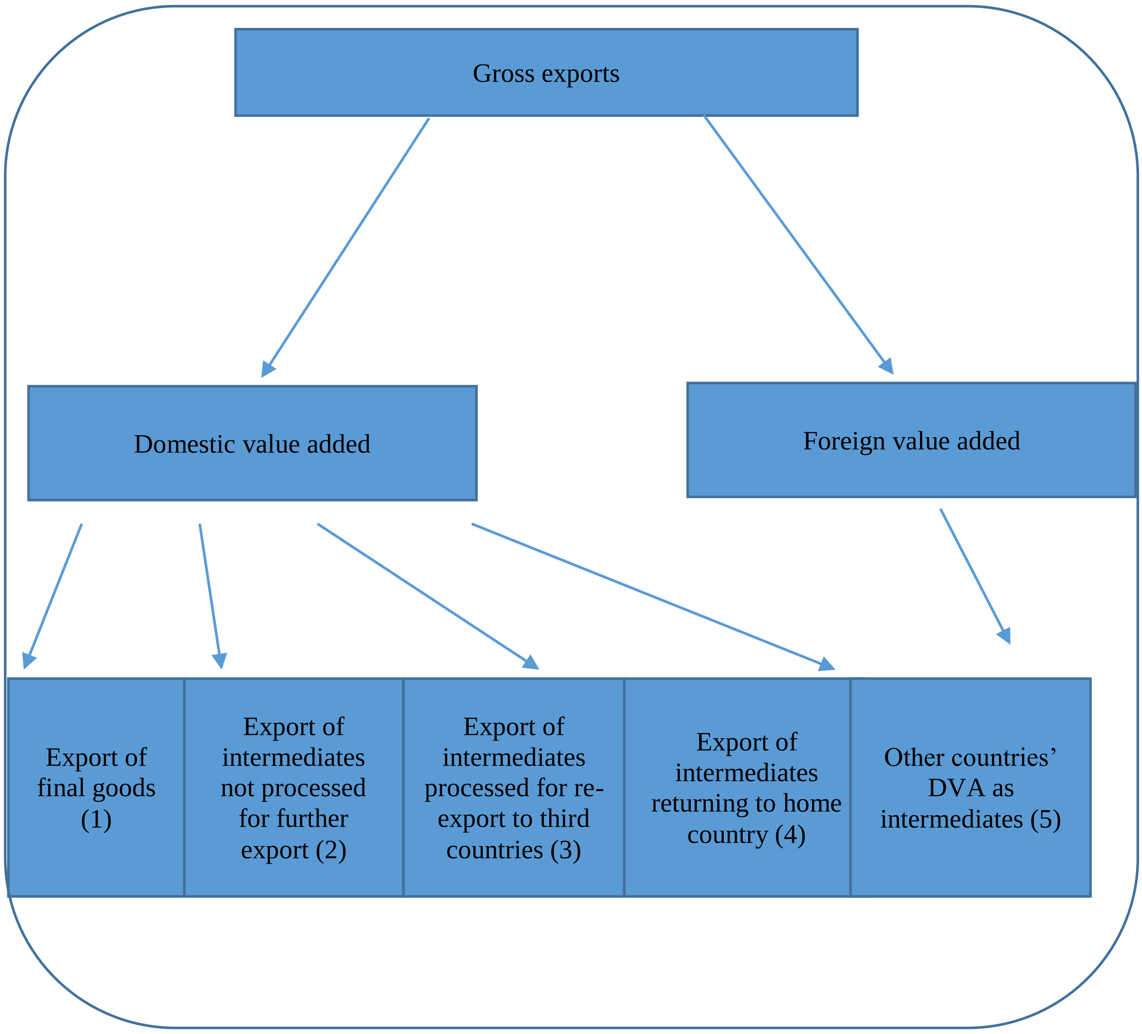
TABLE I.4 TOTAL FACTOR PRODUCTIVITY GROWTH

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average 1996-2013
EU15	**0.68**	**1.24**	**1.12**	**0.99**	**1.53**	**0.47**	**-0.03**	**0.29**	**1.09**	**0.54**	**1.42**	**0.93**	**-1.01**	**-3.84**	**1.97**	**1.11**	**-0.62**	**-0.15**	**0.43**
Latvia	7.43	10.69	9.08	5.75	8.23	5.90	5.84	7.19	5.06	4.26	5.77	0.26	-7.04	-7.15	2.79	5.32	3.92	2.79	**4.23**
Lithuania	4.52	6.48	5.88	-1.36	4.91	7.14	3.14	6.54	4.75	3.78	3.10	4.38	-0.93	-12.17	3.61	4.32	1.73	1.15	**2.83**
Romania	6.34	-4.97	0.16	0.92	3.00	5.99	11.89	5.22	8.50	3.45	4.88	0.80	1.92	-7.85	-2.45	-0.22	1.71	2.70	**2.33**
Slovakia	2.75	2.89	0.26	-1.14	0.86	1.06	2.96	3.85	4.18	3.75	4.76	6.64	1.47	-4.95	4.76	0.68	1.31	1.94	**2.11**
Poland	4.55	4.52	2.14	4.42	2.90	0.99	2.10	3.29	3.44	1.13	2.76	2.22	-0.88	-0.09	2.80	1.81	-0.53	-0.30	**2.07**
Estonia	4.50	8.20	3.86	-0.36	7.47	2.59	2.10	1.84	2.51	3.57	2.27	2.37	-8.50	-10.81	4.26	2.79	1.52	-1.12	**1.62**
Slovenia	3.78	4.97	1.90	2.38	1.62	1.16	1.55	1.62	2.60	2.71	2.71	2.47	-0.66	-7.55	2.39	1.64	-1.88	0.06	**1.30**
Czech Republic	1.94	-1.82	-0.76	1.44	3.47	1.86	0.14	2.78	3.75	4.04	4.66	2.59	-0.05	-5.02	1.77	1.14	-1.77	-1.36	**1.04**
Bulgaria	1.16	-0.14	3.28	-4.17	6.04	2.38	2.70	2.20	3.08	1.28	0.90	1.16	-0.97	-7.34	0.85	1.43	0.00	-0.37	**0.75**
Hungary	-0.62	2.40	2.12	0.45	2.22	2.22	2.57	1.94	3.17	2.31	1.82	-1.70	0.09	-6.40	0.18	1.42	-1.70	0.64	**0.73**
Croatia	0.00	14.23	-4.83	-1.31	3.10	2.52	3.39	1.21	1.27	1.36	-0.03	1.64	-2.51	-8.01	0.35	0.24	-0.69	-1.03	**0.61**
Average NMS	**3.30**	**4.31**	**2.10**	**0.64**	**3.98**	**3.08**	**3.49**	**3.43**	**3.85**	**2.88**	**3.06**	**2.08**	**-1.64**	**-7.03**	**1.94**	**1.87**	**0.33**	**0.46**	**1.78**

Source: AMECO database; authors' calculation

Hummels et al. (2001) proposed vertical specialisation index based on import content of exports. However, this measure does not include the steps of production utilising foreign inputs, thus giving only a partial measure of GVC participation. Therefore, Koopman et al. (2011) developed GVC participation index which decompose gross exports into five different components presented below.

FIGURE I.1 DECOMPOSITION OF GROSS EXPORTS INTO VALUE ADDED COMPONENTS



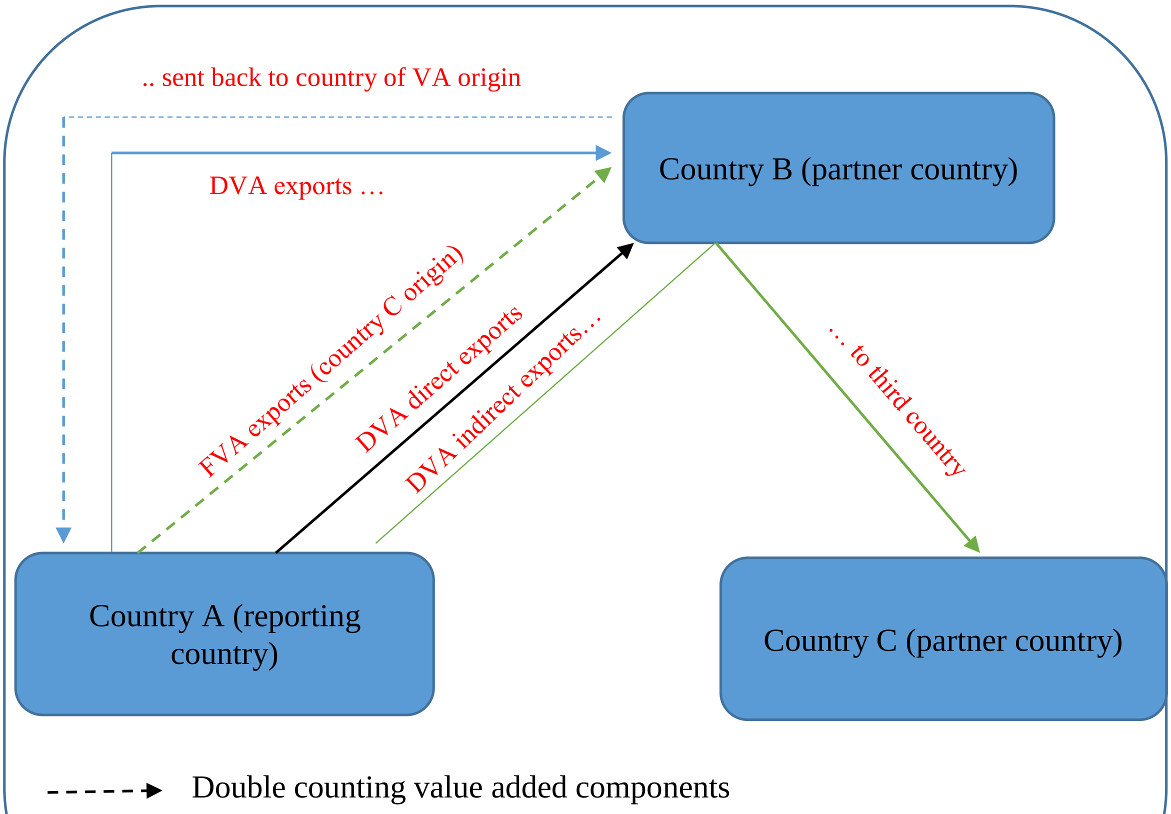
Source: Koopman et al. (2011) and Rahman and Zhao (2013)

Components (1) and (2) reflect the export of countries not included in GVCs. Upstream segments of the GVCs are presented by components (3) and (4) i.e. domestic value added processed for further export while downstream segment of GVC is presented by component (5). The larger is the share of FVA in country's exports, the more likely is that country will be specialising in processing and assembly of parts and components.

Based on this, Koopman et al. (2011) developed two indicators of GVC participation. The first one is related to backward participation measured as the value of foreign value added in total gross exports, while forward participation is measured as value of domestic value added, i.e. value of inputs produced domestically which are used in third country's exports as a share of home country gross exports.

The following example taken from WTO World Trade Report (2014, p.83) illustrates the concept of GVC participation between reporting and partner countries.

FIGURE I.2 VISUALISATION OF VALUE ADDED COMPONENTS OF GROSS EXPORTS

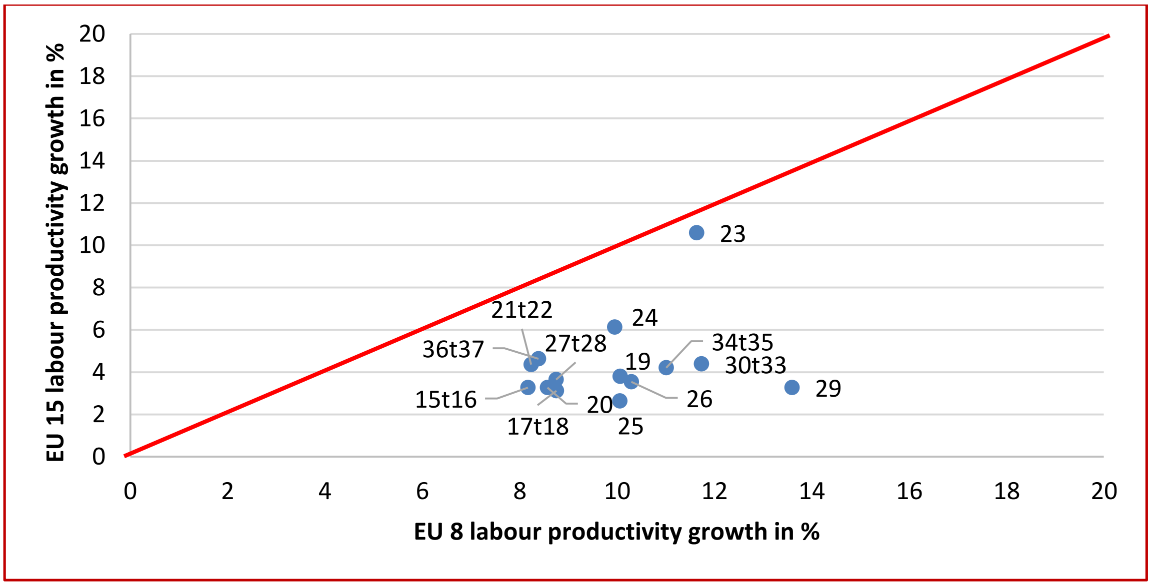


Source: WTO World Trade Report (2014, p.83)

By taking an example of manufacturing process of cars we can illustrate the concept of GVCs' participation and the valued added components of gross export. The central node in GVC is country A which for example export tyres in country B. If country A imports rubber from a third country C the value of rubber embedded in the export of tyres is included in FVA component of gross export indicating the extent of backward participation in GVC. If tyres imported by country B are used in the production of cars which are then exported in country C value added in the production of tyres in country A is then represented by the angled green arrow. This is a measure of forward participation in GVCs. By combining FVA and indirect DVA and dividing it by gross export of country A we are able to measure participation of the latter in GVC. If instead imported tyres by country B are used to produce cars for home market, the value of the tyres is the DVA of direct exports from country A to country B represented by solid blue line. Finally, if cars produced in country B are exported to country A the value added in the production of tyres is part of Country A re-imports.

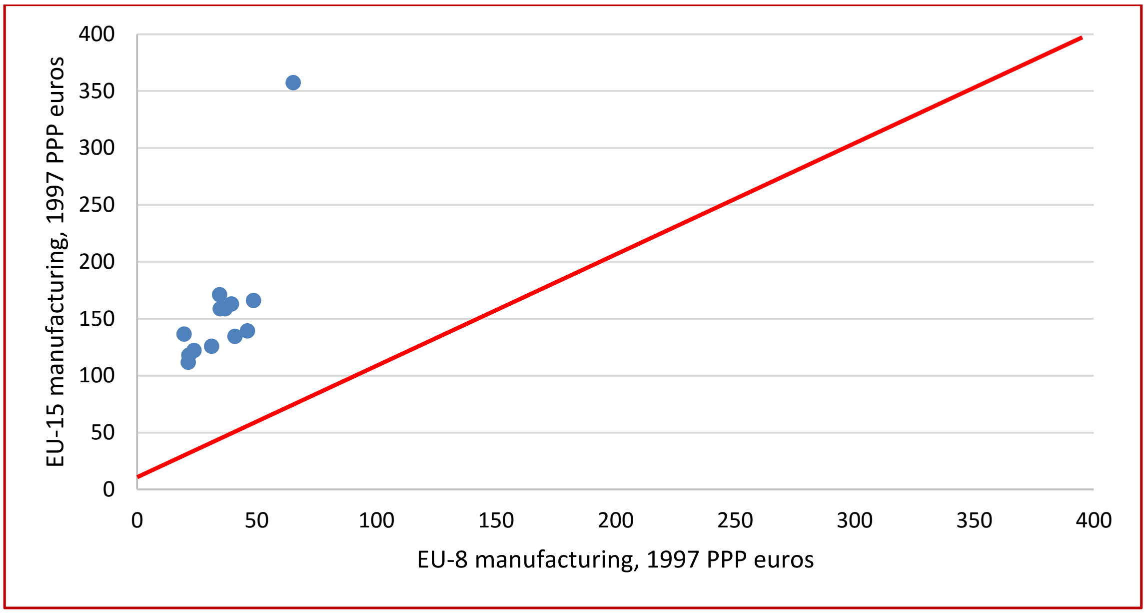
1.3 INDUSTRY PRODUCTIVITY LEVELS AND GROWTH RATES IN NMS

FIGURE I.3 AVERAGE LABOUR PRODUCTIVITY GROWTH IN MANUFACTURING INDUSTRIES OF NMS-8 VS. EU-15, 1995-2009



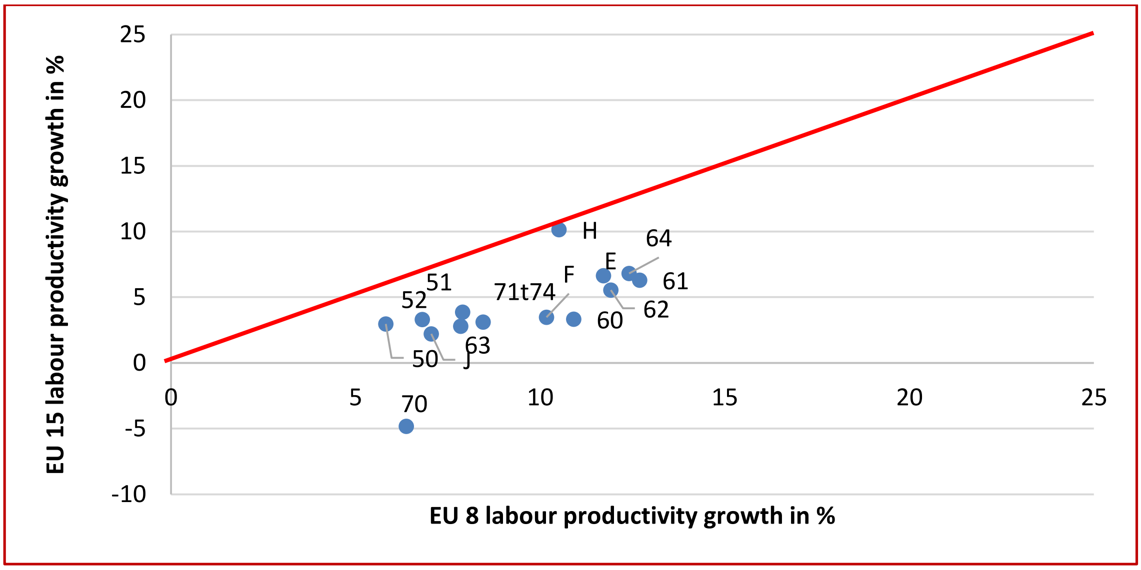
Source: WIOD Database and GGDC Productivity Level Database 1997 benchmark; Author's calculations
Note: Labour productivity is calculated as gross output divided by number of hours worked. We use industry level PPP conversion rates to transform gross nominal output in country c sub-sector j and year t expressed in local currency units into real output in 1997 PPP Euros.

FIGURE I.4 AVERAGE LABOUR PRODUCTIVITY LEVELS IN MANUFACTURING INDUSTRIES OF NMS-8 VS. EU-15, 1995-2009



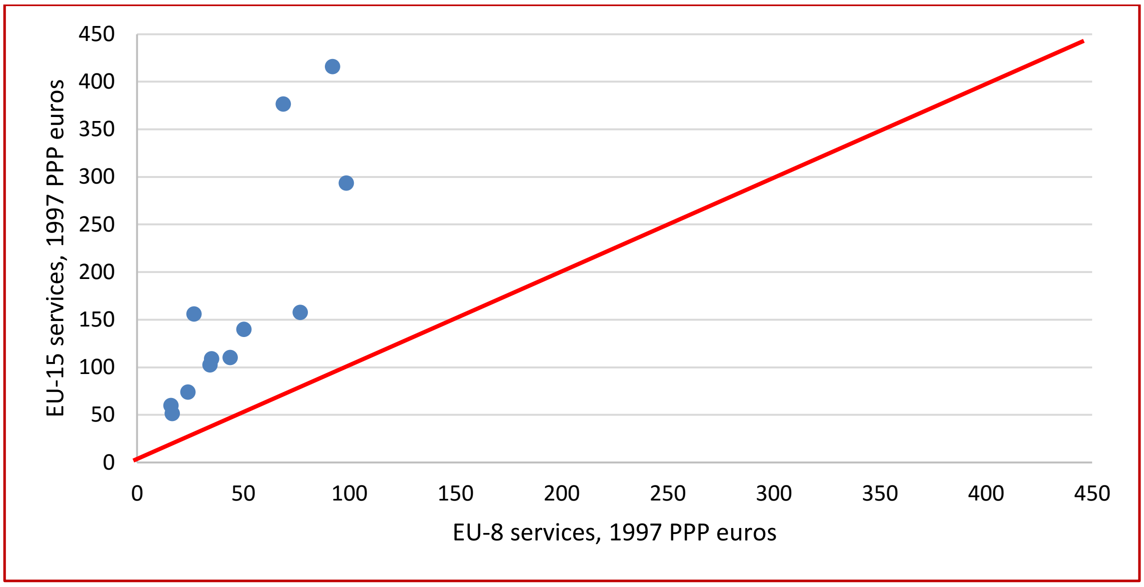
Source: WIOD Database and GGDC Productivity Level Database 1997 benchmark; Author's calculations
Note: Coke, refined petroleum products and nuclear fuel industry is excluded from the Figure.
Labour productivity is calculated as gross output divided by number of hours worked. We use industry level PPP conversion rates to transform gross nominal output in country c sub-sector j and year t expressed in local currency units into real output in 1997 PPP Euros.

FIGURE I.5 AVERAGE LABOUR PRODUCTIVITY GROWTH IN SERVICE INDUSTRIES OF NMS-8 VS. EU-15, 1995-2009



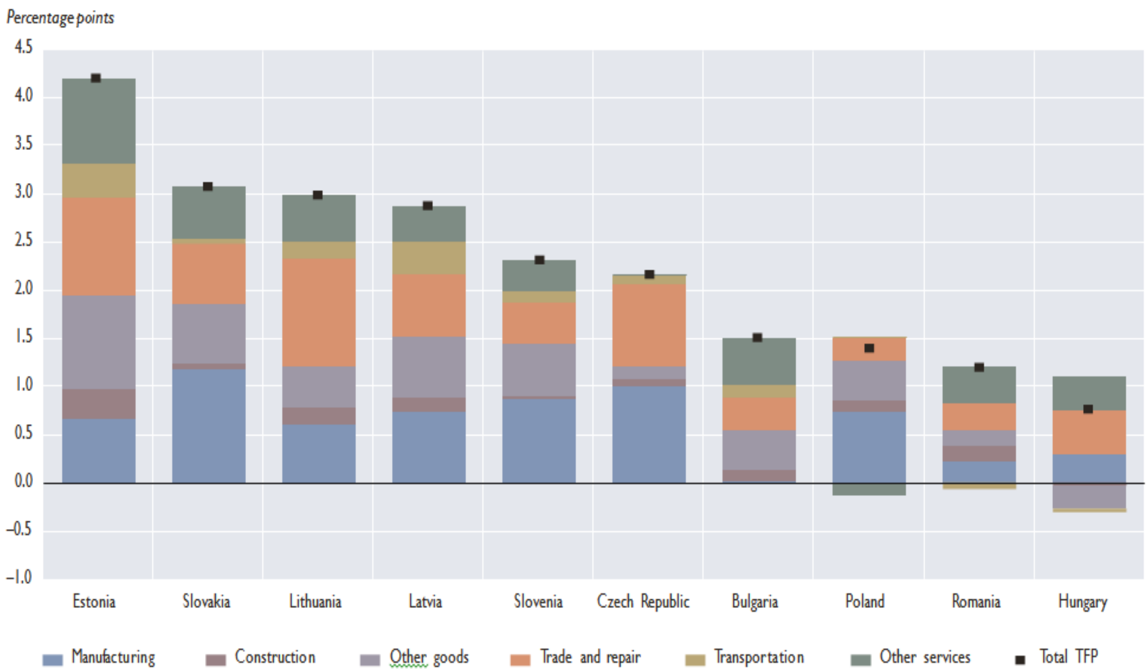
Source: WIOD Database and GGDC Productivity Level Database 1997 benchmark; Author's calculations
Note: Labour productivity is calculated as gross output divided by number of hours worked. We use industry level PPP conversion rates to transform gross nominal output in country c sub-sector j and year t expressed in local currency units into real output in 1997 PPP Euros.

FIGURE I.6 AVERAGE LABOUR PRODUCTIVITY LEVELS IN SERVICES INDUSTRIES OF NMS-8 VS. EU-15, 1995-2009



Source: WIOD Database and GGDC Productivity Level Database 1997 benchmark; Author's calculations
Note: Real estate activities industry is excluded from the Figure.
Labour productivity is calculated as gross output divided by number of hours worked. We use industry level PPP conversion rates to transform gross nominal output in country c sub-sector j and year t expressed in local currency units into real output in 1997 PPP Euros.

FIGURE I.7 TOTAL FACTOR PRODUCTIVITY AND INDUSTRY CONTRIBUTIONS TO VALUE ADDED GROWTH, 1996–2009



Source: Benkovskis et al. (2013, p.19)

APPENDIX II. SUPPLEMENT TO CHAPTER FOUR

2.1 CLEANING PROCEDURE

A unique firm level dataset was constructed using Amadeus database published by Bureau van Dijk. This comprehensive database covers around 19.514.770 companies in Europe, both public and private[71]. In this thesis the focus is on a subset of firms from five countries in Central Europe for which financial information is available in the period 2002-2010. In November 2011 update, Amadeus included 454.738 firms from the Czech Republic, 107.052 firms from Estonia, 377.414 firms from Hungary, 234.761 firms from Slovakia and 62.254 firms from Slovenia resulting in 11,125,971 firm level observations.

In conducting econometric estimation, we did not apply firm's size threshold as Eapen (2013) suggests that in incomplete datasets such as Amadeus the effects of FDI productivity spillovers may be overestimated due to selection effects if one exclude small firms from the sample. Since we are interested in estimating TFP for manufacturing and services firms, our cleaning procedure starts with eliminating certain industries from the sample or firms for which industry code is not provided. These are Agriculture, forestry and fishing (NACE 1.1 codes 01-03), Mining and quarrying (NACE 1.1 codes 05-09), Public administration and defence, compulsory social security (NACE 1.1 code 84), Education (NACE 1.1 code 85), Human health services (NACE 1.1 code 86), Residential care and social work activities (NACE 1.1 codes 87-88), Arts, entertainment and recreation (NACE 1.1 codes 90-93), Other services (NACE 1.1 codes 94-96).

For the construction of TFP sample we need information on firms' sales, tangible fixed assets, number of employees and expenditure on materials. Firms with missing observations on either of the variables of interest are dropped from the sample. Furthermore, firms reporting zero or negative sales, value added, total assets, total fixed assets, tangible fixed assets, number of employees, expenditure of materials and cost of employees from the balance sheet are deleted. We have also eliminated observations for which accounting rules are violated such as situations where total and individual components of fixed assets are larger than total assets or when the date of incorporation appears after the year in which firms have reported their financial information.

[71] The database was accessed in November 2011.

In order to avoid the extreme effects of outliers and aberrant values due to typing errors during data entry we have computed output to labour ratio, value added to labour ratio, capital to output ratio, labour to output ratio and dropped firms below the 1st percentile and above 99th percentile of their respective distributions. Finally, in order to exploit the advantages of panel data the sample is restricted to include at least two consecutive observations per firm. The table below shows the deletion procedure per country.

TABLE II.1 NUMBER OF OBSERVATIONS AFTER CLEANING STEPS

	Czech Republic	*Estonia*	*Hungary*	*Slovakia*	*Slovenia*
Original sample - number of obs.	**4,092,642**	**963,468**	**3,396,726**	**2,112,849**	**560,286**
Firms with NACE codes missing or not corresponding to manufacturing and service activities	840,411	291,942	490,851	449,280	39,798
Firms with missing values on production function variables	2,889,204	509,001	2,881,808	1,584,712	492,972
Firms with zero or negative values of production function variables or having erroneous accounting data	93,244	52,865	3,978	12,599	4,993
Firms with O/L, VA/L, K/O, L/O below 1 or above 99 percentile of distribution	16,627	6,466	1,114	3,917	1,259
Firms with less than two consecutive observations	19,711	8,564	6,232	13,044	1,393
Total deleted - number of obs.	**3,859,197**	**868,838**	**3,383,983**	**2,063,552**	**540,415**
TFP sample - number of obs.	**233,445**	**94,630**	**12,743**	**49,297**	**19,871**

2.2 FOREIGN OWNERSHIP CALCULATIONS

In order to construct time and firm specific ownership information we rely on Amadeus database. The Amadeus-Ownership database contains detailed information on owners of both listed and private firms including name, country of residence, percentage of ownership and type (e.g., bank, industrial company, fund, individual, and so on). Usually Amadeus reports information on ownership only for last year. However, at the time of our access to the database Amadeus introduced new feature which enable to track the ownership changes in the last five years. Since we have financial data for nine years, we used this new available option and gained information for two sub periods. First sub period covers the period 2002-2006 and the second sub period covers the period 2007-2011.[72] Both files were merged using BvD ID number, country ISO code and Shareholder BvD ID number to obtain the ownership changes over the analysed period.

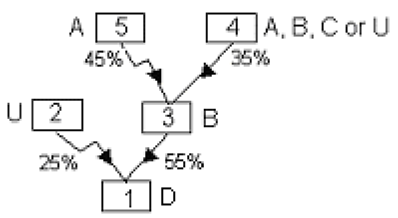
Amadeus ownership database provide several indicators divided in three dimensions:

1. Independence indicator – measure of independence of firm with regard to its shareholders

2. Ultimate owner – an entity which is the ultimate owner of the company obtained by analysing shareholder's structures of companies which according to independent indicator are classified as independent. The company to be independent it must have an indicator of A+, A or A- indicating that no other entity has more than 25% of shares.

3. Shareholders – provides a list of all the shareholders in the company and their corresponding shares in company's capital, both total and direct ownership.

In our analysis of identifying foreign owner we rely on direct ownership for several reasons. Ultimate owner category is calculated by finding at least one owner that has more than 25% of controlling interest in the company. The figure below is taken from Amadeus manual and shows how ultimate owner is calculated. The ownership path of minimum 25% is followed from Company 1 to Company 3 and from Company 3 to Company 5. Company 5 is independent and said to be the UO of Company 1. Company 5 is also the UO of Company 3.



The problem with identifying ultimate owner is also admitted by BvD saying *"even if the scope of the BvD ownership database is very wide, BvD cannot absolutely assert that all the existing links are recorded in the database. More importantly, because certain ownership structures can be very complex, trying to evaluate a controlling ultimate owner could be misleading"* (Bureau van Dijk, 2010). Moreover, since we are interested in continuous ownership over time calculated total percentage of ultimate owner cannot be

[72] Ownership information was accessed in September 2012.

related to any specific date as it relies on information valid at different dates. Finally, as we follow international definition of foreign ownership which states that foreign owner is the firm which owns at least 10% of other firms' capital, the definition of ultimate owner clearly does not correspond to it.

Amadeus ownership database records the ownership link indicating that company A owns a certain share of company B as direct ownership even if the percentage of foreign ownership is 1% except for listed firms where usually the small stock holders are unknown. Sometimes, direct ownership link does not contain actual number but indicates if the company is WO ("wholly owned"), MO ("majority owned"), JO ("jointly owned"), NQ ("negligible") and CQP1 ("50% + 1 share). In this cases we have recoded these values to 100% if WO, 51% if MO, 50% if JO and 50% if CQP1.

In order to identify foreign owner, we have relied on a variable containing the country codes and in cases where country code is different than home country of firm, firm is identified as foreign if it owns more than 10%. If the country code is missing, firms are classified as domestic. The latter is especially problematic if shareholder is a private individual as in these cases country code is almost always missing. Furthermore, as argued by Lesher and Mirodout (2008) even if the shareholder is from foreign country they are less likely to have an active role in the management and therefore are less relevant for estimation of productivity spillovers which is the main research question of this thesis.

After identifying foreign owners, foreign ownership variable is calculated by summing all the percentages owned by foreigners. For a firm i, FO_{it} is the sum of all percentages of direct ownership by foreigners in year *t*. For example, if a Company A has three foreign owners, Italian investor with stakes of 10 percent, French investor owning 20 percent, and German investor owning 30 percent, FO for this company is 60 percent. If foreign owner is identified, but ownership share is missing it is set to zero. If foreign ownership share is missing for all years up to year *t,* it is assumed as it was domestic. For missing observations between years, missing values are replaced with non-missing observations from time *t-1* and previous periods. The assumption behind this procedure as it like there was no ownership change.

TABLE II.2 DISTRIBUTION OF FOREIGN FIRMS ACROSS TECHNOLOGY AND KNOWLEDGE INTENSIVE INDUSTRIES BY COUNTRY

	Cleaned dataset				Original dataset			
	Czech Republic				Czech Republic			
	partially owned	fully owned	EU	non EU	partially owned	fully owned	EU	non EU
Construction and utilities	200	150	346	4	1131	1419	1998	552
High tech	83	224	263	44	143	481	532	92
Medium high tech	335	1228	1451	112	592	2242	2545	289
Medium low tech	402	1115	1495	22	803	2098	2789	112
Low tech	266	558	803	21	617	1289	1722	184
High tech knowledge intensive services	117	397	466	48	350	1230	1371	209
Market knowledge intensive services	283	943	1153	73	4299	9912	11029	3182
Less knowledge intensive services	939	2753	3502	190	4754	9813	11866	2701
Total	**2625**	**7368**	**9479**	**514**	**12689**	**28484**	**33852**	**7321**

	Estonia				Estonia			
	partially owned	fully owned	EU	non EU	partially owned	fully owned	EU	non EU
Construction and utilities	143	94	218	19	1672	2485	3530	627
High tech	44	115	134	25	100	192	246	46
Medium high tech	126	170	278	18	302	388	616	74
Medium low tech	143	249	367	25	393	559	863	89
Low tech	251	417	658	10	695	1071	1646	120
High tech knowledge intensive services	81	128	180	29	522	1111	1300	333
Market knowledge intensive services	202	382	542	42	2082	4725	5703	1104
Less knowledge intensive services	916	1365	2065	216	3311	5297	6954	1654
Total	**1906**	**2920**	**4442**	**384**	**9077**	**15828**	**20858**	**4047**

	Hungary				Hungary			
	partially owned	fully owned	EU	non EU	partially owned	fully owned	EU	non EU
Construction and utilities	47	33	80	-	417	292	666	43
High tech	14	26	40	-	45	108	143	10
Medium high tech	26	108	130	4	109	369	469	9
Medium low tech	54	146	194	6	230	472	668	34
Low tech	30	74	102	2	257	299	530	26
High tech knowledge intensive services	8	29	37	-	125	225	328	22
Market knowledge intensive services	15	51	66	-	683	1008	1599	92
Less knowledge intensive services	115	382	478	19	899	1659	2362	196
Total	**309**	**849**	**1127**	**31**	**2765**	**4432**	**6765**	**432**

	Slovakia				Slovakia			
	partially owned	fully owned	EU	non EU	partially owned	fully owned	EU	non EU
Construction and utilities	26	61	82	5	245	314	511	48
High tech	5	45	40	10	20	108	95	33
Medium high tech	57	225	219	63	155	528	526	157
Medium low tech	103	183	236	50	260	427	558	129
Low tech	100	136	175	61	216	357	436	137
High tech knowledge intensive services	23	57	73	7	112	208	295	25
Market knowledge intensive services	44	128	168	4	339	913	1150	102
Less knowledge intensive services	150	538	625	63	969	2435	3111	293
Total	**508**	**1373**	**1618**	**263**	**2316**	**5290**	**6682**	**924**

	Slovenia				Slovenia			
	partially owned	fully owned	EU	non EU	partially owned	fully owned	EU	non EU
Construction and utilities	2	8	10	-	40	114	141	13
High tech	2	-	2	-	5	2	7	-
Medium high tech	24	7	31	-	40	24	61	3
Medium low tech	3	1	3	1	26	24	46	4
Low tech	8	10	18	-	35	33	67	1
High tech knowledge intensive services	1	10	5	6	118	114	202	30
Market knowledge intensive services	7	14	21	-	126	189	294	21
Less knowledge intensive services	37	189	219	7	232	829	992	69
Total	**84**	**239**	**309**	**14**	**622**	**1329**	**1810**	**141**

TABLE II.3 IN SAMPLE DATA COVERAGE OF FIRMS

	Slovenia		Slovakia		Hungary		Estonia		Czech Republic	
T_i	Obs.	Firms	Obs.	Firms	Obs.	Firms	Obs.	Firms	Obs.	Firms
2	2629	1211	14648	6336	2901	1284	10811	4699	38018	15776
3	3020	955	10419	3130	6909	2190	12059	3420	41770	11813
4	6004	1466	7847	1854	1887	464	11118	2437	41913	9186
5	2545	500	7103	1379	765	153	10041	1878	28351	5304
6	1962	325	2975	483	252	42	9604	1569	34326	5470
7	1486	212	2849	407	21	3	28230	3988	17843	2549
8	1568	196	3456	432	8	1	4352	544	31224	3903
9	657	73	-	-	-	-	8415	935	-	-
Total	**19871**	**4938**	**49297**	**14021**	**12743**	**4137**	**94630**	**19470**	**233445**	**54001**

Note: The number of observations does not exactly match the quotient of firm year multiplication as some firms have gaps in the data. For example, firms with available data for years 2002 and 2003 satisfy the condition of two consecutive observations, however they may have missing information for year 2004 and then report data for subsequent years up to 2010. That will give them maximum number of consecutive observations equal to 6. Therefore, the initial two years would not be counted in the table.

TABLE II.4 DESCRIPTIVE STATISTICS OF PRODUCTION FUNCTION VARIABLES USED IN TFP ESTIMATION OF DOMESTIC FIRMS

CZECH REPUBLIC					
Variable	Obs	Mean	Std. Dev.	Min	Max
Real sales (€, '000)	223452	3,650	25,718	9	3,432,214
Real material costs (€, '000)	223452	2,329	20,077	1	3,379,536
Real tangible fixed assets (€, '000)	223452	1,043	14,480	1	2,616,399
No of employees	223452	47	340	1	65,232
Real value added (€, '000)	223452	1,322	9,449	1	1,077,106
ESTONIA					
Variable	Obs	Mean	Std. Dev.	Min	Max
Real sales (€, '000)	89804	748	4,194	3	314,437
Real material costs (€, '000)	89804	493	2,774	1	190,386
Real tangible fixed assets (€, '000)	89804	204	3,573	1	409,350
No of employees	89804	13	58	1	4,809
Real value added (€, '000)	89804	254	1,851	1	202,071
HUNGARY					
Variable	Obs	Mean	Std. Dev.	Min	Max
Real sales (€, '000)	11585	20,652	80,596	36	2,227,868
Real material costs (€, '000)	11585	6,532	38,463	1	1,358,042
Real tangible fixed assets (€, '000)	11585	7,379	62,231	1	2,766,798
No of employees	11585	189	1,077	1	44,553
Real value added (€, '000)	11585	14,120	62,317	10	2,117,166
SLOVAKIA					
Variable	Obs	Mean	Std. Dev.	Min	Max
Real sales (€, '000)	47416	4,439	20,062	3	1,537,052
Real material costs (€, '000)	47416	2,816	13,908	1	816,008
Real tangible fixed assets (€, '000)	47416	1,724	27,216	1	2,520,726
No of employees	47416	61	320	1	30,000
Real value added (€, '000)	47416	1,623	8,901	1	946,590
SLOVENIA					
Variable	Obs	Mean	Std. Dev.	Min	Max
Real sales (€, '000)	19548	2,135	7,992	15	192,065
Real material costs (€, '000)	19548	1,156	5,824	1	184,152
Real tangible fixed assets (€, '000)	19548	968	7,390	1	335,625
No of employees	19548	19	61	1	1,429
Real value added (€, '000)	19548	980	3,459	7	100,940

2.4 OUTPUT OF COBB-DOUGLAS VALUE ADDED PRODUCTION FUNCTION PER INDUSTRY AND COUNTRY

TABLE II.5 ESTIMATION OF VALUE ADDED PRODUCTION FUNCTION BY INDUSTRIES USING WOOLDRIDGE ESTIMATOR (2009), LEVINSOHN-PETRIN ESTIMATOR (2003) AND OLS IN CZECH REPUBLIC

	OLS				LP				WLP				WLP versus OLS		
NACE GROUP	labour	capital	Observations	Returns to scale	labour	capital	Observations	Returns to scale	labour	capital	Observations	Returns to scale	labour	capital	returns to scale
1516	0.727***	0.281***	5,066	1.01	0.474***	0.175***	5,066	0.65	0.518***	0.172***	3,740	0.69***	-	-	-
1718	0.722***	0.196***	2,712	0.92***	0.546***	0.157***	2,712	0.70***	0.554***	0.154***	1,964	0.708***	-	-	-
19	0.659***	0.234***	386	0.89*	0.589***	0.472***	386	1.06	0.652***	0.521***	274	1.173	-	+	+
20	0.837***	0.200***	3,625	1.04*	0.514***	0.140***	3,625	0.65***	0.554***	0.145***	2,547	0.699***	-	-	-
2122	0.794***	0.169***	4,448	0.96*	0.698***	0.0947***	4,448	0.79***	0.725***	0.102***	3,127	0.827***	-	-	-
2324	0.680***	0.241***	1,776	0.92***	0.404***	0.0899**	1,776	0.49***	0.421***	0.107**	1,315	0.528***	-	-	-
25	0.706***	0.236***	4,103	0.94***	0.469***	0.154***	4,103	0.62***	0.490***	0.166***	2,990	0.656***	-	-	-
26	0.573***	0.370***	2,575	0.94***	0.369***	0.106***	2,575	0.48***	0.353***	0.102***	1,864	0.455***	-	-	-
2728	0.717***	0.219***	13,267	0.94***	0.538***	0.207***	13,267	0.75***	0.570***	0.209***	9,565	0.779***	-	-	-
29	0.764***	0.174***	9,010	0.94***	0.530***	0.136***	9,010	0.67***	0.550***	0.138***	6,568	0.689***	-	-	-
3033	0.691***	0.212***	7,045	0.90***	0.538***	0.168***	7,045	0.71***	0.567***	0.169***	5,080	0.736***	-	-	-
3435	0.685***	0.258***	1,719	0.94**	0.510***	0.224***	1,719	0.73***	0.482***	0.239***	1,278	0.721***	-	-	-
3637	0.667***	0.257***	3,525	0.92***	0.429***	0.200***	3,525	0.63***	0.448***	0.199***	2,556	0.647***	-	-	-
4041	0.825***	0.200***	2,096	1.03	0.674***	0.0439	2,096	0.72***	0.711***	0.0456*	1,561	0.756***	-	-	-
45	0.899***	0.218***	27,589	1.12***	0.773***	0.188***	27,589	0.96***	0.839***	0.192***	19,382	1.031*	-	-	-
50	0.882***	0.169***	8,071	1.05***	0.559***	0.140***	8,071	0.70***	0.615***	0.143***	5,670	0.757***	-	-	-
51	0.900***	0.169***	39,117	1.07***	0.473***	0.132***	39,117	0.61***	0.516***	0.136***	26,856	0.652***	-	-	-
52	0.842***	0.169***	20,581	1.01	0.488***	0.151***	20,581	0.64***	0.513***	0.154***	13,950	0.667***	-	-	-
55	0.945***	0.171***	7,685	1.12***	0.702***	0.0866***	7,685	0.79***	0.818***	0.0823***	5,130	0.9***	-	-	-
6063	0.932***	0.102***	9,870	1.03**	1.024***	0.131***	9,870	1.16***	1.069***	0.120***	6,847	1.189***	+	+	+
64	0.882***	0.164***	740	1.05	1.045***	0.0882	740	1.13	1.128***	0.0914	507	1.219**	+	-	+
6567	0.906***	0.237***	282	1.14	0.975***	0.0205	282	1.00	1.117***	0.0245	196	1.141	+	-	+
70	0.902***	0.180***	11,975	1.08***	0.725***	0.152***	11,975	0.88***	0.748***	0.136***	7,841	0.884***	-	-	+
7174	0.923***	0.175***	36,189	1.10***	0.882***	0.138***	36,189	1.02**	0.906***	0.142***	24,297	1.048***	-	-	-
Mean	***0.791***	***0.211***			***0.622***	***0.149***			***0.661***	***0.153***					
St dev.	***0.106***	***0.053***			***0.194***	***0.084***			***0.218***	***0.092***					

TABLE II.6 ESTIMATION OF VALUE ADDED PRODUCTION FUNCTION BY INDUSTRIES USING WOOLDRIDGE ESTIMATOR (2009), LEVINSOHN-PETRIN ESTIMATOR (2003) AND OLS IN ESTONIA

	OLS				LP				WLP				WLP versus OLS		
NACE GROUP	labour	capital	Observations	Returns to scale	labour	capital	Observations	Returns to scale	labour	capital	Observations	Returns to scale	labour	capital	returns to scale
1516	0.703***	0.299***	1,299	1.00	0.518***	0.128***	1,299	0.65***	0.497***	0.140***	1,013	0.637***	-	-	-
1718	0.789***	0.156***	1,542	0.95**	0.689***	0.0473	1,542	0.74***	0.695***	0.042	1,190	0.737***	-	-	-
19	0.684***	0.260***	167	0.95	0.526***	-0.00699	167	0.52***	0.596***	0.0193	123	0.615***	-	-	-
20	0.822***	0.219***	2,593	1.04**	0.493***	0.217***	2,593	0.71***	0.520***	0.221***	2,000	0.741***	-	+	-
2122	0.844***	0.177***	1,676	1.02	0.558***	0.0934***	1,676	0.65***	0.556***	0.104***	1,298	0.66***	-	-	-
2324	0.836***	0.251***	163	1.09	0.667***	0.0437	163	0.71**	0.776***	0.0631	122	0.839	-	-	-
25	0.888***	0.188***	508	1.08*	0.620***	0.113*	508	0.73***	0.693***	0.140***	387	0.833**	-	-	-
26	0.817***	0.296***	456	1.11**	0.555***	0.253***	456	0.81**	0.565***	0.269***	353	0.835*	-	-	-
2728	0.858***	0.187***	2,508	1.05***	0.708***	0.151***	2,508	0.86***	0.732***	0.154***	1,927	0.886***	-	-	-
29	0.839***	0.152***	948	0.99	0.599***	0.159***	948	0.76***	0.578***	0.178***	706	0.757***	-	+	-
3033	0.850***	0.205***	718	1.06	0.607***	0.188***	718	0.80***	0.657***	0.178***	533	0.835***	-	-	-
3435	0.906***	0.121***	503	1.03	0.627***	0.107*	503	0.73***	0.719***	0.114**	372	0.832	-	-	-
3637	0.821***	0.216***	1,951	1.04*	0.520***	0.181***	1,951	0.70***	0.529***	0.182***	1,482	0.711***	-	-	-
4041	0.796***	0.251***	696	1.05	0.469***	0.0402	696	0.51***	0.466***	0.0522	555	0.518***	-	-	-
45	0.853***	0.208***	13,727	1.06***	0.688***	0.226***	13,727	0.92***	0.731***	0.223***	9,950	0.953**	-	+	-
50	0.965***	0.214***	4,942	1.18***	0.572***	0.115***	4,942	0.69***	0.631***	0.113***	3,772	0.744***	-	-	-
51	0.880***	0.180***	10,453	1.06***	0.456***	0.150***	10,453	0.61***	0.502***	0.150***	7,743	0.652***	-	-	-
52	0.877***	0.172***	10,405	1.05***	0.598***	0.153***	10,405	0.75***	0.642***	0.150***	7,835	0.792***	-	-	-
55	0.932***	0.168***	4,680	1.10***	0.663***	0.0773***	4,680	0.74***	0.719***	0.0779***	3,543	0.797***	-	-	-
6063	0.807***	0.248***	9,569	1.06***	0.651***	0.220***	9,569	0.87***	0.677***	0.220***	7,153	0.897***	-	-	-
64	0.892***	0.192***	390	1.08	0.528***	0.0345	390	0.56***	0.493***	0.0528	289	0.546***	-	-	-
6567	1.013***	0.0982	180	1.11	1.003***	-0.0521	180	0.95	1.258***	-0.0814	125	1.177	+	-	+
70	0.734***	0.178***	5,680	0.91***	0.493***	0.0746***	5,680	0.57***	0.544***	0.0798***	4,055	0.623***	-	-	-
7174	0.872***	0.201***	14,050	1.07***	0.757***	0.166***	14,050	0.92***	0.817***	0.161***	10,099	0.978	-	-	-
Mean	0.844	0.201			0.606	0.120			0.649	0.125					
St dev.	0.074	0.049			0.116	0.077			0.163	0.078					

TABLE II.7 ESTIMATION OF VALUE ADDED PRODUCTION FUNCTION BY INDUSTRIES USING WOOLDRIDGE ESTIMATOR (2009), LEVINSOHN-PETRIN ESTIMATOR (2003) AND OLS IN HUNGARY

	OLS				LP				WLP				WLP versus OLS		
NACE GROUP	labour	capital	Observations	Returns to scale	labour	capital	Observations	Returns to scale	labour	capital	Observations	Returns to scale	labour	capital	returns to scale
1516	0.579***	0.434***	816	1.01	0.516***	0.173	816	0.69**	0.538***	0.192*	496	0.73**	-	-	-
1719	0.656***	0.238**	171	0.89	0.711***	0.275*	171	0.99	0.732***	0.18	107	0.91	+	-	+
20	0.354	0.429***	67	0.78	0.675***	0.662***	67	1.34	0.413	0.288	39	0.70	+	-	-
2122	0.853***	0.142***	309	1.00	0.775***	0.012	309	0.79	0.848***	0.109	196	0.96	-	-	-
2324	0.633***	0.306***	247	0.94	0.529***	0.0614	247	0.59**	0.535***	0.0933	156	0.63***	-	-	-
25	0.615***	0.412***	465	1.03	0.581***	0.304**	465	0.89	0.550***	0.283**	298	0.83	-	-	-
26	0.493***	0.445***	224	0.94	0.518***	0.258	224	0.78	0.487***	0.292**	141	0.78	-	-	-
2728	0.631***	0.323***	746	0.95	0.639***	0.281**	746	0.92	0.609***	0.348***	474	0.96	-	+	+
29	0.609***	0.279***	432	0.89***	0.580***	0.206	432	0.79	0.541***	0.243	281	0.78	-	-	-
3033	0.786***	0.330***	429	1.12**	0.713***	0.192	429	0.91	0.726***	0.218	263	0.94	-	-	-
3435	0.612***	0.420***	209	1.03	0.621***	0.447***	209	1.07	0.676***	0.385***	128	1.06	+	-	+
3637	0.750***	0.245***	176	1.00	0.815***	0.0928	176	0.91	0.789***	-0.00057	114	0.79	+	-	-
4041	0.297***	0.461***	264	0.76***	0.341***	-0.265	264	0.08***	0.354**	-0.353*	160	0.00***	+	-	-
45	0.832***	0.180***	616	1.01	0.783***	0.228	616	1.01	0.803***	0.133	384	0.94	-	-	-
50	0.858***	0.0285	947	0.89**	0.667***	-0.0111	947	0.66***	0.733***	-0.0114	597	0.72***	-	-	-
51	0.761***	0.0968***	2,986	0.86***	0.554***	0.118***	2,986	0.67***	0.596***	0.119***	1,876	0.72***	-	+	-
52	0.670***	0.207***	856	0.88***	0.453***	0.307**	856	0.76	0.481***	0.207*	530	0.69**	-	0	-
55	0.632***	0.143***	115	0.78***	0.503***	0.0971	115	0.60	0.526***	0.0893	67	0.62***	-	-	-
6063	0.702***	0.0709	415	0.77***	0.667***	0.213	415	0.88	0.682***	0.161	251	0.84	-	+	+
6467	0.687***	0.270**	90	0.96	0.539**	0.0805	90	0.62	0.479***	0.0679	57	0.55***	-	-	-
70	0.658***	0.0836	297	0.74***	0.663***	-0.194	297	0.47***	0.655***	-0.142	176	0.51***	-	-	-
7174	0.671***	0.158***	708	0.83***	0.656***	0.245**	708	0.90	0.661***	0.192**	435	0.85	-	+	+
Mean	0.651	0.259			0.613	0.172			0.609	0.140					
St dev.	0.139	0.136			0.115	0.195			0.131	0.164					

TABLE II.8 ESTIMATION OF VALUE ADDED PRODUCTION FUNCTION BY INDUSTRIES USING WOOLDRIDGE ESTIMATOR (2009), LEVINSOHN-PETRIN ESTIMATOR (2003) AND OLS IN SLOVAKIA

	OLS				LP				WLP				WLP versus OLS		
NACE GROUP	labour	capital	Observations	Returns to scale	labour	capital	Observations	Returns to scale	labour	capital	Observations	Returns to scale	labour	capital	returns to scale
1516	0.492***	0.437***	1,360	0.93***	0.327***	0.294***	1,360	0.62***	0.366***	0.322***	967	0.69***	-	-	-
1718	0.482***	0.315***	640	0.80***	0.485***	0.211**	640	0.70***	0.503***	0.246***	440	0.75***	+	-	-
19	0.420***	0.548***	163	0.97	0.353***	0.309*	163	0.66*	0.379***	0.342*	105	0.72	-	-	-
20	0.431***	0.351***	762	0.78***	0.242***	0.326***	762	0.57***	0.272***	0.305***	497	0.58***	-	-	-
2122	0.584***	0.237***	785	0.82***	0.502***	0.197**	785	0.70***	0.577***	0.177**	525	0.75**	-	-	-
2324	0.273***	0.382***	343	0.66***	0.209***	0.219	343	0.43***	0.160**	0.218*	249	0.38***	-	-	-
25	0.454***	0.370***	833	0.82***	0.358***	0.359***	833	0.72***	0.384***	0.324***	564	0.71***	-	-	-
26	0.264***	0.574***	641	0.84***	0.171***	0.642***	641	0.81	0.151***	0.603***	447	0.75**	-	+	-
2728	0.437***	0.315***	2,527	0.75***	0.322***	0.400***	2,527	0.72***	0.367***	0.403***	1,680	0.77***	-	+	+
29	0.451***	0.305***	1,705	0.76***	0.299***	0.347***	1,705	0.65***	0.341***	0.322***	1,185	0.66***	-	+	-
3033	0.499***	0.285***	1,043	0.78***	0.347***	0.255***	1,043	0.60***	0.396***	0.267***	697	0.66***	-	-	-
3435	0.448***	0.309***	420	0.76***	0.207***	0.277**	420	0.48***	0.197***	0.308***	291	0.51***	-	-	-
3637	0.461***	0.395***	768	0.86***	0.320***	0.395***	768	0.72***	0.381***	0.381***	521	0.76**	-	-	-
4041	0.580***	0.218***	662	0.80***	0.427***	0.165*	662	0.59***	0.479***	0.121***	497	0.60***	-	-	-
45	0.464***	0.370***	5,209	0.83***	0.301***	0.354***	5,209	0.65***	0.347***	0.351***	3,460	0.70***	-	-	-
50	0.528***	0.287***	1,730	0.82***	0.312***	0.179***	1,730	0.49***	0.344***	0.189***	1,139	0.53***	-	-	-
51	0.544***	0.262***	10,386	0.81***	0.299***	0.207***	10,386	0.51***	0.355***	0.211***	6,706	0.57***	-	-	-
52	0.491***	0.265***	4,998	0.76***	0.257***	0.270***	4,998	0.53***	0.281***	0.272***	3,038	0.55***	-	+	-
55	0.661***	0.252***	1,129	0.91***	0.404***	0.360***	1,129	0.76***	0.510***	0.339***	705	0.85*	-	+	-
6063	0.501***	0.238***	2,549	0.74***	0.564***	0.339***	2,549	0.90***	0.609***	0.350***	1,652	0.96	+	+	+
64	0.631***	0.325***	143	0.96	0.719***	0.219	143	0.94	0.697***	0.213	95	0.91	+	-	-
6567	0.696***	0.389***	67	1.09	0.551**	0.376	67	0.93	0.528**	0.275	40	0.80	-	-	-
70	0.515***	0.230***	1,974	0.75***	0.316***	0.285***	1,974	0.60***	0.371***	0.288***	1,242	0.66***	-	+	-
7174	0.622***	0.277***	6,579	0.90***	0.552***	0.240***	6,579	0.79***	0.611***	0.245***	3,977	0.86***	-	-	-
Mean	0.497	0.330			0.368	0.301			0.400	0.294					
St dev.	0.103	0.092			0.133	0.101			0.141	0.095					

TABLE II.9 ESTIMATION OF VALUE ADDED PRODUCTION FUNCTION BY INDUSTRIES USING WOOLDRIDGE ESTIMATOR (2009), LEVINSOHN-PETRIN ESTIMATOR (2003) AND OLS IN SLOVENIA

	OLS				LP				WLP				WLP versus OLS		
NACE GROUP	labour	capital	Observations	Returns to scale	labour	capital	Observations	Returns to scale	labour	capital	Observations	Returns to scale	labour	capital	returns to scale
1516	0.829***	0.178***	288	1.01	0.548***	0.0637	288	0.61***	0.582***	0.0508	207	0.63***	-	-	-
1719	0.797***	0.115***	239	0.91**	0.564***	-0.0166	239	0.55***	0.548***	-0.0218	176	0.52***	-	-	-
20	0.612***	0.251***	305	0.86***	0.401***	0.112**	305	0.51***	0.346***	0.169***	219	0.51***	-	-	-
2122	0.891***	0.0981***	745	0.99	0.882***	0.113**	745	1.00	0.928***	0.0942**	558	1.02	+	-	+
2324	0.615***	0.347***	68	0.96	0.537***	0.135	68	0.67*	0.484***	-0.161***	53	0.32***	-	-	-
25	0.603***	0.230***	490	0.83***	0.390***	0.143**	490	0.53***	0.431***	0.147*	364	0.57***	-	-	-
26	1.124***	-0.00103	172	1.12*	0.577***	0.0222	172	0.60**	0.559***	-0.0113	125	0.54***	-	+	-
2728	0.767***	0.169***	1,562	0.94***	0.578***	0.238***	1,562	0.82***	0.595***	0.228***	1,163	0.82***	-	+	-
29	0.764***	0.120***	538	0.88***	0.505***	0.144***	538	0.65***	0.543***	0.147***	403	0.69***	-	+	-
3033	0.698***	0.175***	386	0.87***	0.449***	0.135	386	0.58***	0.445***	0.149**	283	0.59***	-	-	-
3435	0.815***	0.0905	92	0.91	0.510***	0.352***	92	0.86	0.400***	0.385***	69	0.78**	-	+	-
3637	0.648***	0.245***	420	0.89**	0.292***	0.149**	420	0.44***	0.237***	0.156**	308	0.39***	-	-	-
4041	0.819***	0.0877	87	0.91	0.806***	-0.0548	87	0.75	0.947***	-0.0804	66	0.86	+	-	-
45	0.793***	0.226***	2,577	1.02	0.601***	0.154***	2,577	0.76***	0.635***	0.159***	1,873	0.79***	-	-	-
50	1.011***	0.0572**	674	1.07**	0.855***	0.0514	674	0.91	0.890***	0.0484	499	0.93	-	-	-
51	0.834***	0.119***	3,773	0.95**	0.550***	0.118***	3,773	0.67***	0.590***	0.115***	2,777	0.70***	-	-	-
52	0.871***	0.0765***	1,596	0.95**	0.633***	0.0946***	1,596	0.73***	0.668***	0.0967***	1,157	0.76***	-	+	-
55	0.846***	0.119***	525	0.97	0.558***	0.063	525	0.62***	0.575***	0.083	373	0.65***	-	-	-
6063	0.853***	0.132***	2,504	0.98	0.788***	0.0830**	2,504	0.87**	0.860***	0.0626*	1,786	0.92	+	-	-
64	0.976***	0.222**	97	1.20	0.818***	0.352**	97	1.17	0.915***	0.353**	68	1.26	-	+	+
6567	1.108***	0.0112	87	1.12	1.018***	-0.151	87	0.87	0.910***	-0.0685	64	0.84	-	-	-
70	0.761***	0.039	145	0.80***	0.683***	-0.0393	145	0.64***	0.640***	-0.0177	97	0.62***	-	-	-
7174	0.798***	0.142***	2,178	0.94**	0.781***	0.0656**	2,178	0.85***	0.803***	0.0499*	1,569	0.85***	+	-	-
Mean	0.818	0.141			0.622	0.102			0.631	0.093					
St dev.	0.140	0.084			0.179	0.113			0.203	0.126					

TABLE II.10 DIAGNOSTICS TESTS FOR WLP ESTIMATOR

	CZECH REPUBLIC			ESTONIA			HUNGARY			SLOVAKIA			SLOVENIA		
NACE_GROUP	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1516	6696	0	0	1491	0	0	942.9	0	0	1456	0	0	547.3	0	0
1718	6577	0	0	7148	0	0	571.1	0	0	536.4	0	0	341.4	0	0
19	1172	0	0	438	0	0	\	\	\	111.6	0	0	\	\	\
20	2334	0	0	3240	0	0	42.97	0	0.28	354.3	0	0	564.7	0	0
2122	4584	0	0	2639	0	0	221.8	0	0	645.2	0	0	1930	0	0
2324	1636	0	0	752.9	0	0	1020	0	0	982.6	0	0.03	38.99	0.15	0.11
25	3583	0	0	339.1	0	0	1914	0	0	337.5	0	0	821.1	0	0
26	4978	0	0	922.8	0	0	980.6	0	0	719.4	0	0	426.7	0	0
2728	13571	0	0	5495	0	0	1556	0	0	1185	0	0	2080	0	0
29	9635	0	0	2689	0	0	1904	0	0	1360	0	0	1268	0	0
3033	12065	0	0	1381	0	0	1788	0	0	473.7	0	0	1617	0	0
3435	1388	0	0	1263	0	0	138.7	0	0	559.2	0	0.01	163.3	0	0.01
3637	3249	0	0	1269	0	0	238.9	0	0	561.5	0	0	1260	0	0.01
4041	4816	0	0	2674	0	0	2504	0	0.01	1588	0	0	46.24	0.03	0.07
45	33095	0	0	11928	0	0	724.1	0	0	3476	0	0	3239	0	0
50	8202	0	0	5276	0	0	602.6	0	0	492.9	0	0	1132	0	0
51	38350	0	0	10779	0	0	2785	0	0	4670	0	0	6486	0	0
52	21603	0	0	12844	0	0	2649	0	0	1986	0	0	2809	0	0
55	3886	0	0	4265	0	0	415.5	0	0	356.2	0	0	627.6	0	0
6063	15227	0	0	11806	0	0	1843	0	0	2032	0	0	2331	0	0
64	1062	0	0	345.3	0	0	\	\	\	55.03	0.02	0.01	135.3	0	0.02
6567	351.5	0	0.01	478.4	0	0	511.8	0	0.02	68.58	0.02	0.02	821.4	0.03	0.01
70	11825	0	0	6518	0	0	657.6	0	0	1035	0	0	363	0	0
7174	87986	0	0	27013	0	0	2194	0	0	7611	0	0	6674	0	0

Notes: Columns numbers indicate KP weak identification test, KP under identification test (p-value) and Stock and Wright weak instrument test (p-value), respectively. In case of Hungary, industry with NACE code 19 is merged with NACE codes 17 and 18; and NACE 64 is merged with 65, 66 and 67. In case of Slovenia industry with NACE code 19 is merged with NACE codes 17 and 18.

TABLE II.11 CORRELATION MATRICES OF TFP ESTIMATION ALGORITHMS IN CZECH REPUBLIC

RAW	WLP_TFP	LP_TFP	OLS_TFP
WLP_TFP	1.0000		
LP_TFP	0.9970	1.0000	
OLS_TFP	0.8658	0.8566	1.0000

WITHIN	WLP_TFP	LP_TFP	OLS_TFP
WLP_TFP	1.0000		
LP_TFP	0.9995	1.0000	
OLS_TFP	0.9845	0.9806	1.0000

DEMEANED	WLP_TFP	LP_TFP	OLS_TFP
WLP_TFP	1.0000		
LP_TFP	0.9970	1.0000	
OLS_TFP	0.8657	0.8565	1.0000

GROWTH RATES	WLP_TFP	LP_TFP	OLS_TFP
WLP_TFP	1.0000		
LP_TFP	0.9996	1.0000	
OLS_TFP	0.9892	0.9864	1.0000

MANUFACTURING	WLP_TFP	LP_TFP	OLS_TFP
WLP_TFP	1.0000		
LP_TFP	0.9970	1.0000	
OLS_TFP	0.7842	0.7833	1.0000

SERVICES	WLP_TFP	LP_TFP	OLS_TFP
WLP_TFP	1.0000		
LP_TFP	0.9969	1.0000	
OLS_TFP	0.8963	0.8836	1.0000

TABLE II.12 CORRELATION MATRICES OF TFP ESTIMATION ALGORITHMS IN ESTONIA

RAW	WLP_TFP	LP_TFP	OLS_TFP
WLP_TFP	1.0000		
LP_TFP	0.9977	1.0000	
OLS_TFP	0.8900	0.8751	1.0000

WITHIN	WLP_TFP	LP_TFP	OLS_TFP
WLP_TFP	1.0000		
LP_TFP	0.9992	1.0000	
OLS_TFP	0.9774	0.9710	1.0000

DEMEANED	WLP_TFP	LP_TFP	OLS_TFP
WLP_TFP	1.0000		
LP_TFP	0.9977	1.0000	
OLS_TFP	0.8904	0.8757	1.0000

GROWTH RATES	WLP_TFP	LP_TFP	OLS_TFP
WLP_TFP	1.0000		
LP_TFP	0.9995	1.0000	
OLS_TFP	0.9864	0.9824	1.0000

MANUFACTURING	WLP_TFP	LP_TFP	OLS_TFP
WLP_TFP	1.0000		
LP_TFP	0.9945	1.0000	
OLS_TFP	0.8444	0.8307	1.0000

SERVICES	WLP_TFP	LP_TFP	OLS_TFP
WLP_TFP	1.0000		
LP_TFP	0.9982	1.0000	
OLS_TFP	0.9019	0.8863	1.0000

TABLE II.13 CORRELATION MATRICES OF TFP ESTIMATION ALGORITHMS IN HUNGARY

RAW	WLP_TFP	LP_TFP	OLS_TFP
WLP_TFP	1.0000		
LP_TFP	0.9371	1.0000	
OLS_TFP	0.4983	0.4947	1.0000

WITHIN	WLP_TFP	LP_TFP	OLS_TFP
WLP_TFP	1.0000		
LP_TFP	0.9974	1.0000	
OLS_TFP	0.9838	0.9784	1.0000

DEMEANED	WLP_TFP	LP_TFP	OLS_TFP
WLP_TFP	1.0000		
LP_TFP	0.9368	1.0000	
OLS_TFP	0.4980	0.4943	1.0000

GROWTH RATES	WLP_TFP	LP_TFP	OLS_TFP
WLP_TFP	1.0000		
LP_TFP	0.9977	1.0000	
OLS_TFP	0.9859	0.9809	1.0000

MANUFACTURING	WLP_TFP	LP_TFP	OLS_TFP
WLP_TFP	1.0000		
LP_TFP	0.8401	1.0000	
OLS_TFP	0.5710	0.5147	1.0000

SERVICES	WLP_TFP	LP_TFP	OLS_TFP
WLP_TFP	1.0000		
LP_TFP	0.9732	1.0000	
OLS_TFP	0.4270	0.4703	1.0000

TABLE II.14 CORRELATION MATRICES OF TFP ESTIMATION ALGORITHMS IN SLOVAKIA

RAW	WLP_TFP	LP_TFP	OLS_TFP
WLP_TFP	1.0000		
LP_TFP	0.9931	1.0000	
OLS_TFP	0.8760	0.8680	1.0000

WITHIN	WLP_TFP	LP_TFP	OLS_TFP
WLP_TFP	1.0000		
LP_TFP	0.9981	1.0000	
OLS_TFP	0.9818	0.9730	1.0000

DEMEANED	WLP_TFP	LP_TFP	OLS_TFP
WLP_TFP	1.0000		
LP_TFP	0.9930	1.0000	
OLS_TFP	0.8751	0.8672	1.0000

GROWTH RATES	WLP_TFP	LP_TFP	OLS_TFP
WLP_TFP	1.0000		
LP_TFP	0.9984	1.0000	
OLS_TFP	0.9852	0.9779	1.0000

MANUFACTURING	WLP_TFP	LP_TFP	OLS_TFP
WLP_TFP	1.0000		
LP_TFP	0.9818	1.0000	
OLS_TFP	0.8384	0.8077	1.0000

SERVICES	WLP_TFP	LP_TFP	OLS_TFP
WLP_TFP	1.0000		
LP_TFP	0.9962	1.0000	
OLS_TFP	0.8862	0.8841	1.0000

TABLE II.15 CORRELATION MATRICES OF TFP ESTIMATION ALGORITHMS IN SLOVENIA

RAW	WLP_TFP	LP_TFP	OLS_TFP
WLP_TFP	1.0000		
LP_TFP	0.9790	1.0000	
OLS_TFP	0.7880	0.7992	1.0000

WITHIN	WLP_TFP	LP_TFP	OLS_TFP
WLP_TFP	1.0000		
LP_TFP	0.9982	1.0000	
OLS_TFP	0.9669	0.9635	1.0000

DEMEANED	WLP_TFP	LP_TFP	OLS_TFP
WLP_TFP	1.0000		
LP_TFP	0.9789	1.0000	
OLS_TFP	0.7879	0.7990	1.0000

GROWTH RATES	WLP_TFP	LP_TFP	OLS_TFP
WLP_TFP	1.0000		
LP_TFP	0.9988	1.0000	
OLS_TFP	0.9799	0.9775	1.0000

MANUFACTURING	WLP_TFP	LP_TFP	OLS_TFP
WLP_TFP	1.0000		
LP_TFP	0.9503	1.0000	
OLS_TFP	0.5072	0.5740	1.0000

SERVICES	WLP_TFP	LP_TFP	OLS_TFP
WLP_TFP	1.0000		
LP_TFP	0.9951	1.0000	
OLS_TFP	0.9112	0.8831	1.0000

TABLE II.16 TRANSITION MATRICES OF INTER-QUARTILE MOVEMENTS IN TFP DISTRIBUTION OF LOCAL FIRMS IN CZECH REPUBLIC

SERVICE SECTOR

Quartiles	1	2	3	4	Total
1	74.58	20.47	3.87	1.08	100.00
2	19.46	56.75	20.66	3.14	100.00
3	4.09	19.12	57.47	19.32	100.00
4	1.13	3.05	15.04	80.79	100.00
Total	28.21	25.86	22.69	23.24	100.00

Manufacturing sector

Quartiles	1	2	3	4	Total
1	59.87	30.77	7.18	2.19	100.00
2	10.82	58.06	28.14	2.98	100.00
3	1.58	14.03	63.82	20.58	100.00
4	0.34	1.40	14.87	83.39	100.00
Total	8.94	21.24	33.68	36.13	100.00

TABLE II.17 TRANSITION MATRICES OF INTER-QUARTILE MOVEMENTS IN TFP DISTRIBUTION OF LOCAL FIRMS IN ESTONIA

Service sector

Quartiles	1	2	3	4	Total
1	68.60	23.67	6.09	1.64	100.00
2	24.07	51.27	21.01	3.65	100.00
3	6.28	22.93	54.36	16.43	100.00
4	1.68	3.92	17.04	77.36	100.00
Total	24.78	25.46	24.67	25.09	100.00

Manufacturing sector

Quartiles	1	2	3	4	Total
1	64.23	26.95	7.47	1.34	100.00
2	16.62	52.40	27.57	3.41	100.00
3	4.03	17.97	60.90	17.11	100.00
4	1.05	2.35	15.45	81.15	100.00
Total	18.65	24.76	30.29	26.30	100.00

TABLE II.18 TRANSITION MATRICES OF INTER-QUARTILE MOVEMENTS IN TFP DISTRIBUTION OF LOCAL FIRMS IN HUNGARY

Service sector

Quartiles	1	2	3	4	Total
1	85.17	11.86	2.26	0.71	100.00
2	22.27	63.82	12.27	1.64	100.00
3	2.58	28.65	61.19	7.58	100.00
4	0.44	2.86	19.47	77.23	100.00
Total	19.62	26.79	27.54	26.06	100.00

Manufacturing sector

Quartiles	1	2	3	4	Total
1	89.47	10.21	0.33	0.00	100.00
2	22.59	65.96	10.69	0.75	100.00
3	1.08	22.20	66.97	9.75	100.00
4	0.18	0.36	15.37	84.09	100.00
Total	36.44	24.41	19.69	19.47	100.00

TABLE II.19 TRANSITION MATRICES OF INTER-QUARTILE MOVEMENTS IN TFP DISTRIBUTION OF LOCAL FIRMS IN SLOVAKIA

Service sector

Quartiles	1	2	3	4	Total
1	77.45	18.49	3.03	1.03	100.00
2	19.85	56.11	21.10	2.94	100.00
3	4.42	20.28	57.09	18.21	100.00
4	1.05	2.93	18.20	77.82	100.00
Total	22.42	22.33	25.65	29.60	100.00

Manufacturing sector

Quartiles	1	2	3	4	Total
1	72.81	23.39	3.29	0.51	100.00
2	18.07	60.28	20.56	1.09	100.00
3	3.62	22.11	58.40	15.87	100.00
4	1.12	3.13	18.64	77.11	100.00
Total	26.19	31.72	25.02	17.07	100.00

TABLE II.20 TRANSITION MATRICES OF INTER-QUARTILE MOVEMENTS IN TFP DISTRIBUTION OF LOCAL FIRMS IN SLOVENIA

Service sector

Quartiles	1	2	3	4	Total
1	71.40	22.68	4.87	1.05	100.00
2	20.60	56.65	20.09	2.67	100.00
3	3.56	19.57	59.69	17.18	100.00
4	0.59	2.89	17.96	78.57	100.00
Total	21.46	25.10	27.07	26.36	100.00

Manufacturing sector

Quartiles	1	2	3	4	Total
1	79.08	18.20	2.31	0.41	100.00
2	21.95	54.88	21.44	1.73	100.00
3	3.33	22.19	56.72	17.76	100.00
4	0.54	1.96	12.84	84.66	100.00
Total	30.75	24.41	20.80	24.03	100.00

2.6 NON PARAMETRIC KOLMOGOROV SMIRNOV TEST OF FOREIGN OWNERSHIP PREMIUM

TABLE II.21 KOLMOGOROV SMIRNOV TEST PER INDUSTRY AND FOREIGN OWNERSHIP TYPE IN SLOVENIA, PRINTOUT FROM STATA

```
. ksmirnov WLP_TFPall, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.3870    0.000
 1:                 -0.0007    1.000
 Combined K-S:       0.3870    0.000      0.000

Note: ties exist in combined dataset;
      there are 19831 unique values out of 19871 observations.
```

MANUFACTURING SECTOR

```
. ksmirnov WLP_TFPall if man==1, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.4452    0.000
 1:                 -0.0117    0.985
 Combined K-S:       0.4452    0.000      0.000

Note: ties exist in combined dataset;
      there are 5359 unique values out of 5360 observations.
```

SERVICE SECTOR

```
. ksmirnov WLP_TFPall if man==0, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.3644    0.000
 1:                 -0.0016    0.999
 Combined K-S:       0.3644    0.000      0.000

Note: ties exist in combined dataset;
      there are 14491 unique values out of 14511 observations.
```

DIFFERENCES BETWEEN FULL AND PARTIAL ONWERSHIP OF MNCs

```
. ksmirnov WLP_for if for_own!=., by( for_own )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.1531    0.054
```

```
 1:                   -0.2207    0.002
 Combined K-S:         0.2207    0.005      0.003
```

DIFFERENCES BETWEEN FULL AND PARTIAL ONWERSHIP OF MNCs - MANUFACTURING

```
. ksmirnov WLP_for if for_own!=. & man==1, by( for_own )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                   0.2417    0.243
 1:                  -0.4054    0.019
 Combined K-S:        0.4054    0.037      0.020
```

DIFFERENCES BETWEEN FULL AND PARTIAL ONWERSHIP OF MNCs - SERVICES

```
. ksmirnov WLP_for if for_own!=. & man==0, by( for_own )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                   0.2994    0.001
 1:                  -0.0960    0.490
 Combined K-S:        0.2994    0.002      0.001
```

TABLE II.22 KOLMOGOROV SMIRNOV TEST PER INDUSTRY AND FOREIGN OWNERSHIP TYPE IN SLOVAKIA, PRINTOUT FROM STATA

```
. ksmirnov WLP_TFPall, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                   0.2118    0.000
 1:                  -0.0008    0.998
 Combined K-S:        0.2118    0.000      0.000

Note: ties exist in combined dataset;
      there are 49142 unique values out of 49297 observations.
```

MANUFACTURING

```
. ksmirnov WLP_TFPall if man==1, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                   0.1822    0.000
 1:                  -0.0026    0.989
 Combined K-S:        0.1822    0.000      0.000

Note: ties exist in combined dataset;
      there are 12836 unique values out of 12844 observations.
```

SERVICES

```
. ksmirnov WLP_TFPall if man==0, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.3554    0.000
 1:                 -0.0009    0.998
 Combined K-S:       0.3554    0.000      0.000

Note: ties exist in combined dataset;
      there are 36329 unique values out of 36453 observations.
```

DIFFERENCES BETWEEN FULL AND PARTIAL ONWERSHIP OF MNCs

```
. ksmirnov WLP_for if for_own!=., by( for_own )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.0801    0.009
 1:                 -0.0067    0.967
 Combined K-S:       0.0801    0.017      0.014
```

DIFFERENCES BETWEEN FULL AND PARTIAL ONWERSHIP OF MNCs - MANUFACTURING

```
. ksmirnov WLP_for if for_own!=. & man==1, by( for_own )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.0536    0.350
 1:                 -0.1071    0.015
 Combined K-S:       0.1071    0.030      0.024
```

DIFFERENCES BETWEEN FULL AND PARTIAL ONWERSHIP OF MNCs - SERVICES

```
. ksmirnov WLP_for if for_own!=. & man==0, by( for_own )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.1297    0.002
 1:                 -0.0035    0.995
 Combined K-S:       0.1297    0.004      0.003
```

TABLE II.23 KOLMOGOROV SMIRNOV TEST PER INDUSTRY AND FOREIGN OWNERSHIP TYPE IN HUNGARY, PRINTOUT FROM STATA

```
. ksmirnov WLP_TFPall, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions
```

```
 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.3085    0.000
 1:                  0.0000    1.000
 Combined K-S:       0.3085    0.000      0.000

Note: ties exist in combined dataset;
      there are 12737 unique values out of 12743 observations.
```

MANUFACTURING

```
. ksmirnov WLP_TFPall if man==1, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.2981    0.000
 1:                 -0.0002    1.000
 Combined K-S:       0.2981    0.000      0.000

Note: ties exist in combined dataset;
      there are 4768 unique values out of 4769 observations.
```

SERVICES

```
. ksmirnov WLP_TFPall if man==0, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.3334    0.000
 1:                  0.0000    1.000
 Combined K-S:       0.3334    0.000      0.000

Note: ties exist in combined dataset;
      there are 7972 unique values out of 7974 observations.
```

DIFFERENCES BETWEEN FULL AND PARTIAL ONWERSHIP OF MNCs

```
. ksmirnov WLP_for if for_own!=., by( for_own )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.2069    0.000
 1:                 -0.0118    0.939
 Combined K-S:       0.2069    0.000      0.000
```

DIFFERENCES BETWEEN FULL AND PARTIAL ONWERSHIP OF MNCs - MANUFACTURING

```
. ksmirnov WLP_for if for_own!=. & man==1, by( for_own )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.1772    0.003
```

```
 1:                  -0.0100    0.982
 Combined K-S:        0.1772    0.006      0.004
```

DIFFERENCES BETWEEN FULL AND PARTIAL ONWERSHIP OF MNCs - SERVICES

```
. ksmirnov WLP_for if for_own!=. & man==0, by( for_own )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                   0.2406    0.000
 1:                  -0.0196    0.902
 Combined K-S:        0.2406    0.000      0.000
```

TABLE II.24 TABLE 4 18 KOLMOGOROV SMIRNOV TEST PER INDUSTRY AND FOREIGN OWNERSHIP TYPE IN ESTONIA, PRINTOUT FROM STATA

```
. ksmirnov WLP_TFPall, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                   0.4333    0.000
 1:                  -0.0002    1.000
 Combined K-S:        0.4333    0.000      0.000

Note: ties exist in combined dataset;
      there are 93528 unique values out of 94630 observations.
```

MANUFACTURING

```
. ksmirnov WLP_TFPall if man==1, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                   0.3808    0.000
 1:                  -0.0003    1.000
 Combined K-S:        0.3808    0.000      0.000

Note: ties exist in combined dataset;
      there are 16512 unique values out of 16547 observations.
```

SERVICES

```
. ksmirnov WLP_TFPall if man==0, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                   0.4557    0.000
 1:                  -0.0002    1.000
 Combined K-S:        0.4557    0.000      0.000
Note: ties exist in combined dataset;
```

```
     there are 77136 unique values out of 78083 observations.
```

DIFFERENCES BETWEEN FULL AND PARTIAL ONWERSHIP OF MNCs

```
. ksmirnov WLP_for if for_own!=., by( for_own )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.1884    0.000
 1:                 -0.0002    1.000
 Combined K-S:       0.1884    0.000      0.000

Note: ties exist in combined dataset;
      there are 4823 unique values out of 4826 observations.
```

DIFFERENCES BETWEEN FULL AND PARTIAL ONWERSHIP OF MNCs - MANUFACTURING

```
. ksmirnov WLP_for if for_own!=. & man==1, by( for_own )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.2439    0.000
 1:                 -0.0011    0.999
 Combined K-S:       0.2439    0.000      0.000

Note: ties exist in combined dataset;
      there are 1514 unique values out of 1515 observations.
```

DIFFERENCES BETWEEN FULL AND PARTIAL ONWERSHIP OF MNCs - SERVICES

```
. ksmirnov WLP_for if for_own!=. & man==0, by( for_own )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.1620    0.000
 1:                 -0.0003    1.000
 Combined K-S:       0.1620    0.000      0.000

Note: ties exist in combined dataset;
      there are 3310 unique values out of 3311 observations.
```

TABLE II.25 KOLMOGOROV SMIRNOV TEST PER INDUSTRY AND FOREIGN OWNERSHIP TYPE IN THE CZECH REPUBLIC, PRINTOUT FROM STATA

```
. ksmirnov WLP_TFPall, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.4479    0.000
 1:                 -0.0001    1.000
```

```
 Combined K-S:        0.4479    0.000      0.000

Note: ties exist in combined dataset;
      there are 230509 unique values out of 233445 observations.
```

MANUFACTURING

```
. ksmirnov WLP_TFPall if man==1, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group        D       P-value  Corrected
 ----------------------------------------------
 0:                   0.4266    0.000
 1:                   0.0000    1.000
 Combined K-S:        0.4266    0.000      0.000

Note: ties exist in combined dataset;
      there are 63268 unique values out of 63468 observations.
```

SERVICES

```
. ksmirnov WLP_TFPall if man==0, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group        D       P-value  Corrected
 ----------------------------------------------
 0:                   0.4316    0.000
 1:                  -0.0001    1.000
 Combined K-S:        0.4316    0.000      0.000

Note: ties exist in combined dataset;
      there are 167937 unique values out of 169977 observations.
```

DIFFERENCES BETWEEN FULL AND PARTIAL ONWERSHIP OF MNCs

```
. ksmirnov WLP_for if for_own!=., by( for_own )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group        D       P-value  Corrected
 ----------------------------------------------
 0:                   0.1478    0.000
 1:                  -0.0011    0.995
 Combined K-S:        0.1478    0.000      0.000

Note: ties exist in combined dataset;
      there are 9990 unique values out of 9993 observations.
```

DIFFERENCES BETWEEN FULL AND PARTIAL ONWERSHIP OF MNCs - MANUFACTURING

```
. ksmirnov WLP_for if for_own!=. & man==1, by( for_own )
```

Two-sample Kolmogorov-Smirnov test for equality of distribution functions

```
 Smaller group        D       P-value  Corrected
 ----------------------------------------------
 0:                   0.1013    0.000
 1:                  -0.0027    0.988
```

```
 Combined K-S:       0.1013    0.000      0.000
```

DIFFERENCES BETWEEN FULL AND PARTIAL ONWERSHIP OF MNCs - SERVICES

```
. ksmirnov WLP_for if for_own!=. & man==0, by( for_own )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.1828    0.000
 1:                 -0.0036    0.971
 Combined K-S:       0.1828    0.000      0.000

Note: ties exist in combined dataset; there are 5781 unique values out
of 5782 observations.
```

TABLE II.26 KOLMOGOROV SMIRNOV TEST FOR EQUALITY OF DISTRIBUTIONS IN CZECH REPUBLIC USING OLS ESTIMATION OF TFP

```
. ksmirnov OLS_TFPall if year==2002, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.1993    0.000
 1:                 -0.0006    1.000
 Combined K-S:       0.1993    0.000      0.000

Note: ties exist in combined dataset;
      there are 12890 unique values out of 12901 observations.

. ksmirnov OLS_TFPall if year==2003, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.2671    0.000
 1:                  0.0000    1.000
 Combined K-S:       0.2671    0.000      0.000

Note: ties exist in combined dataset;
      there are 19317 unique values out of 19331 observations.

. ksmirnov OLS_TFPall if year==2004, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.3294    0.000
 1:                 -0.0006    0.999
 Combined K-S:       0.3294    0.000      0.000
```

```
Note: ties exist in combined dataset;
      there are 27764 unique values out of 27796 observations.

. ksmirnov OLS_TFPall if year==2005, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.3002    0.000
 1:                 -0.0001    1.000
 Combined K-S:       0.3002    0.000      0.000

Note: ties exist in combined dataset;
      there are 28820 unique values out of 30043 observations.

. ksmirnov OLS_TFPall if year==2006, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.3425    0.000
 1:                 -0.0002    1.000
 Combined K-S:       0.3425    0.000      0.000

Note: ties exist in combined dataset;
      there are 36971 unique values out of 37024 observations.

. ksmirnov OLS_TFPall if year==2007, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.3453    0.000
 1:                  0.0000    1.000
 Combined K-S:       0.3453    0.000      0.000

Note: ties exist in combined dataset;
      there are 40533 unique values out of 40602 observations.

. ksmirnov OLS_TFPall if year==2008, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.3233    0.000
 1:                 -0.0002    1.000
 Combined K-S:       0.3233    0.000      0.000

Note: ties exist in combined dataset;
      there are 32956 unique values out of 33005 observations.

. ksmirnov OLS_TFPall if year==2009, by( for_dom )
```

```
Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.3209    0.000
 1:                 -0.0002    1.000
 Combined K-S:       0.3209    0.000      0.000

Note: ties exist in combined dataset;
      there are 32701 unique values out of 32743 observations.
```

TABLE II.27 KOLMOGOROV SMIRNOV TEST FOR EQUALITY OF DISTRIBUTIONS IN ESTONIA USING OLS ESTIMATION OF TFP

```
. ksmirnov OLS_TFPall if year==2002, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.3270    0.006
 1:                 -0.0020    1.000
 Combined K-S:       0.3270    0.012      0.006

Note: ties exist in combined dataset;
      there are 9069 unique values out of 9082 observations.

. ksmirnov OLS_TFPall if year==2003, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.3434    0.000
 1:                 -0.0018    0.998
 Combined K-S:       0.3434    0.000      0.000

Note: ties exist in combined dataset;
      there are 10595 unique values out of 10620 observations.

. ksmirnov OLS_TFPall if year==2004, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.3182    0.000
 1:                 -0.0016    0.998
 Combined K-S:       0.3182    0.000      0.000

Note: ties exist in combined dataset;
      there are 11679 unique values out of 11699 observations.

. ksmirnov OLS_TFPall if year==2005, by( for_dom )
```

```
Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.3200    0.000
 1:                 -0.0019    0.996
 Combined K-S:       0.3200    0.000      0.000

Note: ties exist in combined dataset;
      there are 11935 unique values out of 12597 observations.

. ksmirnov OLS_TFPall if year==2006, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.2907    0.000
 1:                 -0.0003    1.000
 Combined K-S:       0.2907    0.000      0.000

Note: ties exist in combined dataset;
      there are 13932 unique values out of 13958 observations.

. ksmirnov OLS_TFPall if year==2007, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.3097    0.000
 1:                 -0.0022    0.994
 Combined K-S:       0.3097    0.000      0.000

Note: ties exist in combined dataset;
      there are 15519 unique values out of 15553 observations.

. ksmirnov OLS_TFPall if year==2008, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.2969    0.000
 1:                 -0.0004    1.000
 Combined K-S:       0.2969    0.000      0.000

Note: ties exist in combined dataset;
      there are 14401 unique values out of 14428 observations.

. ksmirnov OLS_TFPall if year==2009, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
```

```
 0:                    0.2095    0.000
 1:                   -0.0075    0.950
 Combined K-S:         0.2095    0.000      0.000

Note: ties exist in combined dataset;
      there are 3552 unique values out of 3557 observations.

. ksmirnov OLS_TFPall if year==2010, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                    0.2546    0.000
 1:                    0.0000    1.000
 Combined K-S:         0.2546    0.000      0.000

Note: ties exist in combined dataset;
      there are 3133 unique values out of 3136 observations.
```

TABLE II.28 KOLMOGOROV SMIRNOV TEST FOR EQUALITY OF DISTRIBUTIONS IN HUNGARY USING OLS ESTIMATION OF TFP

```
. ksmirnov OLS_TFPall if year==2004, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                    0.4051    0.008
 1:                   -0.0123    0.996
 Combined K-S:         0.4051    0.017      0.008

. ksmirnov OLS_TFPall if year==2005, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                    0.2194    0.007
 1:                   -0.0051    0.997
 Combined K-S:         0.2194    0.015      0.009

. ksmirnov OLS_TFPall if year==2006, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                    0.1657    0.037
 1:                   -0.0083    0.992
 Combined K-S:         0.1657    0.075      0.055

. ksmirnov OLS_TFPall if year==2007, by( for_dom )
```

```
Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.2009    0.000
 1:                 -0.0062    0.981
 Combined K-S:       0.2009    0.000      0.000

. ksmirnov OLS_TFPall if year==2008, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.1800    0.000
 1:                 -0.0028    0.995
 Combined K-S:       0.1800    0.000      0.000

. ksmirnov OLS_TFPall if year==2009, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.1684    0.000
 1:                 -0.0006    1.000
 Combined K-S:       0.1684    0.000      0.000

Note: ties exist in combined dataset;
      there are 3609 unique values out of 3610 observations.

. ksmirnov OLS_TFPall if year==2010, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.2326    0.046
 1:                 -0.0323    0.942
 Combined K-S:       0.2326    0.092      0.062
```

TABLE II.29 KOLMOGOROV SMIRNOV TEST FOR EQUALITY OF DISTRIBUTIONS IN SLOVAKIA USING OLS ESTIMATION OF TFP

```
. ksmirnov OLS_TFPall if year==2002, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.1584    0.199
 1:                 -0.0446    0.880
 Combined K-S:       0.1584    0.395      0.318

. ksmirnov OLS_TFPall if year==2003, by( for_dom )
```

```
Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.1265    0.169
 1:                 -0.0321    0.892
 Combined K-S:       0.1265    0.337      0.280

. ksmirnov OLS_TFPall if year==2004, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.2546    0.000
 1:                 -0.0149    0.968
 Combined K-S:       0.2546    0.000      0.000

. ksmirnov OLS_TFPall if year==2005, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.2142    0.000
 1:                 -0.0063    0.987
 Combined K-S:       0.2142    0.000      0.000

Note: ties exist in combined dataset;
      there are 5560 unique values out of 5561 observations.

. ksmirnov OLS_TFPall if year==2006, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.2720    0.000
 1:                 -0.0044    0.991
 Combined K-S:       0.2720    0.000      0.000

Note: ties exist in combined dataset;
      there are 9946 unique values out of 9977 observations.

. ksmirnov OLS_TFPall if year==2007, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.3204    0.000
 1:                 -0.0021    0.998
 Combined K-S:       0.3204    0.000      0.000

Note: ties exist in combined dataset;
```

```
      there are 11073 unique values out of 11107 observations.

. ksmirnov OLS_TFPall if year==2008, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group        D       P-value  Corrected
 ----------------------------------------------
 0:                   0.3271    0.000
 1:                  -0.0023    0.998
 Combined K-S:        0.3271    0.000      0.000

Note: ties exist in combined dataset;
      there are 8123 unique values out of 8133 observations.

. ksmirnov OLS_TFPall if year==2009, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group        D       P-value  Corrected
 ----------------------------------------------
 0:                   0.2174    0.000
 1:                  -0.0012    0.998
 Combined K-S:        0.2174    0.000      0.000

Note: ties exist in combined dataset;
      there are 8205 unique values out of 8232 observations.
```

TABLE II.30 KOLMOGOROV SMIRNOV TEST FOR EQUALITY OF DISTRIBUTIONS IN SLOVENIA USING OLS ESTIMATION OF TFP

```
. ksmirnov OLS_TFPall if year==2002, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group        D       P-value  Corrected
 ----------------------------------------------
 0:                   0.6136    0.024
 1:                  -0.1258    0.855
 Combined K-S:        0.6136    0.048      0.020

. ksmirnov OLS_TFPall if year==2003, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group        D       P-value  Corrected
 ----------------------------------------------
 0:                   0.5632    0.006
 1:                  -0.0123    0.998
 Combined K-S:        0.5632    0.013      0.005

Note: ties exist in combined dataset;
      there are 1067 unique values out of 1068 observations.

. ksmirnov OLS_TFPall if year==2004, by( for_dom )
```

```
Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                   0.6320    0.004
 1:                  -0.0247    0.992
 Combined K-S:        0.6320    0.008      0.003

. ksmirnov OLS_TFPall if year==2005, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                   0.5258    0.000
 1:                  -0.0337    0.965
 Combined K-S:        0.5258    0.000      0.000

Note: ties exist in combined dataset;
      there are 2302 unique values out of 2309 observations.

. ksmirnov OLS_TFPall if year==2006, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                   0.5153    0.000
 1:                  -0.0130    0.990
 Combined K-S:        0.5153    0.000      0.000

Note: ties exist in combined dataset;
      there are 3270 unique values out of 3273 observations.

. ksmirnov OLS_TFPall if year==2007, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                   0.4687    0.000
 1:                  -0.0037    0.999
 Combined K-S:        0.4687    0.000      0.000

. ksmirnov OLS_TFPall if year==2008, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                   0.3379    0.000
 1:                  -0.0100    0.988
 Combined K-S:        0.3379    0.000      0.000

. ksmirnov OLS_TFPall if year==2009, by( for_dom )
```

```
Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.3393    0.000
 1:                 -0.0077    0.986
 Combined K-S:       0.3393    0.000      0.000

. ksmirnov OLS_TFPall if year==2010, by( for_dom )

Two-sample Kolmogorov-Smirnov test for equality of distribution
functions

 Smaller group       D       P-value  Corrected
 ----------------------------------------------
 0:                  0.2724    0.007
 1:                 -0.0158    0.983
 Combined K-S:       0.2724    0.014      0.008
```

APPENDIX III.
SUPPLEMENT TO CHAPTER FIVE

3.1 EMPIRICAL RESULTS FOR THE BASELINE MODEL OF PRODUCTIVITY SPILLOVERS FROM FDI PRESENTED IN SECTION 5.6.1

TABLE III.1 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN THE CZECH REPUBLIC FOR ENTIRE ECONOMY, 2002-2009 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP l2.WLP_TFP hor_tot back_tot for_tot humcap1 RD
hhi_sales age age2 logta logta2 demand i.nace_short i.region_code i.year,
gmm(l.WLP_TFP, lag(1 1)coll) gmm(l2.WLP_TFP, lag(1 2)coll) gmm(hor_tot, lag(5
5)coll) gmm(back_tot, lag(4 4)coll) gmm(for_tot, lag(3 3)coll) iv(humcap1 RD
hhi_sales age age2 logta logta2 demand) iv(i.nace_short i.region_code i.year) two
robust ar(4)

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =     97891
Time variable : year                            Number of groups   =     36700
Number of instruments = 62                      Obs per group: min =         1
Wald chi2(55) = 167552.41                                      avg =      2.67
Prob > chi2   =     0.000                                      max =         6
------------------------------------------------------------------------------
             |              Corrected
     WLP_TFP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     WLP_TFP |
         L1. |   .4004412   .0121284    33.02   0.000     .3766699    .4242125
         L2. |   .0774718   .0074724    10.37   0.000     .0628261    .0921175
             |
     hor_tot |   .3044098   .2252638     1.35   0.177    -.1370992    .7459187
    back_tot |   .4594201   .0784107     5.86   0.000     .3057378    .6131023
     for_tot |  -3.883384   .4497637    -8.63   0.000    -4.764905   -3.001863
     humcap1 |    .427409   .0083709    51.06   0.000     .4110023    .4438157
          RD |   .0512461   .0017515    29.26   0.000     .0478133    .0546789
   hhi_sales |  -.3257232   .0662346    -4.92   0.000    -.4555407   -.1959057
         age |  -.0106061   .0010317   -10.28   0.000    -.0126281   -.0085841
        age2 |   .0000847   .0000336     2.52   0.012     .0000187    .0001506
       logta |   .2012549   .0129466    15.54   0.000       .17588    .2266298
      logta2 |   -.004944    .000827    -5.98   0.000    -.0065649   -.0033231
      demand |  -.0070572   .0140818    -0.50   0.616     -.034657    .0205426
             |
  nace_short |
         20  |   .8691183   .1094553     7.94   0.000     .6545899    1.083647
         23  |    1.83654   .2036709     9.02   0.000     1.437352    2.235728
         24  |   1.711917   .1169152    14.64   0.000     1.482767    1.941067
         25  |   1.616547   .1348435    11.99   0.000     1.352258    1.880835
         26  |   1.227997   .1832233     6.70   0.000     .8688863    1.587108
         29  |   1.072375   .1182887     9.07   0.000     .8405334    1.304217
         45  |    .109741   .1279512     0.86   0.391    -.1410388    .3605208
         50  |   1.027582   .1232817     8.34   0.000     .7859539    1.269209
         51  |   1.189422   .1151633    10.33   0.000     .9637059    1.415138
         52  |   1.343126   .0997478    13.47   0.000     1.147624    1.538628
         55  |   .5891138   .0988794     5.96   0.000     .3953138    .7829138
         60  |   .4907669   .1070081     4.59   0.000      .281035    .7004989
         61  |   .7331621   .1663649     4.41   0.000     .4070929    1.059231
         62  |   .4647323   .2210088     2.10   0.035      .031563    .8979017
         63  |   .2376622   .1402796     1.69   0.090    -.0372808    .5126052
         64  |   .1674991    .213603     0.78   0.433    -.2511551    .5861533
         70  |   .6866308   .1079913     6.36   0.000     .4749718    .8982898
       1516  |   .4791926   .1600912     2.99   0.003     .1654197    .7929655
       1718  |   1.117832   .0990488    11.29   0.000     .9236997    1.311964
       2122  |   .6796293   .1290942     5.26   0.000     .4266093    .9326492
       2728  |   .7397055    .125974     5.87   0.000     .4928009      .98661
       3033  |   .6451619   .1632237     3.95   0.000     .3252494    .9650744
       3435  |   .3444385   .2297693     1.50   0.134    -.1059011     .794778
```

```
        3637  |   1.014858   .1107811     9.16   0.000     .7977309    1.231985
        4041  |   .5884436   .1634334     3.60   0.000       .26812    .9087672
        6567  |   .5046571   .2140132     2.36   0.018     .0851989    .9241153
        7174  |   .2036159   .1288091     1.58   0.114    -.0488453    .4560771
              |
  region_code |
           4  |  -.0273446   .0173882    -1.57   0.116    -.0614249    .0067356
           5  |  -.0241492   .0169629    -1.42   0.155    -.0573959    .0090975
           6  |  -.0467679   .0181099    -2.58   0.010    -.0822626   -.0112731
           7  |  -.0021429   .0161978    -0.13   0.895      -.03389    .0296041
           8  |  -.0304769    .017412    -1.75   0.080    -.0646037      .00365
           9  |  -.0211048   .0172131    -1.23   0.220    -.0548418    .0126321
          10  |  -.0077954   .0172893    -0.45   0.652    -.0416818    .0260911
          11  |   .0121333   .0158227     0.77   0.443    -.0188785    .0431451
          13  |  -.0077648   .0151043    -0.51   0.607    -.0373687    .0218391
          14  |  -.0394854    .016693    -2.37   0.018    -.0722031   -.0067677
              |
         year |
        2004  |  -.1741713   .0359903    -4.84   0.000     -.244711   -.1036317
        2005  |  -.0657536   .0297827    -2.21   0.027    -.1241265   -.0073806
        2006  |  -.0588609   .0309974    -1.90   0.058    -.1196146    .0018929
        2007  |  -.0398565   .0311755    -1.28   0.201    -.1009594    .0212463
        2008  |   .0170925   .0089953     1.90   0.057     -.000538    .0347231
              |
        _cons |  -.0794507   .1453476    -0.55   0.585    -.3643268    .2054255
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(humcap1 RD hhi_sales age age2 logta logta2 demand 19b.nace_short
    20.nace_short 23.nace_short 24.nace_short 25.nace_short 26.nace_short
    29.nace_short 45.nace_short 50.nace_short 51.nace_short 52.nace_short
    55.nace_short 60.nace_short 61.nace_short 62.nace_short 63.nace_short
    64.nace_short 70.nace_short 1516.nace_short 1718.nace_short
    2122.nace_short 2728.nace_short 3033.nace_short 3435.nace_short
    3637.nace_short 4041.nace_short 6567.nace_short 7174.nace_short
    3b.region_code 4.region_code 5.region_code 6.region_code 7.region_code
    8.region_code 9.region_code 10.region_code 11.region_code 13.region_code
    14.region_code 2002b.year 2003.year 2004.year 2005.year 2006.year
    2007.year 2008.year 2009.year)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L3.for_tot collapsed
    L4.back_tot collapsed
    L5.hor_tot collapsed
    L(1/2).L2.WLP_TFP collapsed
    L.L.WLP_TFP collapsed
Instruments for levels equation
  Standard
    humcap1 RD hhi_sales age age2 logta logta2 demand 19b.nace_short
    20.nace_short 23.nace_short 24.nace_short 25.nace_short 26.nace_short
    29.nace_short 45.nace_short 50.nace_short 51.nace_short 52.nace_short
    55.nace_short 60.nace_short 61.nace_short 62.nace_short 63.nace_short
    64.nace_short 70.nace_short 1516.nace_short 1718.nace_short
    2122.nace_short 2728.nace_short 3033.nace_short 3435.nace_short
    3637.nace_short 4041.nace_short 6567.nace_short 7174.nace_short
    3b.region_code 4.region_code 5.region_code 6.region_code 7.region_code
    8.region_code 9.region_code 10.region_code 11.region_code 13.region_code
    14.region_code 2002b.year 2003.year 2004.year 2005.year 2006.year
    2007.year 2008.year 2009.year
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL2.for_tot collapsed
    DL3.back_tot collapsed
    DL4.hor_tot collapsed
    D.L2.WLP_TFP collapsed
    D.L.WLP_TFP collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z = -31.01  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   1.12  Pr > z =  0.261
```

```
Arellano-Bond test for AR(3) in first differences: z =   0.87  Pr > z =  0.382
Arellano-Bond test for AR(4) in first differences: z =  -0.72  Pr > z =  0.469
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(6)    = 16.02  Prob > chi2 =  0.014
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(6)    =  8.67  Prob > chi2 =  0.193
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(1)    =  1.86  Prob > chi2 =  0.173
    Difference (null H = exogenous): chi2(5)    =  6.81  Prob > chi2 =  0.235
  gmm(L.WLP_TFP, collapse lag(1 1))
    Hansen test excluding group:     chi2(4)    =  8.09  Prob > chi2 =  0.088
    Difference (null H = exogenous): chi2(2)    =  0.58  Prob > chi2 =  0.749
  gmm(L2.WLP_TFP, collapse lag(1 2))
    Hansen test excluding group:     chi2(3)    =  5.77  Prob > chi2 =  0.123
    Difference (null H = exogenous): chi2(3)    =  2.89  Prob > chi2 =  0.408
  gmm(hor_tot, collapse lag(5 5))
    Hansen test excluding group:     chi2(4)    =  8.47  Prob > chi2 =  0.076
    Difference (null H = exogenous): chi2(2)    =  0.20  Prob > chi2 =  0.904
  gmm(back_tot, collapse lag(4 4))
    Hansen test excluding group:     chi2(4)    =  6.09  Prob > chi2 =  0.192
    Difference (null H = exogenous): chi2(2)    =  2.58  Prob > chi2 =  0.276
  gmm(for_tot, collapse lag(3 3))
    Hansen test excluding group:     chi2(4)    =  5.85  Prob > chi2 =  0.211
    Difference (null H = exogenous): chi2(2)    =  2.82  Prob > chi2 =  0.244
```

LONG RUN COEFFICIENTS

```
nlcom(LR_hor:_b[hor_tot]/(1-_b[l.WLP_TFP]))(LR_back:_b[back_tot]/(1-_b[l.WLP_TFP]))
(LR_for:_b[for_tot]/(1_b[l.WLP_TFP]))(LR_human_capital:_b[humcap1]/(1_b[l.WLP_TFP])
(LR_intangibles:_b[RD]/(1-_b[l.WLP_TFP]))(LR_HHI:_b[hhi_sales]/(1-_b[l.WLP_TFP]))
(LR_age:_b[age]/(1_b[l.WLP_TFP]))(LR_agesq:_b[age2]/(1_b[l.WLP_TFP]))(LR_size:_b[logta]/(
1_b[l.WLP_TFP]))(LR_sizesq:_b[logta2]/(1_b[l.WLP_TFP]))(LR_demand:_b[demand]/(1-
_b[l.WLP_TFP]))
```

```
-----------------------------------------------------------------------------
        WLP_TFP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
----------------+------------------------------------------------------------
         LR_hor |    .507723   .3775394     1.34   0.179    -.2322407    1.247687
        LR_back |   .7662635   .1333288     5.75   0.000      .504944    1.027583
         LR_for |  -6.477069   .7997264    -8.10   0.000    -8.044504   -4.909634
LR_human_capital |   .7128725   .0090626    78.66   0.000     .6951102    .7306348
  LR_intangibles |    .085473   .0021769    39.26   0.000     .0812064    .0897396
         LR_HHI |  -.5432714   .1108451    -4.90   0.000    -.7605238   -.3260191
         LR_age |  -.0176898   .0016893   -10.47   0.000    -.0210008   -.0143789
       LR_agesq |   .0001413   .0000563     2.51   0.012     .0000308    .0002517
        LR_size |   .3356717   .0187608    17.89   0.000     .2989012    .3724422
      LR_sizesq |  -.0082461   .0013491    -6.11   0.000    -.0108903   -.0056018
      LR_demand |  -.0117707   .0234809    -0.50   0.616    -.0577925     .034251
-----------------------------------------------------------------------------
```

TABLE III.2 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN ESTONIA FOR ENTIRE ECONOMY, 2002-2010 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP l2.WLP_TFP hor_tot back_tot for_tot humcap1 RD
hhi_sales age age2 logta logta2 demand i.nace_short i.region_code i.year,
gmm(l.WLP_TFP, lag(1 1)coll) gmm(l2.WLP_TFP, lag(1 1)coll) gmm(hor_tot, lag(4
4)coll) gmm(back_tot, lag(3 3)coll) gmm(for_tot, lag(4 5)coll) iv(humcap1 RD
hhi_sales age age2 logta logta2 demand) iv(i.nace_short i.region_code i.year) two
robust ar(4)
```

```
Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =     46368
Time variable : year                            Number of groups   =     13978
```

```
Number of instruments = 57                      Obs per group: min =          1
Wald chi2(50)  =   68825.07                                    avg =       3.32
Prob > chi2    =      0.000                                    max =          7
------------------------------------------------------------------------------
             |              Corrected
     WLP_TFP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     WLP_TFP |
         L1. |   .4020706   .0143753    27.97   0.000     .3738956    .4302457
         L2. |   .0512044   .0114014     4.49   0.000      .028858    .0735508
             |
     hor_tot |   4.117834   1.008713     4.08   0.000     2.140793    6.094874
    back_tot |  -.9454669   .1996697    -4.74   0.000    -1.336812   -.5541215
     for_tot |  -4.918265   1.256692    -3.91   0.000    -7.381336   -2.455194
     humcap1 |    .368289   .0105128    35.03   0.000     .3476843    .3888937
          RD |   .0928872   .0040246    23.08   0.000     .0849992    .1007752
   hhi_sales |   -4.38157   1.056969    -4.15   0.000    -6.453192   -2.309949
         age |   -.007443   .0014646    -5.08   0.000    -.0103137   -.0045724
        age2 |   .0000939   .0000126     7.44   0.000     .0000692    .0001186
       logta |   .3605523   .0401258     8.99   0.000     .2819073    .4391973
      logta2 |  -.0191272   .0038602    -4.95   0.000    -.0266932   -.0115613
      demand |  -.1047016   .0349181    -3.00   0.003    -.1731397   -.0362635
             |
  nace_short |
         20  |   2.348868   .6989497     3.36   0.001     .9789516    3.718784
         23  |    274.916   64.57678     4.26   0.000     148.3479    401.4842
         24  |   1.412645   .6555408     2.15   0.031     .1278083    2.697481
         25  |   2.822841   .7544113     3.74   0.000     1.344222     4.30146
         26  |   1.625253   .6368524     2.55   0.011     .3770455    2.873461
         29  |   2.581484   .6928311     3.73   0.000     1.223561    3.939408
         45  |   3.073993   .8562026     3.59   0.000     1.395866    4.752119
         50  |   3.018263    .760916     3.97   0.000     1.526895    4.509631
         51  |   4.423449   .9750819     4.54   0.000     2.512324    6.334575
         52  |   3.795149   .9225396     4.11   0.000     1.987005    5.603294
         55  |   3.687772   .8865344     4.16   0.000     1.950196    5.425347
         60  |   4.644521   1.091097     4.26   0.000     2.506009    6.783032
         61  |   2.738497   .9267006     2.96   0.003     .9221974    4.554797
         62  |   2.219392   .8846724     2.51   0.012     .4854658    3.953318
         63  |   3.667283   .9195223     3.99   0.000     1.865053    5.469514
         64  |   5.150309   1.206627     4.27   0.000     2.785364    7.515255
         70  |   4.418441   1.006413     4.39   0.000     2.445907    6.390975
       1516  |   1.963859   .6135502     3.20   0.001     .7613227    3.166395
       1718  |   2.669324   .7057763     3.78   0.000     1.286027     4.05262
       2122  |   2.927144   .7371982     3.97   0.000     1.482262    4.372026
       2728  |   2.601357   .7402582     3.51   0.000     1.150477    4.052236
       3033  |   1.037442   .6097973     1.70   0.089    -.1577388    2.232623
       3435  |   3.278107   .8523508     3.85   0.000      1.60753    4.948684
       3637  |   2.565004   .6967136     3.68   0.000      1.19947    3.930538
       4041  |   6.413858    1.47664     4.34   0.000     3.519697    9.308019
       6567  |   4.438247   1.169659     3.79   0.000     2.145758    6.730736
       7174  |   4.308536   1.026774     4.20   0.000     2.296096    6.320976
             |
 region_code |
          2  |  -.0380578   .0086314    -4.41   0.000     -.054975   -.0211405
          3  |  -.0496247   .0102656    -4.83   0.000    -.0697449   -.0295045
          4  |  -.1517806   .0248965    -6.10   0.000    -.2005769   -.1029843
          5  |  -.0349341   .0072661    -4.81   0.000    -.0491754   -.0206929
             |
        year |
       2004  |  -.2927213   .1238711    -2.36   0.018    -.5355042   -.0499384
       2005  |  -.0769728    .071195    -1.08   0.280    -.2165125    .0625669
       2006  |  -.1069835   .0688956    -1.55   0.120    -.2420163    .0280493
       2007  |   -.193283   .0786422    -2.46   0.014    -.3474189   -.0391472
       2008  |  -.3424189   .0539256    -6.35   0.000    -.4481112   -.2367266
       2009  |  -.4227557   .0373395   -11.32   0.000    -.4959397   -.3495717
             |
       _cons |  -1.882269   .8175833    -2.30   0.021    -3.484703   -.2798353
------------------------------------------------------------------------------
```

```
Instruments for first differences equation
  Standard
    D.(19b.nace_short 20.nace_short 23.nace_short 24.nace_short 25.nace_short
    26.nace_short 29.nace_short 45.nace_short 50.nace_short 51.nace_short
    52.nace_short 55.nace_short 60.nace_short 61.nace_short 62.nace_short
    63.nace_short 64.nace_short 70.nace_short 1516.nace_short 1718.nace_short
    2122.nace_short 2728.nace_short 3033.nace_short 3435.nace_short
    3637.nace_short 4041.nace_short 6567.nace_short 7174.nace_short
    1b.region_code 2.region_code 3.region_code 4.region_code 5.region_code
    2002b.year 2003.year 2004.year 2005.year 2006.year 2007.year 2008.year
    2009.year 2010.year)
    D.(humcap1 RD hhi_sales age age2 logta logta2 demand)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(4/5).for_tot collapsed
    L3.back_tot collapsed
    L4.hor_tot collapsed
    L.L2.WLP_TFP collapsed
    L.L.WLP_TFP collapsed
Instruments for levels equation
  Standard
    19b.nace_short 20.nace_short 23.nace_short 24.nace_short 25.nace_short
    26.nace_short 29.nace_short 45.nace_short 50.nace_short 51.nace_short
    52.nace_short 55.nace_short 60.nace_short 61.nace_short 62.nace_short
    63.nace_short 64.nace_short 70.nace_short 1516.nace_short 1718.nace_short
    2122.nace_short 2728.nace_short 3033.nace_short 3435.nace_short
    3637.nace_short 4041.nace_short 6567.nace_short 7174.nace_short
    1b.region_code 2.region_code 3.region_code 4.region_code 5.region_code
    2002b.year 2003.year 2004.year 2005.year 2006.year 2007.year 2008.year
    2009.year 2010.year
    humcap1 RD hhi_sales age age2 logta logta2 demand
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL3.for_tot collapsed
    DL2.back_tot collapsed
    DL3.hor_tot collapsed
    D.L2.WLP_TFP collapsed
    D.L.WLP_TFP collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z = -28.70  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -1.04  Pr > z =  0.298
Arellano-Bond test for AR(3) in first differences: z =  -0.80  Pr > z =  0.421
Arellano-Bond test for AR(4) in first differences: z =   0.90  Pr > z =  0.367
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(6)    =  43.16  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(6)    =   9.34  Prob > chi2 =  0.155
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(1)    =   0.00  Prob > chi2 =  1.000
    Difference (null H = exogenous): chi2(5)    =   9.34  Prob > chi2 =  0.096
  gmm(L.WLP_TFP, collapse lag(1 1))
    Hansen test excluding group:     chi2(4)    =   4.91  Prob > chi2 =  0.297
    Difference (null H = exogenous): chi2(2)    =   4.44  Prob > chi2 =  0.109
  gmm(L2.WLP_TFP, collapse lag(1 1))
    Hansen test excluding group:     chi2(4)    =   6.92  Prob > chi2 =  0.140
    Difference (null H = exogenous): chi2(2)    =   2.42  Prob > chi2 =  0.297
  gmm(hor_tot, collapse lag(4 4))
    Hansen test excluding group:     chi2(4)    =   4.99  Prob > chi2 =  0.289
    Difference (null H = exogenous): chi2(2)    =   4.36  Prob > chi2 =  0.113
  gmm(back_tot, collapse lag(3 3))
    Hansen test excluding group:     chi2(4)    =   6.76  Prob > chi2 =  0.149
    Difference (null H = exogenous): chi2(2)    =   2.58  Prob > chi2 =  0.275
  gmm(for_tot, collapse lag(4 5))
    Hansen test excluding group:     chi2(3)    =   6.84  Prob > chi2 =  0.077
    Difference (null H = exogenous): chi2(3)    =   2.51  Prob > chi2 =  0.474
```

LONG RUN COEFFICIENTS

```
nlcom(LR_hor:_b[hor_tot]/(1-_b[l.WLP_TFP]))(LR_back:_b[back_tot]/(1-_b[l.WLP_TFP]))
(LR_for:_b[for_tot]/(1_b[l.WLP_TFP]))(LR_human_capital:_b[humcap1]/(1_b[l.WLP_TFP])
(LR_intangibles:_b[RD]/(1-_b[l.WLP_TFP]))(LR_HHI:_b[hhi_sales]/(1-_b[l.WLP_TFP]))
(LR_age:_b[age]/(1_b[l.WLP_TFP]))(LR_agesq:_b[age2]/(1_b[l.WLP_TFP]))(LR_size:_b[logta]/(
1_b[l.WLP_TFP]))(LR_sizesq:_b[logta2]/(1_b[l.WLP_TFP]))(LR_demand:_b[demand]/(1-
_b[l.WLP_TFP]))
```

WLP_TFP	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
LR_hor	6.886823	1.658566	4.15	0.000	3.636093	10.13755
LR_back	-1.581235	.328903	-4.81	0.000	-2.225873	-.9365971
LR_for	-8.225495	2.085196	-3.94	0.000	-12.3124	-4.138586
LR_human_capital	.6159407	.0123263	49.97	0.000	.5917815	.6400998
LR_intangibles	.1553481	.0059565	26.08	0.000	.1436737	.1670226
LR_HHI	-7.327906	1.760122	-4.16	0.000	-10.77768	-3.87813
LR_age	-.012448	.0024076	-5.17	0.000	-.0171668	-.0077292
LR_agesq	.000157	.0000206	7.63	0.000	.0001167	.0001974
LR_size	.6030014	.065337	9.23	0.000	.4749432	.7310597
LR_sizesq	-.0319891	.0064384	-4.97	0.000	-.0446081	-.0193701
LR_demand	-.175107	.0584642	-3.00	0.003	-.2896948	-.0605192

TABLE III.3 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN HUNGARY FOR ENTIRE ECONOMY, 2002-2010 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP hor_tot back_tot for_tot humcap1 RD hhi_sales age age2
logta logta2 demand i.nace_short i.region_code i.year, gmm(l.WLP_TFP, lag(1 1))
gmm(hor_tot, lag(2 4)coll) gmm(back_tot, lag(3 5)coll) gmm(for_tot, lag(3 3)coll)
iv(humcap1 RD hhi_sales age age2 logta logta2 demand) iv(i.nace_short
i.region_code i.year) two robust ar(4)
```

Dynamic panel-data estimation, two-step system GMM

Group variable: id		Number of obs =	6910
Time variable : year		Number of groups =	3635
Number of instruments = 86		Obs per group: min =	1
Wald chi2(65) =	20239.28	avg =	1.90
Prob > chi2 =	0.000	max =	7

WLP_TFP	Coef.	Corrected Std. Err.	z	P>|z|	[95% Conf.	Interval]
WLP_TFP						
L1.	.4628177	.0635733	7.28	0.000	.3382163	.5874192
hor_tot	3.834854	.7218798	5.31	0.000	2.419996	5.249712
back_tot	1.907728	1.063455	1.79	0.073	-.176606	3.992063
for_tot	-5.465031	5.023408	-1.09	0.277	-15.31073	4.380669
humcap1	.3479531	.0306634	11.35	0.000	.2878539	.4080523
RD	.0116799	.0035862	3.26	0.001	.0046512	.0187087
hhi_sales	-.1722894	.1106604	-1.56	0.119	-.3891798	.044601
age	-.0109282	.0020271	-5.39	0.000	-.0149013	-.0069551
age2	.0000429	.0000156	2.75	0.006	.0000124	.0000734
logta	.1114902	.0686357	1.62	0.104	-.0230334	.2460137
logta2	.0011727	.0041883	0.28	0.779	-.0070363	.0093816
demand	.1010379	.1080639	0.93	0.350	-.1107635	.3128394
nace_short						
20	-.2055486	.3340902	-0.62	0.538	-.8603534	.4492562
23	-2.268544	.7469586	-3.04	0.002	-3.732556	-.804532
24	-.6179579	.4586733	-1.35	0.178	-1.516941	.2810253
25	-.697873	.3226821	-2.16	0.031	-1.330318	-.0654276

```
          26  |  -1.001788   .3534915    -2.83   0.005    -1.694619   -.3089574
          29  |  -.1907323   .5130719    -0.37   0.710    -1.196335      .81487
          45  |  -.3297669   .3663165    -0.90   0.368    -1.047734    .3882003
          50  |  -.3228549   .3587953    -0.90   0.368    -1.026081    .3803711
          51  |  -1.360118   .4113481    -3.31   0.001    -2.166346   -.5538909
          52  |  -.5937078   .3286188    -1.81   0.071    -1.237789    .0503733
          55  |   .6610898   .2851557     2.32   0.020     .1021949    1.219985
          60  |  -.2343265   .2641967    -0.89   0.375    -.7521424    .2834895
          61  |   1.095198   .7917709     1.38   0.167     -.456645     2.64704
          62  |   1.302303   .3262851     3.99   0.000     .6627964     1.94181
          63  |  -.1687007     .45361    -0.37   0.710     -1.05776    .7203586
          64  |  -1.102578   .7208162    -1.53   0.126    -2.515352    .3101954
          70  |    .633838   .3670541     1.73   0.084    -.0855749    1.353251
        1516  |  -.3150564   .7555876    -0.42   0.677    -1.795981    1.165868
        1718  |  -.6795939   .3833254    -1.77   0.076    -1.430898    .0717101
        2122  |   -.397425    .418152    -0.95   0.342    -1.216988    .4221378
        2728  |   -.783869   .2633819    -2.98   0.003    -1.300088   -.2676501
        3033  |  -1.592503   .4000386    -3.98   0.000    -2.376564   -.8084418
        3435  |  -3.028337   .6562235    -4.61   0.000    -4.314511   -1.742163
        3637  |   1.004958   .2622871     3.83   0.000     .4908851    1.519032
        4041  |   1.637037   .6420791     2.55   0.011     .3785852    2.895489
        6567  |   -.313951   .5149386    -0.61   0.542    -1.323212    .6953102
        7174  |  -1.835442   .6598554    -2.78   0.005    -3.128735   -.5421495
              |
 region_code  |
           2  |  -.1119225   .0594145    -1.88   0.060    -.2283727    .0045277
           3  |  -.0742801   .0521679    -1.42   0.154    -.1765273    .0279671
           4  |  -.0579786   .0511344    -1.13   0.257    -.1582003    .0422431
           5  |   .0057032   .0339442     0.17   0.867    -.0608261    .0722326
           6  |  -.0660226   .0471241    -1.40   0.161    -.1583842     .026339
           7  |  -.0460653   .0450842    -1.02   0.307    -.1344287     .042298
           8  |  -.0606415    .041331    -1.47   0.142    -.1416489    .0203658
           9  |  -.0629448   .0464101    -1.36   0.175    -.1539069    .0280174
          10  |  -.0051584   .0573093    -0.09   0.928    -.1174825    .1071657
          11  |  -.0880364   .0480707    -1.83   0.067    -.1822531    .0061804
          12  |   .0258385   .0541552     0.48   0.633    -.0803036    .1319807
          13  |  -.1534642   .0643621    -2.38   0.017    -.2796116   -.0273167
          14  |  -.0069602   .0367353    -0.19   0.850    -.0789601    .0650397
          15  |  -.0516931   .0571186    -0.91   0.365    -.1636435    .0602573
          16  |     -.0808   .0490153    -1.65   0.099    -.1768683    .0152683
          17  |  -.0705602    .086974    -0.81   0.417    -.2410262    .0999058
          18  |  -.0757368   .0523796    -1.45   0.148     -.178399    .0269254
          19  |  -.0150905   .0550186    -0.27   0.784    -.1229249     .092744
          20  |  -.1020345   .0549722    -1.86   0.063    -.2097779     .005709
              |
        year  |
        2003  |   .0962872   .8140349     0.12   0.906    -1.499192    1.691766
        2004  |   .3632323   .2086345     1.74   0.082    -.0456838    .7721484
        2005  |   .3569313    .167919     2.13   0.034     .0278162    .6860464
        2006  |     .29908   .1373523     2.18   0.029     .0298744    .5682856
        2007  |   .2311862   .1504571     1.54   0.124    -.0637043    .5260766
        2008  |   .1728373   .1874535     0.92   0.357    -.1945648    .5402395
        2009  |   .0926708    .191066     0.49   0.628    -.2818117    .4671532
              |
       _cons  |  -.0063773   .7791163    -0.01   0.993    -1.533417    1.520663
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -4.85  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   1.36  Pr > z =  0.173
Arellano-Bond test for AR(3) in first differences: z =  -0.95  Pr > z =  0.344
Arellano-Bond test for AR(4) in first differences: z =  -0.10  Pr > z =  0.918
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(20)   =  40.69  Prob > chi2 =  0.004
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(20)   =  20.43  Prob > chi2 =  0.431
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
```

```
  GMM instruments for levels
    Hansen test excluding group:     chi2(10)    =  12.56  Prob > chi2 =  0.249
    Difference (null H = exogenous): chi2(10)    =   7.87  Prob > chi2 =  0.642
  gmm(L.WLP_TFP, lag(1 1))
    Hansen test excluding group:     chi2(6)     =   7.67  Prob > chi2 =  0.263
    Difference (null H = exogenous): chi2(14)    =  12.76  Prob > chi2 =  0.546
  gmm(hor_tot, collapse lag(2 4))
    Hansen test excluding group:     chi2(16)    =  14.29  Prob > chi2 =  0.577
    Difference (null H = exogenous): chi2(4)     =   6.15  Prob > chi2 =  0.189
  gmm(back_tot, collapse lag(3 5))
    Hansen test excluding group:     chi2(16)    =  13.04  Prob > chi2 =  0.670
    Difference (null H = exogenous): chi2(4)     =   7.39  Prob > chi2 =  0.116
  gmm(for_tot, collapse lag(3 3))
    Hansen test excluding group:     chi2(18)    =  18.53  Prob > chi2 =  0.421
    Difference (null H = exogenous): chi2(2)     =   1.90  Prob > chi2 =  0.386
  iv(humcap1 RD hhi_sales age age2 logta logta2 demand)
    Hansen test excluding group:     chi2(12)    =  13.64  Prob > chi2 =  0.324
    Difference (null H = exogenous): chi2(8)     =   6.80  Prob > chi2 =  0.559
```

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```
nlcom(LR_hor:_b[hor_tot]/(1-_b[l.WLP_TFP]))(LR_back:_b[back_tot]/(1-_b[l.WLP_TFP]))
(LR_for:_b[for_tot]/(1_b[l.WLP_TFP]))(LR_human_capital:_b[humcap1]/(1_b[l.WLP_TFP])
(LR_intangibles:_b[RD]/(1-_b[l.WLP_TFP]))(LR_HHI:_b[hhi_sales]/(1-_b[l.WLP_TFP]))
(LR_age:_b[age]/(1_b[l.WLP_TFP]))(LR_agesq:_b[age2]/(1_b[l.WLP_TFP]))(LR_size:_b[logta]/(
1_b[l.WLP_TFP]))(LR_sizesq:_b[logta2]/(1_b[l.WLP_TFP]))(LR_demand:_b[demand]/(1-
_b[l.WLP_TFP]))
```

WLP_TFP	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
LR_hor	7.138832	1.655764	4.31	0.000	3.893593	10.38407
LR_back	3.551361	1.872844	1.90	0.058	-.1193451	7.222067
LR_for	-10.17351	9.680953	-1.05	0.293	-29.14783	8.800807
LR_human_capital	.6477374	.0407618	15.89	0.000	.5678458	.7276291
LR_intangibles	.021743	.0061803	3.52	0.000	.0096298	.0338561
LR_HHI	-.320728	.2047735	-1.57	0.117	-.7220767	.0806207
LR_age	-.0203435	.0032841	-6.19	0.000	-.0267803	-.0139068
LR_agesq	.0000799	.000028	2.85	0.004	.0000249	.0001348
LR_size	.2075463	.1278656	1.62	0.105	-.0430656	.4581582
LR_sizesq	.002183	.0077629	0.28	0.779	-.013032	.0173981
LR_demand	.1880887	.2098072	0.90	0.370	-.2231259	.5993034

TABLE III.4 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN SLOVAKIA FOR ENTIRE ECONOMY, 2002-2009 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP hor_tot back_tot for_tot humcap1 RD hhi_sales age age2
logta logta2 demand i.nace_short i.region_code i.year, gmm(l.WLP_TFP, lag(2
2)coll) gmm(hor_tot, lag(4 4)coll) gmm(back_tot, lag(3 5)coll) gmm(for_tot, lag(3
3)coll) iv(humcap1 RD hhi_sales age age2 logta logta2 demand i.nace_short
i.region_code i.year) two robust ar(4)

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =     30490
Time variable : year                            Number of groups   =     13595
Number of instruments = 59                      Obs per group: min =         1
Wald chi2(52)  =  49549.62                                     avg =      2.24
Prob > chi2    =     0.000                                     max =         7
------------------------------------------------------------------------------
             |              Corrected
     WLP_TFP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     WLP_TFP |
         L1. |   .6583275   .0648368    10.15   0.000     .5312496    .7854053
             |
```

hor_tot	-3.082445	.6138517	-5.02	0.000	-4.285573	-1.879318
back_tot	.2026982	.0936737	2.16	0.030	.0191011	.3862953
for_tot	5.599042	1.278966	4.38	0.000	3.092314	8.10577
humcap1	.283401	.0153208	18.50	0.000	.2533728	.3134292
RD	.0592413	.0067165	8.82	0.000	.0460772	.0724054
hhi_sales	.7736867	.2235261	3.46	0.001	.3355837	1.21179
age	-.0104226	.0014847	-7.02	0.000	-.0133325	-.0075126
age2	.0002089	.0000286	7.30	0.000	.0001528	.000265
logta	.1594498	.0388146	4.11	0.000	.0833746	.2355249
logta2	-.0063172	.0018293	-3.45	0.001	-.0099027	-.0027318
demand	-.0868262	.0228071	-3.81	0.000	-.1315272	-.0421252
nace_short						
20	-.20696	.1139086	-1.82	0.069	-.4302168	.0162968
23	1.409192	.5264923	2.68	0.007	.3772861	2.441098
24	.4425923	.1419753	3.12	0.002	.1643259	.7208587
25	-.5503192	.1280798	-4.30	0.000	-.801351	-.2992874
26	-.3019585	.1002041	-3.01	0.003	-.4983548	-.1055621
29	-.2820129	.0965521	-2.92	0.003	-.4712514	-.0927743
45	.5203278	.1665664	3.12	0.002	.1938636	.8467919
50	.1123333	.094656	1.19	0.235	-.0731891	.2978557
51	-.472137	.176342	-2.68	0.007	-.817761	-.1265131
52	-.6662163	.181598	-3.67	0.000	-1.022142	-.3102908
55	-.7568514	.1055398	-7.17	0.000	-.9637055	-.5499972
60	-.6914636	.1351342	-5.12	0.000	-.9563218	-.4266054
61	-1.78086	.3229327	-5.51	0.000	-2.413796	-1.147923
62	-1.542998	.4241249	-3.64	0.000	-2.374268	-.7117289
63	-.0145324	.1368391	-0.11	0.915	-.282732	.2536672
64	2.073486	.4362048	4.75	0.000	1.21854	2.928431
70	-.2789785	.1053444	-2.65	0.008	-.4854498	-.0725072
1516	.8254433	.2275615	3.63	0.000	.379431	1.271456
1718	-.4571465	.1120001	-4.08	0.000	-.6766626	-.2376304
2122	-.1639623	.1125681	-1.46	0.145	-.3845917	.0566671
2728	-.2195525	.089848	-2.44	0.015	-.3956513	-.0434537
3033	1.302874	.2194685	5.94	0.000	.8727237	1.733025
3435	2.576932	.4554945	5.66	0.000	1.684179	3.469685
3637	-.2690155	.0824976	-3.26	0.001	-.4307078	-.1073233
4041	1.066272	.2431102	4.39	0.000	.5897844	1.542759
6567	.1991943	.2464095	0.81	0.419	-.2837594	.6821481
7174	-.1699989	.1179512	-1.44	0.150	-.401179	.0611812
region_code						
2	.0312532	.0198874	1.57	0.116	-.0077254	.0702318
3	-.0152078	.0158433	-0.96	0.337	-.0462602	.0158445
4	.0090949	.0147301	0.62	0.537	-.0197755	.0379654
5	-.0068624	.0158636	-0.43	0.665	-.0379544	.0242297
6	-.0145014	.0144755	-1.00	0.316	-.0428729	.0138701
7	.0061695	.014164	0.44	0.663	-.0215915	.0339304
8	.0008741	.0145836	0.06	0.952	-.0277094	.0294575
year						
2003	.3692608	.083602	4.42	0.000	.2054038	.5331177
2004	.2975516	.066481	4.48	0.000	.1672512	.4278519
2005	.4641672	.0917948	5.06	0.000	.2842528	.6440816
2006	.583335	.1052983	5.54	0.000	.3769541	.7897159
2007	.1509266	.0348403	4.33	0.000	.0826409	.2192123
2008	.2960467	.0436126	6.79	0.000	.2105677	.3815258
_cons	.2226542	.1292149	1.72	0.085	-.0306024	.4759108

```
Arellano-Bond test for AR(1) in first differences: z =  -9.59  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -0.22  Pr > z =  0.827
Arellano-Bond test for AR(3) in first differences: z =   3.11  Pr > z =  0.002
Arellano-Bond test for AR(4) in first differences: z =  -2.02  Pr > z =  0.044
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(6)    =   7.84  Prob > chi2 =  0.250
  (Not robust, but not weakened by many instruments.)
```

```
Hansen test of overid. restrictions: chi2(6)    =   8.02  Prob > chi2 =  0.236
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(2)    =   1.69  Prob > chi2 =  0.430
    Difference (null H = exogenous): chi2(4)    =   6.34  Prob > chi2 =  0.175
  gmm(L.WLP_TFP, collapse lag(2 2))
    Hansen test excluding group:     chi2(4)    =   3.79  Prob > chi2 =  0.435
    Difference (null H = exogenous): chi2(2)    =   4.23  Prob > chi2 =  0.121
  gmm(hor_tot, collapse lag(4 4))
    Hansen test excluding group:     chi2(4)    =   4.39  Prob > chi2 =  0.356
    Difference (null H = exogenous): chi2(2)    =   3.63  Prob > chi2 =  0.163
  gmm(back_tot, collapse lag(3 5))
    Hansen test excluding group:     chi2(2)    =   3.34  Prob > chi2 =  0.188
    Difference (null H = exogenous): chi2(4)    =   4.68  Prob > chi2 =  0.322
  gmm(for_tot, collapse lag(3 3))
    Hansen test excluding group:     chi2(4)    =   6.70  Prob > chi2 =  0.152
    Difference (null H = exogenous): chi2(2)    =   1.32  Prob > chi2 =  0.517
```

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```
nlcom(LR_hor:_b[hor_tot]/(1-_b[l.WLP_TFP]))(LR_back:_b[back_tot]/(1-_b[l.WLP_TFP]))
(LR_for:_b[for_tot]/(1_b[l.WLP_TFP]))(LR_human_capital:_b[humcap1]/(1_b[l.WLP_TFP])
(LR_intangibles:_b[RD]/(1-_b[l.WLP_TFP]))(LR_HHI:_b[hhi_sales]/(1-_b[l.WLP_TFP]))
(LR_age:_b[age]/(1_b[l.WLP_TFP]))(LR_agesq:_b[age2]/(1_b[l.WLP_TFP]))(LR_size:_b[logta]/(
1_b[l.WLP_TFP]))(LR_sizesq:_b[logta2]/(1_b[l.WLP_TFP]))(LR_demand:_b[demand]/(1-
_b[l.WLP_TFP]))
```

WLP_TFP	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
LR_hor	-9.021637	2.929108	-3.08	0.002	-14.76258	-3.280691
LR_back	.593253	.3278504	1.81	0.070	-.0493219	1.235828
LR_for	16.38716	5.375934	3.05	0.002	5.850522	26.9238
LR_human_capital	.8294521	.1181762	7.02	0.000	.597831	1.061073
LR_intangibles	.1733862	.0163517	10.60	0.000	.1413374	.205435
LR_HHI	2.26441	.9359424	2.42	0.016	.4299966	4.098824
LR_age	-.0305046	.0050278	-6.07	0.000	-.0403589	-.0206503
LR_agesq	.0006114	.0001314	4.65	0.000	.0003539	.0008689
LR_size	.4666742	.0487146	9.58	0.000	.3711954	.562153
LR_sizesq	-.0184891	.0033598	-5.50	0.000	-.0250742	-.0119041
LR_demand	-.2541212	.0877737	-2.90	0.004	-.4261544	-.082088

TABLE III.5 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN SLOVENIA FOR ENTIRE ECONOMY, 2002-2010 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP hor_tot back_tot for_tot humcap1 RD hhi_sales age age2
logta logta2 demand i.nace_short i.region_code i.year, gmm(l.WLP_TFP, lag(2
5)coll) gmm(hor_tot, lag(2 2)coll) gmm(back_tot, lag(3 5)coll) gmm(for_tot, lag(3
5)coll) iv(humcap1 RD hhi_sales age age2 logta logta2 demand) iv(i.nace_short
i.region_code i.year) two robust ar(4)

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =     12884
Time variable : year                            Number of groups   =      4335
Number of instruments = 69                      Obs per group: min =         1
Wald chi2(57)  =   1702.37                                     avg =      2.97
Prob > chi2    =     0.000                                     max =         8
------------------------------------------------------------------------------
```

WLP_TFP	Coef.	Corrected Std. Err.	z	P>|z|	[95% Conf.	Interval]
WLP_TFP						
L1.	.5717098	.1019355	5.61	0.000	.37192	.7714997
hor_tot	-1.208292	.4333519	-2.79	0.005	-2.057646	-.3589381

```
   back_tot |  -.0693661   .1068533    -0.65   0.516    -.2787947    .1400624
    for_tot |   4.863913   1.629256     2.99   0.003      1.67063    8.057195
   humcap1 |   .3173406   .0429852     7.38   0.000     .2330911      .40159
         RD |   .0319693   .0059041     5.41   0.000     .0203974    .0435412
  hhi_sales |  -.2587784   .1159904    -2.23   0.026    -.4861154   -.0314414
        age |    .031558   .0129971     2.43   0.015     .0060841    .0570319
       age2 |  -.0017937   .0006045    -2.97   0.003    -.0029784    -.000609
      logta |   .0910366   .0276663     3.29   0.001     .0368117    .1452616
     logta2 |   .0003955   .0015309     0.26   0.796    -.0026051     .003396
     demand |  -.3875461   .2714775    -1.43   0.153    -.9196323    .1445401
            |
 nace_short |
        20  |   9.740354   3.180528     3.06   0.002     3.506633    15.97407
        23  |   .7251854   5.633267     0.13   0.898    -10.31582    11.76619
        24  |   10.87912   3.377413     3.22   0.001      4.25951    17.49873
        25  |   9.602245   3.102772     3.09   0.002     3.520923    15.68357
        26  |   10.19529   3.236857     3.15   0.002     3.851164    16.53941
        29  |   9.570389   3.220144     2.97   0.003     3.259023    15.88176
        45  |   10.43473   3.236882     3.22   0.001     4.090555     16.7789
        50  |   10.37311   3.295715     3.15   0.002     3.913629    16.83259
        51  |   10.60996   3.249951     3.26   0.001     4.240178    16.97975
        52  |   10.51507   3.249323     3.24   0.001     4.146511    16.88362
        55  |   10.00411   3.191597     3.13   0.002     3.748693    16.25952
        60  |    10.4191   3.202909     3.25   0.001     4.141512    16.69668
        61  |   32.93995   10.58225     3.11   0.002     12.19911    53.68078
        62  |   9.813074   3.289496     2.98   0.003      3.36578    16.26037
        63  |   10.38334   3.279004     3.17   0.002      3.95661    16.81007
        64  |   9.471135   3.179406     2.98   0.003     3.239615    15.70266
        70  |   10.38975   3.189148     3.26   0.001     4.139131    16.64036
      1516  |   10.17559   3.218222     3.16   0.002     3.867987    16.48319
      1718  |   10.20259   3.252018     3.14   0.002     3.828752    16.57643
      2122  |   9.894403   3.210852     3.08   0.002     3.601249    16.18756
      2728  |   10.00382   3.179732     3.15   0.002     3.771655    16.23598
      3033  |   10.01745   3.195984     3.13   0.002     3.753436    16.28146
      3435  |   9.456383    3.38237     2.80   0.005     2.827059    16.08571
      3637  |    9.96133   3.249104     3.07   0.002     3.593204    16.32946
      4041  |   10.70867   3.327237     3.22   0.001     4.187401    17.22993
      6567  |   10.42947    3.23688     3.22   0.001     4.085298    16.77363
      7174  |   10.93683   3.307067     3.31   0.001     4.455095    17.41856
            |
region_code |
         2  |  -.0273115   .0195971    -1.39   0.163    -.0657212    .0110982
         3  |  -.0055709    .019232    -0.29   0.772    -.0432649    .0321231
         4  |   .0627412   .0253755     2.47   0.013     .0130061    .1124763
         5  |   -.050154   .0248677    -2.02   0.044    -.0988939   -.0014141
         6  |  -.1583262   .0577699    -2.74   0.006    -.2715531   -.0450992
         7  |   .0365276   .0144129     2.53   0.011     .0082788    .0647764
         8  |  -.0011711   .0150639    -0.08   0.938    -.0306959    .0283537
         9  |   .0834473   .0445656     1.87   0.061    -.0038997    .1707942
        10  |   .0212408    .015514     1.37   0.171     -.009166    .0516477
        11  |  -.0127006   .0238907    -0.53   0.595    -.0595255    .0341243
        12  |  -.0608891   .0368069    -1.65   0.098    -.1330293     .011251
            |
       year |
      2003  |   .6032539   .2033118     2.97   0.003     .2047702    1.001738
      2004  |   .2729232   .1166117     2.34   0.019     .0443685    .5014779
      2005  |   .1901328   .1194995     1.59   0.112    -.0440819    .4243475
      2006  |   .2675073   .1305059     2.05   0.040     .0117204    .5232941
      2007  |   .2436445   .1201532     2.03   0.043     .0081487    .4791404
      2008  |   .2342361   .1094841     2.14   0.032     .0196512     .448821
      2009  |  -.1084826   .0681565    -1.59   0.111     -.242067    .0251017
            |
      _cons |  -7.347184   3.732304    -1.97   0.049    -14.66236    -.032003
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -5.86  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   1.72  Pr > z =  0.085
Arellano-Bond test for AR(3) in first differences: z =   0.06  Pr > z =  0.953
```

```
Arellano-Bond test for AR(4) in first differences: z =   1.07  Pr > z =  0.287
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(11)    = 24.48  Prob > chi2 =  0.011
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(11)    = 15.67  Prob > chi2 =  0.154
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(7)     = 10.02  Prob > chi2 =  0.187
    Difference (null H = exogenous): chi2(4)     =  5.64  Prob > chi2 =  0.228
  gmm(L.WLP_TFP, collapse lag(2 5))
    Hansen test excluding group:     chi2(6)     =  6.66  Prob > chi2 =  0.353
    Difference (null H = exogenous): chi2(5)     =  9.00  Prob > chi2 =  0.109
  gmm(hor_tot, collapse lag(2 2))
    Hansen test excluding group:     chi2(9)     = 14.27  Prob > chi2 =  0.113
    Difference (null H = exogenous): chi2(2)     =  1.40  Prob > chi2 =  0.496
  gmm(back_tot, collapse lag(3 5))
    Hansen test excluding group:     chi2(7)     = 13.85  Prob > chi2 =  0.054
    Difference (null H = exogenous): chi2(4)     =  1.81  Prob > chi2 =  0.770
  gmm(for_tot, collapse lag(3 5))
    Hansen test excluding group:     chi2(7)     =  9.42  Prob > chi2 =  0.224
    Difference (null H = exogenous): chi2(4)     =  6.24  Prob > chi2 =  0.182
  iv(humcap1 RD hhi_sales age age2 logta logta2 demand)
    Hansen test excluding group:     chi2(3)     =  1.14  Prob > chi2 =  0.768
    Difference (null H = exogenous): chi2(8)     = 14.53  Prob > chi2 =  0.069
```

LONG RUN COEFFICIENTS

```
nlcom(LR_hor:_b[hor_tot]/(1-_b[l.WLP_TFP]))(LR_back:_b[back_tot]/(1-_b[l.WLP_TFP]))
(LR_for:_b[for_tot]/(1_b[l.WLP_TFP]))(LR_human_capital:_b[humcap1]/(1_b[l.WLP_TFP])
(LR_intangibles:_b[RD]/(1-_b[l.WLP_TFP]))(LR_HHI:_b[hhi_sales]/(1-_b[l.WLP_TFP]))
(LR_age:_b[age]/(1_b[l.WLP_TFP]))(LR_agesq:_b[age2]/(1_b[l.WLP_TFP]))(LR_size:_b[logta]/(
1_b[l.WLP_TFP]))(LR_sizesq:_b[logta2]/(1_b[l.WLP_TFP]))(LR_demand:_b[demand]/(1-
_b[l.WLP_TFP]))
```

WLP_TFP	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
LR_hor	-2.8212	.9201598	-3.07	0.002	-4.62468	-1.01772
LR_back	-.1619606	.2531728	-0.64	0.522	-.6581703	.334249
LR_for	11.35658	3.632986	3.13	0.002	4.236062	18.4771
LR_human_capital	.7409476	.1115201	6.64	0.000	.5223722	.9595231
LR_intangibles	.074644	.0091424	8.16	0.000	.0567251	.0925628
LR_HHI	-.6042128	.2851575	-2.12	0.034	-1.163111	-.0453145
LR_age	.0736836	.027844	2.65	0.008	.0191105	.1282568
LR_agesq	-.0041881	.0012988	-3.22	0.001	-.0067337	-.0016425
LR_size	.2125583	.0424961	5.00	0.000	.1292675	.2958491
LR_sizesq	.0009234	.0035341	0.26	0.794	-.0060034	.0078501
LR_demand	-.9048681	.5790172	-1.56	0.118	-2.039721	.2299848

3.2 EMPIRICAL RESULTS FOR THE EFFECTS OF MNCS' ORIGIN ON PRODUCTIVITY OF LOCAL FIRMS PRESENTED IN SECTION 5.6.3

TABLE III.6 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN THE CZECH REPUBLIC ACCORDING TO MNC'S ORIGIN, 2002-2009 (DEP. VARIABLE TFP)

```
xtabond2 WLP_TFP l.WLP_TFP  l2.WLP_TFP hor_EU hor_nonEU back_EU back_nonEU
for_EU for_nonEU humcap1 RD hhi_sales age age2 logta logta2 demand i.nace_short
i.region_code i.year, gmm(l.WLP_TFP, lag(1 2)coll) gmm(l2.WLP_TFP, lag(1
1)coll) gmm(hor_EU, lag(3 4)coll) gmm(hor_nonEU, lag(2 2)coll)  gmm(back_EU,
lag(3 3)coll) gmm(back_nonEU, lag(4 4)coll) gmm(for_EU, lag(2 2)coll)
```

```
gmm(for_nonEU, lag(4 4)coll) iv(humcap1 RD hhi_sales age age2 logta logta2
demand) iv(i.nace_short i.region_code i.year) two robust ar(4)

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =     97891
Time variable : year                            Number of groups   =     36700
Number of instruments = 68                      Obs per group: min =         1
Wald chi2(58) = 163480.57                                      avg =      2.67
Prob > chi2   =     0.000                                      max =         6
------------------------------------------------------------------------------
             |              Corrected
     WLP_TFP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     WLP_TFP |
         L1. |   .3867443   .0122666    31.53   0.000     .3627022    .4107863
         L2. |   .0680729   .0074617     9.12   0.000     .0534482    .0826976
             |
      hor_EU |   .4636075   .1028814     4.51   0.000     .2619637    .6652514
   hor_nonEU |   -2.95881   .5057317    -5.85   0.000    -3.950026   -1.967594
     back_EU |  -1.963876   .2816985    -6.97   0.000    -2.515994   -1.411757
  back_nonEU |   11.13578   1.604228     6.94   0.000     7.991551    14.28001
      for_EU |   1.910089   .5277166     3.62   0.000     .8757839    2.944395
   for_nonEU |  -12.03661   1.971361    -6.11   0.000    -15.90041   -8.172814
    humcap1 |   .4383052    .008362    52.42   0.000      .421916    .4546944
          RD |   .0525092    .001767    29.72   0.000      .049046    .0559724
   hhi_sales |  -.3165572   .0625763    -5.06   0.000    -.4392046   -.1939098
         age |  -.0106267   .0010665    -9.96   0.000     -.012717   -.0085364
        age2 |   .0000848   .0000351     2.41   0.016     .0000159    .0001536
       logta |   .2078478   .0131873    15.76   0.000     .1820012    .2336944
      logta2 |  -.0049956   .0008403    -5.95   0.000    -.0066425   -.0033487
      demand |   .0840185   .0191514     4.39   0.000     .0464824    .1215545
             |
  nace_short |
         20  |   1.054221    .092366    11.41   0.000     .8731867    1.235255
         23  |   1.615949   .2300302     7.02   0.000     1.165098      2.0668
         24  |   1.439816   .1282456    11.23   0.000     1.188459    1.691173
         25  |   .9949897   .1462664     6.80   0.000     .7083128    1.281666
         26  |   1.651396   .1091032    15.14   0.000     1.437558    1.865235
         29  |    1.18529   .1013099    11.70   0.000     .9867267    1.383854
         45  |   .8690088   .0994775     8.74   0.000     .6740365    1.063981
         50  |   .8159457   .1152225     7.08   0.000     .5901138    1.041778
         51  |   1.700288   .1080256    15.74   0.000     1.488561    1.912014
         52  |   1.235096   .1080546    11.43   0.000     1.023313     1.44688
         55  |   .7342845   .0873004     8.41   0.000      .563179    .9053901
         60  |   .6381451   .1085025     5.88   0.000     .4254841    .8508061
         61  |   .5830411   .1947942     2.99   0.003     .2012515    .9648306
         62  |   .9238705   .2441319     3.78   0.000     .4453807     1.40236
         63  |     .28657   .1397231     2.05   0.040     .0127179    .5604222
         64  |   .3928325   .1228693     3.20   0.001      .152013    .6336519
         70  |   1.059451   .0943744    11.23   0.000     .8744802    1.244421
       1516  |   1.222051   .0947393    12.90   0.000     1.036365    1.407736
       1718  |   1.178546   .0914225    12.89   0.000     .9993615    1.357731
       2122  |   1.052318    .091326    11.52   0.000     .8733227    1.231314
       2728  |   .9826873   .1033888     9.50   0.000     .7800491    1.185326
       3033  |   1.183201   .1025608    11.54   0.000     .9821858    1.384217
       3435  |   1.020143   .1082401     9.42   0.000     .8079966     1.23229
       3637  |   1.307574   .0877882    14.89   0.000     1.135513    1.479636
       4041  |    1.00218   .1100217     9.11   0.000     .7865413    1.217818
       6567  |   .7562094   .1737694     4.35   0.000     .4156276    1.096791
       7174  |    1.31642   .1199315    10.98   0.000     1.081359    1.551482
             |
 region_code |
          4  |  -.0273686   .0176365    -1.55   0.121    -.0619354    .0071983
          5  |  -.0214129   .0172582    -1.24   0.215    -.0552383    .0124124
          6  |  -.0449394   .0184355    -2.44   0.015    -.0810723   -.0088064
          7  |  -.0009908   .0164975    -0.06   0.952    -.0333254    .0313438
          8  |  -.0309211   .0176742    -1.75   0.080    -.0655618    .0037196
```

```
           9  |  -.0196525   .0175301    -1.12   0.262    -.0540107    .0147058
          10  |  -.0061059   .0175969    -0.35   0.729    -.0405953    .0283835
          11  |    .016848    .016106     1.05   0.296    -.0147192    .0484152
          13  |  -.0069688   .0153898    -0.45   0.651    -.0371322    .0231946
          14  |  -.0365081   .0170002    -2.15   0.032    -.0698279   -.0031884
              |
        year  |
        2004  |   .0572053   .0340067     1.68   0.093    -.0094466    .1238572
        2005  |    .103776   .0276672     3.75   0.000     .0495492    .1580028
        2006  |   .1263278   .0285299     4.43   0.000     .0704102    .1822453
        2007  |   .1456909   .0283015     5.15   0.000     .0902209    .2011608
        2008  |   .0652287   .0090316     7.22   0.000      .047527    .0829304
              |
       _cons  |  -1.773812   .1771658   -10.01   0.000     -2.12105   -1.426573
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z = -30.77  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   1.29  Pr > z =  0.198
Arellano-Bond test for AR(3) in first differences: z =   0.71  Pr > z =  0.475
Arellano-Bond test for AR(4) in first differences: z =  -1.64  Pr > z =  0.102
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(9)    =  36.27  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(9)    =  21.75  Prob > chi2 =  0.010
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(1)    =  11.59  Prob > chi2 =  0.001
    Difference (null H = exogenous): chi2(8)    =  10.16  Prob > chi2 =  0.254
  gmm(L.WLP_TFP, collapse lag(1 2))
    Hansen test excluding group:     chi2(7)    =  15.93  Prob > chi2 =  0.026
    Difference (null H = exogenous): chi2(2)    =   5.82  Prob > chi2 =  0.054
  gmm(L2.WLP_TFP, collapse lag(1 1))
    Hansen test excluding group:     chi2(7)    =  20.07  Prob > chi2 =  0.005
    Difference (null H = exogenous): chi2(2)    =   1.68  Prob > chi2 =  0.431
  gmm(hor_EU, collapse lag(3 4))
    Hansen test excluding group:     chi2(6)    =  16.66  Prob > chi2 =  0.011
    Difference (null H = exogenous): chi2(3)    =   5.09  Prob > chi2 =  0.165
  gmm(hor_nonEU, collapse lag(2 2))
    Hansen test excluding group:     chi2(7)    =  21.35  Prob > chi2 =  0.003
    Difference (null H = exogenous): chi2(2)    =   0.40  Prob > chi2 =  0.817
  gmm(back_EU, collapse lag(3 3))
    Hansen test excluding group:     chi2(7)    =  20.79  Prob > chi2 =  0.004
    Difference (null H = exogenous): chi2(2)    =   0.96  Prob > chi2 =  0.619
  gmm(back_nonEU, collapse lag(4 4))
    Hansen test excluding group:     chi2(7)    =  21.12  Prob > chi2 =  0.004
    Difference (null H = exogenous): chi2(2)    =   0.63  Prob > chi2 =  0.728
  gmm(for_EU, collapse lag(2 2))
    Hansen test excluding group:     chi2(7)    =  19.30  Prob > chi2 =  0.007
    Difference (null H = exogenous): chi2(2)    =   2.45  Prob > chi2 =  0.294
  gmm(for_nonEU, collapse lag(4 4))
    Hansen test excluding group:     chi2(7)    =  20.66  Prob > chi2 =  0.004
    Difference (null H = exogenous): chi2(2)    =   1.09  Prob > chi2 =  0.580
  iv(humcap1 RD hhi_sales age age2 logta logta2 demand)
    Hansen test excluding group:     chi2(1)    =   0.02  Prob > chi2 =  0.885
    Difference (null H = exogenous): chi2(8)    =  21.73  Prob > chi2 =  0.005
```

TABLE III.7 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN ESTONIA ACCORDING TO MNC'S ORIGIN, 2002-2010 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP  hor_EU hor_nonEU back_EU back_nonEU for_EU for_nonEU
humcap1 RD hhi_sales age age2 logta logta2 demand i.nace_short i.region_code
i.year, gmm(l.WLP_TFP, lag(2 2)coll) gmm(hor_EU, lag(4 4)coll) gmm(hor_nonEU,
lag(3 4)coll) gmm(back_EU, lag(4 5)coll) gmm(back_nonEU, lag(4 4)coll)
gmm(for_EU, lag(3 5)coll) gmm(for_nonEU, lag(4 4)coll)  iv(humcap1 RD hhi_sales
```

```
age age2 logta logta2  demand) iv(i.nace_short i.region_code i.year)  two robust
ar(4)


Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =     66194
Time variable : year                            Number of groups   =     18684
Number of instruments = 65                      Obs per group: min =         1
Wald chi2(53) =  90747.87                                      avg =      3.54
Prob > chi2   =     0.000                                      max =         8
------------------------------------------------------------------------------
             |              Corrected
     WLP_TFP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     WLP_TFP |
         L1. |   .5397097   .0358424    15.06   0.000     .4694598    .6099595
             |
      hor_EU |   2.122868   .4186632     5.07   0.000     1.302303    2.943433
   hor_nonEU |   6.976797   1.084044     6.44   0.000      4.85211    9.101484
     back_EU |   -1.51022   .2121416    -7.12   0.000     -1.92601    -1.09443
  back_nonEU |   6.131187    .945056     6.49   0.000     4.278911    7.983463
      for_EU |   .6678111   .9448292     0.71   0.480     -1.18402    2.519642
   for_nonEU |  -22.32216   5.529855    -4.04   0.000    -33.16048   -11.48385
    humcap1 |   .3316521   .0132046    25.12   0.000     .3057716    .3575327
          RD |   .0856262   .0035247    24.29   0.000      .078718    .0925344
   hhi_sales |    -3.0738   .6713938    -4.58   0.000    -4.389707   -1.757892
         age |  -.0112066   .0010793   -10.38   0.000     -.013322   -.0090912
        age2 |   .0001285   .0000109    11.78   0.000     .0001071    .0001498
       logta |    .279298   .0239451    11.66   0.000     .2323664    .3262296
      logta2 |  -.0135191   .0023748    -5.69   0.000    -.0181737   -.0088645
      demand |  -.0834589   .0272965    -3.06   0.002    -.1369591   -.0299587
             |
  nace_short |
         20  |   2.051327   .5086046     4.03   0.000      1.05448    3.048174
         23  |   127.2922   27.58956     4.61   0.000     73.21761    181.3667
         24  |    .404393   .4350706     0.93   0.353    -.4483298    1.257116
         25  |   2.244727   .5242109     4.28   0.000     1.217292    3.272161
         26  |   1.878908    .569681     3.30   0.001     .7623536    2.995462
         29  |   2.392412   .5530252     4.33   0.000     1.308503    3.476322
         45  |   2.670666    .587264     4.55   0.000      1.51965    3.821683
         50  |   2.525673   .5691728     4.44   0.000     1.410115    3.641231
         51  |   3.135089   .6205568     5.05   0.000      1.91882    4.351358
         52  |   2.845715   .6281384     4.53   0.000     1.614586    4.076843
         55  |   3.011074   .5741419     5.24   0.000     1.885777    4.136372
         60  |   3.314857   .6591673     5.03   0.000     2.022913    4.606801
         61  |   2.028286   .7097946     2.86   0.004     .6371145    3.419458
         62  |    2.67894   .8484972     3.16   0.002     1.015916    4.341964
         63  |    3.18914   .6614868     4.82   0.000      1.89265     4.48563
         64  |   4.385969   .8599237     5.10   0.000      2.70055    6.071389
         70  |   3.403302   .6259059     5.44   0.000     2.176549    4.630055
       1516  |   2.251057   .5363136     4.20   0.000     1.199901    3.302212
       1718  |   2.510638   .5709056     4.40   0.000     1.391684    3.629592
       2122  |   2.583795   .5374468     4.81   0.000     1.530419    3.637172
       2728  |    2.03353    .529003     3.84   0.000     .9967036    3.070357
       3033  |   1.645447   .5951617     2.76   0.006     .4789512    2.811942
       3435  |    2.36377   .5763356     4.10   0.000     1.234173    3.493367
       3637  |   2.297197   .5202662     4.42   0.000     1.277494      3.3169
       4041  |    4.67945   .9448669     4.95   0.000     2.827545    6.531355
       6567  |    3.68272   .7758298     4.75   0.000     2.162121    5.203318
       7174  |   3.177785   .6611825     4.81   0.000     1.881891    4.473678
             |
 region_code |
          2  |  -.0276117   .0079788    -3.46   0.001    -.0432498   -.0119736
          3  |   -.035418    .009538    -3.71   0.000    -.0541122   -.0167238
          4  |   -.096738   .0177933    -5.44   0.000    -.1316123   -.0618636
          5  |  -.0211885   .0070139    -3.02   0.003    -.0349355   -.0074415
             |
```

```
        year |
        2003  |  -.1511706   .1045634    -1.45   0.148    -.356111    .0537699
        2004  |  -.1593799   .0883035    -1.80   0.071   -.3324516    .0136917
        2005  |  -.1519803   .0615353    -2.47   0.014   -.2725874   -.0313733
        2006  |   -.171171   .0578515    -2.96   0.003   -.2845579   -.0577841
        2007  |  -.2054769   .0601869    -3.41   0.001   -.3234409   -.0875128
        2008  |  -.3766558   .0427463    -8.81   0.000    -.460437   -.2928746
        2009  |  -.3525483   .0263649   -13.37   0.000   -.4042226   -.3008741
              |
       _cons |  -1.773718   .5305261    -3.34   0.001    -2.81353   -.7339061
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z = -16.14  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   2.02  Pr > z =  0.044
Arellano-Bond test for AR(3) in first differences: z =  -1.38  Pr > z =  0.167
Arellano-Bond test for AR(4) in first differences: z =   2.14  Pr > z =  0.032
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(11)   =  42.06  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(11)   =  14.00  Prob > chi2 =  0.233
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(4)    =   3.14  Prob > chi2 =  0.534
    Difference (null H = exogenous): chi2(7)    =  10.85  Prob > chi2 =  0.145
  gmm(L.WLP_TFP, collapse lag(2 2))
    Hansen test excluding group:     chi2(9)    =  12.77  Prob > chi2 =  0.173
    Difference (null H = exogenous): chi2(2)    =   1.23  Prob > chi2 =  0.542
  gmm(hor_EU, collapse lag(4 4))
    Hansen test excluding group:     chi2(9)    =   6.34  Prob > chi2 =  0.705
    Difference (null H = exogenous): chi2(2)    =   7.66  Prob > chi2 =  0.022
  gmm(hor_nonEU, collapse lag(3 4))
    Hansen test excluding group:     chi2(8)    =  12.47  Prob > chi2 =  0.131
    Difference (null H = exogenous): chi2(3)    =   1.52  Prob > chi2 =  0.677
  gmm(back_EU, collapse lag(4 5))
    Hansen test excluding group:     chi2(8)    =   7.43  Prob > chi2 =  0.491
    Difference (null H = exogenous): chi2(3)    =   6.57  Prob > chi2 =  0.087
  gmm(back_nonEU, collapse lag(4 4))
    Hansen test excluding group:     chi2(9)    =   9.92  Prob > chi2 =  0.357
    Difference (null H = exogenous): chi2(2)    =   4.07  Prob > chi2 =  0.130
  gmm(for_EU, collapse lag(3 5))
    Hansen test excluding group:     chi2(7)    =  10.67  Prob > chi2 =  0.154
    Difference (null H = exogenous): chi2(4)    =   3.32  Prob > chi2 =  0.505
  gmm(for_nonEU, collapse lag(4 4))
    Hansen test excluding group:     chi2(9)    =  11.61  Prob > chi2 =  0.236
    Difference (null H = exogenous): chi2(2)    =   2.39  Prob > chi2 =  0.302
  iv(humcap1 RD hhi_sales age age2 logta logta2 demand)
    Hansen test excluding group:     chi2(3)    =   5.15  Prob > chi2 =  0.161
    Difference (null H = exogenous): chi2(8)    =   8.85  Prob > chi2 =  0.356
```

TABLE III.8 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN HUNGARY ACCORDING TO MNC'S ORIGIN, 2002-2010 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP  hor_EU hor_nonEU back_EU back_nonEU for_EU for_nonEU
humcap1 RD hhi_sales age age2 logta logta2 demand i.nace_short i.region_code
i.year, gmm(l.WLP_TFP, lag(1 3)) gmm(hor_EU, lag(2 5)coll) gmm(hor_nonEU, lag(2
3)coll)  gmm(back_EU, lag(4 4)coll) gmm(back_nonEU, lag(4 4)coll) gmm(for_EU,
lag(2 3)coll) gmm(for_nonEU, lag(3 3)coll) iv(humcap1 RD hhi_sales age age2 logta
logta2  demand) iv(i.nace_short i.region_code i.year) two robust ar(4)

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =      6910
```

Time variable : year   Number of groups   =   3635
Number of instruments = 104   Obs per group: min =   1
Wald chi2(68) = 20611.24   avg =   1.90
Prob > chi2   =   0.000   max =   7

WLP_TFP	Coef.	Corrected Std. Err.	z	P>|z|	[95% Conf.	Interval]
WLP_TFP						
L1.	.361733	.0671313	5.39	0.000	.2301581	.4933078
hor_EU	1.564565	.456128	3.43	0.001	.6705702	2.458559
hor_nonEU	.7011953	.6209977	1.13	0.259	-.5159379	1.918328
back_EU	2.499622	1.250722	2.00	0.046	.0482525	4.950991
back_nonEU	3.368784	3.195139	1.05	0.292	-2.893573	9.63114
for_EU	6.218142	1.708433	3.64	0.000	2.869674	9.56661
for_nonEU	-7.255255	3.577859	-2.03	0.043	-14.26773	-.2427797
humcap1	.383537	.031415	12.21	0.000	.3219646	.4451093
RD	.0138398	.003618	3.83	0.000	.0067486	.0209309
hhi_sales	-.3276325	.1117312	-2.93	0.003	-.5466215	-.1086434
age	-.0126063	.0020002	-6.30	0.000	-.0165266	-.008686
age2	.0000523	.0000151	3.46	0.001	.0000227	.000082
logta	.1362314	.0595797	2.29	0.022	.0194573	.2530054
logta2	.0013778	.0036284	0.38	0.704	-.0057338	.0084894
demand	.0743514	.1234954	0.60	0.547	-.167695	.3163979
nace_short						
20	.1811904	.2000006	0.91	0.365	-.2108037	.5731844
23	-.4472407	.4958476	-0.90	0.367	-1.419084	.5246028
24	-.1842551	.455823	-0.40	0.686	-1.077652	.7091415
25	-1.105561	.3238434	-3.41	0.001	-1.740283	-.4708398
26	-.695387	.2662464	-2.61	0.009	-1.21722	-.1735537
29	-1.240053	.4269056	-2.90	0.004	-2.076773	-.4033338
45	-.611202	.3744838	-1.63	0.103	-1.345177	.1227728
50	-.9051297	.447893	-2.02	0.043	-1.782984	-.0272756
51	-2.086685	.3637574	-5.74	0.000	-2.799637	-1.373734
52	-1.587585	.3455198	-4.59	0.000	-2.264792	-.9103791
55	.539488	.3178364	1.70	0.090	-.0834598	1.162436
60	-1.115609	.3412836	-3.27	0.001	-1.784513	-.4467059
61	-.3305602	.5928338	-0.56	0.577	-1.492493	.8313728
62	.8292188	.2979787	2.78	0.005	.2451913	1.413246
63	-.2194126	.5066875	-0.43	0.665	-1.212502	.7736765
64	.282759	.4870645	0.58	0.562	-.6718699	1.237388
70	.2616159	.3463996	0.76	0.450	-.4173149	.9405466
1516	.5058921	.4361339	1.16	0.246	-.3489146	1.360699
1718	-.31589	.2217939	-1.42	0.154	-.750598	.118818
2122	-.3945745	.3321738	-1.19	0.235	-1.045623	.2564743
2728	-1.736598	.2926987	-5.93	0.000	-2.310277	-1.162919
3033	-1.430851	.3922632	-3.65	0.000	-2.199673	-.6620295
3435	-1.743731	.3082379	-5.66	0.000	-2.347866	-1.139595
3637	.1002497	.2484548	0.40	0.687	-.3867126	.5872121
4041	2.142076	.5530671	3.87	0.000	1.058085	3.226068
6567	-.3324346	.3487591	-0.95	0.340	-1.01599	.3511207
7174	-2.955447	.7320644	-4.04	0.000	-4.390267	-1.520627
region_code						
2	-.1325332	.0606726	-2.18	0.029	-.2514493	-.0136172
3	-.0818082	.0529617	-1.54	0.122	-.1856112	.0219948
4	-.0711605	.0526636	-1.35	0.177	-.1743794	.0320583
5	.0099827	.0338818	0.29	0.768	-.0564245	.0763899
6	-.084116	.0477289	-1.76	0.078	-.1776628	.0094309
7	-.0582475	.0460969	-1.26	0.206	-.1485957	.0321007
8	-.0605945	.0412746	-1.47	0.142	-.1414913	.0203022
9	-.0769624	.0462025	-1.67	0.096	-.1675176	.0135929
10	-.0207101	.0586232	-0.35	0.724	-.1356094	.0941892
11	-.1044642	.0490764	-2.13	0.033	-.2006521	-.0082763
12	.018681	.0537917	0.35	0.728	-.0867488	.1241107
13	-.1961369	.0653256	-3.00	0.003	-.3241726	-.0681012

```
        14  |    -.01526   .0363294    -0.42   0.674    -.0864643    .0559442
        15  |  -.0762463   .0577188    -1.32   0.187     -.189373    .0368803
        16  |  -.1101879   .0498985    -2.21   0.027    -.2079872   -.0123886
        17  |  -.1272752   .0889998    -1.43   0.153    -.3017117    .0471613
        18  |   -.093764   .0511347    -1.83   0.067    -.1939861    .0064582
        19  |   -.017173   .0557805    -0.31   0.758    -.1265009    .0921548
        20  |  -.1331277   .0542153    -2.46   0.014    -.2393878   -.0268676
            |
       year |
      2003  |  -.0571037   .2533825    -0.23   0.822    -.5537242    .4395168
      2004  |   .1369293   .2109256     0.65   0.516    -.2764773    .5503359
      2005  |   .0224152   .2166416     0.10   0.918    -.4021945     .447025
      2006  |   -.144037   .1868525    -0.77   0.441    -.5102611    .2221872
      2007  |  -.4350382   .2118302    -2.05   0.040    -.8502177   -.0198588
      2008  |  -.5803595   .2271847    -2.55   0.011    -1.025633   -.1350856
      2009  |  -.4907859   .2540436    -1.93   0.053    -.9887023    .0071305
            |
      _cons |   .0174931   1.001784     0.02   0.986    -1.945967    1.980954
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -4.42  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   1.53  Pr > z =  0.125
Arellano-Bond test for AR(3) in first differences: z =  -1.24  Pr > z =  0.215
Arellano-Bond test for AR(4) in first differences: z =   0.09  Pr > z =  0.928
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(35)   =  44.78  Prob > chi2 =  0.124
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(35)   =  22.57  Prob > chi2 =  0.948
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(22)   =  13.04  Prob > chi2 =  0.932
    Difference (null H = exogenous): chi2(13)   =   9.53  Prob > chi2 =  0.732
  gmm(L.WLP_TFP, lag(1 3))
    Hansen test excluding group:     chi2(10)   =   8.77  Prob > chi2 =  0.554
    Difference (null H = exogenous): chi2(25)   =  13.80  Prob > chi2 =  0.965
  gmm(hor_EU, collapse lag(2 5))
    Hansen test excluding group:     chi2(30)   =  20.21  Prob > chi2 =  0.911
    Difference (null H = exogenous): chi2(5)    =   2.37  Prob > chi2 =  0.797
  gmm(hor_nonEU, collapse lag(2 3))
    Hansen test excluding group:     chi2(32)   =  15.92  Prob > chi2 =  0.992
    Difference (null H = exogenous): chi2(3)    =   6.66  Prob > chi2 =  0.084
  gmm(back_EU, collapse lag(4 4))
    Hansen test excluding group:     chi2(33)   =  18.97  Prob > chi2 =  0.976
    Difference (null H = exogenous): chi2(2)    =   3.60  Prob > chi2 =  0.165
  gmm(back_nonEU, collapse lag(4 4))
    Hansen test excluding group:     chi2(33)   =  19.01  Prob > chi2 =  0.975
    Difference (null H = exogenous): chi2(2)    =   3.56  Prob > chi2 =  0.168
  gmm(for_EU, collapse lag(2 3))
    Hansen test excluding group:     chi2(32)   =  22.23  Prob > chi2 =  0.901
    Difference (null H = exogenous): chi2(3)    =   0.34  Prob > chi2 =  0.952
  gmm(for_nonEU, collapse lag(3 3))
    Hansen test excluding group:     chi2(33)   =  21.94  Prob > chi2 =  0.929
    Difference (null H = exogenous): chi2(2)    =   0.63  Prob > chi2 =  0.729
  iv(humcap1 RD hhi_sales age age2 logta logta2 demand)
    Hansen test excluding group:     chi2(27)   =  15.32  Prob > chi2 =  0.965
    Difference (null H = exogenous): chi2(8)    =   7.25  Prob > chi2 =  0.510
```

TABLE III.9 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN SLOVAKIA ACCORDING TO MNC'S ORIGIN, 2002-2009 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP l2.WLP_TFP hor_EU hor_nonEU back_EU back_nonEU for_EU
for_nonEU  humcap1  RD  hhi_sales  age  age2  logta  logta2  demand  i.nace_short
i.region_code i.year, gmm(l.WLP_TFP, lag(1 1)coll)  gmm(l2.WLP_TFP, lag(1 1)coll)
gmm(hor_EU,  lag(3  5)coll)  gmm(hor_nonEU,  lag(4  4)coll)   gmm(back_EU,  lag(3
```

3)coll) gmm(back_nonEU, lag(3 3)coll) gmm(for_EU, lag(2 3)coll) gmm(for_nonEU, lag(2 2)coll) iv(humcap1 RD hhi_sales age age2 logta logta2 demand) iv(i.nace_short i.region_code i.year) two robust ar(4)

Dynamic panel-data estimation, two-step system GMM

Group variable: id	Number of obs = 16440
Time variable : year	Number of groups = 7326
Number of instruments = 67	Obs per group: min = 1
Wald chi2(55) = 33428.59	avg = 2.24
Prob > chi2 = 0.000	max = 6

WLP_TFP	Coef.	Corrected Std. Err.	z	P>|z|	[95% Conf.	Interval]
WLP_TFP						
L1.	.5459904	.0289945	18.83	0.000	.4891622	.6028185
L2.	.0779585	.0200809	3.88	0.000	.0386007	.1173164
hor_EU	-.1902562	.3201752	-0.59	0.552	-.8177881	.4372757
hor_nonEU	-1.046677	.5167058	-2.03	0.043	-2.059401	-.0339519
back_EU	2.048379	.5819804	3.52	0.000	.9077189	3.18904
back_nonEU	-5.132732	1.536052	-3.34	0.001	-8.143338	-2.122126
for_EU	2.56245	.4803094	5.33	0.000	1.621061	3.503839
for_nonEU	1.037034	.9926848	1.04	0.296	-.9085921	2.982661
humcap1	.2823919	.0143896	19.62	0.000	.2541887	.3105951
RD	.0547732	.0047133	11.62	0.000	.0455353	.064011
hhi_sales	.0289473	.1588277	0.18	0.855	-.2823494	.3402439
age	-.0087532	.0019182	-4.56	0.000	-.0125128	-.0049936
age2	.0001598	.0000317	5.03	0.000	.0000976	.000222
logta	.1475888	.0333697	4.42	0.000	.0821854	.2129923
logta2	-.0047053	.0018478	-2.55	0.011	-.0083269	-.0010837
demand	.0019693	.0107589	0.18	0.855	-.0191177	.0230563
nace_short						
20	-.0500397	.121236	-0.41	0.680	-.2876579	.1875785
23	.5409354	.2124482	2.55	0.011	.1245445	.9573263
24	.3992833	.1245076	3.21	0.001	.155253	.6433136
25	-.1696908	.1461543	-1.16	0.246	-.456148	.1167665
26	-.392111	.1068835	-3.67	0.000	-.6015988	-.1826233
29	-.1155975	.0844529	-1.37	0.171	-.2811221	.049927
45	.1966155	.1081441	1.82	0.069	-.0153431	.4085741
50	-.0127159	.0935241	-0.14	0.892	-.1960198	.170588
51	-.2204608	.1307601	-1.69	0.092	-.4767459	.0358242
52	-.2288854	.1395984	-1.64	0.101	-.5024932	.0447224
55	-.4778109	.1221797	-3.91	0.000	-.7172788	-.2383431
60	-.7427398	.1356063	-5.48	0.000	-1.008523	-.4769562
61	-.66451	.2924814	-2.27	0.023	-1.237763	-.091257
62	-.3755205	.5249448	-0.72	0.474	-1.404393	.6533523
63	-.1699911	.124933	-1.36	0.174	-.4148553	.074873
64	.1370583	.1713891	0.80	0.424	-.1988582	.4729748
70	-.2629596	.1129788	-2.33	0.020	-.484394	-.0415253
1516	.0796228	.0982739	0.81	0.418	-.1129905	.2722361
1718	-.1169984	.0889438	-1.32	0.188	-.291325	.0573282
2122	.0654519	.1196595	0.55	0.584	-.1690765	.2999802
2728	-.2866786	.0956845	-3.00	0.003	-.4742168	-.0991404
3033	.5686124	.1859048	3.06	0.002	.2042456	.9329792
3435	.8191594	.170504	4.80	0.000	.4849777	1.153341
3637	-.1673406	.0948046	-1.77	0.078	-.3531542	.0184731
4041	-.1480285	.1731062	-0.86	0.392	-.4873103	.1912534
6567	-.7813201	.1767422	-4.42	0.000	-1.127729	-.4349116
7174	-.5473339	.1252893	-4.37	0.000	-.7928965	-.3017714
region_code						
2	.0252574	.0211627	1.19	0.233	-.0162208	.0667356
3	-.0083889	.0203403	-0.41	0.680	-.0482551	.0314773
4	.0074328	.0178064	0.42	0.676	-.027467	.0423326
5	.0106587	.0188818	0.56	0.572	-.0263489	.0476663

```
           6  |  -.0159401   .0175856    -0.91   0.365    -.0504072     .018527
           7  |   .0073188   .0177036     0.41   0.679    -.0273796    .0420172
           8  |   .0011712   .0179299     0.07   0.948    -.0339707    .0363131
              |
         year |
        2004  |   .2714758    .044016     6.17   0.000      .185206    .3577456
        2005  |   .4023952   .0554791     7.25   0.000     .2936581    .5111322
        2006  |   .3174389   .0467495     6.79   0.000     .2258115    .4090663
        2007  |   .4408074   .0715708     6.16   0.000     .3005312    .5810837
        2008  |   .3522496   .0479151     7.35   0.000     .2583378    .4461615
              |
        _cons |  -.3712672   .1648466    -2.25   0.024    -.6943605   -.0481739
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z = -12.83  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   1.51  Pr > z =  0.132
Arellano-Bond test for AR(3) in first differences: z =  -0.77  Pr > z =  0.442
Arellano-Bond test for AR(4) in first differences: z =  -0.16  Pr > z =  0.875
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(11)   =  16.06  Prob > chi2 =  0.139
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(11)   =  14.68  Prob > chi2 =  0.198
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(3)    =   4.34  Prob > chi2 =  0.227
    Difference (null H = exogenous): chi2(8)    =  10.34  Prob > chi2 =  0.242
  gmm(L.WLP_TFP, collapse lag(1 1))
    Hansen test excluding group:     chi2(9)    =  13.71  Prob > chi2 =  0.133
    Difference (null H = exogenous): chi2(2)    =   0.97  Prob > chi2 =  0.616
  gmm(L2.WLP_TFP, collapse lag(1 1))
    Hansen test excluding group:     chi2(9)    =  12.05  Prob > chi2 =  0.211
    Difference (null H = exogenous): chi2(2)    =   2.63  Prob > chi2 =  0.268
  gmm(hor_EU, collapse lag(3 5))
    Hansen test excluding group:     chi2(7)    =   8.42  Prob > chi2 =  0.297
    Difference (null H = exogenous): chi2(4)    =   6.26  Prob > chi2 =  0.180
  gmm(hor_nonEU, collapse lag(4 4))
    Hansen test excluding group:     chi2(9)    =  13.24  Prob > chi2 =  0.152
    Difference (null H = exogenous): chi2(2)    =   1.44  Prob > chi2 =  0.487
  gmm(back_EU, collapse lag(3 3))
    Hansen test excluding group:     chi2(9)    =  11.67  Prob > chi2 =  0.233
    Difference (null H = exogenous): chi2(2)    =   3.01  Prob > chi2 =  0.222
  gmm(back_nonEU, collapse lag(3 3))
    Hansen test excluding group:     chi2(9)    =  13.70  Prob > chi2 =  0.133
    Difference (null H = exogenous): chi2(2)    =   0.98  Prob > chi2 =  0.614
  gmm(for_EU, collapse lag(2 3))
    Hansen test excluding group:     chi2(8)    =   8.50  Prob > chi2 =  0.386
    Difference (null H = exogenous): chi2(3)    =   6.18  Prob > chi2 =  0.103
  gmm(for_nonEU, collapse lag(2 2))
    Hansen test excluding group:     chi2(9)    =  13.87  Prob > chi2 =  0.127
    Difference (null H = exogenous): chi2(2)    =   0.81  Prob > chi2 =  0.668
  iv(humcap1 RD hhi_sales age age2 logta logta2 demand)
    Hansen test excluding group:     chi2(3)    =   2.86  Prob > chi2 =  0.413
    Difference (null H = exogenous): chi2(8)    =  11.82  Prob > chi2 =  0.160
```

TABLE III.10 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN SLOVENIA ACCORDING TO MNC'S ORIGIN, 2002-2010 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP  hor_EU hor_nonEU back_EU back_nonEU for_EU for_nonEU humcap1 RD hhi_sales age age2 logta logta2 demand i.nace_short i.region_code i.year, gmm(l.WLP_TFP, lag(2 .)coll) gmm(hor_EU, lag(2 2)coll) gmm(hor_nonEU, lag(2 2)coll) gmm(back_EU, lag(2 2)coll) gmm(back_nonEU, lag(3 4)coll) gmm(for_EU, lag(3 4)coll) gmm(for_nonEU, lag(2 2)coll) iv(humcap1 RD hhi_sales age age2 logta logta2  demand) iv(i.nace_short i.region_code i.year) two robust ar(4)
```

Dynamic panel-data estimation, two-step system GMM

Group variable: id		Number of obs =	12884
Time variable : year		Number of groups =	4335
Number of instruments = 75		Obs per group: min =	1
Wald chi2(60) =	325.58	avg =	2.97
Prob > chi2 =	0.000	max =	8

WLP_TFP	Coef.	Corrected Std. Err.	z	P>|z|	[95% Conf.	Interval]
WLP_TFP						
L1.	.5555752	.1018935	5.45	0.000	.3558676	.7552827
hor_EU	-1.299304	.2685	-4.84	0.000	-1.825554	-.7730533
hor_nonEU	2.976953	1.442834	2.06	0.039	.14905	5.804856
back_EU	-1.815617	.5024354	-3.61	0.000	-2.800373	-.8308622
back_nonEU	3.014502	.9254596	3.26	0.001	1.200635	4.82837
for_EU	4.173428	1.256146	3.32	0.001	1.711427	6.635429
for_nonEU	7.674522	20.26835	0.38	0.705	-32.05072	47.39977
humcap1	.3843973	.0503896	7.63	0.000	.2856356	.483159
RD	.0324215	.0052188	6.21	0.000	.0221928	.0426502
hhi_sales	.3376329	.1601546	2.11	0.035	.0237356	.6515302
age	.0128379	.0094555	1.36	0.175	-.0056945	.0313703
age2	-.000901	.0004335	-2.08	0.038	-.0017507	-.0000513
logta	.0717881	.0268885	2.67	0.008	.0190877	.1244885
logta2	.0020664	.0013297	1.55	0.120	-.0005398	.0046725
demand	-.8363578	.2359936	-3.54	0.000	-1.298897	-.3738189
nace_short						
20	.5257132	2.699013	0.19	0.846	-4.764254	5.815681
23	-17.94016	5.619507	-3.19	0.001	-28.95419	-6.926132
24	1.327058	2.770442	0.48	0.632	-4.102909	6.757025
25	1.001878	2.686521	0.37	0.709	-4.263606	6.267361
26	1.009892	2.679858	0.38	0.706	-4.242534	6.262318
29	.0470328	2.788621	0.02	0.987	-5.418563	5.512629
45	2.032557	2.667816	0.76	0.446	-3.196267	7.261381
50	.8962521	2.851273	0.31	0.753	-4.69214	6.484644
51	2.716471	2.69819	1.01	0.314	-2.571884	8.004827
52	2.447512	2.665756	0.92	0.359	-2.777273	7.672298
55	1.078592	2.760465	0.39	0.696	-4.33182	6.489004
60	2.044163	2.713446	0.75	0.451	-3.274093	7.362418
61	9.950941	8.438568	1.18	0.238	-6.588348	26.49023
62	-.7213488	3.032495	-0.24	0.812	-6.66493	5.222233
63	1.36599	2.800895	0.49	0.626	-4.123664	6.855644
64	.3965788	2.762136	0.14	0.886	-5.017108	5.810266
70	1.744897	2.910778	0.60	0.549	-3.960123	7.449917
1516	1.152245	2.695879	0.43	0.669	-4.131581	6.436071
1718	.8359997	2.725576	0.31	0.759	-4.506032	6.178031
2122	.8846084	2.747689	0.32	0.747	-4.500763	6.26998
2728	1.700874	2.641088	0.64	0.520	-3.475563	6.877311
3033	.9121065	2.728715	0.33	0.738	-4.436076	6.260289
3435	-.6529355	2.901349	-0.23	0.822	-6.339475	5.033604
3637	.4429731	2.728935	0.16	0.871	-4.905641	5.791587
4041	1.747058	2.772919	0.63	0.529	-3.687763	7.181878
6567	1.813205	2.765563	0.66	0.512	-3.607198	7.233608
7174	3.036749	2.717974	1.12	0.264	-2.290383	8.363881
region_code						
2	-.0075048	.0181335	-0.41	0.679	-.0430457	.0280361
3	.031893	.019276	1.65	0.098	-.0058873	.0696734
4	.0628492	.0221786	2.83	0.005	.0193799	.1063184
5	-.0104155	.0235631	-0.44	0.658	-.0565983	.0357673
6	-.0394438	.046276	-0.85	0.394	-.1301431	.0512555
7	.0431697	.0140736	3.07	0.002	.015586	.0707534
8	.0288409	.0148779	1.94	0.053	-.0003193	.0580011
9	.145524	.0345587	4.21	0.000	.0777902	.2132577

```
          10  |   .0465577    .015528     3.00   0.003     .0161234    .0769919
          11  |   .0302706   .0246285     1.23   0.219    -.0180005    .0785417
          12  |  -.0427334   .0346372    -1.23   0.217    -.1106211    .0251543
              |
         year |
         2003 |   .4833689   .1566845     3.08   0.002     .1762729     .790465
         2004 |  -.1206243   .1184034    -1.02   0.308    -.3526907     .111442
         2005 |  -.2117742   .1220458    -1.74   0.083    -.4509796    .0274313
         2006 |   -.192464   .1335642    -1.44   0.150     -.454245     .069317
         2007 |  -.1680285   .1195307    -1.41   0.160    -.4023043    .0662473
         2008 |  -.1046415   .1104421    -0.95   0.343     -.321104     .111821
         2009 |  -.2995262   .1450602    -2.06   0.039     -.583839   -.0152134
              |
        _cons |   5.040377   3.464963     1.45   0.146    -1.750825    11.83158
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -5.79  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   1.38  Pr > z =  0.167
Arellano-Bond test for AR(3) in first differences: z =  -0.03  Pr > z =  0.974
Arellano-Bond test for AR(4) in first differences: z =   1.52  Pr > z =  0.128
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(14)   =  40.01  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(14)   =  18.41  Prob > chi2 =  0.189
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(7)    =  10.37  Prob > chi2 =  0.169
    Difference (null H = exogenous): chi2(7)    =   8.04  Prob > chi2 =  0.329
  gmm(L.WLP_TFP, collapse lag(2 .))
    Hansen test excluding group:     chi2(7)    =  10.54  Prob > chi2 =  0.160
    Difference (null H = exogenous): chi2(7)    =   7.87  Prob > chi2 =  0.345
  gmm(hor_EU, collapse lag(2 2))
    Hansen test excluding group:     chi2(12)   =  15.50  Prob > chi2 =  0.215
    Difference (null H = exogenous): chi2(2)    =   2.90  Prob > chi2 =  0.234
  gmm(hor_nonEU, collapse lag(2 2))
    Hansen test excluding group:     chi2(12)   =  15.99  Prob > chi2 =  0.192
    Difference (null H = exogenous): chi2(2)    =   2.41  Prob > chi2 =  0.299
  gmm(back_EU, collapse lag(2 2))
    Hansen test excluding group:     chi2(12)   =  16.28  Prob > chi2 =  0.179
    Difference (null H = exogenous): chi2(2)    =   2.13  Prob > chi2 =  0.345
  gmm(back_nonEU, collapse lag(3 4))
    Hansen test excluding group:     chi2(11)   =  13.00  Prob > chi2 =  0.293
    Difference (null H = exogenous): chi2(3)    =   5.40  Prob > chi2 =  0.145
  gmm(for_EU, collapse lag(3 4))
    Hansen test excluding group:     chi2(11)   =  12.69  Prob > chi2 =  0.314
    Difference (null H = exogenous): chi2(3)    =   5.71  Prob > chi2 =  0.126
  gmm(for_nonEU, collapse lag(2 2))
    Hansen test excluding group:     chi2(12)   =  17.86  Prob > chi2 =  0.120
    Difference (null H = exogenous): chi2(2)    =   0.54  Prob > chi2 =  0.762
  iv(humcap1 RD hhi_sales age age2 logta logta2 demand)
    Hansen test excluding group:     chi2(6)    =   5.02  Prob > chi2 =  0.541
    Difference (null H = exogenous): chi2(8)    =  13.38  Prob > chi2 =  0.099
```

3.3 EMPIRICAL RESULTS FOR THE EFFECTS OF MNCS' OWNERSHIP STRUCTURE ON PRODUCTIVITY OF LOCAL FIRMS PRESENTED IN SECTION 5.6.2

TABLE III.11 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN THE CZECH REPUBLIC ACCORDING TO MNC'S OWNERSHIP, 2002-2009 (DEP. VARIABLE LN TFP)

```
xtabond2  WLP_TFP  l.WLP_TFP  l2.WLP_TFP  hor_full  hor_part  back_full  back_part
for_full for_part humcap1 RD hhi_sales age age2 logta logta2 demand i.nace_short
i.region_code i.year, gmm(l.WLP_TFP, lag(1 1)coll) gmm(l2.WLP_TFP, lag(1 1)coll)
```

```
gmm(hor_full, lag(5 5)coll) gmm(hor_part, lag(4 4)coll)  gmm(back_full, lag(4
4)coll) gmm(back_part, lag(3 3)coll) gmm(for_full, lag(3 3)coll) gmm(for_part,
lag(4  4)coll)  iv(humcap1  RD  hhi_sales  age  age2  logta  logta2   demand)
iv(i.nace_short i.region_code i.year) two robust ar(4)

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =     97891
Time variable : year                            Number of groups   =     36700
Number of instruments = 67                      Obs per group: min =         1
Wald chi2(58) = 165684.97                                      avg =      2.67
Prob > chi2   =     0.000                                      max =         6
------------------------------------------------------------------------------
             |              Corrected
     WLP_TFP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     WLP_TFP |
         L1. |   .3892673   .0125925    30.91   0.000     .3645865    .4139481
         L2. |   .0708338   .0076634     9.24   0.000     .0558138    .0858539
             |
    hor_full |  -.3559641   .3466775    -1.03   0.305     -1.03544    .3235114
    hor_part |   .5678079   .1921664     2.95   0.003     .1911686    .9444471
   back_full |   .0591373   .0918997     0.64   0.520    -.1209827    .2392574
   back_part |   1.868385   .8660111     2.16   0.031     .1710344    3.565736
    for_full |  -1.784608   .5534377    -3.22   0.001    -2.869326   -.6998897
    for_part |  -6.071363   2.067413    -2.94   0.003    -10.12342   -2.019308
     humcap1 |   .4350822   .0085197    51.07   0.000      .418384    .4517804
          RD |   .0524158   .0017984    29.15   0.000      .048891    .0559406
   hhi_sales |  -.2533555   .0744184    -3.40   0.001    -.3992129   -.1074981
         age |  -.0108153   .0010441   -10.36   0.000    -.0128618   -.0087688
        age2 |   .0000843   .0000338     2.49   0.013      .000018    .0001507
       logta |   .2091355   .0132915    15.73   0.000     .1830847    .2351863
      logta2 |  -.0051975   .0008403    -6.19   0.000    -.0068445   -.0035504
      demand |  -.0597447   .0381841    -1.56   0.118    -.1345841    .0150948
             |
  nace_short |
         20  |   1.239587   .1819726     6.81   0.000     .8829276    1.596247
         23  |   2.055919   .2795342     7.35   0.000     1.508042    2.603796
         24  |   2.098231   .2408572     8.71   0.000      1.62616    2.570303
         25  |   1.827497   .2474142     7.39   0.000     1.342574     2.31242
         26  |   1.827052   .2758456     6.62   0.000     1.286405      2.3677
         29  |   1.470154   .2102508     6.99   0.000      1.05807    1.882238
         45  |   .5517895   .1962148     2.81   0.005     .1672156    .9363634
         50  |   1.467288   .2532753     5.79   0.000     .9708779    1.963699
         51  |   1.560413   .1808381     8.63   0.000     1.205977    1.914849
         52  |   1.610459   .1816287     8.87   0.000     1.254474    1.966445
         55  |   .8977338   .1649574     5.44   0.000     .5744232    1.221044
         60  |   .7425994   .1579369     4.70   0.000     .4330487     1.05215
         61  |    .607498   .1826684     3.33   0.001     .2494745    .9655216
         62  |   .5450643   .2235091     2.44   0.015     .1069944    .9831341
         63  |    .698008   .2313322     3.02   0.003     .2446053    1.151411
         64  |   .5486424   .2662716     2.06   0.039     .0267596    1.070525
         70  |   1.053935   .1824914     5.78   0.000     .6962582    1.411611
       1516  |   1.012936   .2337119     4.33   0.000     .5548695    1.471003
       1718  |   1.423117   .1637252     8.69   0.000     1.102221    1.744012
       2122  |   1.113354   .2032615     5.48   0.000     .7149685    1.511739
       2728  |    1.13773   .2164712     5.26   0.000      .713454    1.562006
       3033  |   1.254273   .2772942     4.52   0.000     .7107863     1.79776
       3435  |   1.159926   .3682529     3.15   0.002     .4381638    1.881689
       3637  |   1.338485   .1606098     8.33   0.000     1.023696    1.653275
       4041  |   1.136231   .2592844     4.38   0.000      .628043    1.644419
       6567  |     1.1719   .3320895     3.53   0.000     .5210167    1.822784
       7174  |   .6663217   .1854007     3.59   0.000     .3029431      1.0297
             |
 region_code |
          4  |  -.0284042   .0175372    -1.62   0.105    -.0627764    .0059681
          5  |  -.0250068   .0171057    -1.46   0.144    -.0585334    .0085197
          6  |  -.0484409   .0182837    -2.65   0.008    -.0842763   -.0126055
```

```
           7  |  -.0033284    .016341    -0.20   0.839    -.0353562    .0286994
           8  |  -.0318684   .0175714    -1.81   0.070    -.0663076    .0025708
           9  |  -.0203444   .0173787    -1.17   0.242     -.054406    .0137172
          10  |  -.0068211   .0174119    -0.39   0.695    -.0409478    .0273056
          11  |   .0142344   .0159506     0.89   0.372    -.0170282     .045497
          13  |  -.0076572   .0152253    -0.50   0.615    -.0374982    .0221838
          14  |  -.0390346   .0168367    -2.32   0.020    -.0720339   -.0060352
              |
        year  |
        2004  |  -.1586069    .045387    -3.49   0.000    -.2475638   -.0696499
        2005  |  -.0517255   .0369308    -1.40   0.161    -.1241085    .0206575
        2006  |  -.0007966   .0366748    -0.02   0.983    -.0726779    .0710847
        2007  |    .018346   .0372031     0.49   0.622    -.0545707    .0912627
        2008  |   .0254687    .009814     2.60   0.009     .0062336    .0447037
              |
       _cons  |  -.1629038   .2408272    -0.68   0.499    -.6349165    .3091089
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z = -30.15  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   0.84  Pr > z =  0.399
Arellano-Bond test for AR(3) in first differences: z =   0.87  Pr > z =  0.382
Arellano-Bond test for AR(4) in first differences: z =  -0.92  Pr > z =  0.360
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(8)    =  24.34  Prob > chi2 =  0.002
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(8)    =  12.94  Prob > chi2 =  0.114
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(0)    =   0.00  Prob > chi2 =      .
    Difference (null H = exogenous): chi2(8)    =  12.94  Prob > chi2 =  0.114
  gmm(L.WLP_TFP, collapse lag(1 1))
    Hansen test excluding group:     chi2(6)    =  10.41  Prob > chi2 =  0.108
    Difference (null H = exogenous): chi2(2)    =   2.52  Prob > chi2 =  0.283
  gmm(L2.WLP_TFP, collapse lag(1 1))
    Hansen test excluding group:     chi2(6)    =   7.17  Prob > chi2 =  0.306
    Difference (null H = exogenous): chi2(2)    =   5.77  Prob > chi2 =  0.056
  gmm(hor_full, collapse lag(5 5))
    Hansen test excluding group:     chi2(6)    =  11.84  Prob > chi2 =  0.066
    Difference (null H = exogenous): chi2(2)    =   1.09  Prob > chi2 =  0.579
  gmm(hor_part, collapse lag(4 4))
    Hansen test excluding group:     chi2(6)    =  11.05  Prob > chi2 =  0.087
    Difference (null H = exogenous): chi2(2)    =   1.88  Prob > chi2 =  0.390
  gmm(back_full, collapse lag(4 4))
    Hansen test excluding group:     chi2(6)    =  11.90  Prob > chi2 =  0.064
    Difference (null H = exogenous): chi2(2)    =   1.03  Prob > chi2 =  0.596
  gmm(back_part, collapse lag(3 3))
    Hansen test excluding group:     chi2(6)    =   9.43  Prob > chi2 =  0.151
    Difference (null H = exogenous): chi2(2)    =   3.51  Prob > chi2 =  0.173
  gmm(for_full, collapse lag(3 3))
    Hansen test excluding group:     chi2(6)    =  10.70  Prob > chi2 =  0.098
    Difference (null H = exogenous): chi2(2)    =   2.24  Prob > chi2 =  0.327
  gmm(for_part, collapse lag(4 4))
    Hansen test excluding group:     chi2(6)    =  11.45  Prob > chi2 =  0.076
    Difference (null H = exogenous): chi2(2)    =   1.49  Prob > chi2 =  0.475
  iv(humcap1 RD hhi_sales age age2 logta logta2 demand)
    Hansen test excluding group:     chi2(0)    =   0.00  Prob > chi2 =      .
    Difference (null H = exogenous): chi2(8)    =  12.94  Prob > chi2 =  0.114
```

TABLE III.12 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN ESTONIA ACCORDING TO MNC'S OWNERSHIP, 2002-2010 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP  hor_full hor_part back_full back_part for_full
for_part humcap1 RD hhi_sales age age2 logta logta2 demand i.nace_short
i.region_code i.year, gmm(l.WLP_TFP, lag(2 2)coll) gmm(hor_full, lag(3 3)coll)
```

```
gmm(hor_part, lag(3 3)coll)  gmm(back_full, lag(4 4)coll) gmm(back_part, lag(4
4)coll) gmm(for_full, lag(4 4)coll) gmm(for_part, lag(3 3)coll) iv(humcap1 RD
hhi_sales age age2 logta logta2  demand) iv(i.nace_short i.region_code i.year)
two robust ar(4)

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =     66194
Time variable : year                            Number of groups   =     18684
Number of instruments = 61                      Obs per group: min =         1
Wald chi2(53) =  90031.53                                      avg =      3.54
Prob > chi2   =     0.000                                      max =         8
------------------------------------------------------------------------------
             |              Corrected
     WLP_TFP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     WLP_TFP |
         L1. |   .5302716   .0363676    14.58   0.000     .4589924    .6015508
             |
    hor_full |   .7210959   .5699513     1.27   0.206     -.395988     1.83818
    hor_part |   1.438225   .7268392     1.98   0.048     .0136462    2.862803
   back_full |   .5226227   .2408655     2.17   0.030      .050535    .9947104
   back_part |  -2.382896   .6426598    -3.71   0.000    -3.642486   -1.123306
    for_full |  -4.766868   1.252898    -3.80   0.000    -7.222504   -2.311233
    for_part |   7.145351   2.192716     3.26   0.001     2.847707      11.443
    humcap1  |   .3354093    .013352    25.12   0.000     .3092398    .3615788
          RD |   .0826397   .0034835    23.72   0.000     .0758122    .0894673
   hhi_sales |  -1.298192   .5636372    -2.30   0.021    -2.402901   -.1934838
         age |  -.0125318   .0010554   -11.87   0.000    -.0146004   -.0104633
        age2 |   .0001386   .0000109    12.67   0.000     .0001172    .0001601
       logta |   .2358141    .021505    10.97   0.000     .1936652    .2779631
      logta2 |  -.0087182   .0020565    -4.24   0.000    -.0127489   -.0046876
      demand |  -.0338529   .0411225    -0.82   0.410    -.1144516    .0467457
             |
  nace_short |
         20  |   .6791729   .3709281     1.83   0.067    -.0478328    1.406179
         23  |   62.54415   23.41483     2.67   0.008     16.65192    108.4364
         24  |   .4949647   .5577795     0.89   0.375    -.5982629    1.588192
         25  |   .8773287   .3835155     2.29   0.022     .1256522    1.629005
         26  |    .537078   .4185088     1.28   0.199    -.2831841     1.35734
         29  |   .8092176   .3836191     2.11   0.035     .0573379    1.561097
         45  |   .7794912   .4041144     1.93   0.054    -.0125585    1.571541
         50  |   1.097383   .4248291     2.58   0.010     .2647336    1.930033
         51  |   1.689547   .4548951     3.71   0.000     .7979692    2.581125
         52  |    1.28107   .4625226     2.77   0.006     .3745426    2.187598
         55  |    .918677   .3810952     2.41   0.016     .1717442     1.66561
         60  |   1.404214   .4579027     3.07   0.002     .5067408    2.301686
         61  |    .322591   .7191665     0.45   0.654    -1.086949    1.732131
         62  |   .1264703   .7689516     0.16   0.869    -1.380647    1.633588
         63  |   1.628992   .4815221     3.38   0.001     .6852264    2.572758
         64  |   1.829356     .63881     2.86   0.004     .5773112    3.081401
         70  |   1.453286   .4346695     3.34   0.001      .601349    2.305222
       1516  |     .82843   .3674258     2.25   0.024     .1082886    1.548571
       1718  |   .8759508   .3883521     2.26   0.024     .1147947    1.637107
       2122  |   1.036989   .3729725     2.78   0.005     .3059761    1.768002
       2728  |   .7903398   .4088212     1.93   0.053     -.010935    1.591615
       3033  |   .4897804   .4875653     1.00   0.315    -.4658301    1.445391
       3435  |   .5170436   .5060033     1.02   0.307    -.4747045    1.508792
       3637  |    .827229   .3585759     2.31   0.021     .1244331    1.530025
       4041  |    2.18388    .727289     3.00   0.003       .75842    3.609341
       6567  |   1.228408   .5546519     2.21   0.027       .14131    2.315506
       7174  |     1.6496   .4696793     3.51   0.000     .7290452    2.570154
             |
 region_code |
          2  |  -.0304358    .007976    -3.82   0.000    -.0460685   -.0148031
          3  |  -.0390979   .0095302    -4.10   0.000    -.0577768    -.020419
          4  |  -.0727287   .0170323    -4.27   0.000    -.1061114    -.039346
```

```
           5 |  -.0246426   .0069664    -3.54   0.000    -.0382965   -.0109886
             |
        year |
        2003 |  -.3505737   .1617891    -2.17   0.030    -.6676746   -.0334728
        2004 |  -.3380964   .1298402    -2.60   0.009    -.5925784   -.0836143
        2005 |  -.2070292   .0846399    -2.45   0.014    -.3729203    -.041138
        2006 |   -.188537   .0810478    -2.33   0.020    -.3473877   -.0296862
        2007 |  -.1860047   .0855155    -2.18   0.030    -.3536121   -.0183973
        2008 |  -.2949558   .0416695    -7.08   0.000    -.3766267    -.213285
        2009 |  -.3803397   .0304127   -12.51   0.000    -.4399476   -.3207319
             |
       _cons |  -.1007989   .6542783    -0.15   0.878    -1.383161    1.181563
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z = -15.87  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   2.03  Pr > z =  0.042
Arellano-Bond test for AR(3) in first differences: z =  -0.77  Pr > z =  0.441
Arellano-Bond test for AR(4) in first differences: z =   1.47  Pr > z =  0.141
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(7)    =  24.07  Prob > chi2 =  0.001
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(7)    =  10.67  Prob > chi2 =  0.153
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(0)    =   0.00  Prob > chi2 =      .
    Difference (null H = exogenous): chi2(7)    =  10.67  Prob > chi2 =  0.153
  gmm(L.WLP_TFP, collapse lag(2 2))
    Hansen test excluding group:     chi2(5)    =  10.25  Prob > chi2 =  0.068
    Difference (null H = exogenous): chi2(2)    =   0.42  Prob > chi2 =  0.810
  gmm(hor_full, collapse lag(3 3))
    Hansen test excluding group:     chi2(5)    =   6.13  Prob > chi2 =  0.293
    Difference (null H = exogenous): chi2(2)    =   4.54  Prob > chi2 =  0.103
  gmm(hor_part, collapse lag(3 3))
    Hansen test excluding group:     chi2(5)    =   4.95  Prob > chi2 =  0.422
    Difference (null H = exogenous): chi2(2)    =   5.72  Prob > chi2 =  0.057
  gmm(back_full, collapse lag(4 4))
    Hansen test excluding group:     chi2(5)    =  10.32  Prob > chi2 =  0.067
    Difference (null H = exogenous): chi2(2)    =   0.35  Prob > chi2 =  0.839
  gmm(back_part, collapse lag(4 4))
    Hansen test excluding group:     chi2(5)    =   8.88  Prob > chi2 =  0.114
    Difference (null H = exogenous): chi2(2)    =   1.79  Prob > chi2 =  0.408
  gmm(for_full, collapse lag(4 4))
    Hansen test excluding group:     chi2(5)    =   9.83  Prob > chi2 =  0.080
    Difference (null H = exogenous): chi2(2)    =   0.84  Prob > chi2 =  0.656
  gmm(for_part, collapse lag(3 3))
    Hansen test excluding group:     chi2(5)    =   8.24  Prob > chi2 =  0.144
    Difference (null H = exogenous): chi2(2)    =   2.44  Prob > chi2 =  0.296
```

TABLE III.13 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN HUNGARY ACCORDING TO MNC'S OWNERSHIP, 2002-2010 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP  hor_full hor_part back_full back_part for_full
for_part humcap1 RD hhi_sales age age2 logta logta2 demand i.nace_short
i.region_code i.year, gmm(l.WLP_TFP, lag(1 1)coll) gmm(hor_full, lag(3 3))
gmm(hor_part, lag(3 3))  gmm(back_full, lag(2 3)coll) gmm(back_part, lag(2
4)coll) gmm(for_full, lag(3 3)) gmm(for_part, lag(2 3)) iv(humcap1 RD hhi_sales
age age2 logta logta2  demand) iv(i.nace_short i.region_code i.year) two robust
ar(4)

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =      6910
Time variable : year                            Number of groups   =      3635
Number of instruments = 119                     Obs per group: min =         1
```

Wald chi2(68) = 25303.89 avg = 1.90
Prob > chi2 = 0.000 max = 7

WLP_TFP	Coef.	Corrected Std. Err.	z	P>|z|	[95% Conf.	Interval]
WLP_TFP						
L1.	.5591379	.0826019	6.77	0.000	.3972413	.7210346
hor_full	-.4801596	.3827038	-1.25	0.210	-1.230245	.269926
hor_part	1.620323	.8787358	1.84	0.065	-.101967	3.342614
back_full	1.558281	.854456	1.82	0.068	-.1164214	3.232984
back_part	-3.800701	1.546225	-2.46	0.014	-6.831247	-.7701556
for_full	-7.678721	2.089753	-3.67	0.000	-11.77456	-3.58288
for_part	-5.630146	2.514815	-2.24	0.025	-10.55909	-.701199
humcap1	.307247	.0380677	8.07	0.000	.2326357	.3818583
RD	.0104234	.0033699	3.09	0.002	.0038184	.0170283
hhi_sales	-.130873	.0998433	-1.31	0.190	-.3265623	.0648162
age	-.0095395	.0019377	-4.92	0.000	-.0133374	-.0057417
age2	.0000369	.0000132	2.80	0.005	.0000111	.0000627
logta	.1321182	.0580668	2.28	0.023	.0183095	.245927
logta2	-.0014534	.0032191	-0.45	0.652	-.0077627	.0048559
demand	.1130658	.0673085	1.68	0.093	-.0188564	.244988
nace_short						
20	-.2511708	.1745865	-1.44	0.150	-.593354	.0910123
23	-1.033579	.8674365	-1.19	0.233	-2.733724	.6665651
24	-.1460306	.3844316	-0.38	0.704	-.8995027	.6074415
25	-.0057752	.2950481	-0.02	0.984	-.5840587	.5725084
26	-.484965	.2147759	-2.26	0.024	-.905918	-.064012
29	.5688524	.4009544	1.42	0.156	-.2170039	1.354709
45	-.5404089	.2733077	-1.98	0.048	-1.076082	-.0047357
50	.1646882	.3155322	0.52	0.602	-.4537436	.78312
51	-.0925181	.365131	-0.25	0.800	-.8081618	.6231256
52	-.026807	.3256977	-0.08	0.934	-.6651628	.6115488
55	-.0491335	.2209935	-0.22	0.824	-.4822728	.3840057
60	-.3046459	.3026681	-1.01	0.314	-.8978645	.2885727
61	.2627028	.717333	0.37	0.714	-1.143244	1.66865
62	.3955597	.2693591	1.47	0.142	-.1323745	.9234939
63	-.3382546	.3139596	-1.08	0.281	-.9536042	.277095
64	-.3806858	.5142164	-0.74	0.459	-1.388531	.6271598
70	.358751	.3417654	1.05	0.294	-.3110969	1.028599
1516	-.9121696	.3222848	-2.83	0.005	-1.543836	-.280503
1718	-.7846027	.1859122	-4.22	0.000	-1.148984	-.4202215
2122	-.9090375	.2550814	-3.56	0.000	-1.408988	-.4090871
2728	-.6894288	.3459137	-1.99	0.046	-1.367407	-.0114504
3033	-.3929607	.2822334	-1.39	0.164	-.9461281	.1602067
3435	-1.40993	.2903187	-4.86	0.000	-1.978944	-.8409154
3637	.3236693	.2034667	1.59	0.112	-.075118	.7224566
4041	1.842067	.6268292	2.94	0.003	.6135042	3.07063
6567	-.5038259	.3338792	-1.51	0.131	-1.158217	.1505654
7174	-.3141554	.3864728	-0.81	0.416	-1.071628	.4433174
region_code						
2	-.0897807	.0533838	-1.68	0.093	-.1944111	.0148497
3	-.0515521	.0481924	-1.07	0.285	-.1460074	.0429033
4	-.0278367	.0460695	-0.60	0.546	-.1181313	.0624579
5	-.002147	.0303705	-0.07	0.944	-.0616721	.057378
6	-.0477298	.0453521	-1.05	0.293	-.1366183	.0411586
7	-.0512306	.0408787	-1.25	0.210	-.1313513	.0288901
8	-.0393384	.0363499	-1.08	0.279	-.1105828	.0319061
9	-.0537958	.0422564	-1.27	0.203	-.1366168	.0290253
10	.0024354	.0499583	0.05	0.961	-.0954811	.100352
11	-.0640727	.0447167	-1.43	0.152	-.1517159	.0235705
12	.0094323	.0491027	0.19	0.848	-.0868072	.1056719
13	-.142834	.0600206	-2.38	0.017	-.2604723	-.0251957
14	-.0093019	.0323451	-0.29	0.774	-.0726972	.0540933
15	-.0260722	.0504132	-0.52	0.605	-.1248801	.0727358

```
      16  |  -.0631844   .0454598    -1.39   0.165    -.1522839    .0259151
      17  |  -.0790768   .0852281    -0.93   0.353    -.2461208    .0879672
      18  |  -.0557938   .0449019    -1.24   0.214    -.1437998    .0322122
      19  |   -.008445   .0480341    -0.18   0.860    -.1025902    .0857001
      20  |   -.085713   .0494791    -1.73   0.083    -.1826902    .0112642
          |
     year |
     2003 |   -.464365   .3158103    -1.47   0.141    -1.083342    .1546119
     2004 |  -.2666064   .1914405    -1.39   0.164    -.6418229    .1086101
     2005 |   .0033082   .1512251     0.02   0.983    -.2930875    .2997038
     2006 |   .0679006   .1226053     0.55   0.580    -.1724014    .3082025
     2007 |   .1371081   .1198633     1.14   0.253    -.0978196    .3720358
     2008 |   .1486006   .1229125     1.21   0.227    -.0923036    .3895047
     2009 |   .0324953      .1244     0.26   0.794    -.2113241    .2763147
          |
    _cons |   .7364508   .6631861     1.11   0.267    -.5633702    2.036272
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -4.09  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   1.40  Pr > z =  0.161
Arellano-Bond test for AR(3) in first differences: z =  -0.91  Pr > z =  0.364
Arellano-Bond test for AR(4) in first differences: z =   0.09  Pr > z =  0.926
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(50)   = 103.81  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(50)   =  54.20  Prob > chi2 =  0.317
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(23)   =  18.01  Prob > chi2 =  0.757
    Difference (null H = exogenous): chi2(27)   =  36.19  Prob > chi2 =  0.111
  gmm(hor_full, lag(3 3))
    Hansen test excluding group:     chi2(42)   =  44.98  Prob > chi2 =  0.348
    Difference (null H = exogenous): chi2(8)    =   9.22  Prob > chi2 =  0.324
  gmm(hor_part, lag(3 3))
    Hansen test excluding group:     chi2(37)   =  40.30  Prob > chi2 =  0.327
    Difference (null H = exogenous): chi2(13)   =  13.90  Prob > chi2 =  0.381
  gmm(back_full, collapse lag(2 3))
    Hansen test excluding group:     chi2(48)   =  52.28  Prob > chi2 =  0.311
    Difference (null H = exogenous): chi2(2)    =   1.92  Prob > chi2 =  0.383
  gmm(back_part, collapse lag(2 4))
    Hansen test excluding group:     chi2(46)   =  46.73  Prob > chi2 =  0.442
    Difference (null H = exogenous): chi2(4)    =   7.47  Prob > chi2 =  0.113
  gmm(for_full, lag(3 3))
    Hansen test excluding group:     chi2(38)   =  40.92  Prob > chi2 =  0.343
    Difference (null H = exogenous): chi2(12)   =  13.28  Prob > chi2 =  0.349
  gmm(for_part, lag(2 3))
    Hansen test excluding group:     chi2(32)   =  36.74  Prob > chi2 =  0.259
    Difference (null H = exogenous): chi2(18)   =  17.46  Prob > chi2 =  0.492
  iv(humcap1 RD hhi_sales age age2 logta logta2 demand)
    Hansen test excluding group:     chi2(42)   =  45.30  Prob > chi2 =  0.336
    Difference (null H = exogenous): chi2(8)    =   8.90  Prob > chi2 =  0.351
```

TABLE III.14 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN SLOVAKIA ACCORDING TO MNC'S OWNERSHIP, 2002-2009 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP  hor_full hor_part back_full back_part for_full
for_part humcap1 RD hhi_sales age age2 logta logta2 demand i.nace_short
i.region_code i.year, gmm(l.WLP_TFP, lag(1 1)coll) gmm(hor_full, lag(2 2)coll)
gmm(hor_part, lag(3 3)coll)  gmm(back_full, lag(3 4)coll) gmm(back_part, lag(3
3)coll) gmm(for_full, lag(3 4)coll) gmm(for_part, lag(3 3)coll) iv(humcap1 RD
hhi_sales age age2 logta logta2  demand) iv(i.nace_short i.region_code i.year)
two robust ar(4)
```

Dynamic panel-data estimation, two-step system GMM

Group variable: id		Number of obs =	30490
Time variable : year		Number of groups =	13595
Number of instruments = 65		Obs per group: min =	1
Wald chi2(55) =	39641.52	avg =	2.24
Prob > chi2 =	0.000	max =	7

WLP_TFP	Coef.	Corrected Std. Err.	z	P>|z|	[95% Conf.	Interval]
WLP_TFP						
L1.	.434749	.0241908	17.97	0.000	.3873358	.4821622
hor_full	-1.112986	.2742083	-4.06	0.000	-1.650425	-.5755479
hor_part	-2.579578	.7759796	-3.32	0.001	-4.10047	-1.058686
back_full	.2869311	.1134852	2.53	0.011	.0645041	.509358
back_part	-3.069953	.8546643	-3.59	0.000	-4.745064	-1.394842
for_full	2.223056	.8358983	2.66	0.008	.5847252	3.861386
for_part	5.508839	3.128624	1.76	0.078	-.6231518	11.64083
humcap1	.3239875	.0084832	38.19	0.000	.3073608	.3406143
RD	.0816958	.0035157	23.24	0.000	.0748053	.0885864
hhi_sales	.1956906	.1394546	1.40	0.161	-.0776354	.4690165
age	-.013219	.0014205	-9.31	0.000	-.0160031	-.0104349
age2	.0002141	.0000302	7.09	0.000	.0001549	.0002733
logta	.282871	.0227045	12.46	0.000	.2383711	.3273709
logta2	-.0111974	.0014571	-7.68	0.000	-.0140532	-.0083416
demand	-.0580833	.0229467	-2.53	0.011	-.1030579	-.0131086
nace_short						
20	-.0956544	.1116373	-0.86	0.392	-.3144595	.1231508
23	1.347679	.3083591	4.37	0.000	.7433057	1.952051
24	.7812698	.1321436	5.91	0.000	.5222731	1.040266
25	-.0716322	.0946774	-0.76	0.449	-.2571966	.1139321
26	-.5331535	.1013062	-5.26	0.000	-.73171	-.334597
29	-.1826606	.1229253	-1.49	0.137	-.4235897	.0582685
45	.4382771	.1423997	3.08	0.002	.1591788	.7173754
50	.1621329	.1158579	1.40	0.162	-.0649443	.3892101
51	.5405399	.2168423	2.49	0.013	.1155368	.9655431
52	.1825867	.1983134	0.92	0.357	-.2061004	.5712739
55	-.8792783	.1279143	-6.87	0.000	-1.129986	-.6285708
60	-.2616448	.1818819	-1.44	0.150	-.6181269	.0948372
61	-1.372825	.3861126	-3.56	0.000	-2.129592	-.6160581
62	-1.246268	.4785824	-2.60	0.009	-2.184272	-.3082635
63	-.0559849	.1368072	-0.41	0.682	-.3241222	.2121523
64	1.322441	.3739387	3.54	0.000	.5895342	2.055347
70	-.2285896	.1461981	-1.56	0.118	-.5151326	.0579533
1516	.2669648	.1622589	1.65	0.100	-.0510567	.5849864
1718	-.3051212	.1182132	-2.58	0.010	-.5368149	-.0734276
2122	.0188182	.1078845	0.17	0.862	-.1926315	.2302678
2728	-.1587526	.1100202	-1.44	0.149	-.3743882	.056883
3033	.5881038	.128543	4.58	0.000	.3361642	.8400434
3435	1.356042	.2451929	5.53	0.000	.8754724	1.836611
3637	-.4357316	.1566952	-2.78	0.005	-.7428486	-.1286146
4041	1.539651	.3027967	5.08	0.000	.9461805	2.133122
6567	-.4591432	.2031227	-2.26	0.024	-.8572563	-.0610301
7174	.4472227	.1865786	2.40	0.017	.0815354	.81291
region_code						
2	.0791554	.0183319	4.32	0.000	.0432256	.1150853
3	-.0188309	.019146	-0.98	0.325	-.0563564	.0186945
4	.0007798	.0171532	0.05	0.964	-.0328399	.0343995
5	-.0122348	.0185523	-0.66	0.510	-.0485965	.024127
6	-.0225917	.0167782	-1.35	0.178	-.0554763	.0102929
7	.0101132	.0166095	0.61	0.543	-.0224408	.0426671
8	.0007597	.0174676	0.04	0.965	-.0334762	.0349957
year						

```
        2003 |   .2637031   .1077481     2.45   0.014     .0525207    .4748855
        2004 |    .219949   .0754251     2.92   0.004     .0721185    .3677794
        2005 |   .3343723   .0855432     3.91   0.000     .1667107     .502034
        2006 |   .3500378   .1121109     3.12   0.002     .1303044    .5697712
        2007 |   .2272266   .0727671     3.12   0.002     .0846056    .3698475
        2008 |   .2560636   .0592414     4.32   0.000     .1399526    .3721747
             |
       _cons |   .4945084    .223637     2.21   0.027     .0561879     .932829
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z = -16.77  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   1.20  Pr > z =  0.229
Arellano-Bond test for AR(3) in first differences: z =   1.42  Pr > z =  0.155
Arellano-Bond test for AR(4) in first differences: z =  -1.24  Pr > z =  0.217
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(9)    =  14.45  Prob > chi2 =  0.107
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(9)    =  10.44  Prob > chi2 =  0.316
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(2)    =   0.88  Prob > chi2 =  0.645
    Difference (null H = exogenous): chi2(7)    =   9.56  Prob > chi2 =  0.215
  gmm(L.WLP_TFP, collapse lag(1 1))
    Hansen test excluding group:     chi2(7)    =   8.00  Prob > chi2 =  0.332
    Difference (null H = exogenous): chi2(2)    =   2.43  Prob > chi2 =  0.297
  gmm(hor_full, collapse lag(2 2))
    Hansen test excluding group:     chi2(7)    =   9.15  Prob > chi2 =  0.242
    Difference (null H = exogenous): chi2(2)    =   1.28  Prob > chi2 =  0.526
  gmm(hor_part, collapse lag(3 3))
    Hansen test excluding group:     chi2(7)    =   5.16  Prob > chi2 =  0.640
    Difference (null H = exogenous): chi2(2)    =   5.27  Prob > chi2 =  0.072
  gmm(back_full, collapse lag(3 4))
    Hansen test excluding group:     chi2(6)    =   9.90  Prob > chi2 =  0.129
    Difference (null H = exogenous): chi2(3)    =   0.54  Prob > chi2 =  0.910
  gmm(back_part, collapse lag(3 3))
    Hansen test excluding group:     chi2(7)    =   8.66  Prob > chi2 =  0.278
    Difference (null H = exogenous): chi2(2)    =   1.78  Prob > chi2 =  0.411
  gmm(for_full, collapse lag(3 4))
    Hansen test excluding group:     chi2(6)    =   8.38  Prob > chi2 =  0.212
    Difference (null H = exogenous): chi2(3)    =   2.05  Prob > chi2 =  0.561
  gmm(for_part, collapse lag(3 3))
    Hansen test excluding group:     chi2(7)    =   7.56  Prob > chi2 =  0.373
    Difference (null H = exogenous): chi2(2)    =   2.87  Prob > chi2 =  0.238
  iv(humcap1 RD hhi_sales age age2 logta logta2 demand)
    Hansen test excluding group:     chi2(1)    =   1.30  Prob > chi2 =  0.255
    Difference (null H = exogenous): chi2(8)    =   9.14  Prob > chi2 =  0.331
```

TABLE III.15 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN SLOVENIA ACCORDING TO MNC'S OWNERSHIP, 2002-2010 (DEP. VARIABLE LN TFP)

```
xtabond2  WLP_TFP  l.WLP_TFP   hor_full  hor_part  back_full  back_part  for_full
for_part  humcap1  RD  hhi_sales  age  age2  logta  logta2  demand  i.nace_short
i.region_code i.year, gmm(l.WLP_TFP, lag(2 4)coll) gmm(hor_full, lag(2 2)coll)
gmm(hor_part, lag(2 2)coll)  gmm(back_full, lag(3 3)coll) gmm(back_part, lag(3
3)coll) gmm(for_full, lag(3 4)coll) gmm(for_part, lag(3 3)coll) iv(humcap1 RD
hhi_sales age age2 logta logta2  demand) iv(i.nace_short i.region_code i.year)
two robust ar(4)

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =     12884
Time variable : year                            Number of groups   =      4335
Number of instruments = 71                      Obs per group: min =         1
Wald chi2(60) =    684.35                                      avg =      2.97
```

Prob > chi2 = 0.000 max = 8

WLP_TFP	Coef.	Corrected Std. Err.	z	P>|z|	[95% Conf.	Interval]
WLP_TFP						
L1.	.5234803	.1014861	5.16	0.000	.3245712	.7223893
hor_full	-.7850001	.3203075	-2.45	0.014	-1.412791	-.1572089
hor_part	.5488629	.4413376	1.24	0.214	-.3161428	1.413869
back_full	-.2399256	.1481363	-1.62	0.105	-.5302674	.0504162
back_part	1.035774	.393355	2.63	0.008	.2648128	1.806736
for_full	4.723631	1.565403	3.02	0.003	1.655498	7.791765
for_part	2.712053	1.384235	1.96	0.050	-.0009978	5.425104
humcap1	.3690418	.0400614	9.21	0.000	.2905229	.4475607
RD	.0356342	.0055475	6.42	0.000	.0247613	.046507
hhi_sales	.0101016	.0993342	0.10	0.919	-.1845898	.2047929
age	.0252001	.0093811	2.69	0.007	.0068136	.0435867
age2	-.0014885	.0004363	-3.41	0.001	-.0023437	-.0006333
logta	.0804659	.028708	2.80	0.005	.0241992	.1367326
logta2	.002304	.0015297	1.51	0.132	-.0006941	.0053021
demand	-.9539151	.2372875	-4.02	0.000	-1.41899	-.4888401
nace_short						
20	4.94301	1.877052	2.63	0.008	1.264056	8.621964
23	-13.53727	3.838353	-3.53	0.000	-21.0603	-6.014236
24	5.22591	1.979721	2.64	0.008	1.345728	9.106092
25	5.382328	1.844382	2.92	0.004	1.767406	8.99725
26	5.414316	1.931966	2.80	0.005	1.627732	9.2009
29	4.355571	1.86944	2.33	0.020	.6915352	8.019607
45	6.500171	1.982898	3.28	0.001	2.613762	10.38658
50	5.845834	1.940889	3.01	0.003	2.041761	9.649907
51	7.040581	2.020938	3.48	0.000	3.079616	11.00155
52	6.754575	1.998961	3.38	0.001	2.836683	10.67247
55	5.557951	1.905588	2.92	0.004	1.823067	9.292835
60	6.491786	1.955714	3.32	0.001	2.658657	10.32492
61	21.80991	6.340983	3.44	0.001	9.381809	34.23801
62	4.316491	1.924394	2.24	0.025	.5447474	8.088234
63	5.907131	1.96395	3.01	0.003	2.057859	9.756403
64	4.934626	1.865733	2.64	0.008	1.277856	8.591395
70	6.275639	1.926646	3.26	0.001	2.499481	10.0518
1516	5.63809	1.923315	2.93	0.003	1.868463	9.407718
1718	5.313738	1.941122	2.74	0.006	1.50921	9.118266
2122	5.307023	1.89699	2.80	0.005	1.588991	9.025056
2728	6.027251	1.923186	3.13	0.002	2.257875	9.796626
3033	5.448158	1.903274	2.86	0.004	1.717809	9.178506
3435	3.198709	1.912997	1.67	0.095	-.5506959	6.948114
3637	4.77822	1.91318	2.50	0.013	1.028455	8.527985
4041	6.399882	2.021903	3.17	0.002	2.437024	10.36274
6567	6.380415	1.96786	3.24	0.001	2.523479	10.23735
7174	7.570889	2.084423	3.63	0.000	3.485495	11.65628
region_code						
2	-.0152944	.0186134	-0.82	0.411	-.0517761	.0211872
3	.0170521	.0174485	0.98	0.328	-.0171463	.0512506
4	.0728746	.024432	2.98	0.003	.0249888	.1207605
5	-.0270859	.0240974	-1.12	0.261	-.0743159	.0201441
6	-.1056451	.0400826	-2.64	0.008	-.1842055	-.0270847
7	.0429514	.014728	2.92	0.004	.0140851	.0718178
8	.0154572	.0143524	1.08	0.281	-.012673	.0435874
9	.1381229	.0414335	3.33	0.001	.0569147	.219331
10	.0304589	.0150717	2.02	0.043	.0009189	.0599989
11	.0066596	.0218246	0.31	0.760	-.0361158	.049435
12	-.057601	.0355636	-1.62	0.105	-.1273043	.0121024
year						
2003	.9261481	.1965061	4.71	0.000	.5410033	1.311293
2004	.1964089	.1062125	1.85	0.064	-.0117638	.4045817

```
        2005  |   .0733293   .1058648     0.69   0.489    -.1341619    .2808205
        2006  |   .1217861   .1138809     1.07   0.285    -.1014164    .3449886
        2007  |   .1324273   .1057407     1.25   0.210    -.0748206    .3396752
        2008  |   .1381718   .0959664     1.44   0.150    -.0499189    .3262624
        2009  |  -.2882952   .0721995    -3.99   0.000    -.4298037   -.1467867
              |
       _cons  |   1.257602   2.300818     0.55   0.585    -3.251918    5.767121
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -5.66  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   0.97  Pr > z =  0.333
Arellano-Bond test for AR(3) in first differences: z =   0.01  Pr > z =  0.990
Arellano-Bond test for AR(4) in first differences: z =   2.02  Pr > z =  0.044
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(10)   =  26.09  Prob > chi2 =  0.004
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(10)   =  13.02  Prob > chi2 =  0.223
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(3)    =   3.89  Prob > chi2 =  0.274
    Difference (null H = exogenous): chi2(7)    =   9.13  Prob > chi2 =  0.243
  gmm(L.WLP_TFP, collapse lag(2 4))
    Hansen test excluding group:     chi2(6)    =  10.24  Prob > chi2 =  0.115
    Difference (null H = exogenous): chi2(4)    =   2.78  Prob > chi2 =  0.595
  gmm(hor_full, collapse lag(2 2))
    Hansen test excluding group:     chi2(8)    =  11.03  Prob > chi2 =  0.200
    Difference (null H = exogenous): chi2(2)    =   1.99  Prob > chi2 =  0.371
  gmm(hor_part, collapse lag(2 2))
    Hansen test excluding group:     chi2(8)    =  11.09  Prob > chi2 =  0.197
    Difference (null H = exogenous): chi2(2)    =   1.93  Prob > chi2 =  0.381
  gmm(back_full, collapse lag(3 3))
    Hansen test excluding group:     chi2(8)    =  10.53  Prob > chi2 =  0.230
    Difference (null H = exogenous): chi2(2)    =   2.49  Prob > chi2 =  0.288
  gmm(back_part, collapse lag(3 3))
    Hansen test excluding group:     chi2(8)    =   8.99  Prob > chi2 =  0.343
    Difference (null H = exogenous): chi2(2)    =   4.03  Prob > chi2 =  0.133
  gmm(for_full, collapse lag(3 4))
    Hansen test excluding group:     chi2(7)    =   7.86  Prob > chi2 =  0.345
    Difference (null H = exogenous): chi2(3)    =   5.16  Prob > chi2 =  0.161
  gmm(for_part, collapse lag(3 3))
    Hansen test excluding group:     chi2(8)    =  10.53  Prob > chi2 =  0.230
    Difference (null H = exogenous): chi2(2)    =   2.49  Prob > chi2 =  0.288
  iv(humcap1 RD hhi_sales age age2 logta logta2 demand)
    Hansen test excluding group:     chi2(2)    =   0.01  Prob > chi2 =  0.996
    Difference (null H = exogenous): chi2(8)    =  13.01  Prob > chi2 =  0.111
```

TABLE III.16 COMPARISON OF VALUES OF LAGGED DEPENDENT VARIABLE BETWEEN OLS, FE AND SYSTEM GMM

CZECH REPUBLIC			
	BASELINE	OWNERSHIP	MNC ORIGIN
FE	0.090	0.080	0.080
OLS	0.620	0.620	0.620
GMM	0.400	0.389	0.387
ESTONIA			
	BASELINE	OWNERSHIP	MNC ORIGIN
FE	0.060	0.060	0.060
OLS	0.510	0.510	0.510
GMM	0.402	0.530	0.540
HUNGARY			
	BASELINE	OWNERSHIP	MNC ORIGIN
FE	-0.100	-0.100	-0.110
OLS	0.810	0.810	0.810
GMM	0.463	0.559	0.362
SLOVAKIA			
	BASELINE	OWNERSHIP	MNC ORIGIN
FE	0.090	0.090	0.090
OLS	0.680	0.680	0.680
GMM	0.415	0.435	0.546
SLOVENIA			
	BASELINE	OWNERSHIP	MNC ORIGIN
FE	0.100	0.100	0.100
OLS	0.700	0.700	0.700
GMM	0.572	0.523	0.556

APPENDIX IV.
SUPPLEMENT TO CHAPTER SIX

4.1 DEVELOPMENT OF FOREIGN FIRMS' OUTPUT IN SERVICES AND FOREIGN SERVICES INPUTS IN MANUFACTURING INDUSTRIES

FIGURE IV.1 DEVELOPMENT OF FOREIGN FIRMS' OUTPUT IN SERVICES

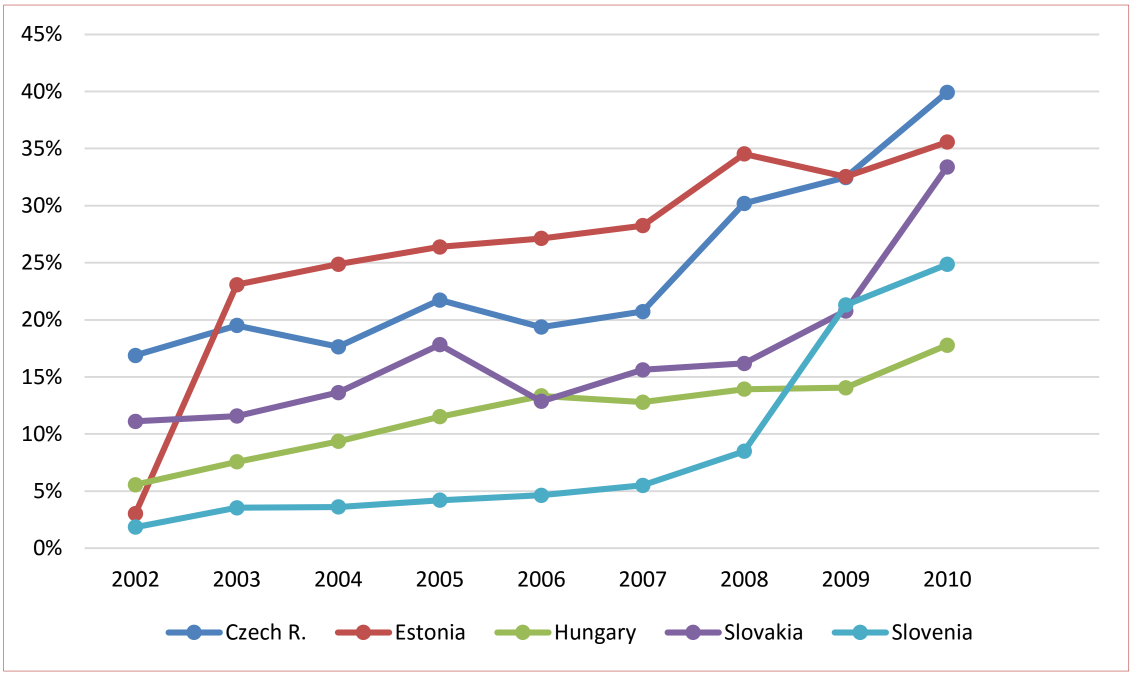
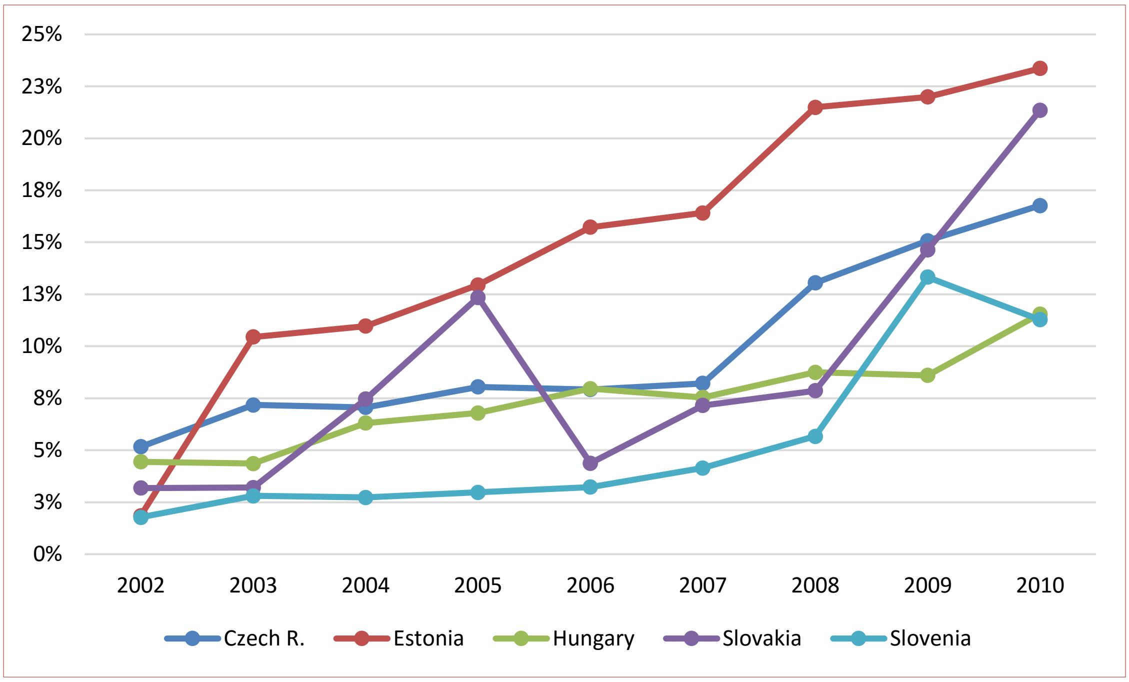


FIGURE IV.2 AVERAGE SHARE OF FOREIGN SERVICES INPUTS IN MANUFACTURING INDUSTRIES



4.2 EMPIRICAL RESULTS FOR THE BASELINE MODEL OF PRODUCTIVITY SPILLOVERS FROM FDI IN MANUFACTURING SECTOR PRESENTED IN SECTION 6.4.1

TABLE IV.1 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN THE CZECH REPUBLIC FOR MANUFACTURING SECTOR, 2002-2009 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP l2.WLP_TFP hor_tot back_tot for_tot humcap1 RD
hhi_sales age age2 logta logta2 demand i.nace_short i.region_code i.year if
man==1, gmm(l.WLP_TFP, lag(1 1)coll) gmm(l2.WLP_TFP, lag(1 1)coll) gmm(hor_tot,
lag(4 4)coll) gmm(back_tot, lag(3 3)coll) gmm(for_tot, lag(3 3)coll) iv(humcap1
RD hhi_sales age age2 logta logta2 demand) iv(i.nace_short i.region_code i.year)
two robust ar(4)

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =     29263
Time variable : year                            Number of groups   =      9712
Number of instruments = 47                      Obs per group: min =         1
Wald chi2(41)  =  51123.50                                     avg =      3.01
Prob > chi2    =     0.000                                     max =         6
------------------------------------------------------------------------------
             |              Corrected
     WLP_TFP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     WLP_TFP |
         L1. |   .3925197   .0218542    17.96   0.000     .3496863     .435353
         L2. |   .0636378   .0132634     4.80   0.000      .037642    .0896336
             |
     hor_tot |  -.6708867   .1863039    -3.60   0.000    -1.036036   -.3057378
    back_tot |   -.275951   .3710011    -0.74   0.457      -1.0031    .4511978
     for_tot |  -2.791898   .6227806    -4.48   0.000    -4.012525    -1.57127
    humcap1 |   .4781354    .014006    34.14   0.000     .4506843    .5055866
          RD |   .0449014   .0025638    17.51   0.000     .0398764    .0499264
   hhi_sales |  -.1911537   .0587091    -3.26   0.001    -.3062215   -.0760859
         age |  -.0091495   .0014733    -6.21   0.000    -.0120371   -.0062618
        age2 |   .0000805   .0000398     2.02   0.043     2.49e-06    .0001584
       logta |   .2126773   .0182006    11.69   0.000     .1770048    .2483499
      logta2 |  -.0044626   .0009291    -4.80   0.000    -.0062836   -.0026416
      demand |  -.0093027    .026721    -0.35   0.728     -.061675    .0430696
             |
  nace_short |
          20 |   1.178272   .1144024    10.30   0.000     .9540478    1.402497
          23 |   2.144024    .202082    10.61   0.000     1.747951    2.540098
          24 |   2.022489   .1458955    13.86   0.000     1.736539    2.308439
          25 |   2.116363   .1737815    12.18   0.000     1.775758    2.456969
          26 |   1.861833    .134903    13.80   0.000     1.597428    2.126238
          29 |   1.405433   .1196823    11.74   0.000      1.17086    1.640006
        1516 |   .9832033   .1279775     7.68   0.000      .732372    1.234035
        1718 |   1.351406   .1088952    12.41   0.000     1.137975    1.564836
        2122 |    1.07093   .1147976     9.33   0.000     .8459305    1.295929
        2728 |   1.272423   .1227184    10.37   0.000     1.031899    1.512947
        3033 |   1.223825   .1134627    10.79   0.000     1.001443    1.446208
        3435 |   1.230608    .118932    10.35   0.000     .9975054     1.46371
        3637 |    1.28161   .1163911    11.01   0.000     1.053488    1.509733
             |
 region_code |
           4 |  -.0582088   .0241892    -2.41   0.016    -.1056188   -.0107988
           5 |  -.0815118   .0239856    -3.40   0.001    -.1285228   -.0345008
           6 |  -.0689571    .024756    -2.79   0.005    -.1174781   -.0204361
           7 |  -.0219346   .0230522    -0.95   0.341    -.0671161    .0232468
           8 |  -.0662169   .0240615    -2.75   0.006    -.1133766   -.0190572
           9 |   -.040673   .0237358    -1.71   0.087    -.0871942    .0058483
          10 |  -.0269293   .0247529    -1.09   0.277    -.0754442    .0215855
          11 |  -.0300984   .0236204    -1.27   0.203    -.0763935    .0161968
          13 |  -.0458918   .0212784    -2.16   0.031    -.0875967    -.004187
```

```
          14  |  -.0746142   .0234976    -3.18   0.001    -.1206687   -.0285597
              |
         year |
         2004  |  -.2639856   .0728375    -3.62   0.000    -.4067445   -.1212267
         2005  |  -.1401693   .0652612    -2.15   0.032    -.2680789   -.0122596
         2006  |  -.1265405   .0696048    -1.82   0.069    -.2629634    .0098824
         2007  |  -.1718016   .0722193    -2.38   0.017    -.3133487   -.0302544
         2008  |   .0545478   .0231976     2.35   0.019     .0090814    .1000141
              |
        _cons |  -.3816861   .2651916    -1.44   0.150    -.9014521    .1380798
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z = -15.88  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   0.57  Pr > z =  0.570
Arellano-Bond test for AR(3) in first differences: z =  -0.82  Pr > z =  0.411
Arellano-Bond test for AR(4) in first differences: z =  -0.09  Pr > z =  0.925
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(5)    =  19.85  Prob > chi2 =  0.001
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(5)    =   6.32  Prob > chi2 =  0.277
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(0)    =   0.00  Prob > chi2 =      .
    Difference (null H = exogenous): chi2(5)    =   6.32  Prob > chi2 =  0.277
  gmm(L.WLP_TFP, collapse lag(1 1))
    Hansen test excluding group:     chi2(3)    =   2.97  Prob > chi2 =  0.396
    Difference (null H = exogenous): chi2(2)    =   3.34  Prob > chi2 =  0.188
  gmm(L2.WLP_TFP, collapse lag(1 1))
    Hansen test excluding group:     chi2(3)    =   2.22  Prob > chi2 =  0.529
    Difference (null H = exogenous): chi2(2)    =   4.10  Prob > chi2 =  0.129
  gmm(hor_tot, collapse lag(4 4))
    Hansen test excluding group:     chi2(3)    =   5.50  Prob > chi2 =  0.139
    Difference (null H = exogenous): chi2(2)    =   0.82  Prob > chi2 =  0.664
  gmm(back_tot, collapse lag(3 3))
    Hansen test excluding group:     chi2(3)    =   3.83  Prob > chi2 =  0.280
    Difference (null H = exogenous): chi2(2)    =   2.49  Prob > chi2 =  0.288
  gmm(for_tot, collapse lag(3 3))
    Hansen test excluding group:     chi2(3)    =   5.63  Prob > chi2 =  0.131
    Difference (null H = exogenous): chi2(2)    =   0.69  Prob > chi2 =  0.709
```

LONG RUN COEFFICIENTS

```
nlcom(LR_hor:_b[hor_tot]/(1-_b[l.WLP_TFP]))(LR_back:_b[back_tot]/(1-_b[l.WLP_TFP]))
(LR_for:_b[for_tot]/(1_b[l.WLP_TFP]))(LR_human_capital:_b[humcap1]/(1_b[l.WLP_TFP])
(LR_intangibles:_b[RD]/(1-_b[l.WLP_TFP]))(LR_HHI:_b[hhi_sales]/(1-_b[l.WLP_TFP]))
(LR_age:_b[age]/(1_b[l.WLP_TFP]))(LR_agesq:_b[age2]/(1_b[l.WLP_TFP]))(LR_size:_b[logta]/(
1_b[l.WLP_TFP]))(LR_sizesq:_b[logta2]/(1_b[l.WLP_TFP]))(LR_demand:_b[demand]/(1-
_b[l.WLP_TFP]))

------------------------------------------------------------------------------
         WLP_TFP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-----------------+------------------------------------------------------------
          LR_hor |  -1.104376   .3142836    -3.51   0.000    -1.720361   -.4883914
         LR_back |   -.454255   .6092875    -0.75   0.456    -1.648437    .7399266
          LR_for |  -4.595865   1.054562    -4.36   0.000    -6.662768   -2.528962
LR_human_capital |   .7870797   .0179202    43.92   0.000     .7519568    .8222027
  LR_intangibles |   .0739142   .0031458    23.50   0.000     .0677484    .0800799
          LR_HHI |  -.3146665   .0963677    -3.27   0.001    -.5035437   -.1257893
          LR_age |  -.0150613   .0023489    -6.41   0.000    -.0196651   -.0104575
        LR_agesq |   .0001324   .0000656     2.02   0.043     3.92e-06    .0002609
         LR_size |   .3500974   .0237839    14.72   0.000     .3034818     .396713
       LR_sizesq |  -.0073461   .0014874    -4.94   0.000    -.0102613   -.0044308
       LR_demand |  -.0153136   .0440215    -0.35   0.728    -.1015943     .070967
------------------------------------------------------------------------------
```

TABLE IV.2 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN ESTONIA FOR MANUFACTURING SECTOR, 2002-2010 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP hor_tot back_tot for_tot humcap1 RD hhi_sales age age2
logta logta2 demand i.nace_short i.region_code i.year if man==1, gmm(l.WLP_TFP,
lag(2 2)coll) gmm(hor_tot, lag(3 3)coll) gmm(back_tot, lag(2 3)coll) gmm(for_tot,
lag(3  3)coll)  iv(humcap1  RD  hhi_sales  age  age2  logta  logta2  demand)  iv(
i.nace_short i.region_code i.year) two robust ar(4)

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =     11451
Time variable : year                            Number of groups   =      2870
Number of instruments = 42                      Obs per group: min =         1
Wald chi2(36)  =  15814.34                                     avg =      3.99
Prob > chi2    =     0.000                                     max =         8
------------------------------------------------------------------------------
             |              Corrected
     WLP_TFP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     WLP_TFP |
         L1. |   .3449443   .1089459     3.17   0.002     .1314141    .5584744
             |
     hor_tot |  -1.773618   .8341122    -2.13   0.033    -3.408448   -.1387886
    back_tot |  -1.935952    .882441    -2.19   0.028    -3.665504    -.206399
     for_tot |  -1.374246   1.056993    -1.30   0.194    -3.445914    .6974232
     humcap1 |   .4203326   .0393683    10.68   0.000     .3431721    .4974931
          RD |   .1006591   .0148214     6.79   0.000     .0716097    .1297085
   hhi_sales |  -3.523549   1.297593    -2.72   0.007    -6.066785   -.9803125
         age |  -.0016731   .0043819    -0.38   0.703    -.0102615    .0069152
        age2 |   .0000565   .0000426     1.33   0.185    -.0000271      .00014
       logta |   .6377572   .1471909     4.33   0.000     .3492684     .926246
      logta2 |  -.0457454   .0135823    -3.37   0.001    -.0723663   -.0191245
      demand |   .0626452   .0694452     0.90   0.367    -.0734649    .1987553
             |
  nace_short |
         20  |   .3931776     .49383     0.80   0.426    -.5747114    1.361067
         23  |   92.40565   31.98779     2.89   0.004     29.71074    155.1006
         24  |   2.129813   .8867199     2.40   0.016     .3918743    3.867752
         25  |   .7043336   .5074959     1.39   0.165    -.2903401    1.699007
         26  |   .9508257   .6327068     1.50   0.133    -.2892568    2.190908
         29  |   .8925063   .5139831     1.74   0.082     -.114882    1.899895
       1516  |   .9761453   .5391692     1.81   0.070    -.0806068    2.032897
       1718  |    1.14088    .559784     2.04   0.042     .0437232    2.238036
       2122  |   .6971443   .5124362     1.36   0.174    -.3072122    1.701501
       2728  |    .908417   .5594952     1.62   0.104    -.1881734    2.005007
       3033  |   1.912958    .820874     2.33   0.020     .3040744    3.521841
       3435  |    1.33666   .7186743     1.86   0.063     -.071916    2.745235
       3637  |    .578158   .4825936     1.20   0.231     -.367708    1.524024
             |
 region_code |
          2  |   -.026187   .0191503    -1.37   0.171     -.063721     .011347
          3  |   -.044536   .0218318    -2.04   0.041    -.0873257   -.0017464
          4  |  -.2720266   .0848677    -3.21   0.001    -.4383643   -.1056889
          5  |  -.0475457   .0202552    -2.35   0.019    -.0872451   -.0078462
             |
        year |
       2003  |  -.6807995   .3509911    -1.94   0.052    -1.368729    .0071305
       2004  |  -.6000888   .2990628    -2.01   0.045    -1.186241   -.0139365
       2005  |  -.5488359   .2657045    -2.07   0.039    -1.069607   -.0280647
       2006  |  -.4908083   .2300777    -2.13   0.033    -.9417524   -.0398642
       2007  |  -.5523806   .2116948    -2.61   0.009    -.9672947   -.1374664
       2008  |  -.5258489   .1592791    -3.30   0.001    -.8380303   -.2136675
       2009  |  -.3714523   .0821932    -4.52   0.000    -.5325479   -.2103566
             |
       _cons |   .3154618   .5217162     0.60   0.545    -.7070831    1.338007
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -5.10  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   0.36  Pr > z =  0.718
Arellano-Bond test for AR(3) in first differences: z =  -0.41  Pr > z =  0.684
```

```
Arellano-Bond test for AR(4) in first differences: z =  -0.29  Pr > z =  0.771
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(5)    =  19.21  Prob > chi2 =  0.002
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(5)    =   5.99  Prob > chi2 =  0.307
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(1)    =   0.00  Prob > chi2 =  1.000
    Difference (null H = exogenous): chi2(4)    =   5.99  Prob > chi2 =  0.200
  gmm(L.WLP_TFP, collapse lag(2 2))
    Hansen test excluding group:     chi2(3)    =   5.72  Prob > chi2 =  0.126
    Difference (null H = exogenous): chi2(2)    =   0.27  Prob > chi2 =  0.872
  gmm(hor_tot, collapse lag(3 3))
    Hansen test excluding group:     chi2(3)    =   4.01  Prob > chi2 =  0.260
    Difference (null H = exogenous): chi2(2)    =   1.98  Prob > chi2 =  0.371
  gmm(back_tot, collapse lag(2 3))
    Hansen test excluding group:     chi2(2)    =   0.21  Prob > chi2 =  0.900
    Difference (null H = exogenous): chi2(3)    =   5.78  Prob > chi2 =  0.123
  gmm(for_tot, collapse lag(3 3))
    Hansen test excluding group:     chi2(3)    =   4.87  Prob > chi2 =  0.181
    Difference (null H = exogenous): chi2(2)    =   1.12  Prob > chi2 =  0.571
```

LONG RUN COEFFICIENTS

```
nlcom(LR_hor:_b[hor_tot]/(1-_b[l.WLP_TFP]))(LR_back:_b[back_tot]/(1-_b[l.WLP_TFP]))
(LR_for:_b[for_tot]/(1_b[l.WLP_TFP]))(LR_human_capital:_b[humcap1]/(1_b[l.WLP_TFP])
(LR_intangibles:_b[RD]/(1-_b[l.WLP_TFP]))(LR_HHI:_b[hhi_sales]/(1-_b[l.WLP_TFP]))
(LR_age:_b[age]/(1_b[l.WLP_TFP]))(LR_agesq:_b[age2]/(1_b[l.WLP_TFP]))(LR_size:_b[logta]/(
1_b[l.WLP_TFP]))(LR_sizesq:_b[logta2]/(1_b[l.WLP_TFP]))(LR_demand:_b[demand]/(1-
_b[l.WLP_TFP]))
```

WLP_TFP	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
LR_hor	-2.707584	1.352003	-2.00	0.045	-5.35746	-.0577074
LR_back	-2.9554	1.510739	-1.96	0.050	-5.916394	.0055943
LR_for	-2.097906	1.682613	-1.25	0.212	-5.395767	1.199954
LR_human_capital	.6416746	.0582413	11.02	0.000	.5275237	.7558254
LR_intangibles	.1536649	.0192419	7.99	0.000	.1159515	.1913782
LR_HHI	-5.379006	1.984529	-2.71	0.007	-9.268612	-1.4894
LR_age	-.0025542	.0067164	-0.38	0.704	-.0157181	.0106097
LR_agesq	.0000862	.0000671	1.28	0.199	-.0000453	.0002178
LR_size	.9735923	.2134501	4.56	0.000	.5552379	1.391947
LR_sizesq	-.0698344	.0212338	-3.29	0.001	-.1114518	-.028217
LR_demand	.0956333	.1105415	0.87	0.387	-.121024	.3122906

TABLE IV.3 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN HUNGARY FOR MANUFACTURING SECTOR, 2002-2010 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP hor_tot back_tot for_tot humcap1 RD hhi_sales age age2
logta logta2 demand i.nace_short i.region_code i.year if man==1, gmm(l.WLP_TFP,
lag(1 2)coll) gmm(hor_tot, lag(3 3)coll) gmm(back_tot, lag(2 5)coll) gmm(for_tot,
lag(2 5)coll) iv(humcap1 RD hhi_sales age age2 logta logta2 demand)
iv(i.nace_short i.region_code i.year) two robust ar(4)

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =      2499
Time variable : year                            Number of groups   =      1278
Number of instruments = 63                      Obs per group: min =         1
Wald chi2(51) =  15501.40                                      avg =      1.96
Prob > chi2   =     0.000                                      max =         7
------------------------------------------------------------------------------
             |              Corrected
     WLP_TFP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
```

WLP_TFP						
L1.	.5467549	.103385	5.29	0.000	.3441241	.7493857
hor_tot	-1.144667	.3881924	-2.95	0.003	-1.90551	-.3838241
back_tot	-2.414232	.8535465	-2.83	0.005	-4.087152	-.7413114
for_tot	-2.03704	1.838051	-1.11	0.268	-5.639554	1.565473
humcap1	.3106084	.0526446	5.90	0.000	.2074269	.41379
RD	.0095635	.0046169	2.07	0.038	.0005144	.0186125
hhi_sales	-.2027423	.1135242	-1.79	0.074	-.4252457	.0197612
age	-.0072496	.0041451	-1.75	0.080	-.0153737	.0008746
age2	-.0000159	.0001317	-0.12	0.904	-.000274	.0002421
logta	.0865239	.0600711	1.44	0.150	-.0312132	.2042611
logta2	.0009974	.003495	0.29	0.775	-.0058527	.0078475
demand	.0925491	.0529855	1.75	0.081	-.0113005	.1963987
nace_short						
20	.1121933	.1900081	0.59	0.555	-.2602158	.4846024
23	1.679487	.4888636	3.44	0.001	.7213319	2.637642
24	.6456333	.3164467	2.04	0.041	.0254092	1.265857
25	.0211933	.2407701	0.09	0.930	-.4507075	.4930941
26	-.0444133	.1942293	-0.23	0.819	-.4250958	.3362692
29	.3516929	.3261931	1.08	0.281	-.2876338	.9910195
1516	-.2017612	.2995775	-0.67	0.501	-.7889223	.3854
1718	-.4274033	.1605491	-2.66	0.008	-.7420738	-.1127329
2122	-.4457008	.1845901	-2.41	0.016	-.8074908	-.0839108
2728	-.2980135	.2453809	-1.21	0.225	-.7789511	.1829241
3033	-.111165	.2596011	-0.43	0.668	-.6199737	.3976438
3435	-.6473702	.2627441	-2.46	0.014	-1.162339	-.1324013
3637	.0780932	.1953294	0.40	0.689	-.3047454	.4609318
region_code						
2	.008569	.0571744	0.15	0.881	-.1034908	.1206288
3	-.0882057	.0545473	-1.62	0.106	-.1951164	.0187049
4	-.0440056	.0525348	-0.84	0.402	-.1469719	.0589608
5	.0203461	.0324303	0.63	0.530	-.043216	.0839083
6	.0404167	.055375	0.73	0.465	-.0681162	.1489497
7	-.0568529	.0422917	-1.34	0.179	-.1397431	.0260373
8	-.0212948	.0383726	-0.55	0.579	-.0965036	.0539141
9	-.0177322	.0467138	-0.38	0.704	-.1092896	.0738252
10	.0197028	.0614724	0.32	0.749	-.1007809	.1401865
11	-.0322004	.0510389	-0.63	0.528	-.1322349	.0678341
12	.0120419	.0475222	0.25	0.800	-.0810999	.1051837
13	-.0591242	.0635442	-0.93	0.352	-.1836686	.0654201
14	-.0011042	.037942	-0.03	0.977	-.0754692	.0732609
15	-.0070629	.0550538	-0.13	0.898	-.1149664	.1008405
16	-.0220889	.0588969	-0.38	0.708	-.1375246	.0933469
17	-.0212165	.081157	-0.26	0.794	-.1802813	.1378482
18	-.0537406	.0611146	-0.88	0.379	-.1735231	.0660419
19	-.000207	.0572298	-0.00	0.997	-.1123754	.1119615
20	-.047876	.0534366	-0.90	0.370	-.1526097	.0568577
year						
2004	-.0684947	.1508805	-0.45	0.650	-.364215	.2272256
2005	-.2968794	.1565715	-1.90	0.058	-.6037538	.0099951
2006	-.2723051	.1562098	-1.74	0.081	-.5784708	.0338606
2007	-.2535934	.1667643	-1.52	0.128	-.5804454	.0732585
2008	-.2699415	.1738068	-1.55	0.120	-.6105964	.0707135
2009	-.3788334	.1672376	-2.27	0.023	-.7066131	-.0510538
2010	-.343618	.1512133	-2.27	0.023	-.6399907	-.0472454
_cons	.8563584	.5647456	1.52	0.129	-.2505227	1.96324

Arellano-Bond test for AR(1) in first differences: z = -3.27 Pr > z = 0.001
Arellano-Bond test for AR(2) in first differences: z = 0.16 Pr > z = 0.869
Arellano-Bond test for AR(3) in first differences: z = -0.95 Pr > z = 0.342
Arellano-Bond test for AR(4) in first differences: z = -1.29 Pr > z = 0.196

```
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(11)    = 20.16  Prob > chi2 =  0.043
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(11)    = 13.24  Prob > chi2 =  0.278
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(7)     =  5.88  Prob > chi2 =  0.554
    Difference (null H = exogenous): chi2(4)     =  7.36  Prob > chi2 =  0.118
  gmm(L.WLP_TFP, collapse lag(1 2))
    Hansen test excluding group:     chi2(8)     = 12.77  Prob > chi2 =  0.120
    Difference (null H = exogenous): chi2(3)     =  0.47  Prob > chi2 =  0.925
  gmm(hor_tot, collapse lag(3 3))
    Hansen test excluding group:     chi2(9)     =  9.49  Prob > chi2 =  0.393
    Difference (null H = exogenous): chi2(2)     =  3.75  Prob > chi2 =  0.153
  gmm(back_tot, collapse lag(2 5))
    Hansen test excluding group:     chi2(6)     =  4.11  Prob > chi2 =  0.662
    Difference (null H = exogenous): chi2(5)     =  9.13  Prob > chi2 =  0.104
  gmm(for_tot, collapse lag(2 5))
    Hansen test excluding group:     chi2(6)     =  8.19  Prob > chi2 =  0.224
    Difference (null H = exogenous): chi2(5)     =  5.05  Prob > chi2 =  0.410
  iv(humcap1 RD hhi_sales age age2 logta logta2 demand)
    Hansen test excluding group:     chi2(3)     =  1.10  Prob > chi2 =  0.778
    Difference (null H = exogenous): chi2(8)     = 12.14  Prob > chi2 =  0.145
```

LONG RUN COEFFICIENTS

```
nlcom(LR_hor:_b[hor_tot]/(1-_b[l.WLP_TFP]))(LR_back:_b[back_tot]/(1-_b[l.WLP_TFP]))
(LR_for:_b[for_tot]/(1_b[l.WLP_TFP]))(LR_human_capital:_b[humcap1]/(1_b[l.WLP_TFP])
(LR_intangibles:_b[RD]/(1-_b[l.WLP_TFP]))(LR_HHI:_b[hhi_sales]/(1-_b[l.WLP_TFP]))
(LR_age:_b[age]/(1_b[l.WLP_TFP]))(LR_agesq:_b[age2]/(1_b[l.WLP_TFP]))(LR_size:_b[logta]/(
1_b[l.WLP_TFP]))(LR_sizesq:_b[logta2]/(1_b[l.WLP_TFP]))(LR_demand:_b[demand]/(1-
_b[l.WLP_TFP]))

------------------------------------------------------------------------------
     WLP_TFP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      LR_hor |  -2.525493    .934928    -2.70   0.007    -4.357918   -.6930674
     LR_back |  -5.326548   2.138356    -2.49   0.013    -9.517648   -1.135448
      LR_for |  -4.494346   4.581995    -0.98   0.327    -13.47489    4.486199
LR_human_capital |   .685299   .0753282     9.10   0.000     .5376585    .8329395
LR_intangibles |     .0211   .0086685     2.43   0.015     .0041101    .0380898
      LR_HHI |  -.4473126   .2750489    -1.63   0.104    -.9863985    .0917732
      LR_age |  -.0159948   .0081924    -1.95   0.051    -.0320516     .000062
    LR_agesq |  -.0000351   .0002923    -0.12   0.904    -.0006081    .0005378
     LR_size |   .1908988   .1350971     1.41   0.158    -.0738867    .4556843
   LR_sizesq |   .0022006   .0075825     0.29   0.772    -.0126609    .0170621
   LR_demand |   .2041922   .1278687     1.60   0.110    -.0464258    .4548102
------------------------------------------------------------------------------
```

TABLE IV.4 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN SLOVAKIA FOR MANUFACTURING SECTOR, 2002-2009 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP hor_tot back_tot for_tot humcap1 RD hhi_sales age age2
logta logta2 demand i.nace_short i.region_code i.year if man==1, gmm(l.WLP_TFP,
lag(1 2)) gmm(hor_tot, lag(3 3)coll) gmm(back_tot, lag(3 3)coll) gmm(for_tot,
lag(3 5)coll) iv(humcap1 RD hhi_sales age age2 logta logta2 demand)
iv(i.nace_short i.region_code i.year) two robust ar(4)

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =      8140
Time variable : year                            Number of groups   =      3074
Number of instruments = 60                      Obs per group: min =         1
Wald chi2(38)  =  10085.65                                     avg =      2.65
Prob > chi2    =     0.000                                     max =         7
------------------------------------------------------------------------------
             |              Corrected
```

WLP_TFP	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
WLP_TFP						
L1.	.3807744	.0407335	9.35	0.000	.3009382	.4606106
hor_tot	-.4006397	.1787159	-2.24	0.025	-.7509165	-.050363
back_tot	.8735587	.8192449	1.07	0.286	-.7321318	2.479249
for_tot	.2469473	.3823793	0.65	0.518	-.5025024	.9963969
humcap1	.3386129	.0144199	23.48	0.000	.3103505	.3668753
RD	.0608208	.005165	11.78	0.000	.0506975	.0709441
hhi_sales	-.0942838	.1085733	-0.87	0.385	-.3070836	.118516
age	-.0092094	.0025658	-3.59	0.000	-.0142382	-.0041806
age2	.0000876	.0000476	1.84	0.066	-5.69e-06	.000181
logta	.1422287	.0315067	4.51	0.000	.0804768	.2039806
logta2	-.0024373	.0019909	-1.22	0.221	-.0063395	.0014649
demand	-.011462	.0151008	-0.76	0.448	-.041059	.018135
nace_short						
20	-.1312321	.1149867	-1.14	0.254	-.3566018	.0941376
23	1.206204	.2306547	5.23	0.000	.754129	1.658279
24	.7981141	.1127308	7.08	0.000	.5771658	1.019062
25	-.2464845	.1087551	-2.27	0.023	-.4596406	-.0333283
26	-.7631435	.1042753	-7.32	0.000	-.9675194	-.5587676
29	.0125764	.0856359	0.15	0.883	-.1552669	.1804197
1516	-.1646652	.1097999	-1.50	0.134	-.3798691	.0505387
1718	-.1088201	.082653	-1.32	0.188	-.270817	.0531768
2122	.0663854	.1010117	0.66	0.511	-.1315939	.2643646
2728	-.5091928	.1737019	-2.93	0.003	-.8496423	-.1687433
3033	.4719134	.0946705	4.98	0.000	.2863626	.6574641
3435	.7779109	.1347215	5.77	0.000	.5138615	1.04196
3637	-.2267976	.090157	-2.52	0.012	-.4035021	-.050093
region_code						
2	.0980831	.0377262	2.60	0.009	.0241411	.172025
3	-.0163304	.0352365	-0.46	0.643	-.0853927	.0527318
4	.0335529	.0292936	1.15	0.252	-.0238615	.0909674
5	.0279928	.0323347	0.87	0.387	-.035382	.0913676
6	-.0009168	.0273793	-0.03	0.973	-.0545792	.0527456
7	.0298911	.0282688	1.06	0.290	-.0255147	.0852969
8	-.0006193	.0291924	-0.02	0.983	-.0578354	.0565969
year						
2003	.1232193	.0736173	1.67	0.094	-.0210679	.2675065
2004	.130122	.0626031	2.08	0.038	.0074222	.2528219
2005	.1232039	.065043	1.89	0.058	-.004278	.2506858
2006	.1661935	.071075	2.34	0.019	.0268891	.305498
2007	.1758382	.0410664	4.28	0.000	.0953495	.2563268
2008	.2158678	.0377681	5.72	0.000	.1418438	.2898918
_cons	.9189749	.1784835	5.15	0.000	.5691537	1.268796

```
Arellano-Bond test for AR(1) in first differences: z = -10.51  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   0.33  Pr > z =  0.742
Arellano-Bond test for AR(3) in first differences: z =   1.90  Pr > z =  0.058
Arellano-Bond test for AR(4) in first differences: z =  -0.31  Pr > z =  0.756
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(21)   =  22.48  Prob > chi2 =  0.372
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(21)   =  13.67  Prob > chi2 =  0.883
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(12)   =   7.14  Prob > chi2 =  0.848
    Difference (null H = exogenous): chi2(9)    =   6.53  Prob > chi2 =  0.686
  gmm(L.WLP_TFP, lag(1 2))
    Hansen test excluding group:     chi2(4)    =   4.28  Prob > chi2 =  0.369
```

```
    Difference (null H = exogenous): chi2(17)    =   9.38  Prob > chi2 =  0.927
  gmm(hor_tot, collapse lag(3 3))
    Hansen test excluding group:     chi2(19)    =  13.28  Prob > chi2 =  0.824
    Difference (null H = exogenous): chi2(2)     =   0.38  Prob > chi2 =  0.825
  gmm(back_tot, collapse lag(3 3))
    Hansen test excluding group:     chi2(19)    =  13.49  Prob > chi2 =  0.813
    Difference (null H = exogenous): chi2(2)     =   0.18  Prob > chi2 =  0.914
  gmm(for_tot, collapse lag(3 5))
    Hansen test excluding group:     chi2(17)    =  10.74  Prob > chi2 =  0.870
    Difference (null H = exogenous): chi2(4)     =   2.93  Prob > chi2 =  0.569
  iv(humcap1 RD hhi_sales age age2 logta logta2 demand)
    Hansen test excluding group:     chi2(13)    =   7.47  Prob > chi2 =  0.876
    Difference (null H = exogenous): chi2(8)     =   6.19  Prob > chi2 =  0.625
```

LONG RUN COEFFICIENTS

```
nlcom(LR_hor:_b[hor_tot]/(1-_b[l.WLP_TFP]))(LR_back:_b[back_tot]/(1-_b[l.WLP_TFP]))
(LR_for:_b[for_tot]/(1_b[l.WLP_TFP]))(LR_human_capital:_b[humcap1]/(1_b[l.WLP_TFP])
(LR_intangibles:_b[RD]/(1-_b[l.WLP_TFP]))(LR_HHI:_b[hhi_sales]/(1-_b[l.WLP_TFP]))
(LR_age:_b[age]/(1_b[l.WLP_TFP]))(LR_agesq:_b[age2]/(1_b[l.WLP_TFP]))(LR_size:_b[logta]/(
1_b[l.WLP_TFP]))(LR_sizesq:_b[logta2]/(1_b[l.WLP_TFP]))(LR_demand:_b[demand]/(1-
_b[l.WLP_TFP]))
```

WLP_TFP	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
LR_hor	-.6470012	.2935254	-2.20	0.028	-1.2223	-.0717021
LR_back	1.410728	1.325428	1.06	0.287	-1.187064	4.008519
LR_for	.3988001	.6145715	0.65	0.516	-.8057378	1.603338
LR_human_capital	.5468329	.0279556	19.56	0.000	.4920408	.6016249
LR_intangibles	.0982207	.0071763	13.69	0.000	.0841553	.1122861
LR_HHI	-.1522608	.1740006	-0.88	0.382	-.4932958	.1887741
LR_age	-.0148724	.0041474	-3.59	0.000	-.0230011	-.0067438
LR_agesq	.0001415	.0000778	1.82	0.069	-.0000109	.000294
LR_size	.229688	.0473672	4.85	0.000	.1368499	.3225261
LR_sizesq	-.003936	.0031885	-1.23	0.217	-.0101853	.0023132
LR_demand	-.0185102	.024365	-0.76	0.447	-.0662647	.0292443

TABLE IV.5 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN SLOVENIA FOR MANUFACTURING SECTOR, 2002-2010 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP hor_tot back_tot for_tot humcap1 RD hhi_sales age age2
logta logta2 demand i.nace_short i.region_code i.year if man==1, gmm(l.WLP_TFP,
lag(1 2)) gmm(hor_tot, lag(2 2)coll) gmm(back_tot, lag(3 4)coll) gmm(for_tot,
lag(2 3)coll) iv(humcap1 RD hhi_sales age age2 logta logta2 demand0 iv(
i.nace_short i.region_code i.year) two robust ar(4)
```

```
Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =      3584
Time variable : year                            Number of groups   =      1136
Number of instruments = 68                      Obs per group: min =         1
Wald chi2(43) =   6159.85                                      avg =      3.15
Prob > chi2   =     0.000                                      max =         8
------------------------------------------------------------------------------
```

WLP_TFP	Coef.	Corrected Std. Err.	z	P>|z|	[95% Conf.	Interval]
WLP_TFP						
L1.	.4425096	.0591313	7.48	0.000	.3266143	.5584048
hor_tot	1.948354	.9454084	2.06	0.039	.0953882	3.801321
back_tot	1.7311	.8979263	1.93	0.054	-.0288034	3.491003
for_tot	.7626071	1.168297	0.65	0.514	-1.527214	3.052428
humcap1	.5168935	.049528	10.44	0.000	.4198205	.6139665

```
          RD |   .0290221   .0057209     5.07   0.000     .0178094    .0402349
   hhi_sales |  -.1347725   .1530708    -0.88   0.379    -.4347857    .1652406
         age |  -.0103004     .00283    -3.64   0.000    -.0158472   -.0047537
        age2 |    .000045   .0000847     0.53   0.595     -.000121    .0002111
       logta |   -.018502   .0606706    -0.30   0.760    -.1374142    .1004102
      logta2 |   .0097217   .0049485     1.96   0.049     .0000227    .0194207
      demand |  -.0779417   .1783277    -0.44   0.662    -.4274577    .2715742
             |
  nace_short |
         20  |  -.3659174   .1798576    -2.03   0.042    -.7184318   -.0134029
         23  |  -.2432156   1.894091    -0.13   0.898    -3.955566    3.469135
         24  |   .0218688   .3837448     0.06   0.955    -.7302571    .7739947
         25  |  -.6628558   .2408833    -2.75   0.006    -1.134978   -.1907332
         26  |   -.074303    .187815    -0.40   0.692    -.4424137    .2938076
         29  |  -.7371707   .2311942    -3.19   0.001    -1.190303   -.2840384
       1516  |   -.281934   .1925926    -1.46   0.143    -.6594085    .0955406
       1718  |   -.002745   .1803845    -0.02   0.988    -.3562922    .3508022
       2122  |   -.826935   .2092614    -3.95   0.000     -1.23708   -.4167901
       2728  |  -.9167497   .2958357    -3.10   0.002    -1.496577   -.3369222
       3033  |  -.2979411   .1755386    -1.70   0.090    -.6419905    .0461082
       3435  |  -1.965703   .6502606    -3.02   0.003     -3.24019   -.6912153
       3637  |  -.2159023   .2141865    -1.01   0.313       -.6357    .2038955
             |
 region_code |
          2  |  -.0227627   .0458429    -0.50   0.620    -.1126131    .0670877
          3  |    .064433   .0448825     1.44   0.151     -.023535     .152401
          4  |   .0189333   .0477101     0.40   0.691    -.0745768    .1124434
          5  |   .0054825   .0502483     0.11   0.913    -.0930023    .1039673
          6  |   .0384147   .0530029     0.72   0.469     -.065469    .1422985
          7  |   .0333082   .0325578     1.02   0.306    -.0305039    .0971204
          8  |   .0151727   .0394005     0.39   0.700    -.0620508    .0923962
          9  |   .0229111   .0630454     0.36   0.716    -.1006555    .1464778
         10  |   .0154764   .0413461     0.37   0.708    -.0655605    .0965133
         11  |   .0624112    .053754     1.16   0.246    -.0429448    .1677672
         12  |  -.0343209   .0756912    -0.45   0.650    -.1826729    .1140311
             |
        year |
       2003  |   .5375263     .20297     2.65   0.008     .1397124    .9353402
       2004  |   .3835903   .1261885     3.04   0.002     .1362654    .6309152
       2005  |    .332181   .1176597     2.82   0.005     .1015723    .5627897
       2006  |   .3974388   .1284319     3.09   0.002     .1457169    .6491607
       2007  |   .3282541   .1184943     2.77   0.006     .0960095    .5604988
       2008  |   .2762468   .1086694     2.54   0.011     .0632588    .4892349
       2009  |  -.2302258   .0709097    -3.25   0.001    -.3692062   -.0912455
             |
       _cons |   1.393855    1.28487     1.08   0.278    -1.124444    3.912154
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -8.59  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   1.21  Pr > z =  0.228
Arellano-Bond test for AR(3) in first differences: z =  -0.44  Pr > z =  0.663
Arellano-Bond test for AR(4) in first differences: z =  -0.03  Pr > z =  0.977
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(24)   =  48.68  Prob > chi2 =  0.002
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(24)   =  23.66  Prob > chi2 =  0.481
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(14)   =  13.18  Prob > chi2 =  0.512
    Difference (null H = exogenous): chi2(10)   =  10.48  Prob > chi2 =  0.400
  gmm(L.WLP_TFP, lag(1 2))
    Hansen test excluding group:     chi2(4)    =   2.23  Prob > chi2 =  0.694
    Difference (null H = exogenous): chi2(20)   =  21.43  Prob > chi2 =  0.372
  gmm(hor_tot, collapse lag(2 2))
    Hansen test excluding group:     chi2(22)   =  23.53  Prob > chi2 =  0.373
    Difference (null H = exogenous): chi2(2)    =   0.13  Prob > chi2 =  0.935
```

```
  gmm(back_tot, collapse lag(3 4))
    Hansen test excluding group:     chi2(21)    =  21.74  Prob > chi2 =  0.415
    Difference (null H = exogenous): chi2(3)     =   1.92  Prob > chi2 =  0.590
  gmm(for_tot, collapse lag(2 3))
    Hansen test excluding group:     chi2(21)    =  21.28  Prob > chi2 =  0.442
    Difference (null H = exogenous): chi2(3)     =   2.38  Prob > chi2 =  0.498
  iv(humcap1 RD hhi_sales age age2 logta logta2 demand)
    Hansen test excluding group:     chi2(16)    =  17.88  Prob > chi2 =  0.331
    Difference (null H = exogenous): chi2(8)     =   5.78  Prob > chi2 =  0.672
```

LONG RUN COEFFICIENTS

```
nlcom(LR_hor:_b[hor_tot]/(1-_b[l.WLP_TFP]))(LR_back:_b[back_tot]/(1-_b[l.WLP_TFP]))
(LR_for:_b[for_tot]/(1_b[l.WLP_TFP]))(LR_human_capital:_b[humcap1]/(1_b[l.WLP_TFP])
(LR_intangibles:_b[RD]/(1-_b[l.WLP_TFP]))(LR_HHI:_b[hhi_sales]/(1-_b[l.WLP_TFP]))
(LR_age:_b[age]/(1_b[l.WLP_TFP]))(LR_agesq:_b[age2]/(1_b[l.WLP_TFP]))(LR_size:_b[logta]/(
1_b[l.WLP_TFP]))(LR_sizesq:_b[logta2]/(1_b[l.WLP_TFP]))(LR_demand:_b[demand]/(1-
_b[l.WLP_TFP]))
```

```
------------------------------------------------------------------------------
     WLP_TFP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      LR_hor |   3.494866   1.704031     2.05   0.040     .1550272    6.834705
     LR_back |   3.105165    1.59528     1.95   0.052    -.0215254    6.231856
      LR_for |   1.367929   2.109792     0.65   0.517    -2.767188    5.503045
LR_human_capital |   .9271791   .0708491    13.09   0.000     .7883174    1.066041
 LR_intangibles |   .0520585   .0087712     5.94   0.000     .0348674    .0692497
      LR_HHI |  -.2417486   .2761538    -0.88   0.381    -.7830002     .299503
      LR_age |  -.0184764   .0056723    -3.26   0.001    -.0295939   -.0073589
    LR_agesq |   .0000808   .0001549     0.52   0.602    -.0002228    .0003844
     LR_size |   -.033188    .108654    -0.31   0.760    -.2461458    .1797699
   LR_sizesq |   .0174383   .0085685     2.04   0.042     .0006444    .0342323
   LR_demand |  -.1398082     .31344    -0.45   0.656    -.7541393    .4745229
------------------------------------------------------------------------------
```

4.3 EMPIRICAL RESULTS FOR THE BASELINE MODEL OF PRODUCTIVITY SPILLOVERS FROM FDI IN SERVICE SECTOR PRESENTED IN SECTION 6.4.1

TABLE IV.6 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN THE CZECH REPUBLIC FOR SERVICES SECTOR, 2002-2009 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP l2.WLP_TFP hor_tot back_tot for_tot humcap1 RD
hhi_sales age age2 logta logta2 demand i.nace_short i.region_code i.year if
man==0, gmm(l.WLP_TFP, lag(1 2)coll) gmm(l2.WLP_TFP,lag(1 1)coll) gmm(hor_tot,
lag(2 2)coll) gmm(back_tot, lag(2 2)coll) gmm(for_tot, lag(2 2)coll) iv(humcap1
RD hhi_sales age age2 logta logta2 demand) iv(i.nace_short i.region_code i.year)
two robust ar(4)

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =     68628
Time variable : year                            Number of groups   =     26988
Number of instruments = 47                      Obs per group: min =         1
Wald chi2(41) = 112015.62                                      avg =      2.54
Prob > chi2   =     0.000                                      max =         6
------------------------------------------------------------------------------
             |              Corrected
     WLP_TFP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     WLP_TFP |
         L1. |   .4096403   .0144477    28.35   0.000     .3813234    .4379573
         L2. |   .0818678   .0090795     9.02   0.000     .0640724    .0996633
```

```
             |
     hor_tot |    1.69027   .2148659     7.87   0.000     1.269141      2.1114
    back_tot |  -.7743065   .1298834    -5.96   0.000    -1.028873   -.5197396
     for_tot |  -5.041915   .5419953    -9.30   0.000    -6.104206   -3.979624
     humcap1 |   .4137492   .0100627    41.12   0.000     .3940266    .4334718
          RD |   .0526286   .0022361    23.54   0.000      .048246    .0570112
   hhi_sales |  -1.326875    .237236    -5.59   0.000    -1.791849   -.8619014
         age |  -.0097676   .0015477    -6.31   0.000     -.012801   -.0067342
        age2 |   .0000338   .0000616     0.55   0.583    -.0000869    .0001545
       logta |   .2093268   .0173085    12.09   0.000     .1754027    .2432509
      logta2 |  -.0062714   .0011654    -5.38   0.000    -.0085556   -.0039872
      demand |   .1977529   .0290606     6.80   0.000     .1407952    .2547106
             |
  nace_short |
         45  |  -.3655451   .0681419    -5.36   0.000    -.4991008   -.2319894
         50  |   .2116272   .0630227     3.36   0.001     .0881049    .3351495
         51  |   .9677945   .0397166    24.37   0.000     .8899513    1.045638
         52  |   1.057776   .0579624    18.25   0.000     .9441715     1.17138
         55  |   .1357055   .0623536     2.18   0.030     .0134946    .2579164
         60  |   .1841448   .0499421     3.69   0.000     .0862601    .2820295
         61  |   1.890148   .2842885     6.65   0.000     1.332952    2.447343
         62  |   1.103922   .2460288     4.49   0.000      .621714    1.586129
         63  |    -.65656   .0941384    -6.97   0.000    -.8410678   -.4720522
         64  |  -.8937918   .1678507    -5.32   0.000    -1.222773   -.5648104
         70  |    .286106   .0371807     7.70   0.000     .2132332    .3589787
       4041  |  -.3457341   .1062587    -3.25   0.001    -.5539973   -.1374708
       6567  |  -.5222784   .1710057    -3.05   0.002    -.8574433   -.1871135
             |
 region_code |
          4  |   -.020808   .0233017    -0.89   0.372    -.0664786    .0248625
          5  |   .0039841   .0223241     0.18   0.858    -.0397702    .0477385
          6  |   -.039214   .0240423    -1.63   0.103    -.0863362    .0079081
          7  |   .0072933   .0211213     0.35   0.730    -.0341036    .0486902
          8  |  -.0153223   .0232276    -0.66   0.509    -.0608475     .030203
          9  |  -.0160648   .0230202    -0.70   0.485    -.0611836     .029054
         10  |  -.0074217   .0226598    -0.33   0.743    -.0518341    .0369908
         11  |     .02487   .0204751     1.21   0.225    -.0152605    .0650004
         13  |   .0053727   .0198324     0.27   0.786    -.0334982    .0442435
         14  |  -.0242532   .0221896    -1.09   0.274     -.067744    .0192375
             |
        year |
       2004  |  -.4570998   .0740754    -6.17   0.000     -.602285   -.3119146
       2005  |  -.3039608   .0583317    -5.21   0.000    -.4182888   -.1896328
       2006  |  -.3374211   .0640139    -5.27   0.000     -.462886   -.2119562
       2007  |  -.3249541   .0668977    -4.86   0.000    -.4560711   -.1938371
       2008  |  -.0882397   .0170111    -5.19   0.000    -.1215809   -.0548986
             |
       _cons |  -.9327803   .2025605    -4.60   0.000    -1.329792   -.5357689
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z = -26.34  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   0.54  Pr > z =  0.588
Arellano-Bond test for AR(3) in first differences: z =   1.31  Pr > z =  0.189
Arellano-Bond test for AR(4) in first differences: z =  -0.03  Pr > z =  0.979
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(5)     =   8.81  Prob > chi2 =  0.117
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(5)     =   5.03  Prob > chi2 =  0.412
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(0)     =   0.00  Prob > chi2 =      .
    Difference (null H = exogenous): chi2(5)     =   5.03  Prob > chi2 =  0.412
  gmm(L.WLP_TFP, collapse lag(1 2))
    Hansen test excluding group:     chi2(3)     =   4.42  Prob > chi2 =  0.219
    Difference (null H = exogenous): chi2(2)     =   0.61  Prob > chi2 =  0.737
  gmm(L2.WLP_TFP, collapse lag(1 1))
```

```
    Hansen test excluding group:     chi2(3)    =   3.68  Prob > chi2 =  0.298
    Difference (null H = exogenous): chi2(2)    =   1.35  Prob > chi2 =  0.508
  gmm(hor_tot, collapse lag(2 2))
    Hansen test excluding group:     chi2(3)    =   1.09  Prob > chi2 =  0.780
    Difference (null H = exogenous): chi2(2)    =   3.95  Prob > chi2 =  0.139
  gmm(back_tot, collapse lag(2 2))
    Hansen test excluding group:     chi2(3)    =   3.64  Prob > chi2 =  0.303
    Difference (null H = exogenous): chi2(2)    =   1.39  Prob > chi2 =  0.499
  gmm(for_tot, collapse lag(2 2))
    Hansen test excluding group:     chi2(3)    =   3.40  Prob > chi2 =  0.334
    Difference (null H = exogenous): chi2(2)    =   1.63  Prob > chi2 =  0.443
```

LONG RUN COEFFICIENTS

```
nlcom(LR_hor:_b[hor_tot]/(1-_b[l.WLP_TFP]))(LR_back:_b[back_tot]/(1-_b[l.WLP_TFP]))
(LR_for:_b[for_tot]/(1_b[l.WLP_TFP]))(LR_human_capital:_b[humcap1]/(1_b[l.WLP_TFP])
(LR_intangibles:_b[RD]/(1-_b[l.WLP_TFP]))(LR_HHI:_b[hhi_sales]/(1-_b[l.WLP_TFP]))
(LR_age:_b[age]/(1_b[l.WLP_TFP]))(LR_agesq:_b[age2]/(1_b[l.WLP_TFP]))(LR_size:_b[logta]/(
1_b[l.WLP_TFP]))(LR_sizesq:_b[logta2]/(1_b[l.WLP_TFP]))(LR_demand:_b[demand]/(1-
_b[l.WLP_TFP]))
```

WLP_TFP	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
LR_hor	2.863119	.3867104	7.40	0.000	2.105181	3.621058
LR_back	-1.311584	.2320193	-5.65	0.000	-1.766334	-.8568349
LR_for	-8.540412	1.017607	-8.39	0.000	-10.53489	-6.545939
LR_human_capital	.7008426	.0105661	66.33	0.000	.6801334	.7215519
LR_intangibles	.0891466	.0028233	31.58	0.000	.083613	.0946802
LR_HHI	-2.247571	.4095308	-5.49	0.000	-3.050237	-1.444906
LR_age	-.0165452	.0026296	-6.29	0.000	-.0216991	-.0113913
LR_agesq	.0000573	.0001046	0.55	0.584	-.0001477	.0002623
LR_size	.3545751	.0255549	13.88	0.000	.3044884	.4046617
LR_sizesq	-.0106231	.0019135	-5.55	0.000	-.0143735	-.0068726
LR_demand	.3349702	.0519509	6.45	0.000	.2331482	.4367922

TABLE IV.7 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN ESTONIA FOR SERVICES SECTOR, 2002-2010 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP hor_tot back_tot for_tot humcap1 RD hhi_sales age age2
logta logta2 demand i.nace_short i.region_code i.year if man==0, gmm(l.WLP_TFP,
lag(2 2)coll) gmm(hor_tot, lag(4 6)coll) gmm(back_tot, lag(3 4)coll) gmm(for_tot,
lag(4 6)coll) iv(humcap1 RD hhi_sales age age2 logta logta2 demand)
iv(i.nace_short i.region_code i.year) two robust ar(4)
```

```
Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =     54743
Time variable : year                            Number of groups   =     15814
Number of instruments = 46                      Obs per group: min =         1
Wald chi2(36)  =  78015.01                                     avg =      3.46
Prob > chi2    =     0.000                                     max =         8
------------------------------------------------------------------------------
```

WLP_TFP	Coef.	Corrected Std. Err.	z	P>|z|	[95% Conf.	Interval]
WLP_TFP						
L1.	.5901357	.0414605	14.23	0.000	.5088746	.6713968
hor_tot	.1604103	.320256	0.50	0.616	-.4672799	.7881005
back_tot	-.3501051	.1212107	-2.89	0.004	-.5876737	-.1125365
for_tot	-5.723594	1.239521	-4.62	0.000	-8.153011	-3.294177
humcap1	.3080943	.0147712	20.86	0.000	.2791434	.3370453
RD	.0801159	.0038511	20.80	0.000	.0725679	.0876639
hhi_sales	.4893748	.1565213	3.13	0.002	.1825988	.7961509
age	-.012556	.0009678	-12.97	0.000	-.0144528	-.0106592
age2	.0001315	.0000104	12.70	0.000	.0001112	.0001518
logta	.1688141	.0159583	10.58	0.000	.1375363	.2000918
logta2	-.0030695	.0011094	-2.77	0.006	-.0052438	-.0008951

```
      demand |   .2234348   .0753608     2.96   0.003     .0757304    .3711392
             |
  nace_short |
          45 |  -.3745669   .1068185    -3.51   0.000    -.5839274   -.1652064
          50 |   .4660656   .0937708     4.97   0.000     .2822781     .649853
          51 |   .7388933   .1076528     6.86   0.000     .5278977    .9498889
          52 |   .5610951   .1271296     4.41   0.000     .3119257    .8102646
          55 |   .3958085    .126243     3.14   0.002     .1483768    .6432403
          60 |   .5268563    .116946     4.51   0.000     .2976464    .7560661
          61 |  -.1105922   .2794766    -0.40   0.692    -.6583563     .437172
          62 |   .4858292   .2879202     1.69   0.092    -.0784839    1.050142
          63 |  -.3342459   .0732653    -4.56   0.000    -.4778432   -.1906485
          64 |  -.0065716   .1342619    -0.05   0.961    -.2697201    .2565769
          70 |   .3566814   .0708458     5.03   0.000     .2178261    .4955367
        4041 |  -.0642846   .1163342    -0.55   0.581    -.2922954    .1637262
        6567 |  -.4507117   .1225269    -3.68   0.000      -.69086   -.2105635
             |
 region_code |
           2 |  -.0232228    .008841    -2.63   0.009    -.0405509   -.0058947
           3 |  -.0298868   .0108414    -2.76   0.006    -.0511355    -.008638
           4 |  -.0339187   .0166614    -2.04   0.042    -.0665745   -.0012629
           5 |  -.0208578   .0075182    -2.77   0.006    -.0355932   -.0061225
             |
        year |
        2003 |  -.6379444   .1562541    -4.08   0.000    -.9441967    -.331692
        2004 |  -.5189491   .1263639    -4.11   0.000    -.7666178   -.2712804
        2005 |  -.2951318   .0750607    -3.93   0.000    -.4422481   -.1480154
        2006 |  -.3585103   .0793966    -4.52   0.000    -.5141247   -.2028959
        2007 |  -.3842661   .0849188    -4.53   0.000    -.5507039   -.2178282
        2008 |  -.2865788   .0301165    -9.52   0.000     -.345606   -.2275516
        2009 |  -.4468583   .0308118   -14.50   0.000    -.5072483   -.3864683
             |
       _cons |   .0415914   .6106317     0.07   0.946    -1.155225    1.238408
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z = -14.37  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   2.55  Pr > z =  0.011
Arellano-Bond test for AR(3) in first differences: z =  -0.81  Pr > z =  0.418
Arellano-Bond test for AR(4) in first differences: z =   0.91  Pr > z =  0.361
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(9)    =  10.99  Prob > chi2 =  0.277
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(9)    =  10.85  Prob > chi2 =  0.286
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(5)    =   8.18  Prob > chi2 =  0.147
    Difference (null H = exogenous): chi2(4)    =   2.67  Prob > chi2 =  0.615
  gmm(L.WLP_TFP, collapse lag(2 2))
    Hansen test excluding group:     chi2(7)    =   6.66  Prob > chi2 =  0.465
    Difference (null H = exogenous): chi2(2)    =   4.19  Prob > chi2 =  0.123
  gmm(hor_tot, collapse lag(4 6))
    Hansen test excluding group:     chi2(5)    =   2.57  Prob > chi2 =  0.766
    Difference (null H = exogenous): chi2(4)    =   8.28  Prob > chi2 =  0.082
  gmm(back_tot, collapse lag(3 4))
    Hansen test excluding group:     chi2(6)    =   9.49  Prob > chi2 =  0.148
    Difference (null H = exogenous): chi2(3)    =   1.36  Prob > chi2 =  0.715
  gmm(for_tot, collapse lag(4 6))
    Hansen test excluding group:     chi2(5)    =   4.50  Prob > chi2 =  0.480
    Difference (null H = exogenous): chi2(4)    =   6.35  Prob > chi2 =  0.175
  iv(humcap1 RD hhi_sales age age2 logta logta2 demand)
    Hansen test excluding group:     chi2(1)    =   0.29  Prob > chi2 =  0.593
    Difference (null H = exogenous): chi2(8)    =  10.56  Prob > chi2 =  0.228
```

LONG RUN COEFFICIENTS

```
nlcom(LR_hor:_b[hor_tot]/(1-_b[l.WLP_TFP]))(LR_back:_b[back_tot]/(1-_b[l.WLP_TFP]))
(LR_for:_b[for_tot]/(1_b[l.WLP_TFP]))(LR_human_capital:_b[humcap1]/(1_b[l.WLP_TFP])
(LR_intangibles:_b[RD]/(1-_b[l.WLP_TFP]))(LR_HHI:_b[hhi_sales]/(1-_b[l.WLP_TFP]))
(LR_age:_b[age]/(1_b[l.WLP_TFP]))(LR_agesq:_b[age2]/(1_b[l.WLP_TFP]))(LR_size:_b[logta]/(
1_b[l.WLP_TFP]))(LR_sizesq:_b[logta2]/(1_b[l.WLP_TFP]))(LR_demand:_b[demand]/(1-
_b[l.WLP_TFP]))
```

WLP_TFP	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
LR_hor	.391374	.7783643	0.50	0.615	-1.134192	1.91694
LR_back	-.8541976	.3077914	-2.78	0.006	-1.457458	-.2509376
LR_for	-13.96461	3.353516	-4.16	0.000	-20.53738	-7.391837
LR_human_capital	.7516983	.0451368	16.65	0.000	.6632318	.8401649
LR_intangibles	.1954694	.013533	14.44	0.000	.1689451	.2219936
LR_HHI	1.193992	.4042285	2.95	0.003	.401719	1.986266
LR_age	-.0306345	.0020666	-14.82	0.000	-.0346849	-.026584
LR_agesq	.0003209	.0000278	11.54	0.000	.0002664	.0003754
LR_size	.4118779	.0305735	13.47	0.000	.351955	.4718008
LR_sizesq	-.007489	.0028377	-2.64	0.008	-.0130508	-.0019273
LR_demand	.5451433	.1976908	2.76	0.006	.1576763	.9326102

TABLE IV.8 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN HUNGARY FOR SERVICES SECTOR, 2002-2010 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP hor_tot back_tot for_tot humcap1 RD hhi_sales age age2
logta logta2 demand i.nace_short i.region_code i.year if man==0, gmm(l.WLP_TFP,
lag(1 3)) gmm(hor_tot, lag(2 2)) gmm(back_tot, lag(2 3)coll) gmm(for_tot, lag(3
3)coll) iv(humcap1 RD hhi_sales age age2 logta logta2 demand) iv(i.nace_short
i.region_code i.year) two robust ar(4)
```

Dynamic panel-data estimation, two-step system GMM

```
Group variable: id                            Number of obs      =      4411
Time variable : year                          Number of groups   =      2357
Number of instruments = 86                    Obs per group: min =         1
Wald chi2(51)  =  14268.75                                   avg =      1.87
Prob > chi2    =     0.000                                   max =         6
```

WLP_TFP	Coef.	Corrected Std. Err.	z	P>|z|	[95% Conf.	Interval]
WLP_TFP						
L1.	.4863216	.0821365	5.92	0.000	.325337	.6473061
hor_tot	1.074539	.5940016	1.81	0.070	-.0896826	2.238761
back_tot	1.565045	.6244017	2.51	0.012	.3412399	2.78885
for_tot	-23.13061	4.903054	-4.72	0.000	-32.74042	-13.5208
humcap1	.3275966	.038535	8.50	0.000	.2520694	.4031237
RD	.0102987	.0044132	2.33	0.020	.001649	.0189485
hhi_sales	-.1231828	.1926446	-0.64	0.523	-.5007593	.2543937
age	-.0109792	.0024885	-4.41	0.000	-.0158565	-.0061019
age2	.0000351	.0000181	1.94	0.052	-2.83e-07	.0000705
logta	.1212183	.0956648	1.27	0.205	-.0662813	.3087179
logta2	.00066	.0057359	0.12	0.908	-.0105821	.0119021
demand	.4469405	.231733	1.93	0.054	-.0072479	.9011288
nace_short						
45	1.213581	.3977521	3.05	0.002	.4340014	1.993161
50	2.769296	.6371469	4.35	0.000	1.520511	4.018081
51	1.694628	.4382706	3.87	0.000	.8356332	2.553622
52	2.047254	.4302085	4.76	0.000	1.204061	2.890448
55	2.58031	.6403135	4.03	0.000	1.325319	3.835302
60	2.20442	.4912589	4.49	0.000	1.24157	3.16727
61	5.592956	1.450953	3.85	0.000	2.749141	8.436771
62	4.414333	1.251522	3.53	0.000	1.961394	6.867272
63	1.4551	.4551395	3.20	0.001	.5630434	2.347157
64	1.246844	.6057693	2.06	0.040	.0595578	2.43413

```
          70  |   1.960987   .3575921     5.48   0.000     1.260119    2.661855
        4041  |   3.157311   .5803485     5.44   0.000     2.019849    4.294773
        6567  |   .4473823   .3817384     1.17   0.241    -.3008112    1.195576
              |
 region_code  |
           2  |  -.1883178   .0769393    -2.45   0.014    -.3391161   -.0375195
           3  |  -.0295932   .0768539    -0.39   0.700    -.1802242    .1210377
           4  |   -.046539   .0715235    -0.65   0.515    -.1867226    .0936446
           5  |  -.0194239   .0459677    -0.42   0.673    -.1095188    .0706711
           6  |  -.1136715   .0633516    -1.79   0.073    -.2378383    .0104953
           7  |  -.0385425    .066669    -0.58   0.563    -.1692113    .0921263
           8  |   -.073705   .0615724    -1.20   0.231    -.1943846    .0469746
           9  |  -.0896902   .0622165    -1.44   0.149    -.2116324     .032252
          10  |  -.0308271   .0801629    -0.38   0.701    -.1879435    .1262894
          11  |  -.1305749    .073358    -1.78   0.075     -.274354    .0132041
          12  |   .0129786   .0805328     0.16   0.872    -.1448629      .17082
          13  |  -.3132104   .0921117    -3.40   0.001    -.4937459   -.1326749
          14  |  -.0225427   .0492312    -0.46   0.647     -.119034    .0739486
          15  |  -.0904657   .0768296    -1.18   0.239    -.2410489    .0601175
          16  |  -.1216052   .0636549    -1.91   0.056    -.2463666    .0031562
          17  |  -.1727057   .1206606    -1.43   0.152     -.409196    .0637847
          18  |  -.0820498    .066578    -1.23   0.218    -.2125403    .0484408
          19  |  -.0892265    .078472    -1.14   0.256    -.2430287    .0645758
          20  |  -.1515744   .0796189    -1.90   0.057    -.3076246    .0044759
              |
        year  |
        2003  |  -1.710372   .5235024    -3.27   0.001    -2.736418   -.6843262
        2004  |  -.7907017   .2334605    -3.39   0.001    -1.248276   -.3331274
        2005  |  -.0823408   .1573496    -0.52   0.601    -.3907404    .2260587
        2006  |  -.1550889   .1370791    -1.13   0.258     -.423759    .1135812
        2007  |   .0705042   .1410904     0.50   0.617    -.2060279    .3470363
        2008  |    .314872   .1868292     1.69   0.092    -.0513065    .6810505
        2009  |   .2455149   .2079703     1.18   0.238    -.1620994    .6531293
              |
       _cons  |  -2.186255   1.802716    -1.21   0.225    -5.719514    1.347003
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -3.80  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   1.68  Pr > z =  0.093
Arellano-Bond test for AR(3) in first differences: z =  -0.72  Pr > z =  0.474
Arellano-Bond test for AR(4) in first differences: z =   1.35  Pr > z =  0.178
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(34)   = 78.43  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(34)   = 35.40  Prob > chi2 =  0.402
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(20)   = 19.19  Prob > chi2 =  0.509
    Difference (null H = exogenous): chi2(14)   = 16.20  Prob > chi2 =  0.301
  gmm(L.WLP_TFP, lag(1 3))
    Hansen test excluding group:     chi2(13)   = 12.38  Prob > chi2 =  0.497
    Difference (null H = exogenous): chi2(21)   = 23.02  Prob > chi2 =  0.343
  gmm(hor_tot, lag(2 2))
    Hansen test excluding group:     chi2(22)   = 20.73  Prob > chi2 =  0.538
    Difference (null H = exogenous): chi2(12)   = 14.67  Prob > chi2 =  0.260
  gmm(back_tot, collapse lag(2 3))
    Hansen test excluding group:     chi2(31)   = 34.71  Prob > chi2 =  0.295
    Difference (null H = exogenous): chi2(3)    =  0.69  Prob > chi2 =  0.876
  gmm(for_tot, collapse lag(3 3))
    Hansen test excluding group:     chi2(32)   = 35.32  Prob > chi2 =  0.314
    Difference (null H = exogenous): chi2(2)    =  0.07  Prob > chi2 =  0.964
  iv(humcap1 RD hhi_sales age age2 logta logta2 demand)
    Hansen test excluding group:     chi2(26)   = 26.96  Prob > chi2 =  0.412
    Difference (null H = exogenous): chi2(8)    =  8.44  Prob > chi2 =  0.391
```

LONG RUN COEFFICIENTS

```
nlcom(LR_hor:_b[hor_tot]/(1-_b[l.WLP_TFP]))(LR_back:_b[back_tot]/(1-_b[l.WLP_TFP]))
(LR_for:_b[for_tot]/(1_b[l.WLP_TFP]))(LR_human_capital:_b[humcap1]/(1_b[l.WLP_TFP])
(LR_intangibles:_b[RD]/(1-_b[l.WLP_TFP]))(LR_HHI:_b[hhi_sales]/(1-_b[l.WLP_TFP]))
(LR_age:_b[age]/(1_b[l.WLP_TFP]))(LR_agesq:_b[age2]/(1_b[l.WLP_TFP]))(LR_size:_b[logta]/(
1_b[l.WLP_TFP]))(LR_sizesq:_b[logta2]/(1_b[l.WLP_TFP]))(LR_demand:_b[demand]/(1-
_b[l.WLP_TFP]))
```

```
------------------------------------------------------------------------------
     WLP_TFP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      LR_hor |   2.091852   1.253776     1.67   0.095    -.3655029    4.549207
     LR_back |   3.046741   1.328398     2.29   0.022     .4431274    5.650354
      LR_for |  -45.02935   11.23402    -4.01   0.000    -67.04762   -23.01107
LR_human_capital |   .6377464    .050637    12.59   0.000     .5384996    .7369932
LR_intangibles |    .020049   .0079432     2.52   0.012     .0044807    .0356173
      LR_HHI |  -.2398053    .371676    -0.65   0.519     -.968277    .4886663
      LR_age |  -.0213737   .0042379    -5.04   0.000    -.0296799   -.0130675
    LR_agesq |   .0000683   .0000341     2.00   0.045     1.51e-06    .0001352
     LR_size |   .2359809    .179494     1.31   0.189    -.1158208    .5877827
   LR_sizesq |   .0012848    .011177     0.11   0.908    -.0206218    .0231914
   LR_demand |   .8700781   .4465447     1.95   0.051    -.0051333     1.74529
------------------------------------------------------------------------------
```

TABLE IV.9 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN SLOVAKIA FOR SERVICES SECTOR, 2002-2009 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP hor_tot back_tot for_tot humcap1 RD hhi_sales age age2
logta logta2 demand i.nace_short i.region_code i.year if man==0, gmm(l.WLP_TFP,
lag(4 4)coll) gmm(hor_tot, lag(2 5)coll) gmm(back_tot, lag(3 .)coll) gmm(for_tot,
lag(2 5)coll) iv(humcap1 RD hhi_sales age age2 logta logta2 demand i.nace_short
i.region_code i.year) two robust ar(4)
```

```
Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =     22350
Time variable : year                            Number of groups   =     10521
Number of instruments = 53                      Obs per group: min =         1
Wald chi2(38)  =  27518.10                                     avg =      2.12
Prob > chi2    =     0.000                                     max =         7
------------------------------------------------------------------------------
             |              Corrected
     WLP_TFP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     WLP_TFP |
         L1. |    .325111   .1056186     3.08   0.002     .1181023    .5321197
             |
     hor_tot |  -1.770856   .2584203    -6.85   0.000     -2.27735   -1.264361
    back_tot |   .7582404   .1202703     6.30   0.000     .5225149    .9939659
     for_tot |   .7121091   .4298617     1.66   0.098    -.1304044    1.554623
     humcap1 |   .3474347    .024366    14.26   0.000     .2996782    .3951913
          RD |   .1032786    .011761     8.78   0.000     .0802274    .1263298
   hhi_sales |  -.3060941   .1438634    -2.13   0.033    -.5880613    -.024127
         age |  -.0183129   .0023358    -7.84   0.000    -.0228911   -.0137348
        age2 |   .0003368   .0000446     7.55   0.000     .0002493    .0004242
       logta |   .3863502   .0687798     5.62   0.000     .2515442    .5211562
      logta2 |  -.0157882   .0033531    -4.71   0.000    -.0223603   -.0092162
      demand |   -.172336   .0332565    -5.18   0.000    -.2375176   -.1071544
             |
  nace_short |
         45  |   1.380723   .4456739     3.10   0.002     .5072183    2.254228
         50  |   1.591276   .4286694     3.71   0.000     .7510991    2.431452
         51  |   1.232233   .4343764     2.84   0.005     .3808705    2.083595
         52  |   1.117508   .4187471     2.67   0.008     .2967791    1.938237
         55  |   .1320041   .3776684     0.35   0.727    -.6082123    .8722204
         60  |   .7096223   .3989855     1.78   0.075    -.0723749    1.491619
         61  |  -.1374885   .5584888    -0.25   0.806    -1.232106    .9571294
         63  |   1.121689   .4413757     2.54   0.011      .256609     1.98677
```

```
        64  |   2.258598   .4585127     4.93   0.000     1.359929    3.157266
        70  |   .8106643   .4010333     2.02   0.043     .0246535    1.596675
      4041  |   1.980914   .4812106     4.12   0.000     1.037759     2.92407
      6567  |   .6950131   .4236266     1.64   0.101    -.1352799    1.525306
      7174  |   1.059597   .4203793     2.52   0.012     .2356684    1.883525
            |
region_code |
         2  |   .0819584   .0317036     2.59   0.010     .0198206    .1440962
         3  |  -.0230882   .0243882    -0.95   0.344    -.0708882    .0247117
         4  |   -.023124   .0231623    -1.00   0.318    -.0685214    .0222733
         5  |  -.0278515   .0245346    -1.14   0.256    -.0759385    .0202355
         6  |  -.0327809    .022234    -1.47   0.140    -.0763586    .0107969
         7  |   .0100558   .0214703     0.47   0.640    -.0320252    .0521368
         8  |  -.0045052   .0227852    -0.20   0.843    -.0491633    .0401529
            |
       year |
      2004  |  -.1146604   .0272548    -4.21   0.000    -.1680788    -.061242
      2005  |   .0381737   .0333808     1.14   0.253    -.0272515    .1035989
      2006  |   .0590172   .0354323     1.67   0.096    -.0104289    .1284633
      2007  |  -.2417373   .0578237    -4.18   0.000    -.3550697    -.128405
      2008  |  -.0568972   .0523279    -1.09   0.277     -.159458    .0456635
      2009  |  -.2861224   .0837031    -3.42   0.001    -.4501775   -.1220674
            |
      _cons |    .931371   .4353895     2.14   0.032     .0780233    1.784719
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -5.45  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   0.54  Pr > z =  0.591
Arellano-Bond test for AR(3) in first differences: z =  -0.70  Pr > z =  0.484
Arellano-Bond test for AR(4) in first differences: z =   0.19  Pr > z =  0.852
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(14)    =  22.19  Prob > chi2 =  0.075
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(14)    =  20.69  Prob > chi2 =  0.110
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(10)    =  11.25  Prob > chi2 =  0.338
    Difference (null H = exogenous): chi2(4)     =   9.43  Prob > chi2 =  0.051
  gmm(L.WLP_TFP, collapse lag(4 4))
    Hansen test excluding group:     chi2(12)    =  14.94  Prob > chi2 =  0.245
    Difference (null H = exogenous): chi2(2)     =   5.75  Prob > chi2 =  0.056
  gmm(hor_tot, collapse lag(2 5))
    Hansen test excluding group:     chi2(9)     =  18.18  Prob > chi2 =  0.033
    Difference (null H = exogenous): chi2(5)     =   2.51  Prob > chi2 =  0.775
  gmm(back_tot, collapse lag(3 .))
    Hansen test excluding group:     chi2(8)     =  15.78  Prob > chi2 =  0.046
    Difference (null H = exogenous): chi2(6)     =   4.91  Prob > chi2 =  0.556
  gmm(for_tot, collapse lag(2 5))
    Hansen test excluding group:     chi2(9)     =  14.37  Prob > chi2 =  0.110
    Difference (null H = exogenous): chi2(5)     =   6.31  Prob > chi2 =  0.277
```

LONG RUN COEFFICIENTS

```
nlcom(LR_hor:_b[hor_tot]/(1-_b[l.WLP_TFP]))(LR_back:_b[back_tot]/(1-_b[l.WLP_TFP]))
(LR_for:_b[for_tot]/(1_b[l.WLP_TFP]))(LR_human_capital:_b[humcap1]/(1_b[l.WLP_TFP])
(LR_intangibles:_b[RD]/(1-_b[l.WLP_TFP]))(LR_HHI:_b[hhi_sales]/(1-_b[l.WLP_TFP]))
(LR_age:_b[age]/(1_b[l.WLP_TFP]))(LR_agesq:_b[age2]/(1_b[l.WLP_TFP]))(LR_size:_b[logta]/(
1_b[l.WLP_TFP]))(LR_sizesq:_b[logta2]/(1_b[l.WLP_TFP]))(LR_demand:_b[demand]/(1-
_b[l.WLP_TFP]))

------------------------------------------------------------------------------
     WLP_TFP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      LR_hor |  -2.623922   .6628254    -3.96   0.000    -3.923036   -1.324808
     LR_back |   1.123504   .2358862     4.76   0.000     .6611754    1.585832
      LR_for |    1.05515   .5698714     1.85   0.064    -.0617776    2.172077
```

```
LR_human_capital |   .5148027   .0473593    10.87   0.000     .4219802    .6076253
  LR_intangibles |   .1530305   .0086824    17.63   0.000     .1360132    .1700478
          LR_HHI |  -.4535473   .1840472    -2.46   0.014    -.8142732   -.0928215
          LR_age |  -.0271347   .0031465    -8.62   0.000    -.0333018   -.0209677
        LR_agesq |    .000499   .0000748     6.67   0.000     .0003523    .0006457
         LR_size |   .5724648   .0362925    15.77   0.000     .5013329    .6435967
       LR_sizesq |  -.0233938   .0028296    -8.27   0.000    -.0289398   -.0178478
       LR_demand |  -.2553546   .0465701    -5.48   0.000    -.3466302   -.1640789
--------------------------------------------------------------------------------
```

TABLE IV.10 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN SLOVENIA FOR SERVICES SECTOR, 2002-2010 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP l2.WLP_TFP hor_tot back_tot for_tot humcap1 RD
hhi_sales age age2 logta logta2 demand i.nace_short i.region_code i.year if
man==0, gmm(l.WLP_TFP, lag(1 1)) gmm(l2.WLP_TFP, lag(1 1)) gmm(hor_tot, lag(3
3)coll) gmm(back_tot, lag(2 2)coll) gmm(for_tot, lag(2 3)coll) iv(humcap1 RD
hhi_sales age age2 logta logta2 demand) iv(i.nace_short i.region_code i.year) two
robust ar(4)

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =      6016
Time variable : year                            Number of groups   =      2394
Number of instruments = 71                      Obs per group: min =         1
Wald chi2(43) =  16975.95                                      avg =      2.51
Prob > chi2   =     0.000                                      max =         7
------------------------------------------------------------------------------
             |              Corrected
     WLP_TFP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     WLP_TFP |
         L1. |   .6013771   .0335787    17.91   0.000     .5355641    .6671901
         L2. |   .1022724   .0299121     3.42   0.001     .0436458     .160899
             |
     hor_tot |  -.8333048   .3111269    -2.68   0.007    -1.443102   -.2235073
    back_tot |  -.1126106   .1443883    -0.78   0.435    -.3956064    .1703851
     for_tot |    4.98527   2.817598     1.77   0.077    -.5371193    10.50766
     humcap1 |    .295767   .0277644    10.65   0.000     .2413498    .3501843
          RD |   .0185743   .0032232     5.76   0.000      .012257    .0248916
   hhi_sales |   .0904097   .1301803     0.69   0.487    -.1647389    .3455583
         age |  -.0032778   .0019762    -1.66   0.097     -.007151    .0005954
        age2 |  -.0000375   .0000659    -0.57   0.569    -.0001666    .0000916
       logta |   .0906169   .0264871     3.42   0.001      .038703    .1425307
      logta2 |  -.0025897   .0016738    -1.55   0.122    -.0058702    .0006909
      demand |  -.0857527   .3080787    -0.28   0.781    -.6895758    .5180705
             |
  nace_short |
         45  |  -.0344639   .4341162    -0.08   0.937     -.885316    .8163881
         50  |  -.1153615    .534718    -0.22   0.829     -1.16339    .9326667
         51  |  -.1559678   .0952343    -1.64   0.101    -.3426236    .0306881
         52  |  -.1553431   .2085627    -0.74   0.456    -.5641184    .2534322
         55  |  -.2482463   .6158451    -0.40   0.687     -1.45528     .958788
         60  |  -.0923177   .3494483    -0.26   0.792    -.7772237    .5925884
         61  |  -.0115002   1.358412    -0.01   0.993     -2.67394    2.650939
         62  |  -.1752398   1.018447    -0.17   0.863    -2.171358    1.820879
         63  |    -.12828   .5919111    -0.22   0.828    -1.288404    1.031845
         64  |  -.6600363   .6526763    -1.01   0.312    -1.939258    .6191857
         70  |  -.0993368   .3477449    -0.29   0.775    -.7809044    .5822308
       4041  |   .0046821   .4626176     0.01   0.992    -.9020318     .911396
       6567  |  -.1902912   .3201852    -0.59   0.552    -.8178426    .4372602
             |
 region_code |
          2  |   .0133398   .0272706     0.49   0.625    -.0401096    .0667892
          3  |   .0240105   .0257923     0.93   0.352    -.0265415    .0745625
          4  |  -.0128287   .0308525    -0.42   0.678    -.0732984    .0476411
          5  |   .0058236   .0358894     0.16   0.871    -.0645183    .0761654
```

```
           6  |   .0253619   .0246638     1.03   0.304    -.0229782    .0737021
           7  |   .0397563   .0180257     2.21   0.027     .0044266    .0750859
           8  |   .0128587   .0196838     0.65   0.514    -.0257208    .0514382
           9  |  -.0022933   .0265221    -0.09   0.931    -.0542757    .0496891
          10  |   .0310275   .0230742     1.34   0.179     -.014197     .076252
          11  |    .019704   .0403384     0.49   0.625    -.0593579    .0987659
          12  |  -.0037796   .0603058    -0.06   0.950    -.1219768    .1144177
              |
        year  |
        2004  |   .4548752   .3402772     1.34   0.181    -.2120559    1.121806
        2005  |   .3635069   .3404271     1.07   0.286    -.3037179    1.030732
        2006  |   .4567151   .3557858     1.28   0.199    -.2406122    1.154042
        2007  |   .4047157   .3220541     1.26   0.209    -.2264988     1.03593
        2008  |   .3352668   .2701869     1.24   0.215    -.1942898    .8648234
        2009  |  -.0025891   .1432996    -0.02   0.986    -.2834512    .2782731
              |
       _cons  |   .2586498     3.2541     0.08   0.937    -6.119268    6.636568
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -8.09  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -0.60  Pr > z =  0.546
Arellano-Bond test for AR(3) in first differences: z =   1.62  Pr > z =  0.106
Arellano-Bond test for AR(4) in first differences: z =  -0.11  Pr > z =  0.913
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(27)   =  55.45  Prob > chi2 =  0.001
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(27)   =  25.34  Prob > chi2 =  0.555
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(11)   =  14.38  Prob > chi2 =  0.213
    Difference (null H = exogenous): chi2(16)   =  10.97  Prob > chi2 =  0.812
  gmm(L.WLP_TFP, lag(1 1))
    Hansen test excluding group:     chi2(14)   =  14.35  Prob > chi2 =  0.424
    Difference (null H = exogenous): chi2(13)   =  11.00  Prob > chi2 =  0.611
  gmm(L2.WLP_TFP, lag(1 1))
    Hansen test excluding group:     chi2(15)   =  19.13  Prob > chi2 =  0.208
    Difference (null H = exogenous): chi2(12)   =   6.22  Prob > chi2 =  0.905
  gmm(hor_tot, collapse lag(3 3))
    Hansen test excluding group:     chi2(25)   =  22.54  Prob > chi2 =  0.604
    Difference (null H = exogenous): chi2(2)    =   2.80  Prob > chi2 =  0.246
  gmm(back_tot, collapse lag(2 2))
    Hansen test excluding group:     chi2(25)   =  22.34  Prob > chi2 =  0.616
    Difference (null H = exogenous): chi2(2)    =   3.00  Prob > chi2 =  0.223
  gmm(for_tot, collapse lag(2 3))
    Hansen test excluding group:     chi2(24)   =  21.53  Prob > chi2 =  0.608
    Difference (null H = exogenous): chi2(3)    =   3.82  Prob > chi2 =  0.282
  iv(humcap1 RD hhi_sales age age2 logta logta2 demand)
    Hansen test excluding group:     chi2(19)   =  20.29  Prob > chi2 =  0.377
    Difference (null H = exogenous): chi2(8)    =   5.05  Prob > chi2 =  0.752
```

LONG RUN COEFFICIENTS

```
nlcom(LR_hor:_b[hor_tot]/(1-_b[l.WLP_TFP]))(LR_back:_b[back_tot]/(1-_b[l.WLP_TFP]))
(LR_for:_b[for_tot]/(1_b[l.WLP_TFP]))(LR_human_capital:_b[humcap1]/(1_b[l.WLP_TFP])
(LR_intangibles:_b[RD]/(1-_b[l.WLP_TFP]))(LR_HHI:_b[hhi_sales]/(1-_b[l.WLP_TFP]))
(LR_age:_b[age]/(1_b[l.WLP_TFP]))(LR_agesq:_b[age2]/(1_b[l.WLP_TFP]))(LR_size:_b[logta]/(
1_b[l.WLP_TFP]))(LR_sizesq:_b[logta2]/(1_b[l.WLP_TFP]))(LR_demand:_b[demand]/(1-
_b[l.WLP_TFP]))

------------------------------------------------------------------------------
         WLP_TFP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-----------------+------------------------------------------------------------
          LR_hor |  -1.974176   .7376705    -2.68   0.007    -3.419984   -.5283685
         LR_back |  -.2393546   .3399233    -0.70   0.481     -.905592    .4268829
          LR_for |   11.59739   6.700439     1.73   0.083    -1.535229    24.73001
LR_human_capital |   .7392165   .0541009    13.66   0.000     .6331806    .8452523
  LR_intangibles |   .0466021   .0069164     6.74   0.000     .0330461    .0601581
```

```
      LR_HHI |   .1942563   .3145012     0.62   0.537    -.4221547    .8106672
      LR_age |  -.0080936   .0049047    -1.65   0.099    -.0177066    .0015194
    LR_agesq |  -.0001029   .0001612    -0.64   0.523    -.0004188     .000213
     LR_size |   .2271995   .0608852     3.73   0.000     .1078668    .3465323
   LR_sizesq |  -.0063687   .0041637    -1.53   0.126    -.0145293     .001792
   LR_demand |  -.3049067   .7259413    -0.42   0.674    -1.727725    1.117912
------------------------------------------------------------------------------
```

4.4 EMPIRICAL RESULTS OF THE EFFECTS OF SERVICES AND MANUFACTURING FDI LINKAGES ON PRODUCTIVITY OF LOCAL FIRMS IN MANUFACTURING SECTOR PRESENTED IN SECTION 6.4.2

TABLE IV.11 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN THE CZECH REPUBLIC FOR MANUFACTURING SECTOR ACCORDING TO INDUSTRY SOURCE, 2002-2009 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP l2.WLP_TFP hor_tot man_link_back man_link_for
serv_link_back serv_link_for humcap1 RD hhi_sales age age2 logta logta2 demand
i.nace_short i.region_code i.year if man==1, gmm(l.WLP_TFP, lag(1 1)coll)
gmm(l2.WLP_TFP, lag(1 1)coll) gmm(hor_tot, lag(2 5)coll) gmm(man_link_back, lag(4
4)coll) gmm(man_link_for, lag(3 3)coll) gmm(serv_link_back, lag(2 2)coll)
gmm(serv_link_for, lag(4 5)coll) iv(humcap1 RD hhi_sales age age2 logta logta2
demand) iv(i.nace_short i.region_code i.year) two robust ar(4)
```

```
Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =     29263
Time variable : year                            Number of groups   =      9712
Number of instruments = 55                      Obs per group: min =         1
Wald chi2(43)  =  50229.16                                     avg =      3.01
Prob > chi2    =     0.000                                     max =         6
------------------------------------------------------------------------------
             |              Corrected
     WLP_TFP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     WLP_TFP |
         L1. |   .3846379   .0218807    17.58   0.000     .3417524    .4275234
         L2. |   .0620989   .0133581     4.65   0.000     .0359176    .0882802
             |
     hor_tot |  -.1670993   .0828592    -2.02   0.044    -.3295004   -.0046982
man_link_back |    1.73955    .599065     2.90   0.004     .5654042    2.913696
 man_link_for |  -2.572901   .4854003    -5.30   0.000    -3.524268   -1.621534
serv_link_back |   -7.57644   2.158493    -3.51   0.000    -11.80701   -3.345871
serv_link_for |   4.416947    1.49179     2.96   0.003     1.493093    7.340801
     humcap1 |   .4822277   .0140919    34.22   0.000      .454608    .5098474
          RD |   .0453483   .0025427    17.83   0.000     .0403646     .050332
   hhi_sales |  -.2315009   .0619267    -3.74   0.000     -.352875   -.1101267
         age |  -.0087719    .001519    -5.77   0.000    -.0117491   -.0057946
        age2 |   .0000768   .0000413     1.86   0.063    -4.11e-06    .0001577
       logta |   .2126285   .0182529    11.65   0.000     .1768534    .2484036
      logta2 |  -.0042681   .0009337    -4.57   0.000     -.006098   -.0024381
      demand |  -.0331898   .0239656    -1.38   0.166    -.0801614    .0137819
             |
  nace_short |
         20  |   1.025257   .1318084     7.78   0.000     .7669171    1.283597
         23  |   2.021413   .2056856     9.83   0.000     1.618276    2.424549
         24  |    1.84296   .1560536    11.81   0.000     1.537101     2.14882
         25  |   1.816765   .1603278    11.33   0.000     1.502528    2.131001
         26  |   1.555596   .1710512     9.09   0.000     1.220342     1.89085
         29  |   1.321963   .1310747    10.09   0.000     1.065061    1.578865
       1516  |   1.213025    .114428    10.60   0.000     .9887501      1.4373
       1718  |   1.365707   .1174849    11.62   0.000     1.135441    1.595974
       2122  |   .9747992   .1287999     7.57   0.000     .7223561    1.227242
       2728  |   .9891598   .1493787     6.62   0.000     .6963829    1.281937
       3033  |   1.249703   .1209557    10.33   0.000     1.012635    1.486772
       3435  |   1.500181    .140191    10.70   0.000     1.225412    1.774951
       3637  |   1.308005   .1200369    10.90   0.000     1.072738    1.543273
             |
 region_code |
```

```
          4  |  -.0603947   .0245472    -2.46   0.014    -.1085063   -.0122831
          5  |  -.0835096    .024402    -3.42   0.001    -.1313365   -.0356826
          6  |  -.0695771   .0252423    -2.76   0.006    -.1190512   -.0201031
          7  |  -.0242176   .0234653    -1.03   0.302    -.0702087    .0217736
          8  |  -.0703168   .0245071    -2.87   0.004    -.1183498   -.0222838
          9  |  -.0421014   .0241569    -1.74   0.081    -.0894481    .0052453
         10  |  -.0269572    .025277    -1.07   0.286    -.0764991    .0225847
         11  |  -.0293338   .0240207    -1.22   0.222    -.0764136    .0177459
         13  |   -.047132   .0217012    -2.17   0.030    -.0896656   -.0045984
         14  |  -.0775366   .0239243    -3.24   0.001    -.1244273   -.0306459
             |
        year |
       2004  |   .0241877   .0472107     0.51   0.608    -.0683436    .1167189
       2005  |   .1266076   .0459174     2.76   0.006     .0366111    .2166041
       2006  |   .1875472   .0538759     3.48   0.000     .0819523    .2931421
       2007  |   .1435483   .0521808     2.75   0.006     .0412757    .2458209
       2008  |   .1443496   .0179318     8.05   0.000     .1092039    .1794954
             |
       _cons |  -.7746253   .1730724    -4.48   0.000    -1.113841   -.4354097
--------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z = -15.81  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   0.58  Pr > z =  0.562
Arellano-Bond test for AR(3) in first differences: z =  -0.19  Pr > z =  0.850
Arellano-Bond test for AR(4) in first differences: z =  -0.15  Pr > z =  0.879
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(11)    =  34.89  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(11)    =  17.08  Prob > chi2 =  0.106
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(4)     =   4.13  Prob > chi2 =  0.389
    Difference (null H = exogenous): chi2(7)     =  12.95  Prob > chi2 =  0.073
  gmm(L.WLP_TFP, collapse lag(1 1))
    Hansen test excluding group:     chi2(9)     =  13.43  Prob > chi2 =  0.144
    Difference (null H = exogenous): chi2(2)     =   3.64  Prob > chi2 =  0.162
  gmm(L2.WLP_TFP, collapse lag(1 1))
    Hansen test excluding group:     chi2(9)     =  13.49  Prob > chi2 =  0.142
    Difference (null H = exogenous): chi2(2)     =   3.59  Prob > chi2 =  0.167
  gmm(hor_tot, collapse lag(2 5))
    Hansen test excluding group:     chi2(6)     =   9.97  Prob > chi2 =  0.126
    Difference (null H = exogenous): chi2(5)     =   7.11  Prob > chi2 =  0.212
  gmm(man_link_back, collapse lag(4 4))
    Hansen test excluding group:     chi2(9)     =  13.18  Prob > chi2 =  0.155
    Difference (null H = exogenous): chi2(2)     =   3.90  Prob > chi2 =  0.143
  gmm(man_link_for, collapse lag(3 3))
    Hansen test excluding group:     chi2(9)     =  14.25  Prob > chi2 =  0.114
    Difference (null H = exogenous): chi2(2)     =   2.83  Prob > chi2 =  0.243
  gmm(serv_link_back, collapse lag(2 2))
    Hansen test excluding group:     chi2(9)     =  15.44  Prob > chi2 =  0.079
    Difference (null H = exogenous): chi2(2)     =   1.63  Prob > chi2 =  0.442
  gmm(serv_link_for, collapse lag(4 5))
    Hansen test excluding group:     chi2(8)     =  14.46  Prob > chi2 =  0.071
    Difference (null H = exogenous): chi2(3)     =   2.62  Prob > chi2 =  0.454
  iv(humcap1 RD hhi_sales age age2 logta logta2 demand)
    Hansen test excluding group:     chi2(3)     =   5.86  Prob > chi2 =  0.119
    Difference (null H = exogenous): chi2(8)     =  11.22  Prob > chi2 =  0.190
```

LONG RUN EFFECTS

```
nlcom(LR_hor:_b[hor_tot]/(1-_b[l.WLP_TFP]))(LR_man_back:_b[man_link_back]/(1-
_b[l.WLP_TFP]))(LR_man_for:_b[man_link_for]/(1-_b[l.WLP_TFP]))
(LR_serv_back:_b[serv_link_back]/(1-_b[l.WLP_TFP]))     (LR_serv_for:_b[serv_link_for]/(1-
_b[l.WLP_TFP]))(LR_human_capital:_b[humcap1]/(1-_b[l.WLP_TFP]))
(LR_intangibles:_b[RD]/(1-_b[l.WLP_TFP]))LR_HHI:_b[hhi_sales]/(1
_b[l.WLP_TFP]))(LR_age:_b[age]/(1-_b[l.WLP_TFP]))(LR_agesq:_b[age2]/(1_b[l.WLP_TFP]))
(LR_size:_b[logta]/(1-_b[l.WLP_TFP]))(LR_sizesq:_b[logta2]/(1-_b[l.WLP_TFP]))
(LR_demand:_b[demand]/(1-_b[l.WLP_TFP]))
```

```
------------------------------------------------------------------------------
     WLP_TFP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      LR_hor |  -.2715464   .1350781    -2.01   0.044    -.5362945   -.0067982
 LR_man_back |   2.826872   .9937898     2.84   0.004       .87908    4.774664
  LR_man_for |  -4.181117    .809132    -5.17   0.000    -5.766987   -2.595248
LR_serv_back |  -12.31217    3.61671    -3.40   0.001    -19.40079   -5.223544
 LR_serv_for |   7.177801   2.484574     2.89   0.004     2.308127    12.04748
LR_human_capital | .7836487  .0176038  44.52   0.000     .7491459    .8181514
LR_intangibles |  .0736937   .0030944   23.82   0.000     .0676289    .0797585
      LR_HHI |  -.3762027   .1013085    -3.71   0.000    -.5747637   -.1776416
      LR_age |  -.0142548   .0023738    -6.01   0.000    -.0189073   -.0096023
    LR_agesq |   .0001248   .0000669     1.86   0.062    -6.44e-06     .000256
     LR_size |    .345534   .0235862    14.65   0.000     .2993058    .3917622
   LR_sizesq |  -.0069359   .0014755    -4.70   0.000    -.0098278   -.0040439
   LR_demand |  -.0539353   .0389647    -1.38   0.166    -.1303046     .022434
------------------------------------------------------------------------------
```

TABLE IV.12 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN ESTONIA FOR MANUFACTURING SECTOR ACCORDING TO INDUSTRY SOURCE, 2002-2010 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP hor_tot man_link_back man_link_for serv_link_back
serv_link_for humcap1 RD hhi_sales age age2 logta logta2 demand i.nace_short
i.region_code i.year if man==1, gmm(l.WLP_TFP, lag(1 1)) gmm(hor_tot, lag(2 2))
gmm(man_link_back, lag(3 5)coll) gmm(man_link_for, lag(3 5)coll)
gmm(serv_link_back, lag(2 3)coll) gmm(serv_link_for, lag(2 2)) iv(humcap1 RD
hhi_sales age age2 logta logta2 demand) iv(i.nace_short i.region_code i.year) two
robust ar(4)
```

```
Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =     11451
Time variable : year                            Number of groups   =      2870
Number of instruments = 86                      Obs per group: min =         1
Wald chi2(38) =  12711.20                                      avg =      3.99
Prob > chi2   =     0.000                                      max =         8
--------------------------------------------------------------------------------
               |              Corrected
       WLP_TFP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
---------------+----------------------------------------------------------------
       WLP_TFP |
           L1. |   .2671068   .0273702     9.76   0.000     .2134623    .3207514
               |
       hor_tot |  -.6347624   .1583157    -4.01   0.000    -.9450555   -.3244693
 man_link_back |  -.5970995   .3386729    -1.76   0.078    -1.260886    .0666871
  man_link_for |  -1.331032   .4089995    -3.25   0.001    -2.132656   -.5294076
serv_link_back |   1.285845   .6737904     1.91   0.056    -.0347603     2.60645
 serv_link_for |   3.109686   .7103007     4.38   0.000     1.717522     4.50185
       humcap1 |   .4877283    .016275    29.97   0.000     .4558299    .5196267
            RD |   .0765912   .0058506    13.09   0.000     .0651241    .0880583
     hhi_sales |   .2413764   .1364489     1.77   0.077    -.0260586    .5088114
           age |  -.0149599    .001577    -9.49   0.000    -.0180508   -.0118691
          age2 |   .0001723   .0000251     6.86   0.000     .0001231    .0002215
         logta |    .270384   .0243495    11.10   0.000       .22266    .3181081
        logta2 |  -.0072472   .0020291    -3.57   0.000    -.0112241   -.0032703
        demand |  -.0455697   .0334629    -1.36   0.173    -.1111558    .0200165
               |
    nace_short |
          20   |  -.4102839    .107854    -3.80   0.000    -.6216738   -.1988939
          23   |  -.5651945   1.695896    -0.33   0.739     -3.88909    2.758701
          24   |  -.0787823   .1222515    -0.64   0.519     -.318391    .1608263
          25   |  -.3710252   .0994556    -3.73   0.000    -.5659545   -.1760958
          26   |  -.5809854   .1101502    -5.27   0.000    -.7968759   -.3650949
          29   |  -.1977956   .1016779    -1.95   0.052    -.3970806    .0014893
        1516   |  -.0629308   .0974073    -0.65   0.518    -.2538455    .1279839
        1718   |  -.1537217   .0901471    -1.71   0.088    -.3304067    .0229633
        2122   |  -.3579954   .0987684    -3.62   0.000     -.551578   -.1644128
        2728   |  -.3067345   .1082114    -2.83   0.005    -.5188249   -.0946441
```

```
        3033  |  -.2369483   .1081191    -2.19   0.028    -.4488579   -.0250387
        3435  |  -.4389201   .1133585    -3.87   0.000    -.6610987   -.2167415
        3637  |  -.3092319   .0963035    -3.21   0.001    -.4979834   -.1204804
              |
  region_code |
           2  |  -.0532419   .0178145    -2.99   0.003    -.0881577   -.0183261
           3  |  -.0704711    .020236    -3.48   0.000     -.110133   -.0308093
           4  |  -.0723041   .0230133    -3.14   0.002    -.1174093    -.027199
           5  |  -.0607318   .0152432    -3.98   0.000    -.0906078   -.0308557
              |
         year |
        2003  |   .2045107   .0511638     4.00   0.000     .1042315    .3047899
        2004  |   .1405731   .0422368     3.33   0.001     .0577905    .2233556
        2005  |   .2103482   .0437232     4.81   0.000     .1246523    .2960442
        2006  |   .1943175   .0400909     4.85   0.000     .1157407    .2728943
        2007  |   .0841551   .0351088     2.40   0.017     .0153431    .1529671
        2008  |  -.0720072   .0280361    -2.57   0.010     -.126957   -.0170574
        2009  |  -.1670312   .0250264    -6.67   0.000    -.2160821   -.1179803
              |
        _cons |   1.071369   .1524679     7.03   0.000     .7725372      1.3702
--------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z = -14.38  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   0.27  Pr > z =  0.788
Arellano-Bond test for AR(3) in first differences: z =  -0.02  Pr > z =  0.983
Arellano-Bond test for AR(4) in first differences: z =  -0.25  Pr > z =  0.803
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(47)   = 114.84  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(47)   =  59.31  Prob > chi2 =  0.107
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(21)   =  27.87  Prob > chi2 =  0.144
    Difference (null H = exogenous): chi2(26)   =  31.43  Prob > chi2 =  0.213
  gmm(L.WLP_TFP, lag(1 1))
    Hansen test excluding group:     chi2(34)   =  40.36  Prob > chi2 =  0.210
    Difference (null H = exogenous): chi2(13)   =  18.94  Prob > chi2 =  0.125
  gmm(hor_tot, lag(2 2))
    Hansen test excluding group:     chi2(33)   =  47.23  Prob > chi2 =  0.052
    Difference (null H = exogenous): chi2(14)   =  12.08  Prob > chi2 =  0.600
  gmm(man_link_back, collapse lag(3 5))
    Hansen test excluding group:     chi2(43)   =  55.00  Prob > chi2 =  0.104
    Difference (null H = exogenous): chi2(4)    =   4.30  Prob > chi2 =  0.367
  gmm(man_link_for, collapse lag(3 5))
    Hansen test excluding group:     chi2(43)   =  54.97  Prob > chi2 =  0.104
    Difference (null H = exogenous): chi2(4)    =   4.34  Prob > chi2 =  0.362
  gmm(serv_link_back, collapse lag(2 3))
    Hansen test excluding group:     chi2(44)   =  59.15  Prob > chi2 =  0.063
    Difference (null H = exogenous): chi2(3)    =   0.16  Prob > chi2 =  0.984
  gmm(serv_link_for, lag(2 2))
    Hansen test excluding group:     chi2(32)   =  45.44  Prob > chi2 =  0.058
    Difference (null H = exogenous): chi2(15)   =  13.86  Prob > chi2 =  0.536
  iv(humcap1 RD hhi_sales age age2 logta logta2 demand)
    Hansen test excluding group:     chi2(39)   =  37.57  Prob > chi2 =  0.535
    Difference (null H = exogenous): chi2(8)    =  21.73  Prob > chi2 =  0.005
  iv(19b.nace_short 20.nace_short 23.nace_short 24.nace_short 25.nace_short
26.nace_short 29.nace_short 45.nace_short 50.nace_short 51.nace_short 52.nace_short
55.nace_short 60.nace_short 61.nace_short 62.nace_short 63.nace_short 64.nace_short
70.nace_short 1516.nace_short 1718.nace_short 2122.nace_short 2728.nace_short
3033.nace_short 3435.nace_short 3637.nace_short 4041.nace_short 6567.nace_short
7174.nace_short 1b.region_code 2.region_code 3.region_code 4.region_code
5.region_code 2002b.year 2003.year 2004.year 2005.year 2006.year 2007.year 2008.year
2009.year 2010.year)
    Hansen test excluding group:     chi2(22)   =  32.55  Prob > chi2 =  0.068
    Difference (null H = exogenous): chi2(25)   =  26.75  Prob > chi2 =  0.368
```

LONG RUN EFFECTS

```
nlcom(LR_hor:_b[hor_tot]/(1-_b[l.WLP_TFP]))(LR_man_back:_b[man_link_back]/(1-
_b[l.WLP_TFP]))(LR_man_for:_b[man_link_for]/(1-_b[l.WLP_TFP]))
(LR_serv_back:_b[serv_link_back]/(1-_b[l.WLP_TFP]))     (LR_serv_for:_b[serv_link_for]/(1-
_b[l.WLP_TFP]))(LR_human_capital:_b[humcap1]/(1-_b[l.WLP_TFP]))
(LR_intangibles:_b[RD]/(1-_b[l.WLP_TFP]))(LR_HHI:_b[hhi_sales]/(1-
_b[l.WLP_TFP]))(LR_age:_b[age]/(1-_b[l.WLP_TFP]))(LR_agesq:_b[age2]/(1     _b[l.WLP_TFP]))
(LR_size:_b[logta]/(1-_b[l.WLP_TFP]))(LR_sizesq:_b[logta2]/(1-_b[l.WLP_TFP]))
(LR_demand:_b[demand]/(1-_b[l.WLP_TFP]))
```

WLP_TFP	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
LR_hor	-.866105	.2169488	-3.99	0.000	-1.291317	-.4408931
LR_man_back	-.8147156	.4583389	-1.78	0.075	-1.713043	.0836121
LR_man_for	-1.816134	.5647152	-3.22	0.001	-2.922955	-.709312
LR_serv_back	1.754478	.9283338	1.89	0.059	-.0650232	3.573978
LR_serv_for	4.243028	.9960953	4.26	0.000	2.290717	6.195339
LR_human_capital	.6654835	.0208036	31.99	0.000	.6247092	.7062578
LR_intangibles	.1045053	.0070701	14.78	0.000	.0906482	.1183624
LR_HHI	.3293473	.1866027	1.76	0.078	-.0363873	.6950819
LR_age	-.0204122	.0021808	-9.36	0.000	-.0246864	-.0161379
LR_agesq	.0002351	.0000348	6.75	0.000	.0001668	.0003033
LR_size	.3689269	.0296007	12.46	0.000	.3109106	.4269433
LR_sizesq	-.0098885	.0027437	-3.60	0.000	-.0152661	-.0045109
LR_demand	-.0621778	.0461044	-1.35	0.177	-.1525408	.0281853

TABLE IV.13 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN HUNGARY FOR MANUFACTURING SECTOR ACCORDING TO INDUSTRY SOURCE, 2002-2010 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP hor_tot man_link_back man_link_for serv_link_back
serv_link_for humcap1 RD hhi_sales age age2 logta logta2 demand i.nace_short
i.region_code i.year if man==1, gmm(l.WLP_TFP, lag(1 4)) gmm(hor_tot, lag(2
2)coll) gmm(man_link_back, lag(2 2)coll) gmm(man_link_for, lag(2 2)coll)
gmm(serv_link_back, lag(2 5)coll) gmm(serv_link_for, lag(2 5)) iv(humcap1 RD
hhi_sales age age2 logta logta2 demand) iv(i.nace_short i.region_code i.year) two
robust ar(4)
```

```
Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =      2499
Time variable : year                            Number of groups   =      1278
Number of instruments = 107                     Obs per group: min =         1
Wald chi2(53)  =  24118.32                                     avg =      1.96
Prob > chi2    =     0.000                                     max =         7
```

WLP_TFP	Coef.	Corrected Std. Err.	z	P>|z|	[95% Conf.	Interval]
WLP_TFP						
L1.	.6004511	.1136943	5.28	0.000	.3776145	.8232878
hor_tot	-.7012282	.342772	-2.05	0.041	-1.373049	-.0294075
man_link_back	2.764828	1.355095	2.04	0.041	.1088899	5.420766
man_link_for	-3.081534	1.373139	-2.24	0.025	-5.772838	-.3902309
serv_link_back	-20.66204	6.324234	-3.27	0.001	-33.05731	-8.266766
serv_link_for	6.912752	4.14672	1.67	0.096	-1.21467	15.04017
humcap1	.2950236	.0609052	4.84	0.000	.1756516	.4143956
RD	.0077406	.0041003	1.89	0.059	-.0002959	.0157771
hhi_sales	-.1420545	.1162953	-1.22	0.222	-.3699892	.0858801
age	-.004914	.0042258	-1.16	0.245	-.0131963	.0033684
age2	-.0000837	.0001389	-0.60	0.547	-.0003559	.0001886
logta	.0799771	.0485061	1.65	0.099	-.0150932	.1750474
logta2	.0004362	.0029702	0.15	0.883	-.0053852	.0062577
demand	.0655378	.0470871	1.39	0.164	-.0267513	.1578269
nace_short						
20	-.15101	.2214968	-0.68	0.495	-.5851357	.2831157
23	1.65124	.4879397	3.38	0.001	.6948953	2.607584

```
          24  |   .2827353     .26769     1.06   0.291    -.2419274    .8073981
          25  |  -.1322473   .2134351    -0.62   0.536    -.5505724    .2860777
          26  |  -.1441225   .2051445    -0.70   0.482    -.5461984    .2579534
          29  |   .2503679   .2762906     0.91   0.365    -.2911517    .7918874
        1516  |   .0680478   .2436611     0.28   0.780    -.4095191    .5456148
        1718  |  -.4841685   .1825574    -2.65   0.008    -.8419745   -.1263625
        2122  |  -.1833159    .240854    -0.76   0.447    -.6553811    .2887493
        2728  |  -.5639588   .2399405    -2.35   0.019    -1.034233   -.0936841
        3033  |  -.2585052   .2461601    -1.05   0.294    -.7409702    .2239598
        3435  |  -.6538227   .2824443    -2.31   0.021    -1.207403   -.1002421
        3637  |   .0265696   .1827552     0.15   0.884    -.3316239    .3847632
              |
  region_code |
           2  |   .0154358   .0472086     0.33   0.744    -.0770913     .107963
           3  |  -.0639111   .0450209    -1.42   0.156    -.1521505    .0243283
           4  |  -.0548757   .0503335    -1.09   0.276    -.1535277    .0437762
           5  |   .0060461   .0281788     0.21   0.830    -.0491834    .0612756
           6  |   .0270338   .0500088     0.54   0.589    -.0709818    .1250493
           7  |  -.0537229   .0372589    -1.44   0.149    -.1267489    .0193031
           8  |  -.0292578   .0341895    -0.86   0.392    -.0962681    .0377524
           9  |  -.0134415   .0387508    -0.35   0.729    -.0893917    .0625087
          10  |   .0189047   .0515294     0.37   0.714    -.0820912    .1199005
          11  |  -.0260782   .0458754    -0.57   0.570    -.1159923     .063836
          12  |   .0271702   .0423896     0.64   0.522    -.0559119    .1102523
          13  |  -.0484336   .0598391    -0.81   0.418    -.1657161    .0688489
          14  |  -.0108443   .0327385    -0.33   0.740    -.0750106    .0533219
          15  |  -.0051451   .0497206    -0.10   0.918    -.1025956    .0923055
          16  |  -.0188697   .0544027    -0.35   0.729    -.1254971    .0877577
          17  |  -.0168478   .0647549    -0.26   0.795     -.143765    .1100694
          18  |  -.0453781   .0624058    -0.73   0.467    -.1676913    .0769351
          19  |  -.0092264   .0491331    -0.19   0.851    -.1055255    .0870727
          20  |  -.0447472   .0515516    -0.87   0.385    -.1457865     .056292
              |
         year |
        2004  |  -.2782549    .288997    -0.96   0.336    -.8446786    .2881688
        2005  |  -.3612938   .2954865    -1.22   0.221    -.9404367    .2178491
        2006  |    -.32197   .2999488    -1.07   0.283    -.9098589     .265919
        2007  |  -.3435352   .3019839    -1.14   0.255    -.9354129    .2483424
        2008  |  -.3618675   .3095764    -1.17   0.242    -.9686262    .2448911
        2009  |   -.493285    .305643    -1.61   0.107    -1.092334    .1057643
        2010  |  -.3243021   .2910432    -1.11   0.265    -.8947362     .246132
              |
        _cons |   .7985405   .5496932     1.45   0.146    -.2788383    1.875919
------------------------------------------------------------------------------
------------------------------------------------------------------------------
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 =   0.57  Pr > z =  0.569
Arellano-Bond test for AR(3) in first differences: z =  -0.75  Pr > z =  0.455
Arellano-Bond test for AR(4) in first differences: z =  -0.75  Pr > z =  0.456
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(53)    =  58.15  Prob > chi2 =  0.292
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(53)    =  47.64  Prob > chi2 =  0.682
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(36)    =  30.73  Prob > chi2 =  0.717
    Difference (null H = exogenous): chi2(17)    =  16.92  Prob > chi2 =  0.460
  gmm(L.WLP_TFP, lag(1 4))
    Hansen test excluding group:     chi2(27)    =  30.17  Prob > chi2 =  0.306
    Difference (null H = exogenous): chi2(26)    =  17.47  Prob > chi2 =  0.894
  gmm(hor_tot, collapse lag(2 2))
    Hansen test excluding group:     chi2(52)    =  45.96  Prob > chi2 =  0.709
    Difference (null H = exogenous): chi2(1)     =   1.68  Prob > chi2 =  0.195
  gmm(man_link_back, collapse lag(2 2))
    Hansen test excluding group:     chi2(51)    =  46.97  Prob > chi2 =  0.634
    Difference (null H = exogenous): chi2(2)     =   0.67  Prob > chi2 =  0.715
  gmm(man_link_for, collapse lag(2 2))
    Hansen test excluding group:     chi2(51)    =  46.91  Prob > chi2 =  0.637
    Difference (null H = exogenous): chi2(2)     =   0.73  Prob > chi2 =  0.694
  gmm(serv_link_back, collapse lag(2 5))
```

```
    Hansen test excluding group:     chi2(48)    =  45.81  Prob > chi2 =  0.563
    Difference (null H = exogenous): chi2(5)     =   1.83  Prob > chi2 =  0.872
  gmm(serv_link_for, lag(2 5))
    Hansen test excluding group:     chi2(30)    =  24.65  Prob > chi2 =  0.742
    Difference (null H = exogenous): chi2(23)    =  22.99  Prob > chi2 =  0.461
  iv(humcap1 RD hhi_sales age age2 logta logta2 demand)
    Hansen test excluding group:     chi2(45)    =  33.18  Prob > chi2 =  0.904
    Difference (null H = exogenous): chi2(8)     =  14.46  Prob > chi2 =  0.071
  iv(19b.nace_short   20.nace_short   23.nace_short   24.nace_short   25.nace_short
26.nace_short 29.nace_short 45.nace_short 50.nace_short 51.nace_short 52.nace_short
55.nace_short 60.nace_short 61.nace_short 62.nace_short 63.nace_short 64.nace_short
70.nace_short   1516.nace_short   1718.nace_short   2122.nace_short   2728.nace_short
3033.nace_short   3435.nace_short   3637.nace_short   4041.nace_short   6567.nace_short
7174.nace_short     1b.region_code     2.region_code     3.region_code     4.region_code
5.region_code 6.region_code 7.region_code 8.region_code 9.region_code 10.region_code
11.region_code    12.region_code    13.region_code    14.region_code    15.region_code
16.region_code 17.region_code 18.region_code 19.region_code 20.region_code 2002b.year
2003.year 2004.year 2005.year 2006.year 2007.year 2008.year 2009.year 2010.year)
    Hansen test excluding group:     chi2(13)    =  11.62  Prob > chi2 =  0.559
    Difference (null H = exogenous): chi2(40)    =  36.02  Prob > chi2 =  0.650
```

LONG RUN EFFECTS

```
nlcom(LR_hor:_b[hor_tot]/(1-_b[l.WLP_TFP]))(LR_man_back:_b[man_link_back]/(1-
_b[l.WLP_TFP]))(LR_man_for:_b[man_link_for]/(1-_b[l.WLP_TFP]))
(LR_serv_back:_b[serv_link_back]/(1-_b[l.WLP_TFP]))     (LR_serv_for:_b[serv_link_for]/(1-
_b[l.WLP_TFP]))(LR_human_capital:_b[humcap1]/(1-_b[l.WLP_TFP]))
(LR_intangibles:_b[RD]/(1-_b[l.WLP_TFP]))(LR_HHI:_b[hhi_sales]/(1-
_b[l.WLP_TFP]))(LR_age:_b[age]/(1-_b[l.WLP_TFP]))(LR_agesq:_b[age2]/(1     _b[l.WLP_TFP]))
(LR_size:_b[logta]/(1-_b[l.WLP_TFP]))(LR_sizesq:_b[logta2]/(1-_b[l.WLP_TFP]))
(LR_demand:_b[demand]/(1-_b[l.WLP_TFP]))
```

WLP_TFP	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
LR_hor	-1.75505	.9993716	-1.76	0.079	-3.713782	.2036825
LR_man_back	6.919875	4.042248	1.71	0.087	-1.002785	14.84253
LR_man_for	-7.712534	4.258412	-1.81	0.070	-16.05887	.6337997
LR_serv_back	-51.71342	18.63043	-2.78	0.006	-88.22839	-15.19844
LR_serv_for	17.30139	10.12352	1.71	0.087	-2.540338	37.14312
LR_human_capital	.7383917	.0890054	8.30	0.000	.5639444	.912839
LR_intangibles	.0193734	.0091037	2.13	0.033	.0015305	.0372164
LR_HHI	-.3555373	.2634132	-1.35	0.177	-.8718176	.160743
LR_age	-.0122988	.0093486	-1.32	0.188	-.0306217	.0060241
LR_agesq	-.0002094	.0003651	-0.57	0.566	-.0009251	.0005062
LR_size	.2001685	.1312992	1.52	0.127	-.0571733	.4575102
LR_sizesq	.0010918	.0073087	0.15	0.881	-.0132331	.0154167
LR_demand	.1640295	.1128866	1.45	0.146	-.0572242	.3852832

TABLE IV.14 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN SLOVAKIA FOR MANUFACTURING SECTOR ACCORDING TO INDUSTRY SOURCE, 2002-2009 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP hor_tot man_link_back man_link_for serv_link_back
serv_link_for humcap1 RD hhi_sales age age2 logta logta2 demand i.nace_short
i.region_code i.year if man==1, gmm(l.WLP_TFP, lag(1 1)) gmm(hor_tot, lag(3
5)coll) gmm(man_link_back, lag(3 3)coll) gmm(man_link_for, lag(2 2)coll)
gmm(serv_link_back, lag(4 5)coll) gmm(serv_link_for, lag(3 3)coll) iv(humcap1 RD
hhi_sales age age2 logta logta2 demand) iv( i.nace_short i.region_code i.year)
two robust ar(4)
```

```
Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =      8140
Time variable : year                            Number of groups   =      3074
Number of instruments = 60                      Obs per group: min =         1
```

```
Wald chi2(40) =   9889.98                                     avg =      2.65
Prob > chi2   =     0.000                                     max =         7
--------------------------------------------------------------------------------
               |              Corrected
       WLP_TFP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
---------------+----------------------------------------------------------------
       WLP_TFP |
           L1. |   .3846809   .0432201     8.90   0.000      .299971    .4693908
               |
       hor_tot |  -.3825155   .1984508    -1.93   0.054    -.7714719     .006441
 man_link_back |   1.815416   1.100319     1.65   0.099    -.3411692       3.972
  man_link_for |  -.2566443   .4952639    -0.52   0.604    -1.227344    .7140551
serv_link_back |     5.3311   2.801113     1.90   0.057    -.1589812    10.82118
 serv_link_for |   6.150009   1.751681     3.51   0.000     2.716777     9.58324
      humcap1 |   .3317319   .0144672    22.93   0.000     .3033766    .3600871
            RD |   .0597222   .0052113    11.46   0.000     .0495082    .0699362
     hhi_sales |  -.1594395   .1062015    -1.50   0.133    -.3675907    .0487117
           age |  -.0093001   .0025965    -3.58   0.000    -.0143891   -.0042111
          age2 |   .0000916   .0000483     1.90   0.058    -2.98e-06    .0001863
         logta |   .1457716   .0320562     4.55   0.000     .0829426    .2086005
        logta2 |  -.0026921   .0020256    -1.33   0.184    -.0066623    .0012781
        demand |  -.0203586   .0161039    -1.26   0.206    -.0519217    .0112046
               |
    nace_short |
           20  |  -.0894081   .1478983    -0.60   0.545    -.3792835    .2004673
           23  |    1.04788   .2025965     5.17   0.000      .650798    1.444962
           24  |   .8704738   .1294081     6.73   0.000     .6168385    1.124109
           25  |  -.0892498    .105258    -0.85   0.396    -.2955516     .117052
           26  |  -.9029285   .1201293    -7.52   0.000    -1.138378   -.6674794
           29  |   .0096495   .0934676     0.10   0.918    -.1735435    .1928426
         1516  |  -.1240662    .133921    -0.93   0.354    -.3865465     .138414
         1718  |  -.0959543   .0891851    -1.08   0.282    -.2707539    .0788452
         2122  |  -.1775133   .1246049    -1.42   0.154    -.4217344    .0667078
         2728  |  -.6077228   .2124156    -2.86   0.004     -1.02405   -.1913959
         3033  |   .3585049   .0942968     3.80   0.000     .1736867    .5433231
         3435  |   .7869858   .1564073     5.03   0.000     .4804331    1.093538
         3637  |  -.4335699   .1174009    -3.69   0.000    -.6636715   -.2034683
               |
   region_code |
            2  |   .0920868   .0377191     2.44   0.015     .0181587    .1660149
            3  |  -.0177059   .0357651    -0.50   0.621    -.0878041    .0523923
            4  |   .0296187   .0297522     1.00   0.319    -.0286945    .0879318
            5  |   .0272623    .032481     0.84   0.401    -.0363992    .0909239
            6  |  -.0052346   .0274741    -0.19   0.849    -.0590828    .0486136
            7  |   .0233605   .0285068     0.82   0.413    -.0325118    .0792328
            8  |  -.0025515   .0295808    -0.09   0.931    -.0605288    .0554258
               |
          year |
         2003  |   .4399959   .1316755     3.34   0.001     .1819167    .6980751
         2004  |   .4095664    .111389     3.68   0.000     .1912479    .6278849
         2005  |   .2720633   .0959636     2.84   0.005     .0839781    .4601485
         2006  |   .4450775   .1227256     3.63   0.000     .2045397    .6856153
         2007  |   .3792597   .0746986     5.08   0.000     .2328532    .5256662
         2008  |   .3648488   .0657229     5.55   0.000     .2360344    .4936633
               |
         _cons |   .5748605   .2134887     2.69   0.007     .1564303    .9932906
--------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z = -10.72  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -0.36  Pr > z =  0.722
Arellano-Bond test for AR(3) in first differences: z =   1.82  Pr > z =  0.069
Arellano-Bond test for AR(4) in first differences: z =  -0.10  Pr > z =  0.924
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(19)    =  28.68  Prob > chi2 =  0.071
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(19)    =  14.48  Prob > chi2 =  0.755
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(8)     =   8.94  Prob > chi2 =  0.348
    Difference (null H = exogenous): chi2(11)    =   5.54  Prob > chi2 =  0.902
```

```
  gmm(L.WLP_TFP, lag(1 1))
    Hansen test excluding group:     chi2(7)     =   7.60  Prob > chi2 =  0.369
    Difference (null H = exogenous): chi2(12)    =   6.88  Prob > chi2 =  0.865
  gmm(hor_tot, collapse lag(3 5))
    Hansen test excluding group:     chi2(15)    =  10.87  Prob > chi2 =  0.762
    Difference (null H = exogenous): chi2(4)     =   3.61  Prob > chi2 =  0.461
  gmm(man_link_back, collapse lag(3 3))
    Hansen test excluding group:     chi2(17)    =  13.23  Prob > chi2 =  0.721
    Difference (null H = exogenous): chi2(2)     =   1.26  Prob > chi2 =  0.533
  gmm(man_link_for, collapse lag(2 2))
    Hansen test excluding group:     chi2(17)    =  12.03  Prob > chi2 =  0.798
    Difference (null H = exogenous): chi2(2)     =   2.45  Prob > chi2 =  0.294
  gmm(serv_link_back, collapse lag(4 5))
    Hansen test excluding group:     chi2(16)    =  11.72  Prob > chi2 =  0.763
    Difference (null H = exogenous): chi2(3)     =   2.76  Prob > chi2 =  0.430
  gmm(serv_link_for, collapse lag(3 3))
    Hansen test excluding group:     chi2(17)    =  13.02  Prob > chi2 =  0.735
    Difference (null H = exogenous): chi2(2)     =   1.46  Prob > chi2 =  0.482
  iv(humcap1 RD hhi_sales age age2 logta logta2 demand)
    Hansen test excluding group:     chi2(11)    =   9.18  Prob > chi2 =  0.606
    Difference (null H = exogenous): chi2(8)     =   5.31  Prob > chi2 =  0.724
```

LONG RUN EFFECTS

```
nlcom(LR_hor:_b[hor_tot]/(1-_b[l.WLP_TFP]))(LR_man_back:_b[man_link_back]/(1-
_b[l.WLP_TFP]))(LR_man_for:_b[man_link_for]/(1-_b[l.WLP_TFP]))
(LR_serv_back:_b[serv_link_back]/(1-_b[l.WLP_TFP]))    (LR_serv_for:_b[serv_link_for]/(1-
_b[l.WLP_TFP]))(LR_human_capital:_b[humcap1]/(1-_b[l.WLP_TFP]))(LR_intangibles:_b[RD]/(1-
_b[l.WLP_TFP]))(LR_HHI:_b[hhi_sales]/(1-_b[l.WLP_TFP]))(LR_age:_b[age]/(1-
_b[l.WLP_TFP]))(LR_agesq:_b[age2]/(1-_b[l.WLP_TFP]))(LR_size:_b[logta]/(1-
_b[l.WLP_TFP]))(LR_sizesq:_b[logta2]/(1-_b[l.WLP_TFP]))(LR_demand:_b[demand]/(1-
_b[l.WLP_TFP]))
```

WLP_TFP	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
LR_hor	-.6216538	.3280177	-1.90	0.058	-1.264557	.0212491
LR_man_back	2.950364	1.82127	1.62	0.105	-.6192586	6.519987
LR_man_for	-.4170913	.811213	-0.51	0.607	-2.00704	1.172857
LR_serv_back	8.66396	4.499136	1.93	0.054	-.1541852	17.4821
LR_serv_for	9.994828	2.932414	3.41	0.001	4.247403	15.74225
LR_human_capital	.5391217	.0290838	18.54	0.000	.4821184	.5961249
LR_intangibles	.0970589	.0072254	13.43	0.000	.0828973	.1112205
LR_HHI	-.2591167	.1706649	-1.52	0.129	-.5936138	.0753804
LR_age	-.0151143	.004222	-3.58	0.000	-.0233893	-.0068393
LR_agesq	.0001489	.0000794	1.88	0.061	-6.72e-06	.0003046
LR_size	.236904	.0482573	4.91	0.000	.1423214	.3314866
LR_sizesq	-.0043751	.0032622	-1.34	0.180	-.0107689	.0020186
LR_demand	-.0330862	.0262245	-1.26	0.207	-.0844852	.0183128

TABLE IV.15 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN SLOVENIA FOR MANUFACTURING SECTOR ACCORDING TO INDUSTRY SOURCE, 2002-2010 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP hor_tot man_link_back man_link_for serv_link_back
serv_link_for humcap1 RD hhi_sales age age2 logta logta2 demand i.nace_short
i.region_code i.year if man==1, gmm(l.WLP_TFP, lag(1 1)) gmm(hor_tot, lag(3
5)coll) gmm(man_link_back, lag(2 5)coll) gmm(man_link_for,lag(3 3)coll)
gmm(serv_link_back, lag(2 2)coll) gmm(serv_link_for, lag(2 2)) iv(humcap1 RD
hhi_sales age age2 logta logta2 demand) iv(i.nace_short i.region_code i.year) two
robust ar(4)
```

```
Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =      3584
Time variable : year                            Number of groups   =      1136
```

```
Number of instruments = 81                    Obs per group: min =          1
Wald chi2(45)  =    4738.71                                  avg =       3.15
Prob > chi2    =      0.000                                  max =          8
------------------------------------------------------------------------------
             |              Corrected
     WLP_TFP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     WLP_TFP |
         L1. |   .4312347   .0571397     7.55   0.000      .319243    .5432264
             |
     hor_tot |   .2058365    .355617     0.58   0.563    -.4911601     .902833
man_link_back |   1.841391   .9333412     1.97   0.049     .0120763    3.670707
man_link_for |  -.3326346   1.430031    -0.23   0.816    -3.135443    2.470174
serv_link_back |  -9.718623   4.697618    -2.07   0.039    -18.92579   -.5114603
serv_link_for |   13.59875   5.204723     2.61   0.009     3.397679    23.79982
    humcap1 |   .5260964   .0450079    11.69   0.000     .4378826    .6143103
          RD |   .0288811    .005519     5.23   0.000      .018064    .0396982
   hhi_sales |  -.1889508   .1324064    -1.43   0.154    -.4484625    .0705609
         age |  -.0103037   .0024727    -4.17   0.000      -.01515   -.0054574
        age2 |   .0000629   .0000601     1.05   0.295    -.0000548    .0001807
       logta |  -.0264658   .0589938    -0.45   0.654    -.1420916      .08916
      logta2 |   .0105402   .0047363     2.23   0.026     .0012571    .0198232
      demand |   .0293393   .1002046     0.29   0.770     -.167058    .2257367
             |
  nace_short |
         20  |  -.3265792   .1808931    -1.81   0.071    -.6811233    .0279648
         23  |   .4484003   1.042669     0.43   0.667    -1.595192    2.491993
         24  |     .56129   .2433595     2.31   0.021     .0843142    1.038266
         25  |  -.5620158   .2291894    -2.45   0.014    -1.011219   -.1128128
         26  |  -.0063058   .2050838    -0.03   0.975    -.4082626    .3956509
         29  |  -.5443099   .1480004    -3.68   0.000    -.8343853   -.2542344
       1516  |  -.2379968   .2070516    -1.15   0.250    -.6438104    .1678168
       1718  |   .1231618   .1903703     0.65   0.518    -.2499571    .4962808
       2122  |  -.7544544   .2077133    -3.63   0.000    -1.161565   -.3473439
       2728  |  -.8796663   .2894022    -3.04   0.002    -1.446884   -.3124484
       3033  |  -.2978654   .1919752    -1.55   0.121    -.6741299    .0783991
       3435  |  -1.078376   .2555874    -4.22   0.000    -1.579318    -.577434
       3637  |  -.0112375   .1754357    -0.06   0.949    -.3550852    .3326102
             |
 region_code |
          2  |    -.03735   .0449245    -0.83   0.406    -.1254004    .0507003
          3  |   .0510812   .0429555     1.19   0.234    -.0331101    .1352724
          4  |   .0043464   .0457118     0.10   0.924    -.0852471    .0939399
          5  |  -.0003743   .0499037    -0.01   0.994    -.0981838    .0974351
          6  |   .0432373   .0531841     0.81   0.416    -.0610016    .1474762
          7  |   .0341254   .0319403     1.07   0.285    -.0284766    .0967273
          8  |   .0086012   .0382425     0.22   0.822    -.0663527    .0835551
          9  |   .0055493   .0510811     0.11   0.913    -.0945678    .1056664
         10  |   .0215676   .0404825     0.53   0.594    -.0577766    .1009118
         11  |   .0705909   .0511029     1.38   0.167     -.029569    .1707508
         12  |  -.0276763   .0734336    -0.38   0.706    -.1716036     .116251
             |
        year |
       2003  |   .2927939   .1641043     1.78   0.074    -.0288446    .6144324
       2004  |   .2586395    .124197     2.08   0.037     .0152178    .5020611
       2005  |    .219554   .1118121     1.96   0.050     .0004064    .4387017
       2006  |   .2595771   .1124658     2.31   0.021     .0391483     .480006
       2007  |     .18306   .1053143     1.74   0.082    -.0233523    .3894722
       2008  |   .1458267   .1007876     1.45   0.148    -.0517133    .3433667
       2009  |  -.2852688   .0692061    -4.12   0.000    -.4209102   -.1496274
             |
       _cons |   .7260992   .6326576     1.15   0.251    -.5138869    1.966085
------------------------------------------------------------------------------
----------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -8.12  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   0.95  Pr > z =  0.343
Arellano-Bond test for AR(3) in first differences: z =  -1.06  Pr > z =  0.289
Arellano-Bond test for AR(4) in first differences: z =   0.85  Pr > z =  0.394
----------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(35)    =  83.80  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(35)    =  37.55  Prob > chi2 =  0.353
```

```
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(17)    =  23.87  Prob > chi2 =  0.123
    Difference (null H = exogenous): chi2(18)    =  13.67  Prob > chi2 =  0.750
  gmm(L.WLP_TFP, lag(1 1))
    Hansen test excluding group:     chi2(21)    =  23.80  Prob > chi2 =  0.303
    Difference (null H = exogenous): chi2(14)    =  13.75  Prob > chi2 =  0.469
  gmm(hor_tot, collapse lag(3 5))
    Hansen test excluding group:     chi2(32)    =  31.89  Prob > chi2 =  0.472
    Difference (null H = exogenous): chi2(3)     =   5.66  Prob > chi2 =  0.130
  gmm(man_link_back, collapse lag(2 5))
    Hansen test excluding group:     chi2(30)    =  31.19  Prob > chi2 =  0.406
    Difference (null H = exogenous): chi2(5)     =   6.36  Prob > chi2 =  0.273
  gmm(man_link_for, collapse lag(3 3))
    Hansen test excluding group:     chi2(33)    =  37.06  Prob > chi2 =  0.287
    Difference (null H = exogenous): chi2(2)     =   0.49  Prob > chi2 =  0.783
  gmm(serv_link_back, collapse lag(2 2))
    Hansen test excluding group:     chi2(33)    =  36.67  Prob > chi2 =  0.302
    Difference (null H = exogenous): chi2(2)     =   0.87  Prob > chi2 =  0.646
  gmm(serv_link_for, lag(2 2))
    Hansen test excluding group:     chi2(20)    =  29.12  Prob > chi2 =  0.085
    Difference (null H = exogenous): chi2(15)    =   8.43  Prob > chi2 =  0.906
  iv(humcap1 RD hhi_sales age age2 logta logta2 demand)
    Hansen test excluding group:     chi2(27)    =  32.36  Prob > chi2 =  0.219
    Difference (null H = exogenous): chi2(8)     =   5.19  Prob > chi2 =  0.737
  iv(19b.nace_short 20.nace_short 23.nace_short 24.nace_short 25.nace_short
26.nace_short 29.nace_short 45.nace_short 50.nace_short 51.nace_short 52.nace_short
55.nace_short 60.nace_short 61.nace_short 62.nace_short 63.nace_short 64.nace_short
70.nace_short 1516.nace_short 1718.nace_short 2122.nace_short 2728.nace_short
3033.nace_short 3435.nace_short 3637.nace_short 4041.nace_short 6567.nace_short
7174.nace_short 1b.region_code 2.region_code 3.region_code 4.region_code
5.region_code 6.region_code 7.region_code 8.region_code 9.region_code 10.region_code
11.region_code 12.region_code 2002b.year 2003.year 2004.year 2
> 005.year 2006.year 2007.year 2008.year 2009.year 2010.year)
    Hansen test excluding group:     chi2(4)     =  16.14  Prob > chi2 =  0.003
    Difference (null H = exogenous): chi2(31)    =  21.41  Prob > chi2 =  0.901
```

LONG RUN EFFECTS

```
nlcom(LR_hor:_b[hor_tot]/(1-_b[l.WLP_TFP]))(LR_man_back:_b[man_link_back]/(1-
_b[l.WLP_TFP]))(LR_man_for:_b[man_link_for]/(1-_b[l.WLP_TFP]))
(LR_serv_back:_b[serv_link_back]/(1-_b[l.WLP_TFP]))     (LR_serv_for:_b[serv_link_for]/(1-
_b[l.WLP_TFP]))                          (LR_human_capital:_b[humcap1]/(1-_b[l.WLP_TFP]))
(LR_intangibles:_b[RD]/(1-_b[l.WLP_TFP]))                         (LR_HHI:_b[hhi_sales]/(1-
_b[l.WLP_TFP]))(LR_age:_b[age]/(1-_b[l.WLP_TFP]))(LR_agesq:_b[age2]/(1     _b[l.WLP_TFP]))
(LR_size:_b[logta]/(1-_b[l.WLP_TFP]))             (LR_sizesq:_b[logta2]/(1-_b[l.WLP_TFP]))
(LR_demand:_b[demand]/(1-_b[l.WLP_TFP]))
```

WLP_TFP	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
LR_hor	.3619006	.6295545	0.57	0.565	-.8720036	1.595805
LR_man_back	3.237524	1.66667	1.94	0.052	-.0290895	6.504138
LR_man_for	-.5848363	2.521749	-0.23	0.817	-5.527373	4.357701
LR_serv_back	-17.08723	8.304868	-2.06	0.040	-33.36447	-.8099892
LR_serv_for	23.90925	8.985304	2.66	0.008	6.298374	41.52012
LR_human_capital	.9249799	.06595	14.03	0.000	.7957203	1.054239
LR_intangibles	.0507786	.008617	5.89	0.000	.0338897	.0676676
LR_HHI	-.3322122	.2350177	-1.41	0.157	-.7928384	.1284139
LR_age	-.0181159	.0047512	-3.81	0.000	-.0274282	-.0088037
LR_agesq	.0001106	.0001087	1.02	0.309	-.0001024	.0003236
LR_size	-.0465321	.1039083	-0.45	0.654	-.2501886	.1571244
LR_sizesq	.0185317	.0081894	2.26	0.024	.0024808	.0345826
LR_demand	.0515842	.1779965	0.29	0.772	-.2972824	.4004509

4.5 EMPIRICAL RESULTS OF THE MODERATING EFFECTS OF INTANGIBLE ASSETS ON PRODUCTIVITY SPILLOVERS FROM FDI IN MANUFACTURING SECTOR PRESENTED IN SECTION 6.4.3

TABLE IV.16 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN THE CZECH REPUBLIC FOR MANUFACTURING SECTOR – ABSORPTIVE CAPACITY MODEL, 2002-2009 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP l2.WLP_TFP c.hor_tot##c.RD c.man_link_back##c.RD
c.man_link_for##c.RD c.serv_link_back##c.RD c.serv_link_for##c.RD humcap1
hhi_sales age age2 logta logta2 demand i.nace_short i.region_code i.year if
man==1, gmm(l.WLP_TFP, lag(1 1)coll) gmm(l2.WLP_TFP, lag(1 1)coll) gmm(hor_tot
hormanRD , lag(2 4)coll) gmm(man_link_back backmanRD, lag(3 5)coll)
gmm(man_link_for formanRD , lag(3 3)coll) gmm(serv_link_back backservRD , lag(2
3)coll) gmm(serv_link_for forservRD , lag(4 5)coll) iv(humcap1 RD hhi_sales age
age2 logta logta2 demand) iv(i.nace_short i.region_code i.year) two robust ar(4)
```

```
Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =     29263
Time variable : year                            Number of groups   =      9712
Number of instruments = 73                      Obs per group: min =         1
Wald chi2(48)  =  44790.84                                     avg =      3.01
Prob > chi2    =     0.000                                     max =         6
---------------------------------------------------------------------------------------
                     |              Corrected
             WLP_TFP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
---------------------+-----------------------------------------------------------------
             WLP_TFP |
                 L1. |    .381133   .0224778    16.96   0.000     .3370772    .4251887
                 L2. |    .060466   .0133951     4.51   0.000      .034212      .08672
                     |
             hor_tot |  -.9133034   .2223489    -4.11   0.000    -1.349099   -.4775077
                  RD |   .0685183   .0172824     3.96   0.000     .0346453    .1023912
                     |
        c.hor_tot#c.RD |  -.1409316    .040073    -3.52   0.000    -.2194732   -.0623899
                     |
       man_link_back |   2.752012   1.041148     2.64   0.008     .7113991    4.792625
                     |
  c.man_link_back#c.RD |   .3506086   .1670295     2.10   0.036     .0232367    .6779804
                     |
        man_link_for |   -4.95165   1.196496    -4.14   0.000    -7.296739   -2.606561
                     |
   c.man_link_for#c.RD |  -.4428124   .1961466    -2.26   0.024    -.8272528   -.0583721
                     |
      serv_link_back |  -14.63326   6.627533    -2.21   0.027    -27.62298   -1.643531
                     |
 c.serv_link_back#c.RD |  -1.712993   1.096509    -1.56   0.118    -3.862111     .436126
                     |
       serv_link_for |   15.01653   3.985677     3.77   0.000     7.204743    22.82831
                     |
  c.serv_link_for#c.RD |   2.464149   .7102275     3.47   0.001     1.072129     3.85617
                     |
             humcap1 |   .4836789   .0143887    33.62   0.000     .4554775    .5118803
           hhi_sales |  -.2035272   .0655205    -3.11   0.002    -.3319449   -.0751095
                 age |  -.0079344   .0017068    -4.65   0.000    -.0112797   -.0045892
                age2 |   .0000594   .0000493     1.20   0.228    -.0000372    .0001559
               logta |   .2401153   .0215514    11.14   0.000     .1978753    .2823554
              logta2 |  -.0059177   .0011428    -5.18   0.000    -.0081574   -.0036779
              demand |  -.0066628   .0188379    -0.35   0.724    -.0435844    .0302588
                     |
          nace_short |
                 20  |   1.018073     .13738     7.41   0.000     .7488133    1.287333
                 23  |   1.969049   .2700803     7.29   0.000     1.439701    2.498396
                 24  |   1.842761   .1563647    11.79   0.000     1.536292    2.149231
                 25  |   1.820752   .1582884    11.50   0.000     1.510512    2.130991
                 26  |   1.596468   .1788892     8.92   0.000     1.245852    1.947085
                 29  |   1.277805   .1333719     9.58   0.000     1.016401    1.539209
               1516  |   1.076403   .1190722     9.04   0.000     .8430254     1.30978
               1718  |   1.318454     .11544    11.42   0.000     1.092196    1.544712
               2122  |   .8705336   .1377812     6.32   0.000     .6004875     1.14058
               2728  |   1.028181   .1520325     6.76   0.000     .7302025    1.326159
```

```
        3033  |   1.176872    .122324     9.62   0.000     .9371215    1.416623
        3435  |   1.327649   .1383925     9.59   0.000     1.056405    1.598893
        3637  |   1.259026   .1229568    10.24   0.000     1.018036    1.500017
              |
  region_code |
           4  |  -.0696748   .0265765    -2.62   0.009    -.1217638   -.0175858
           5  |  -.1019574   .0269126    -3.79   0.000    -.1547052   -.0492096
           6  |  -.0770349   .0269969    -2.85   0.004    -.1299479    -.024122
           7  |  -.0259888   .0250963    -1.04   0.300    -.0751767    .0231991
           8  |   -.068321   .0261955    -2.61   0.009    -.1196632   -.0169787
           9  |   -.054391    .025969    -2.09   0.036    -.1052893   -.0034927
          10  |  -.0336439   .0269117    -1.25   0.211    -.0863898     .019102
          11  |  -.0478856   .0260586    -1.84   0.066    -.0989594    .0031883
          13  |  -.0516565   .0233845    -2.21   0.027    -.0974893   -.0058236
          14  |  -.0918554   .0259105    -3.55   0.000    -.1426389   -.0410718
              |
         year |
        2004  |  -.0535682   .0447539    -1.20   0.231    -.1412842    .0341477
        2005  |   .0519799   .0429018     1.21   0.226    -.0321062    .1360659
        2006  |   .1026373   .0479951     2.14   0.032     .0085686     .196706
        2007  |   .0562245   .0455557     1.23   0.217    -.0330631    .1455121
        2008  |   .1206998   .0167963     7.19   0.000     .0877796      .15362
              |
        _cons |  -.7326205   .1805775    -4.06   0.000    -1.086546    -.378695
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z = -15.37  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   0.75  Pr > z =  0.452
Arellano-Bond test for AR(3) in first differences: z =  -0.32  Pr > z =  0.748
Arellano-Bond test for AR(4) in first differences: z =  -0.39  Pr > z =  0.699
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(24)   =  42.61  Prob > chi2 =  0.011
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(24)   =  25.69  Prob > chi2 =  0.369
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(12)   =  16.28  Prob > chi2 =  0.179
    Difference (null H = exogenous): chi2(12)   =   9.41  Prob > chi2 =  0.667
  gmm(L.WLP_TFP, collapse lag(1 1))
    Hansen test excluding group:     chi2(22)   =  21.69  Prob > chi2 =  0.479
    Difference (null H = exogenous): chi2(2)    =   4.00  Prob > chi2 =  0.135
  gmm(L2.WLP_TFP, collapse lag(1 1))
    Hansen test excluding group:     chi2(22)   =  22.77  Prob > chi2 =  0.415
    Difference (null H = exogenous): chi2(2)    =   2.92  Prob > chi2 =  0.233
  gmm(hor_tot hormanRD, collapse lag(2 4))
    Hansen test excluding group:     chi2(16)   =  15.21  Prob > chi2 =  0.509
    Difference (null H = exogenous): chi2(8)    =  10.47  Prob > chi2 =  0.233
  gmm(man_link_back backmanRD, collapse lag(3 5))
    Hansen test excluding group:     chi2(16)   =  16.13  Prob > chi2 =  0.444
    Difference (null H = exogenous): chi2(8)    =   9.55  Prob > chi2 =  0.298
  gmm(man_link_for formanRD, collapse lag(3 3))
    Hansen test excluding group:     chi2(20)   =  22.56  Prob > chi2 =  0.311
    Difference (null H = exogenous): chi2(4)    =   3.13  Prob > chi2 =  0.537
  gmm(serv_link_back backservRD, collapse lag(2 3))
    Hansen test excluding group:     chi2(18)   =  19.76  Prob > chi2 =  0.347
    Difference (null H = exogenous): chi2(6)    =   5.93  Prob > chi2 =  0.431
  gmm(serv_link_for forservRD, collapse lag(4 5))
    Hansen test excluding group:     chi2(18)   =  20.18  Prob > chi2 =  0.323
    Difference (null H = exogenous): chi2(6)    =   5.51  Prob > chi2 =  0.480
  iv(humcap1 RD hhi_sales age age2 logta logta2 demand)
    Hansen test excluding group:     chi2(16)   =  15.69  Prob > chi2 =  0.475
    Difference (null H = exogenous): chi2(8)    =  10.00  Prob > chi2 =  0.265
```

MARGINAL EFFECTS

```
margins, dydx(hor_tot serv_link_for serv_link_back man_link_back man_link_for ) at((p1)
RD) at((p10) RD) at((p20) RD) at((p30) RD)  at((p40) RD) at((p50) RD) at((p60) RD)
at((p70) RD) at((p80) RD) at((p90) RD) at((p99) RD) vsquish force level(90)

Average marginal effects                          Number of obs    =      29263
Model VCE    : Corrected
```

```
Expression    : Fitted Values, predict()
dy/dx w.r.t. : hor_tot man_link_back man_link_for serv_link_back serv_link_for
1._at         : RD              =   -8.889859 (p1)
2._at         : RD              =   -7.338238 (p10)
3._at         : RD              =    -6.57368 (p20)
4._at         : RD              =   -6.001415 (p30)
5._at         : RD              =   -5.480639 (p40)
6._at         : RD              =   -4.965173 (p50)
7._at         : RD              =   -4.454347 (p60)
8._at         : RD              =   -3.899951 (p70)
9._at         : RD              =   -3.271986 (p80)
10._at        : RD              =   -2.325058 (p90)
11._at        : RD              =   -.1931912 (p99)

--------------------------------------------------------------------------------
               |            Delta-method
               |      dy/dx   Std. Err.      z    P>|z|     [90% Conf. Interval]
---------------+----------------------------------------------------------------
hor_tot        |
           _at |
            1  |   .3395583   .1694794     2.00   0.045      .0607895    .6183272
            2  |    .120886   .1185519     1.02   0.308     -.0741146    .3158865
            3  |   .0131356   .0983376     0.13   0.894     -.1486154    .1748867
            4  |  -.0675147   .0872766    -0.77   0.439     -.2110719    .0760426
            5  |  -.1409084   .0816268    -1.73   0.084     -.2751725   -.0066443
            6  |  -.2135539   .0810935    -2.63   0.008     -.3469408   -.0801669
            7  |  -.2855453   .0856273    -3.33   0.001     -.4263897    -.144701
            8  |  -.3636773   .0953977    -3.81   0.000     -.5205925   -.2067621
            9  |  -.4521774   .1108892    -4.08   0.000     -.6345739   -.2697808
           10  |  -.5856294   .1396787    -4.19   0.000     -.8153803   -.3558784
           11  |  -.8860767    .215153    -4.12   0.000     -1.239972   -.5321815
---------------+----------------------------------------------------------------
man_link_back  |
           _at |
            1  |  -.3648488   .6985935    -0.52   0.601     -1.513933    .7842352
            2  |   .1791628   .5238216     0.34   0.732     -.6824471    1.040773
            3  |   .4472233   .4674626     0.96   0.339     -.3216843    1.216131
            4  |   .6478645   .4450257     1.46   0.145     -.0841376    1.379867
            5  |    .830453   .4419247     1.88   0.060      .1035516    1.557354
            6  |    1.01118   .4554965     2.22   0.026      .2619547    1.760405
            7  |    1.19028   .4839145     2.46   0.014      .3943111    1.986248
            8  |   1.384656   .5287933     2.62   0.009      .5148683    2.254443
            9  |   1.604826   .5931415     2.71   0.007      .6291947    2.580457
           10  |   1.936827   .7087222     2.73   0.006      .7710824    3.102571
           11  |   2.684277    1.01201     2.65   0.008      1.019669    4.348886
---------------+----------------------------------------------------------------
man_link_for   |
           _at |
            1  |   -1.01511     .79163    -1.28   0.200     -2.317226    .2870053
            2  |  -1.702187   .5736747    -2.97   0.003     -2.645798   -.7585764
            3  |  -2.040743   .5006035    -4.08   0.000     -2.864163   -1.217323
            4  |  -2.294149   .4704053    -4.88   0.000     -3.067897   -1.520402
            5  |  -2.524755   .4652923    -5.43   0.000     -3.290093   -1.759418
            6  |   -2.75301   .4819876    -5.71   0.000     -3.545809   -1.960211
            7  |   -2.97921   .5178366    -5.75   0.000     -3.830975   -2.127445
            8  |  -3.224704   .5742607    -5.62   0.000     -4.169279   -2.280129
            9  |  -3.502774   .6543232    -5.35   0.000      -4.57904   -2.426508
           10  |  -3.922086   .7961409    -4.93   0.000     -5.231621   -2.612551
           11  |  -4.866103   1.161667    -4.19   0.000     -6.776875   -2.955331
---------------+----------------------------------------------------------------
serv_link_back |
           _at |
            1  |   .5950059    3.98946     0.15   0.881     -5.967072    7.157084
            2  |  -2.062909   2.667278    -0.77   0.439     -6.450192    2.324373
            3  |  -3.372592   2.215096    -1.52   0.128       -7.0161     .270917
            4  |  -4.352878   2.043035    -2.13   0.033     -7.713372   -.9923852
            5  |  -5.244963   2.047354    -2.56   0.010     -8.612561   -1.877366
            6  |  -6.127953   2.202582    -2.78   0.005     -9.750878   -2.505029
            7  |  -7.002994   2.476987    -2.83   0.005     -11.07728   -2.928712
            8  |  -7.952671    2.87039    -2.77   0.006     -12.67404     -3.2313
            9  |   -9.02837   3.393328    -2.66   0.008      -14.6099   -3.446842
           10  |  -10.65045   4.271652    -2.49   0.013     -17.67669   -3.624208
           11  |  -14.30232   6.426155    -2.23   0.026     -24.87241   -3.732239
---------------+----------------------------------------------------------------
serv_link_for  |
           _at |
            1  |  -6.889415   2.871784    -2.40   0.016     -11.61308    -2.16575
```

```
           2  |  -3.065989   1.958803    -1.57   0.118    -6.287933    .1559556
           3  |  -1.182004   1.599073    -0.74   0.460    -3.812244    1.448237
           4  |   .2281442   1.408882     0.16   0.871    -2.089261    2.545549
           5  |   1.511414   1.323432     1.14   0.253    -.6654377    3.688265
           6  |   2.781599   1.337838     2.08   0.038     .5810521    4.982147
           7  |    4.04035   1.446461     2.79   0.005     1.661133    6.419567
           8  |   5.406466    1.64875     3.28   0.001     2.694513    8.118419
           9  |   6.953865   1.949901     3.57   0.000     3.746563    10.16117
          10  |   9.287237   2.487684     3.73   0.000     5.195361    13.37911
          11  |   14.54047   3.856441     3.77   0.000     8.197194    20.88376
------------------------------------------------------------------------------
```

TABLE IV.17 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN ESTONIA FOR MANUFACTURING SECTOR – ABSORPTIVE CAPACITY MODEL, 2002-2010 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP c.hor_tot##c.RD c.man_link_back##c.RD c.man_link_for##c.RD c.serv_link_back##c.RD c.serv_link_for##c.RD humcap1 hhi_sales age age2 logta logta2 demand i.nace_short i.region_code i.year if man==1, gmm(l.WLP_TFP, lag(2 3)) gmm(hor_tot hormanRD, lag(4 4)coll) gmm(man_link_back backmanRD , lag(2 2)coll) gmm(man_link_for formanRD , lag(3 3)coll) gmm(serv_link_back backservRD , lag(2 2)coll) gmm(serv_link_for forservRD , lag(3 3)coll) iv(humcap1 RD hhi_sales age age2 logta logta2 demand) iv(i.nace_short i.region_code i.year) two robust ar(4)
```

```
Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =     11451
Time variable : year                            Number of groups   =      2870
Number of instruments = 70                      Obs per group: min =         1
Wald chi2(43)  =  12430.41                                     avg =      3.99
Prob > chi2    =     0.000                                     max =         8
---------------------------------------------------------------------------------------
                      |              Corrected
              WLP_TFP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
----------------------+----------------------------------------------------------------
              WLP_TFP |
                  L1. |   .3149631   .1022585     3.08   0.002     .1145401     .515386
                      |
              hor_tot |   .4835999    .863674     0.56   0.576     -1.20917     2.17637
                   RD |   .0754844   .0407831     1.85   0.064    -.0044489    .1554178
                      |
        c.hor_tot#c.RD |   .4426563   .1512112     2.93   0.003     .1462879    .7390248
                      |
         man_link_back |  -1.101716   .9171142    -1.20   0.230    -2.899227    .6957946
                      |
   c.man_link_back#c.RD |   .2718237   .1300037     2.09   0.037     .0170211    .5266263
                      |
          man_link_for |  -3.426276   1.414267    -2.42   0.015    -6.198189   -.6543632
                      |
    c.man_link_for#c.RD |  -.8213433   .2790018    -2.94   0.003    -1.368177   -.2745099
                      |
        serv_link_back |   -7.11964   2.900438    -2.45   0.014    -12.80439   -1.434885
                      |
  c.serv_link_back#c.RD |  -1.394383   .5897412    -2.36   0.018    -2.550255   -.2385117
                      |
         serv_link_for |  -3.913665   2.087001    -1.88   0.061    -8.004111    .1767816
                      |
   c.serv_link_for#c.RD |    -.82663   .4231969    -1.95   0.051    -1.656081    .0028207
                      |
              humcap1 |   .4629926   .0365259    12.68   0.000     .3914032     .534582
            hhi_sales |   .2654641   .4216983     0.63   0.529    -.5610494    1.091978
                  age |  -.0155424    .001925    -8.07   0.000    -.0193153   -.0117695
                 age2 |   .0001607   .0000305     5.26   0.000     .0001009    .0002205
                logta |   .2713445   .0648397     4.18   0.000     .1442611     .398428
               logta2 |  -.0078032    .004408    -1.77   0.077    -.0164428    .0008364
               demand |   .1532136   .0664451     2.31   0.021     .0229837    .2834436
                      |
           nace_short |
                   20  |   -.942584   .2628651    -3.59   0.000     -1.45779   -.4273778
                   23  |  -2.841413   8.672924    -0.33   0.743    -19.84003    14.15721
```

```
          24  |  -.1209853   .3168069    -0.38   0.703    -.7419154    .4999448
          25  |  -.8130639   .2151539    -3.78   0.000    -1.234758     -.39137
          26  |  -.7983774   .2124086    -3.76   0.000    -1.214691   -.3820643
          29  |  -.5801436   .1791538    -3.24   0.001    -.9312786   -.2290087
        1516  |  -.4257499   .2311734    -1.84   0.066    -.8788414    .0273417
        1718  |  -.4654798   .1798501    -2.59   0.010    -.8179794   -.1129801
        2122  |   -.613885   .2445828    -2.51   0.012    -1.093259   -.1345114
        2728  |  -.6989031   .2006752    -3.48   0.000    -1.092219   -.3055869
        3033  |  -.3468324   .2962421    -1.17   0.242    -.9274561    .2337914
        3435  |  -.7817603   .2470072    -3.16   0.002    -1.265886    -.297635
        3637  |  -.7707947   .2291061    -3.36   0.001    -1.219834    -.321755
              |
 region_code  |
           2  |  -.0437265   .0213177    -2.05   0.040    -.0855084   -.0019445
           3  |  -.0592552   .0244047    -2.43   0.015    -.1070875   -.0114228
           4  |   -.072051   .0431371    -1.67   0.095    -.1565981    .0124962
           5  |  -.0544477   .0214772    -2.54   0.011    -.0965421   -.0123532
              |
        year  |
        2003  |  -.1923038     .19301    -1.00   0.319    -.5705965    .1859889
        2004  |  -.1310405   .1518736    -0.86   0.388    -.4287073    .1666263
        2005  |  -.1367793    .151084    -0.91   0.365    -.4328984    .1593399
        2006  |  -.0916673   .1237325    -0.74   0.459    -.3341785    .1508439
        2007  |  -.1412802   .0997108    -1.42   0.157    -.3367097    .0541494
        2008  |  -.1322625   .0503425    -2.63   0.009     -.230932   -.0335929
        2009  |  -.2270384   .0384994    -5.90   0.000    -.3024958   -.1515811
              |
       _cons  |   1.066566   .3795855     2.81   0.005     .3225923     1.81054
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(19b.nace_short 20.nace_short 23.nace_short 24.nace_short 25.nace_short
    26.nace_short 29.nace_short 45.nace_short 50.nace_short 51.nace_short
    52.nace_short 55.nace_short 60.nace_short 61.nace_short 62.nace_short
    63.nace_short 64.nace_short 70.nace_short 1516.nace_short 1718.nace_short
    2122.nace_short 2728.nace_short 3033.nace_short 3435.nace_short
    3637.nace_short 4041.nace_short 6567.nace_short 7174.nace_short
    1b.region_code 2.region_code 3.region_code 4.region_code 5.region_code
    2002b.year 2003.year 2004.year 2005.year 2006.year 2007.year 2008.year
    2009.year 2010.year)
    D.(humcap1 RD hhi_sales age age2 logta logta2 demand)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L3.(serv_link_for forservRD) collapsed
    L2.(serv_link_back backservRD) collapsed
    L3.(man_link_for formanRD) collapsed
    L2.(man_link_back backmanRD) collapsed
    L4.(hor_tot hormanRD) collapsed
    L(2/3).L.WLP_TFP
Instruments for levels equation
  Standard
    19b.nace_short 20.nace_short 23.nace_short 24.nace_short 25.nace_short
    26.nace_short 29.nace_short 45.nace_short 50.nace_short 51.nace_short
    52.nace_short 55.nace_short 60.nace_short 61.nace_short 62.nace_short
    63.nace_short 64.nace_short 70.nace_short 1516.nace_short 1718.nace_short
    2122.nace_short 2728.nace_short 3033.nace_short 3435.nace_short
    3637.nace_short 4041.nace_short 6567.nace_short 7174.nace_short
    1b.region_code 2.region_code 3.region_code 4.region_code 5.region_code
    2002b.year 2003.year 2004.year 2005.year 2006.year 2007.year 2008.year
    2009.year 2010.year
    humcap1 RD hhi_sales age age2 logta logta2 demand
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL2.(serv_link_for forservRD) collapsed
    DL.(serv_link_back backservRD) collapsed
    DL2.(man_link_for formanRD) collapsed
    DL.(man_link_back backmanRD) collapsed
    DL3.(hor_tot hormanRD) collapsed
    DL.L.WLP_TFP
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -5.42  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   0.35  Pr > z =  0.730
Arellano-Bond test for AR(3) in first differences: z =  -0.34  Pr > z =  0.732
Arellano-Bond test for AR(4) in first differences: z =  -0.10  Pr > z =  0.923
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(26)    =  48.47  Prob > chi2 =  0.005
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(26)    =  32.13  Prob > chi2 =  0.189
```

```
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(10)    =  10.62  Prob > chi2 =  0.388
    Difference (null H = exogenous): chi2(16)    =  21.51  Prob > chi2 =  0.160
  gmm(L.WLP_TFP, lag(2 3))
    Hansen test excluding group:     chi2(9)     =  14.19  Prob > chi2 =  0.116
    Difference (null H = exogenous): chi2(17)    =  17.94  Prob > chi2 =  0.393
  gmm(hor_tot hormanRD, collapse lag(4 4))
    Hansen test excluding group:     chi2(22)    =  28.49  Prob > chi2 =  0.160
    Difference (null H = exogenous): chi2(4)     =   3.64  Prob > chi2 =  0.457
  gmm(man_link_back backmanRD, collapse lag(2 2))
    Hansen test excluding group:     chi2(22)    =  25.98  Prob > chi2 =  0.252
    Difference (null H = exogenous): chi2(4)     =   6.15  Prob > chi2 =  0.189
  gmm(man_link_for formanRD, collapse lag(3 3))
    Hansen test excluding group:     chi2(22)    =  29.90  Prob > chi2 =  0.121
    Difference (null H = exogenous): chi2(4)     =   2.23  Prob > chi2 =  0.693
  gmm(serv_link_back backservRD, collapse lag(2 2))
    Hansen test excluding group:     chi2(22)    =  26.73  Prob > chi2 =  0.222
    Difference (null H = exogenous): chi2(4)     =   5.40  Prob > chi2 =  0.249
  gmm(serv_link_for forservRD, collapse lag(3 3))
    Hansen test excluding group:     chi2(22)    =  24.67  Prob > chi2 =  0.313
    Difference (null H = exogenous): chi2(4)     =   7.46  Prob > chi2 =  0.113
  iv(humcap1 RD hhi_sales age age2 logta logta2 demand)
    Hansen test excluding group:     chi2(18)    =  21.08  Prob > chi2 =  0.275
    Difference (null H = exogenous): chi2(8)     =  11.05  Prob > chi2 =  0.199
  iv(19b.nace_short 20.nace_short 23.nace_short 24.nace_short 25.nace_short 26.nace_short
29.nace_short 45.nace_short 50.nace_short 51.nace_short 52.nace_short 55.nace_short
60.nace_short 61.nace_short 62.nace_short 63.nace_short 64.nace_short 70.nace_short
1516.nace_short 1718.nace_short 2122.nace_short 2728.nace_short 3033.nace_short
3435.nace_short 3637.nace_short 4041.nace_short 6567.nace_short 7174.nace_short
1b.region_code 2.region_code 3.region_code 4.region_code 5.region_code 2002b.year
2003.year 2004.year 2005.year 2006.year 2007.year 2008.year 2009.year 2010.year)
    Hansen test excluding group:     chi2(1)     =   1.73  Prob > chi2 =  0.189
    Difference (null H = exogenous): chi2(25)    =  30.40  Prob > chi2 =  0.210
```

MARGINAL EFFECTS

```
margins, dydx(hor_tot serv_link_for serv_link_back man_link_back man_link_for ) at((p1)
RD) at((p10) RD) at((p20) RD) at((p30) RD)  at((p40) RD) at((p50) RD) at((p60) RD)
at((p70) RD) at((p80) RD) at((p90) RD) at((p99) RD) vsquish force level(90)

Average marginal effects                          Number of obs    =      11451
Model VCE    : Corrected

Expression   : Fitted Values, predict()
dy/dx w.r.t. : hor_tot man_link_back man_link_for serv_link_back serv_link_for
1._at        : RD              =   -8.481566 (p1)
2._at        : RD              =   -6.723833 (p10)
3._at        : RD              =   -5.891644 (p20)
4._at        : RD              =   -5.267858 (p30)
5._at        : RD              =   -4.736198 (p40)
6._at        : RD              =   -4.219508 (p50)
7._at        : RD              =   -3.688879 (p60)
8._at        : RD              =   -3.178054 (p70)
9._at        : RD              =   -2.639057 (p80)
10._at       : RD              =   -1.791759 (p90)
11._at       : RD              =   -.4658742 (p99)

--------------------------------------------------------------------------------
               |            Delta-method
               |      dy/dx   Std. Err.      z    P>|z|     [90% Conf. Interval]
---------------+----------------------------------------------------------------
hor_tot        |
           _at |
            1  |  -3.270819    1.09829    -2.98   0.003    -5.077346   -1.464293
            2  |  -2.492747   .9168498    -2.72   0.007    -4.000831   -.9846635
            3  |  -2.124374   .8466345    -2.51   0.012    -3.516964   -.7317838
            4  |  -1.848251   .8029579    -2.30   0.021    -3.168999   -.5275027
            5  |  -1.612908   .7729033    -2.09   0.037    -2.884221   -.3415956
            6  |  -1.384192   .7508238    -1.84   0.065    -2.619187   -.1491967
            7  |  -1.149306   .7361335    -1.56   0.118    -2.360138    .0615258
            8  |  -.9231858   .7300876    -1.26   0.206    -2.124073    .2777015
            9  |  -.6845956   .7325385    -0.93   0.350    -1.889514     .520323
```

```
          10  |  -.3095338   .7543904    -0.41   0.682    -1.550396    .9313279
          11  |   .2773777     .82815     0.33   0.738    -1.084808    1.639563
--------------+----------------------------------------------------------------
man_link_back |
          _at |
           1  |  -3.407207   .9715652    -3.51   0.000     -5.00529   -1.809124
           2  |  -2.929413   .8502226    -3.45   0.001    -4.327905   -1.530922
           3  |  -2.703205   .8091016    -3.34   0.001    -4.034058   -1.372351
           4  |  -2.533645   .7866699    -3.22   0.001    -3.827602   -1.239688
           5  |  -2.389127   .7737717    -3.09   0.002    -3.661868   -1.116386
           6  |  -2.248678   .7670184    -2.93   0.003    -3.510311   -.9870453
           7  |  -2.104441   .7661747    -2.75   0.006    -3.364686   -.8441958
           8  |  -1.965587   .7712131    -2.55   0.011    -3.234119   -.6970539
           9  |  -1.819075   .7826278    -2.32   0.020    -3.106383   -.5317664
          10  |  -1.588759   .8125515    -1.96   0.051    -2.925287   -.2522306
          11  |  -1.228352    .885231    -1.39   0.165    -2.684427    .2277236
--------------+----------------------------------------------------------------
man_link_for  |
          _at |
           1  |   3.540002   1.392587     2.54   0.011       1.2494    5.830604
           2  |   2.096299   1.015834     2.06   0.039     .4254006    3.767197
           3  |   1.412786   .8775522     1.61   0.107    -.0306588    2.856231
           4  |   .9004438   .8028335     1.12   0.262    -.4200998    2.220987
           5  |   .4637687   .7650799     0.61   0.544    -.7946757    1.722213
           6  |   .0393882   .7549731     0.05   0.958    -1.202432    1.281208
           7  |  -.3964397   .7729597    -0.51   0.608    -1.667845    .8749659
           8  |   -.816003    .815681    -1.00   0.317    -2.157679    .5256729
           9  |  -1.258704   .8837387    -1.42   0.154    -2.712325    .1949167
          10  |  -1.954627   1.026763    -1.90   0.057    -3.643501   -.2657521
          11  |  -3.043634   1.306187    -2.33   0.020     -5.19212   -.8951475
--------------+----------------------------------------------------------------
serv_link_back |
          _at |
           1  |   4.706913   2.829085     1.66   0.096      .053483    9.360344
           2  |   2.255959   1.994483     1.13   0.258    -1.024674    5.536591
           3  |   1.095569    1.67976     0.65   0.514     -1.66739    3.858529
           4  |   .2257726   1.506879     0.15   0.881    -2.252823    2.704368
           5  |  -.5155646   1.419433    -0.36   0.716    -2.850324    1.819195
           6  |  -1.236029   1.398031    -0.88   0.377    -3.535586    1.063527
           7  |  -1.975929   1.444247    -1.37   0.171    -4.351503    .3996456
           8  |  -2.688215   1.548331    -1.74   0.083    -5.234994   -.1414367
           9  |  -3.439783   1.709617    -2.01   0.044    -6.251852   -.6277135
          10  |  -4.621241   2.038953    -2.27   0.023    -7.975019   -1.267462
          11  |  -6.470033   2.662952    -2.43   0.015     -10.8502   -2.089866
--------------+----------------------------------------------------------------
serv_link_for |
          _at |
           1  |   3.097453   2.699474     1.15   0.251    -1.342786    7.537692
           2  |   1.644457   2.136102     0.77   0.441    -1.869118    5.158033
           3  |   .9565451   1.912896     0.50   0.617    -2.189888    4.102978
           4  |   .4409049   1.773243     0.25   0.804     -2.47582     3.35763
           5  |   .0014191   1.677992     0.00   0.999    -2.758633    2.761471
           6  |   -.425693   1.610339    -0.26   0.792    -3.074466     2.22308
           7  |  -.8643262   1.569795    -0.55   0.582    -3.446409    1.717757
           8  |   -1.28659    1.56058    -0.82   0.410    -3.853516    1.280336
           9  |  -1.732141   1.583135    -1.09   0.274    -4.336166    .8718847
          10  |  -2.432543   1.681709    -1.45   0.148    -5.198708    .3336227
          11  |  -3.528559   1.961581    -1.80   0.072    -6.755073   -.3020454
-------------------------------------------------------------------------------
```

TABLE IV.18 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN HUNGARY FOR MANUFACTURING SECTOR – ABSORPTIVE CAPACITY MODEL, 2002-2010 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP c.hor_tot##c.RD c.man_link_back##c.RD c.man_link_for##c.RD c.serv_link_back##c.RD c.serv_link_for##c.RD humcap1 hhi_sales age age2 logta logta2 demand i.nace_short i.region_code i.year if man==1, gmm(l.WLP_TFP, lag(1 3)) gmm(hor_tot hormanRD, lag(2 2)coll) gmm(man_link_back backmanRD , lag(2 3)coll) gmm(man_link_for formanRD , lag(2 2)coll) gmm(serv_link_back backservRD , lag(2 2)coll) gmm(serv_link_for forservRD
```

```
, lag(2 4)) iv(humcap1 RD hhi_sales age age2 logta logta2 demand) iv(i.nace_short
i.region_code i.year) two robust ar(4)

Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =      2499
Time variable : year                            Number of groups   =      1278
Number of instruments = 128                     Obs per group: min =         1
Wald chi2(58) =  19152.69                                      avg =      1.96
Prob > chi2   =     0.000                                      max =         7
---------------------------------------------------------------------------------------
                      |              Corrected
              WLP_TFP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
----------------------+----------------------------------------------------------------
              WLP_TFP |
                  L1. |   .5745605   .0810842     7.09   0.000     .4156384    .7334827
                      |
              hor_tot |  -.6289621   .6232888    -1.01   0.313    -1.850586    .5926615
                   RD |    -.01408   .0605508    -0.23   0.816    -.1327574    .1045975
                      |
       c.hor_tot#c.RD |   .0145166    .098065     0.15   0.882    -.1776872    .2067204
                      |
        man_link_back |   1.795839   2.146526     0.84   0.403    -2.411274    6.002953
                      |
 c.man_link_back#c.RD |  -.1803468   .3979364    -0.45   0.650    -.9602878    .5995942
                      |
         man_link_for |  -3.065781   2.134384    -1.44   0.151    -7.249098    1.117535
                      |
  c.man_link_for#c.RD |   .0140046   .3186146     0.04   0.965    -.6104686    .6384778
                      |
       serv_link_back |  -17.73987   10.36367    -1.71   0.087    -38.05229    2.572544
                      |
c.serv_link_back#c.RD |   .9008084   1.723257     0.52   0.601    -2.476714    4.278331
                      |
        serv_link_for |   10.29962   7.559472     1.36   0.173    -4.516675    25.11591
                      |
 c.serv_link_for#c.RD |   .3642633   1.340153     0.27   0.786    -2.262388    2.990915
                      |
              humcap1 |   .3008745   .0459647     6.55   0.000     .2107853    .3909637
            hhi_sales |  -.2132452   .1071474    -1.99   0.047    -.4232503   -.0032401
                  age |  -.0061616   .0044765    -1.38   0.169    -.0149354    .0026122
                 age2 |  -.0000428   .0001572    -0.27   0.786     -.000351    .0002654
                logta |   .0815283   .0519056     1.57   0.116    -.0202048    .1832615
               logta2 |   .0006602   .0029507     0.22   0.823    -.0051231    .0064435
               demand |   .0902238   .0457397     1.97   0.049     .0005756    .1798719
                      |
           nace_short |
                  20  |  -.2008278   .2469471    -0.81   0.416    -.6848351    .2831796
                  23  |   1.677692   .4380265     3.83   0.000      .819176    2.536208
                  24  |   .2365959   .2481469     0.95   0.340     -.249763    .7229547
                  25  |  -.2155929   .2054557    -1.05   0.294    -.6182786    .1870928
                  26  |  -.2397541   .2154342    -1.11   0.266    -.6619974    .1824891
                  29  |   .1903253   .2750833     0.69   0.489     -.348828    .7294786
                1516  |   .0106967    .252007     0.04   0.966    -.4832279    .5046214
                1718  |  -.5705129   .1873296    -3.05   0.002    -.9376721   -.2033537
                2122  |  -.3191945   .2649098    -1.20   0.228    -.8384082    .2000191
                2728  |   -.650857   .2332421    -2.79   0.005    -1.108003    -.193711
                3033  |  -.3549736    .227416    -1.56   0.119    -.8007008    .0907535
                3435  |  -.7349014    .251444    -2.92   0.003    -1.227723   -.2420803
                3637  |  -.0196045   .1837197    -0.11   0.915    -.3796886    .3404795
                      |
          region_code |
                   2  |   .0114528   .0484596     0.24   0.813    -.0835262    .1064319
                   3  |  -.0555667   .0463588    -1.20   0.231    -.1464282    .0352948
                   4  |  -.0787941   .0463133    -1.70   0.089    -.1695665    .0119782
                   5  |   .0013209   .0303495     0.04   0.965     -.058163    .0608049
                   6  |   .0364381   .0501754     0.73   0.468     -.061904    .1347801
                   7  |  -.0489318   .0416601    -1.17   0.240    -.1305841    .0327205
                   8  |  -.0386328   .0361746    -1.07   0.286    -.1095337    .0322681
                   9  |  -.0133649   .0412003    -0.32   0.746    -.0941161    .0673863
                  10  |  -.0063415   .0559163    -0.11   0.910    -.1159354    .1032524
                  11  |  -.0387499   .0470915    -0.82   0.411    -.1310475    .0535477
                  12  |   .0126997   .0444913     0.29   0.775    -.0745016    .0999011
                  13  |  -.0548527   .0649042    -0.85   0.398    -.1820626    .0723572
                  14  |  -.0104587   .0372264    -0.28   0.779     -.083421    .0625036
                  15  |  -.0201271   .0492713    -0.41   0.683    -.1166971    .0764428
```

```
             16  |  -.0350971   .0525557    -0.67   0.504    -.1381044    .0679102
             17  |  -.0372186   .0727308    -0.51   0.609    -.1797683    .1053311
             18  |  -.0494037   .0604681    -0.82   0.414     -.167919    .0691116
             19  |  -.0132848   .0517498    -0.26   0.797    -.1147125    .0881428
             20  |  -.0635834   .0510931    -1.24   0.213    -.1637241    .0365573
                 |
            year |
           2004  |   -.293952   .2966098    -0.99   0.322    -.8752965    .2873924
           2005  |  -.4365163   .3051257    -1.43   0.153    -1.034552    .1615191
           2006  |  -.4099029   .3095513    -1.32   0.185    -1.016612    .1968065
           2007  |  -.4472685   .3105319    -1.44   0.150      -1.0559    .1613629
           2008  |  -.4690899   .3169312    -1.48   0.139    -1.090264    .1520839
           2009  |  -.5873773   .3135883    -1.87   0.061    -1.201999    .0272445
           2010  |  -.4408848   .3078028    -1.43   0.152    -1.044167    .1623976
                 |
           _cons |   .7251025   .6283147     1.15   0.248    -.5063718    1.956577
------------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -3.68  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   0.63  Pr > z =  0.530
Arellano-Bond test for AR(3) in first differences: z =  -0.90  Pr > z =  0.368
Arellano-Bond test for AR(4) in first differences: z =  -0.66  Pr > z =  0.508
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(69)   = 77.04  Prob > chi2 =  0.237
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(69)   = 59.76  Prob > chi2 =  0.778
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(41)   = 40.93  Prob > chi2 =  0.473
    Difference (null H = exogenous): chi2(28)   = 18.83  Prob > chi2 =  0.903
  gmm(L.WLP_TFP, lag(1 3))
    Hansen test excluding group:     chi2(47)   = 46.97  Prob > chi2 =  0.474
    Difference (null H = exogenous): chi2(22)   = 12.79  Prob > chi2 =  0.939
  gmm(hor_tot hormanRD, collapse lag(2 2))
    Hansen test excluding group:     chi2(66)   = 56.23  Prob > chi2 =  0.799
    Difference (null H = exogenous): chi2(3)    =  3.54  Prob > chi2 =  0.316
  gmm(man_link_back backmanRD, collapse lag(2 3))
    Hansen test excluding group:     chi2(63)   = 57.93  Prob > chi2 =  0.657
    Difference (null H = exogenous): chi2(6)    =  1.84  Prob > chi2 =  0.934
  gmm(man_link_for formanRD, collapse lag(2 2))
    Hansen test excluding group:     chi2(65)   = 58.24  Prob > chi2 =  0.711
    Difference (null H = exogenous): chi2(4)    =  1.52  Prob > chi2 =  0.823
  gmm(serv_link_back backservRD, collapse lag(2 2))
    Hansen test excluding group:     chi2(65)   = 58.89  Prob > chi2 =  0.690
    Difference (null H = exogenous): chi2(4)    =  0.87  Prob > chi2 =  0.928
  gmm(serv_link_for forservRD, lag(2 4))
    Hansen test excluding group:     chi2(28)   = 25.12  Prob > chi2 =  0.621
    Difference (null H = exogenous): chi2(41)   = 34.64  Prob > chi2 =  0.748
  iv(humcap1 RD hhi_sales age age2 logta logta2 demand)
    Hansen test excluding group:     chi2(61)   = 49.05  Prob > chi2 =  0.864
    Difference (null H = exogenous): chi2(8)    = 10.71  Prob > chi2 =  0.219
  iv(19b.nace_short 20.nace_short 23.nace_short 24.nace_short 25.nace_short 26.nace_short
29.nace_short 45.nace_short 50.nace_short 51.nace_short 52.nace_short 55.nace_short
60.nace_short 61.nace_short 62.nace_short 63.nace_short 64.nace_short 70.nace_short
1516.nace_short 1718.nace_short 2122.nace_short 2728.nace_short 3033.nace_short
3435.nace_short 3637.nace_short 4041.nace_short 6567.nace_short 7174.nace_short
1b.region_code 2.region_code 3.region_code 4.region_code 5.region_code 6.region_code
7.region_code 8.region_code 9.region_code 10.region_code 11.region_code 12.region_code
13.region_code 14.region_code 15.region_code 16.region_code 17.region_code 18.region_code
19.region_code 20.region_code 2002b.year 2003.year 2004.year 2005.year 2006.year
2007.year 2008.year 2009.year 2010.year)
    Hansen test excluding group:     chi2(29)   = 19.97  Prob > chi2 =  0.894
    Difference (null H = exogenous): chi2(40)   = 39.79  Prob > chi2 =  0.480
```

MARGINAL EFFECTS

```
margins, dydx(hor_tot serv_link_for serv_link_back man_link_back man_link_for ) at((p1)
RD) at((p10) RD) at((p20) RD) at((p30) RD)  at((p40) RD) at((p50) RD) at((p60) RD)
at((p70) RD) at((p80) RD) at((p90) RD) at((p99) RD) vsquish force level(90)


Average marginal effects                          Number of obs    =       2499
Model VCE    : Corrected
```

```
Expression   : Fitted Values, predict()
dy/dx w.r.t. : hor_tot man_link_back man_link_for serv_link_back serv_link_for
1._at        : RD              =   -8.927978 (p1)
2._at        : RD              =   -7.338179 (p10)
3._at        : RD              =   -6.519147 (p20)
4._at        : RD              =   -5.945421 (p30)
5._at        : RD              =   -5.398604 (p40)
6._at        : RD              =   -4.912655 (p50)
7._at        : RD              =   -4.423348 (p60)
8._at        : RD              =   -3.850761 (p70)
9._at        : RD              =   -3.175261 (p80)
10._at       : RD              =   -2.240247 (p90)
11._at       : RD              =     .709922 (p99)
```

	dy/dx	Delta-method Std. Err.	z	P>|z|	[90% Conf.	Interval]
hor_tot						
_at						
1	-.7585662	.5122836	-1.48	0.139	-1.601198	.0840654
2	-.7354877	.4155598	-1.77	0.077	-1.419023	-.0519527
3	-.7235981	.3813506	-1.90	0.058	-1.350864	-.0963322
4	-.7152695	.366082	-1.95	0.051	-1.317421	-.1131182
5	-.7073316	.3592096	-1.97	0.049	-1.298179	-.1164844
6	-.7002773	.3597614	-1.95	0.052	-1.292032	-.1085224
7	-.6931742	.366629	-1.89	0.059	-1.296225	-.0901231
8	-.6848621	.3822325	-1.79	0.073	-1.313579	-.0561457
9	-.6750562	.4098712	-1.65	0.100	-1.349234	-.0008781
10	-.6614829	.46128	-1.43	0.152	-1.420221	.0972552
11	-.6186564	.6814041	-0.91	0.364	-1.739466	.5021536
man_link_back						
_at						
1	3.405971	2.344542	1.45	0.146	-.450457	7.2624
2	3.119256	1.868457	1.67	0.095	.0459172	6.192595
3	2.971547	1.664401	1.79	0.074	.23385	5.709243
4	2.868077	1.546538	1.85	0.064	.3242485	5.411905
5	2.76946	1.458803	1.90	0.058	.3699433	5.168977
6	2.681821	1.404726	1.91	0.056	.3712524	4.992389
7	2.593576	1.375827	1.89	0.059	.3305416	4.85661
8	2.490312	1.376645	1.81	0.070	.2259314	4.754692
9	2.368487	1.425242	1.66	0.097	.0241729	4.712802
10	2.199861	1.567879	1.40	0.161	-.3790711	4.778792
11	1.667807	2.370725	0.70	0.482	-2.231689	5.567303
man_link_for						
_at						
1	-3.190814	2.133595	-1.50	0.135	-6.700267	.3186378
2	-3.16855	1.835355	-1.73	0.084	-6.187441	-.1496591
3	-3.15708	1.720172	-1.84	0.066	-5.98651	-.3276489
4	-3.149045	1.659286	-1.90	0.058	-5.878327	-.4197628
5	-3.141387	1.618431	-1.94	0.052	-5.803469	-.4793043
6	-3.134581	1.597268	-1.96	0.050	-5.761853	-.5073098
7	-3.127729	1.590969	-1.97	0.049	-5.744639	-.5108183
8	-3.11971	1.602936	-1.95	0.052	-5.756305	-.4831148
9	-3.11025	1.643193	-1.89	0.058	-5.813061	-.4074382
10	-3.097155	1.74179	-1.78	0.075	-5.962145	-.2321656
11	-3.055839	2.291385	-1.33	0.182	-6.824833	.7131545
serv_link_back						
_at						
1	-25.78227	9.592282	-2.69	0.007	-41.56017	-10.00437
2	-24.35016	7.752988	-3.14	0.002	-37.10269	-11.59763
3	-23.61237	7.037883	-3.36	0.001	-35.18866	-12.03609
4	-23.09556	6.670499	-3.46	0.001	-34.06755	-12.12356
5	-22.60298	6.443223	-3.51	0.000	-33.20114	-12.00482
6	-22.16523	6.352701	-3.49	0.000	-32.6145	-11.71597
7	-21.72446	6.372409	-3.41	0.001	-32.20614	-11.24278
8	-21.20867	6.535034	-3.25	0.001	-31.95784	-10.45949
9	-20.60017	6.905552	-2.98	0.003	-31.9588	-9.24155
10	-19.7579	7.684508	-2.57	0.010	-32.39779	-7.118014
11	-17.10037	11.35554	-1.51	0.132	-35.77856	1.57783
serv_link_for						
_at						

1	7.047483	7.161442	0.98	0.325	-4.732041	18.82701
2	7.626589	5.601515	1.36	0.173	-1.587084	16.84026
3	7.924932	4.966233	1.60	0.111	-.2437954	16.09366
4	8.133919	4.625563	1.76	0.079	.5255445	15.74229
5	8.333105	4.402492	1.89	0.058	1.09165	15.57456
6	8.510118	4.300416	1.98	0.048	1.436564	15.58367
7	8.688354	4.29606	2.02	0.043	1.621965	15.75474
8	8.896927	4.416371	2.01	0.044	1.632643	16.16121
9	9.142987	4.717533	1.94	0.053	1.383335	16.90264
10	9.483578	5.363509	1.77	0.077	.6613901	18.30577
11	10.55822	8.360629	1.26	0.207	-3.193794	24.31023

TABLE IV.19 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN SLOVAKIA FOR MANUFACTURING SECTOR – ABSORPTIVE CAPACITY MODEL, 2002-2009 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP c.hor_tot##c.RD c.man_link_back##c.RD c.man_link_for##c.RD c.serv_link_back##c.RD c.serv_link_for##c.RD humcap1 hhi_sales age age2 logta logta2 demand i.nace_short i.region_code i.year if man==1, gmm(l.WLP_TFP, lag(1 1)) gmm(hor_tot hormanRD, lag(3 5)coll) gmm(man_link_back backmanRD , lag(3 3)coll) gmm(man_link_for formanRD , lag(2 2)coll) gmm(serv_link_back backservRD, lag(4 5)coll) gmm(serv_link_for forservRD , lag(3 3)coll) iv(humcap1 RD hhi_sales age age2 logta logta2 demand) iv(i.nace_short i.region_code i.year) two robust ar(4)
```

```
Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =      8140
Time variable : year                            Number of groups   =      3074
Number of instruments = 73                      Obs per group: min =         1
Wald chi2(45)  =   9819.81                                     avg =      2.65
Prob > chi2    =     0.000                                     max =         7
```

WLP_TFP	Coef.	Corrected Std. Err.	z	P>|z|	[95% Conf.	Interval]
WLP_TFP L1.	.3781589	.0430071	8.79	0.000	.2938665	.4624514
hor_tot	-.1759973	.4060463	-0.43	0.665	-.9718334	.6198389
RD	.0595949	.0177793	3.35	0.001	.0247482	.0944417
c.hor_tot#c.RD	.0401559	.0684296	0.59	0.557	-.0939636	.1742754
man_link_back	2.132375	2.130756	1.00	0.317	-2.043831	6.308581
c.man_link_back#c.RD	.0095497	.2938846	0.03	0.974	-.5664536	.585553
man_link_for	-1.96545	1.330002	-1.48	0.139	-4.572206	.6413051
c.man_link_for#c.RD	-.2941371	.220599	-1.33	0.182	-.7265032	.1382291
serv_link_back	-.1984027	10.13448	-0.02	0.984	-20.06161	19.66481
c.serv_link_back#c.RD	-.7958473	1.735153	-0.46	0.646	-4.196684	2.60499
serv_link_for	12.15999	3.849272	3.16	0.002	4.615558	19.70443
c.serv_link_for#c.RD	1.001284	.5655917	1.77	0.077	-.1072554	2.109823
humcap1	.3313668	.0143665	23.07	0.000	.303209	.3595246
hhi_sales	-.1777632	.1132603	-1.57	0.117	-.3997493	.044223
age	-.0099069	.0026533	-3.73	0.000	-.0151073	-.0047065
age2	.0001	.0000495	2.02	0.043	3.02e-06	.0001969
logta	.1652801	.0355182	4.65	0.000	.0956657	.2348944
logta2	-.0037996	.0022068	-1.72	0.085	-.0081249	.0005258
demand	-.0192314	.0163452	-1.18	0.239	-.0512674	.0128046
nace_short						
20	-.1007014	.1489164	-0.68	0.499	-.3925721	.1911693
23	1.122005	.2183843	5.14	0.000	.6939798	1.550031
24	.8713452	.1301722	6.69	0.000	.6162124	1.126478

```
             25  |  -.0852599   .1081863    -0.79   0.431    -.2973013    .1267814
             26  |   -.912005   .1221423    -7.47   0.000    -1.151399   -.6726104
             29  |   .0080772   .0963196     0.08   0.933    -.1807056    .1968601
           1516  |  -.1287667   .1366492    -0.94   0.346    -.3965943    .1390609
           1718  |  -.1032686   .0915695    -1.13   0.259    -.2827416    .0762044
           2122  |  -.2012167   .1241899    -1.62   0.105    -.4446244    .0421909
           2728  |  -.6383419   .2184637    -2.92   0.003    -1.066523   -.2101608
           3033  |   .3369342   .0995704     3.38   0.001     .1417798    .5320886
           3435  |   .8160256   .1633082     5.00   0.000     .4959475    1.136104
           3637  |  -.4622175   .1195064    -3.87   0.000    -.6964457   -.2279893
                 |
     region_code |
              2  |    .086346   .0375338     2.30   0.021     .0127811     .159911
              3  |  -.0141716   .0360884    -0.39   0.695    -.0849035    .0565603
              4  |    .038773   .0301033     1.29   0.198    -.0202283    .0977744
              5  |   .0274194   .0324935     0.84   0.399    -.0362667    .0911054
              6  |    .000877   .0276317     0.03   0.975    -.0532801    .0550341
              7  |   .0215392   .0284608     0.76   0.449    -.0342431    .0773214
              8  |   -.000599   .0298631    -0.02   0.984    -.0591295    .0579316
                 |
            year |
           2004  |  -.0412767   .0314346    -1.31   0.189    -.1028874     .020334
           2005  |  -.1935091   .0548966    -3.52   0.000    -.3011044   -.0859137
           2006  |  -.0126713   .0318182    -0.40   0.690    -.0750338    .0496912
           2007  |  -.0786953   .0646857    -1.22   0.224    -.2054769    .0480863
           2008  |  -.1027943   .0778372    -1.32   0.187    -.2553525    .0497638
           2009  |  -.4696022   .1367837    -3.43   0.001    -.7376934    -.201511
                 |
           _cons |   .9735913   .2061696     4.72   0.000     .5695062    1.377676
------------------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z = -10.55  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -0.58  Pr > z =  0.565
Arellano-Bond test for AR(3) in first differences: z =   1.78  Pr > z =  0.074
Arellano-Bond test for AR(4) in first differences: z =  -0.04  Pr > z =  0.969
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(27)    =  32.57  Prob > chi2 =  0.212
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(27)    =  19.53  Prob > chi2 =  0.850
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(11)    =   9.56  Prob > chi2 =  0.570
    Difference (null H = exogenous): chi2(16)    =   9.97  Prob > chi2 =  0.868
  gmm(L.WLP_TFP, lag(1 1))
    Hansen test excluding group:     chi2(15)    =  11.32  Prob > chi2 =  0.729
    Difference (null H = exogenous): chi2(12)    =   8.21  Prob > chi2 =  0.769
  gmm(hor_tot hormanRD, collapse lag(3 5))
    Hansen test excluding group:     chi2(19)    =  11.50  Prob > chi2 =  0.906
    Difference (null H = exogenous): chi2(8)     =   8.03  Prob > chi2 =  0.430
  gmm(man_link_back backmanRD, collapse lag(3 3))
    Hansen test excluding group:     chi2(23)    =  16.33  Prob > chi2 =  0.841
    Difference (null H = exogenous): chi2(4)     =   3.21  Prob > chi2 =  0.524
  gmm(man_link_for formanRD, collapse lag(2 2))
    Hansen test excluding group:     chi2(23)    =  16.53  Prob > chi2 =  0.831
    Difference (null H = exogenous): chi2(4)     =   3.00  Prob > chi2 =  0.558
  gmm(serv_link_back backservRD, collapse lag(4 5))
    Hansen test excluding group:     chi2(21)    =  16.28  Prob > chi2 =  0.754
    Difference (null H = exogenous): chi2(6)     =   3.25  Prob > chi2 =  0.777
  gmm(serv_link_for forservRD, collapse lag(3 3))
    Hansen test excluding group:     chi2(23)    =  17.82  Prob > chi2 =  0.767
    Difference (null H = exogenous): chi2(4)     =   1.71  Prob > chi2 =  0.789
  iv(humcap1 RD hhi_sales age age2 logta logta2 demand)
    Hansen test excluding group:     chi2(19)    =  10.32  Prob > chi2 =  0.945
    Difference (null H = exogenous): chi2(8)     =   9.21  Prob > chi2 =  0.325
  iv(19b.nace_short 20.nace_short 23.nace_short 24.nace_short 25.nace_short 26.nace_short
29.nace_short 45.nace_short 50.nace_short 51.nace_short 52.nace_short 55.nace_short
60.nace_short 61.nace_short 62.nace_short 63.nace_short 64.nace_short 70.nace_short 15
16.nace_short 1718.nace_short 2122.nace_short 2728.nace_short 3033.nace_short
3435.nace_short 3637.nace_short 4041.nace_short 6567.nace_short 7174.nace_short
1b.region_code 2.region_code 3.region_code 4.region_code 5.region_code 6.region_code
7.region_code 8.region_code 2002b.year 2003.year 2004.year 2005.year 2006.year 2007.year
2008.year 2009.year)
    Hansen test excluding group:     chi2(0)     =   0.80  Prob > chi2 =      .
    Difference (null H = exogenous): chi2(27)    =  18.73  Prob > chi2 =  0.880
```

MARGINAL EFFECTS

```
margins, dydx(hor_tot serv_link_for serv_link_back man_link_back man_link_for ) at((p1)
RD) at((p10) RD) at((p20) RD) at((p30) RD)  at((p40) RD) at((p50) RD) at((p60) RD)
at((p70) RD) at((p80) RD) at((p90) RD) at((p99) RD) vsquish force level(90)


Average marginal effects                          Number of obs    =       8140
Model VCE    : Corrected

Expression   : Fitted Values, predict()
dy/dx w.r.t. : hor_tot man_link_back man_link_for serv_link_back serv_link_for
1._at        : RD              =   -9.225426 (p1)
2._at        : RD              =   -7.632159 (p10)
3._at        : RD              =   -6.860664 (p20)
4._at        : RD              =   -6.328353 (p30)
5._at        : RD              =   -5.844269 (p40)
6._at        : RD              =   -5.375278 (p50)
7._at        : RD              =    -4.87752 (p60)
8._at        : RD              =   -4.361872 (p70)
9._at        : RD              =    -3.78419 (p80)
10._at       : RD              =   -2.890372 (p90)
11._at       : RD              =   -.4519851 (p99)

------------------------------------------------------------------------------
               |            Delta-method
               |      dy/dx   Std. Err.      z    P>|z|     [90% Conf. Interval]
---------------+--------------------------------------------------------------
hor_tot        |
           _at |
            1  |  -.5464526   .3416075    -1.60   0.110    -1.108347    .0154418
            2  |  -.4824735   .2609126    -1.85   0.064    -.9116366   -.0533105
            3  |  -.4514934   .2303808    -1.96   0.050    -.8304362   -.0725507
            4  |   -.430118   .2144191    -2.01   0.045     -.782806     -.07743
            5  |  -.4106792   .2045066    -2.01   0.045    -.7470625   -.0742958
            6  |  -.3918465   .1997319    -1.96   0.050    -.7203763   -.0633166
            7  |  -.3718585   .2002441    -1.86   0.063    -.7012307   -.0424863
            8  |  -.3511522   .2067772    -1.70   0.089    -.6912705   -.0110339
            9  |  -.3279548   .2206658    -1.49   0.137    -.6909178    .0350081
           10  |  -.2920628   .2530565    -1.15   0.248    -.7083036     .124178
           11  |  -.1941472   .3794002    -0.51   0.609    -.8182049    .4299106
---------------+--------------------------------------------------------------
man_link_back  |
           _at |
            1  |   2.044275   1.437386     1.42   0.155    -.3200143    4.408563
            2  |    2.05949   1.201296     1.71   0.086     .0835339    4.035446
            3  |   2.066857   1.139749     1.81   0.070     .1921366    3.941578
            4  |   2.071941     1.1223     1.85   0.065     .2259218     3.91796
            5  |   2.076564   1.125236     1.85   0.065     .2257149    3.927412
            6  |   2.081042   1.145057     1.82   0.069     .1975915    3.964493
            7  |   2.085796   1.183417     1.76   0.078     .1392485    4.032343
            8  |    2.09072   1.240217     1.69   0.092     .0507448    4.130695
            9  |   2.096237   1.321708     1.59   0.113    -.0777795    4.270253
           10  |   2.104773   1.477679     1.42   0.154    -.3257923    4.535337
           11  |   2.128058   2.019015     1.05   0.292    -1.192926    5.449042
---------------+--------------------------------------------------------------
man_link_for   |
           _at |
            1  |   .7480893   .9470389     0.79   0.430    -.8096511     2.30583
            2  |   .2794504   .6750759     0.41   0.679    -.8309507    1.389852
            3  |   .0525252   .5752331     0.09   0.927     -.893649    .9986994
            4  |  -.1040472    .527764    -0.20   0.844    -.9721417    .7640474
            5  |  -.2464343   .5048405    -0.49   0.625    -1.076823    .5839544
            6  |  -.3843817   .5036695    -0.76   0.445    -1.212844    .4440809
            7  |  -.5307909   .5252114    -1.01   0.312    -1.394687     .333105
            8  |   -.682462   .5694186    -1.20   0.231    -1.619072    .2541482
            9  |  -.8523798   .6396762    -1.33   0.183    -1.904554    .1997938
           10  |  -1.115285   .7775775    -1.43   0.151    -2.394286    .1637164
           11  |  -1.832505   1.238227    -1.48   0.139    -3.869207    .2041974
---------------+--------------------------------------------------------------
serv_link_back |
           _at |
            1  |   7.143628   6.888741     1.04   0.300    -4.187344     18.4746
            2  |    5.87563   4.515103     1.30   0.193    -1.551054    13.30231
            3  |   5.261638   3.573762     1.47   0.141    -.6166771    11.13995
```

```
           4  |      4.838   3.099614     1.56   0.119    -.2604112    9.936411
           5  |   4.452743   2.865565     1.55   0.120    -.2606921    9.166178
           6  |   4.079498   2.864369     1.42   0.154    -.6319686    8.790965
           7  |   3.683359   3.105822     1.19   0.236    -1.425263     8.79198
           8  |   3.272982   3.565496     0.92   0.359    -2.591737      9.1377
           9  |   2.813235   4.248518     0.66   0.508    -4.174956    9.801425
          10  |   2.101892   5.501609     0.38   0.702    -6.947449    11.15123
          11  |   .1613085   9.384111     0.02   0.986    -15.27418     15.5968
--------------+----------------------------------------------------------------
serv_link_for |
          _at |
           1  |   2.922722   2.544012     1.15   0.251    -1.261804    7.107249
           2  |   4.518035   2.005807     2.25   0.024     1.218776    7.817293
           3  |    5.29052   1.849633     2.86   0.004     2.248144    8.332896
           4  |   5.823514   1.796585     3.24   0.001     2.868396    8.778633
           5  |    6.30822   1.791426     3.52   0.000     3.361587    9.254853
           6  |   6.777813   1.825996     3.71   0.000     3.774316    9.781309
           7  |    7.27621   1.902872     3.82   0.000     4.146264    10.40616
           8  |    7.79252   2.021151     3.86   0.000     4.468023    11.11702
           9  |   8.370944   2.192501     3.82   0.000     4.764601    11.97729
          10  |   9.265909   2.518914     3.68   0.000     5.122665    13.40915
          11  |   11.70743   3.624848     3.23   0.001     5.745083    17.66977
-------------------------------------------------------------------------------
```

TABLE IV.20 PRINTOUT OF DYNAMIC PANEL SYSTEM GMM ESTIMATION OF FDI SPILLOVERS IN SLOVENIA FOR MANUFACTURING SECTOR – ABSORPTIVE CAPACITY MODEL, 2002-2010 (DEP. VARIABLE LN TFP)

```
xtabond2 WLP_TFP l.WLP_TFP c.hor_tot##c.RD c.man_link_back##c.RD c.man_link_for##c.RD c.serv_link_back##c.RD c.serv_link_for##c.RD humcap1 hhi_sales age age2 logta logta2 demand i.nace_short i.region_code i.year if man==1, gmm(l.WLP_TFP, lag(1 1)) gmm(hor_tot hormanRD , lag(3 3)coll) gmm(man_link_back backmanRD , lag(3 5)coll) gmm(man_link_for formanRD , lag(3 3)coll) gmm(serv_link_back backservRD , lag(2 2)coll) gmm(serv_link_for forservRD , lag(2 2)) iv(humcap1 RD hhi_sales age age2 logta logta2 demand) iv(i.nace_short i.region_code i.year) two robust ar(4)
```

```
Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =      3584
Time variable : year                            Number of groups   =      1136
Number of instruments = 102                     Obs per group: min =         1
Wald chi2(50)  =     367.73                                    avg =      3.15
Prob > chi2    =      0.000                                    max =         8
---------------------------------------------------------------------------------------
                      |              Corrected
              WLP_TFP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
----------------------+----------------------------------------------------------------
              WLP_TFP |
                  L1. |   .3972237   .0567211     7.00   0.000     .2860523    .5083951
                      |
              hor_tot |   1.377847   .7072927     1.95   0.051     -.008421    2.764115
                   RD |   .0377506   .0095976     3.93   0.000     .0189396    .0565616
                      |
       c.hor_tot#c.RD |   .1284106   .1222533     1.05   0.294    -.1112016    .3680227
                      |
        man_link_back |   2.099292   1.642157     1.28   0.201    -1.119277    5.317861
                      |
 c.man_link_back#c.RD |   .0279572    .279473     0.10   0.920    -.5197998    .5757142
                      |
         man_link_for |  -1.284115   2.372006    -0.54   0.588    -5.933161     3.36493
                      |
  c.man_link_for#c.RD |  -.0389077   .3582143    -0.11   0.914    -.7409949    .6631794
                      |
       serv_link_back |   .6076674   8.003704     0.08   0.939     -15.0793    16.29464
                      |
c.serv_link_back#c.RD |   1.079906   1.257287     0.86   0.390    -1.384331    3.544143
                      |
        serv_link_for |   1.801489   8.055203     0.22   0.823    -13.98642     17.5894
                      |
 c.serv_link_for#c.RD |  -1.290486   1.214221    -1.06   0.288    -3.670315    1.089344
                      |
```

```
       humcap1 |    .545768   .0447665    12.19   0.000     .4580273    .6335088
     hhi_sales |  -.1827222   .1220889    -1.50   0.134     -.422012    .0565677
           age |   -.009463   .0024618    -3.84   0.000     -.014288   -.004638
          age2 |   .0000257   .0000596     0.43   0.667    -.0000912    .0001425
         logta |  -.0480626   .0564154    -0.85   0.394    -.1586347    .0625094
        logta2 |   .0128485   .0044796     2.87   0.004     .0040687    .0216283
        demand |   -.056645   .0860594    -0.66   0.510    -.2253184    .1120283
               |
    nace_short |
           20  |  -.4400376   .1933846    -2.28   0.023    -.8190645   -.0610108
           23  |  -.1628087   .9974973    -0.16   0.870    -2.117868     1.79225
           24  |   .3471232   .2696863     1.29   0.198    -.1814522    .8756986
           25  |  -.5605932   .2343969    -2.39   0.017    -1.020003   -.1011837
           26  |  -.1148298   .2101698    -0.55   0.585    -.5267551    .2970954
           29  |  -.7044336   .1748238    -4.03   0.000    -1.047082   -.3617852
         1516  |  -.3623842   .2151877    -1.68   0.092    -.7841443    .0593759
         1718  |  -.0127246   .2024219    -0.06   0.950    -.4094644    .3840151
         2122  |  -.8818658   .2165087    -4.07   0.000    -1.306215   -.4575165
         2728  |  -.9466117   .2748321    -3.44   0.001    -1.485273   -.4079506
         3033  |  -.3340293   .1941771    -1.72   0.085    -.7146095    .0465509
         3435  |  -1.621597   .2795683    -5.80   0.000    -2.169541   -1.073653
         3637  |  -.2104038   .1969809    -1.07   0.285    -.5964793    .1756718
               |
   region_code |
            2  |  -.0375572   .0443447    -0.85   0.397    -.1244713    .0493569
            3  |   .0586848   .0427177     1.37   0.170    -.0250403      .14241
            4  |   .0111696   .0464927     0.24   0.810    -.0799545    .1022938
            5  |  -.0105783   .0521907    -0.20   0.839    -.1128702    .0917136
            6  |   .0429094   .0513691     0.84   0.404    -.0577722     .143591
            7  |    .028513   .0311957     0.91   0.361    -.0326294    .0896554
            8  |   .0003072   .0374251     0.01   0.993    -.0730447    .0736591
            9  |   .0153242   .0519724     0.29   0.768    -.0865399    .1171882
           10  |   .0164727   .0394208     0.42   0.676    -.0607908    .0937361
           11  |   .0718651    .052246     1.38   0.169    -.0305352    .1742655
           12  |  -.0349699   .0760657    -0.46   0.646    -.1840559    .1141161
               |
          year |
         2003  |     .31681   .1635154     1.94   0.053    -.0036744    .6372943
         2004  |   .2581862   .1263414     2.04   0.041     .0105617    .5058108
         2005  |   .2109058   .1164404     1.81   0.070    -.0173132    .4391247
         2006  |   .2437581    .119448     2.04   0.041     .0096442     .477872
         2007  |   .1828785   .1111465     1.65   0.100    -.0349647    .4007216
         2008  |   .1410368   .1071229     1.32   0.188    -.0689202    .3509938
         2009  |  -.2464785   .0703335    -3.50   0.000    -.3843296   -.1086275
               |
         _cons |   1.630692   .5832907     2.80   0.005     .4874632    2.773921
------------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -7.87  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =   0.92  Pr > z =  0.359
Arellano-Bond test for AR(3) in first differences: z =  -0.82  Pr > z =  0.411
Arellano-Bond test for AR(4) in first differences: z =   0.78  Pr > z =  0.434
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(51)   =  98.99  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(51)   =  44.36  Prob > chi2 =  0.733
  (Robust, but weakened by many instruments.)

Difference-in-Hansen tests of exogeneity of instrument subsets:
  GMM instruments for levels
    Hansen test excluding group:     chi2(21)   =  20.45  Prob > chi2 =  0.493
    Difference (null H = exogenous): chi2(30)   =  23.91  Prob > chi2 =  0.776
  gmm(L.WLP_TFP, lag(1 1))
    Hansen test excluding group:     chi2(38)   =  32.12  Prob > chi2 =  0.737
    Difference (null H = exogenous): chi2(13)   =  12.24  Prob > chi2 =  0.508
  gmm(hor_tot hormanRD, collapse lag(3 3))
    Hansen test excluding group:     chi2(48)   =  42.86  Prob > chi2 =  0.683
    Difference (null H = exogenous): chi2(3)    =   1.51  Prob > chi2 =  0.681
  gmm(man_link_back backmanRD, collapse lag(3 5))
    Hansen test excluding group:     chi2(43)   =  34.29  Prob > chi2 =  0.826
    Difference (null H = exogenous): chi2(8)    =  10.07  Prob > chi2 =  0.260
  gmm(man_link_for formanRD, collapse lag(3 3))
    Hansen test excluding group:     chi2(47)   =  43.53  Prob > chi2 =  0.617
    Difference (null H = exogenous): chi2(4)    =   0.83  Prob > chi2 =  0.935
  gmm(serv_link_back backservRD, collapse lag(2 2))
    Hansen test excluding group:     chi2(47)   =  42.60  Prob > chi2 =  0.655
    Difference (null H = exogenous): chi2(4)    =   1.76  Prob > chi2 =  0.779
```

```
  gmm(serv_link_for forservRD, lag(2 2))
    Hansen test excluding group:     chi2(21)    =  18.62  Prob > chi2 =  0.609
    Difference (null H = exogenous): chi2(30)    =  25.74  Prob > chi2 =  0.688
  iv(humcap1 RD hhi_sales age age2 logta logta2 demand)
    Hansen test excluding group:     chi2(43)    =  39.80  Prob > chi2 =  0.611
    Difference (null H = exogenous): chi2(8)     =   4.57  Prob > chi2 =  0.803
  iv(19b.nace_short 20.nace_short 23.nace_short 24.nace_short 25.nace_short 26.nace_short
29.nace_short 45.nace_short 50.nace_short 51.nace_short 52.nace_short 55.nace_short
60.nace_short 61.nace_short 62.nace_short 63.nace_short 64.nace_short 70.nace_short
1516.nace_short 1718.nace_short 2122.nace_short 2728.nace_short 3033.nace_short
3435.nace_short 3637.nace_short 4041.nace_short 6567.nace_short 7174.nace_short
1b.region_code 2.region_code 3.region_code 4.region_code 5.region_code 6.region_code
7.region_code 8.region_code 9.region_code 10.region_code 11.region_code 12.region_code
2002b.year 2003.year 2004.year 2005.year 2006.year 2007.year 2008.year 2009.year
2010.year)
    Hansen test excluding group:     chi2(20)    =  23.04  Prob > chi2 =  0.287
    Difference (null H = exogenous): chi2(31)    =  21.32  Prob > chi2 =  0.903
```

MARGINAL EFFECTS

```
margins, dydx(hor_tot serv_link_for serv_link_back man_link_back man_link_for ) at((p1)
RD) at((p10) RD) at((p20) RD) at((p30) RD)  at((p40) RD) at((p50) RD) at((p60) RD)
at((p70) RD) at((p80) RD) at((p90) RD) at((p99) RD) vsquish force level(90)


Average marginal effects                          Number of obs    =       3584
Model VCE      : Corrected

Expression     : Fitted Values, predict()
dy/dx w.r.t.   : hor_tot man_link_back man_link_for serv_link_back serv_link_for
1._at          : RD               =   -8.480529 (p1)
2._at          : RD               =   -6.977282 (p10)
3._at          : RD               =    -6.24442 (p20)
4._at          : RD               =   -5.762052 (p30)
5._at          : RD               =   -5.327876 (p40)
6._at          : RD               =   -4.901028 (p50)
7._at          : RD               =   -4.392498 (p60)
8._at          : RD               =   -3.740737 (p70)
9._at          : RD               =   -2.995732 (p80)
10._at         : RD               =   -1.994884 (p90)
11._at         : RD               =    .5103831 (p99)

--------------------------------------------------------------------------------
               |            Delta-method
               |      dy/dx   Std. Err.      z    P>|z|     [90% Conf. Interval]
---------------+----------------------------------------------------------------
hor_tot        |
           _at |
            1  |   .2888577   .6318338     0.46   0.648    -.7504164    1.328132
            2  |   .4818905   .5102595     0.94   0.345    -.3574116    1.321193
            3  |   .5759977   .4660105     1.24   0.216    -.1905214    1.342517
            4  |   .6379389   .4444023     1.44   0.151    -.0930378    1.368916
            5  |   .6936916   .4309687     1.61   0.107    -.0151889    1.402572
            6  |   .7485034   .4238704     1.77   0.077     .0512986    1.445708
            7  |    .813804   .4237291     1.92   0.055     .1168317    1.510776
            8  |    .897497   .4366868     2.06   0.040     .1792111    1.615783
            9  |   .9931635   .4679659     2.12   0.034     .2234281    1.762899
           10  |   1.121683   .5320918     2.11   0.035     .2464699    1.996896
           11  |   1.443386   .7582402     1.90   0.057     .1961917     2.69058
---------------+----------------------------------------------------------------
man_link_back  |
           _at |
            1  |     1.8622   1.286085     1.45   0.148    -.2532219    3.977622
            2  |   1.904227   1.009765     1.89   0.059     .2433117    3.565142
            3  |   1.924715   .9156104     2.10   0.036     .4186702     3.43076
            4  |   1.938201   .8745326     2.22   0.027     .4997229    3.376679
            5  |   1.950339   .8542248     2.28   0.022     .5452645    3.355414
            6  |   1.962273   .8508179     2.31   0.021      .562802    3.361744
            7  |    1.97649   .8684023     2.28   0.023     .5480952    3.404885
            8  |   1.994711    .923003     2.16   0.031     .4765065    3.512916
            9  |    2.01554    1.02226     1.97   0.049     .3340711    3.697008
           10  |   2.043521   1.200367     1.70   0.089     .0690933    4.017948
           11  |   2.113561   1.765741     1.20   0.231    -.7908241    5.017946
---------------+----------------------------------------------------------------
man_link_for   |
```

_at						
1	-.9541569	1.824894	-0.52	0.601	-3.95584	2.047527
2	-1.012645	1.546411	-0.65	0.513	-3.556264	1.530974
3	-1.041159	1.464227	-0.71	0.477	-3.449597	1.36728
4	-1.059927	1.433988	-0.74	0.460	-3.418627	1.298774
5	-1.07682	1.424255	-0.76	0.450	-3.419511	1.265872
6	-1.093427	1.431193	-0.76	0.445	-3.44753	1.260676
7	-1.113213	1.460463	-0.76	0.446	-3.51546	1.289034
8	-1.138572	1.529204	-0.74	0.457	-3.653889	1.376746
9	-1.167558	1.645269	-0.71	0.478	-3.873784	1.538668
10	-1.206499	1.850971	-0.65	0.515	-4.251075	1.838078
11	-1.303973	2.5206	-0.52	0.605	-5.449991	2.842045
serv_link_back						
_at						
1	-8.550506	6.578866	-1.30	0.194	-19.37178	2.270766
2	-6.92714	5.512212	-1.26	0.209	-15.99392	2.139643
3	-6.135719	5.165991	-1.19	0.235	-14.63302	2.36158
4	-5.614806	5.018038	-1.12	0.263	-13.86874	2.639133
5	-5.145937	4.945053	-1.04	0.298	-13.27983	2.987951
6	-4.684981	4.931495	-0.95	0.342	-12.79657	3.426606
7	-4.135817	4.991195	-0.83	0.407	-12.3456	4.073968
8	-3.431977	5.183309	-0.66	0.508	-11.95776	5.093807
9	-2.627442	5.544902	-0.47	0.636	-11.74799	6.493111
10	-1.54662	6.2225	-0.25	0.804	-11.78172	8.688482
11	1.158833	8.518427	0.14	0.892	-12.85273	15.1704
serv_link_for						
_at						
1	12.74549	7.182025	1.77	0.076	.932109	24.55887
2	10.80557	6.202921	1.74	0.082	.6026736	21.00847
3	9.859823	5.873946	1.68	0.093	.1980423	19.5216
4	9.237333	5.722976	1.61	0.107	-.1761249	18.65079
5	8.677036	5.635893	1.54	0.124	-.5931835	17.94726
6	8.126195	5.59756	1.45	0.147	-1.080973	17.33336
7	7.469944	5.614353	1.33	0.183	-1.764844	16.70473
8	6.628856	5.733864	1.16	0.248	-2.802511	16.06022
9	5.667438	5.996804	0.95	0.345	-4.196427	15.5313
10	4.375858	6.533109	0.67	0.503	-6.37015	15.12187
11	1.142847	8.5119	0.13	0.893	-12.85798	15.14368