Three Essays on the Impact of Foreign Direct Investment on Productivity

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Abstract

This thesis attempts to provide a better understanding of the role of inward foreign direct investment (FDI) and the productivity relationship by providing both a theoretical and empirical contribution to the existing literature.

Chapter 2 studies how inward FDI can affect economic growth. We extend a leader-follower endogenous growth model and highlight theoretically the endogeneity of FDI in a regression on growth, where FDI acts as a bridge linking technology transfer to firms' adaptation activities, which enable developing countries to catch-up with developed countries. We empirically test the main predictions of our theoretical model and we find positive and statistically significant effects of FDI on the relative level of GDP per capita.

The subsequent chapter investigates whether current measures of vertical linkages capture the spillover effects from multinational firms to domestic firms. We construct measures of vertical linkages at the firm-level to include the differences in firms' sourcing and supplying strategies within an industry and to better measure vertical spillovers derived from multinational activities. Our newly constructed measures show how the differences in sourcing and supplying activities across firms determine the advent of vertical spillovers.

In chapter 4, we exploit alternative mechanisms through which the productivity of domestic firms rises. Our empirical findings suggest that the presence of foreign ownership alters firms' core product competences, skewing firms' production towards

their most profitable product lines and then raising firms' productivity. However, the presence of foreign ownership also increases product market competition by reducing markups across all product lines, and this effect further alters firms' production towards their core varieties.

Declaration

I certify that the thesis I have presented for examination for the PhD degree of the University of Sheffield is solely my own work other than where I have clearly indicated that it is the work of others (in which case the extent of any work carried out jointly by me and any other person is clearly identified in it). The copyright of this thesis rests with the author. Quotation from it is permitted, provided that full acknowledgement is made. This thesis may not be reproduced without my prior written consent. I warrant that this authorisation does not, to the best of my belief, infringe the rights of any third party. I declare that my thesis consists of about 63,380 words.

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Chapter 1

Introduction

1.1 Motivation and Objectives

I do not see how one can look at figures like these without seeing them as representing possibilities. Is there some action a government of India could take that would lead the Indian economy to grow like Indonesia's or Egypt's? If so, what exactly? If not, what is it about the "nature of India" that makes it so? The consequences for human welfare involved in questions like these are simply staggering: Once one starts to think about them, it is hard to think about anything else. – (Lucas Jr, 1988, p. 5). These words were spoken by Lucas in his 1985 Marshall Lecture at Cambridge University, and this statement led subsequently to a large expansion of the economic growth literature.

For an economics researcher, growth theory is one of the important ways to understand more about the changes in our real world. In thinking about economic growth, a question that is always present and cannot be neglected is: "Why are some countries rich and some poor?" According to Hall and Jones (1999), output per worker in the United States was more than 35 times higher than output per worker in Nigeria in the last three decades. How to explain this enormous difference in standards of living across countries? This is the starting point which motivates this thesis.

To answer this question, we should first go back to the 1950s, to when Solow built up theories that helped to clarify the physical capital accumulation process and suggested that exogenous technological progress was the driving force which could explain economic growth. In 1966, Nelson and Phelps (1966) emphasized that what really mattered for a country's outputs were the current services of tangible capital goods, the current number of workers performing each of these jobs and the current educational attainments of each of these job-holders, implying that the absorptive capability of a poor country limited its growth process. However, these models were unable to explain why long-run growth rates differ across countries. Motivated by this limitation, the new growth theory (better known as endogenous growth theory) approach began with models of long-run growth. Grossman and Helpman (1991a) and Barro and Sala-i Martin (1997) thus introduced models that explained the growth rates in developing countries via the creation and adaptation of new technologies which were already prevalent in the rich nations.

While technology diffusion can take place through several different channels, foreign direct investment (henceforth, FDI) by multinational corporations is one of the important channels that can introduce productivity gains, technology transfers, and new production processes to developing countries, as highlighted by Borensztein, De Gregorio, and Lee (1998) and Alfaro, Chanda, Kalemli-Ozcan, and Sayek (2004). The presence of FDI in developing countries has been increasing with time. Alfaro et al. (2004) suggest that around the world in developing countries, FDI contributed more than half of all private capital flows. Many policymakers in developing countries have increased their efforts to attract FDI. However, the contribution of FDI to economic growth remains unclear in the literature, as the empirical findings are still ambiguous. Therefore, to what extent FDI may increase productivity, thereby bringing new products or processes into dimensions at both the country and firm levels, has long been debated. This debate is what motivates the theory development and empirical analysis in this thesis.

The first and foremost objective of this thesis is to understand the mechanism through which FDI increases a firms' productivity, thus contributing to economic growth, and then to further reconcile the benefits of FDI in the empirical literature. The argument is that there are knowledge spillovers which occur from FDI, yet the level of human capital, the capacity to adopt new technologies, the level of technology needed to imitate production processes, and the differences between countries' economic performances may all restrict the potential benefits from FDI. For example, the results provided in Hall and Jones (1999) suggest that differences in the stock of human capital and the total factor productivity (TFP) are the important elements of the production function. They find that differences in per capita capital stocks in the two countries contributed to the income differences by a factor of 1.5, while Benhabib and Spiegel (1994), among others, suggest that the potential correlation between FDI and human capital may determine the process of productivity growth. To tackle such possible variations that may exist between FDI-human capital and FDI-TFP, we consider the endogeneity of FDI and depart from the models of Romer (1990) and Barro and Sala-i Martin (1997). We highlight the fact that the relative levels of country efficiency (human capital and TFP) contribute to the decision of the firm in the developed country to engage in FDI in the developing country and then provide consistent empirical findings.

The second objective of this thesis is to propose a new way of measuring vertical linkages and refine the productivity spillovers from multinational firms at the firm level. Many developing countries strive actively to attract FDI and desire its positive externalities (or productivity spillovers) to be distributed over domestic industries and firms. Further, they hope that domestic firms benefit from foreign firms in terms of knowledge, technology, and even management skills once the multinational firms attempt to purchase input materials from domestic firms, or domestic firms try to purchase inputs materials from multinational firms operating in their country. Establishing linkages where the positive externalities exist from multinational firms has become an important exercise in the FDI empirical literature. Nevertheless, most of the recent literature finds no evidence of within-firm productivity spillovers and finds inconsistent evidence of vertical linkage spillovers. For example, Javorcik (2004) and Newman, Rand, Talbot, and Tarp (2015) find an insignificant effect of horizontal spillovers and negative effects of forward linkage spillovers on firms' performances, while Gorodnichenko, Svejnar, and Terrell (2014) find that the effect of forward linkage spillovers is positive but insignificant. Similarly, spillovers through backward linkages are sometimes confirmed as positive (Newman et al., 2015), while, at other times, they are less significant (Gorodnichenko et al., 2014). Why are different spillover effects observed in different studies if such positive linkage spillovers exist? To investigate this question, we focus on how the literature has constructed measures of productivity spillovers. We try to relax the assumptions applied in the existing literature, where the differences in firms' sourcing and supplying behaviours are assumed to be constant across firms, which may potentially affect the identification in both forward and backward linkage spillovers. Thus, we construct new measures of vertical linkages and try to control for the difference in sourcing and supplying behaviours across firms and then provide evidence showing the robustness of our proposed measures.

While much attention has been given to searching for the linkage spillovers on firm productivity and the macro-effect of FDI in growth, there are potential mechanisms that may shed light on the positive externalities of FDI in terms of firms' productivity that have been much less emphasized in the FDI literature - the alteration of firm's core product competences and the tougher product-market competition. As highlighted in the trade literature, countries with greater openness to foreign markets have been shown to raise firms' productivity (Bernard, Redding, & Schott, 2011). A recent study also emphasizes that multinational firms transfer superior technologies through new products and innovations in processes (Guadalupe, Kuzmina, & Thomas, 2012). In the literature regarding multi-product firms, changes in a firm's production structure through changes in its product range and product scale play an important role in determining the firm's aggregate productivity gains. For example, Eckel and Neary (2010) suggest that a firm's productivity increases when they concentrate on their core product lines, whilst Mayer, Melitz, and Ottaviano (2014) suggest that a firm's productivity declines discretely when they increase product variety. Tougher market competition is also predicted theoretically to increase firms' core product competences through markups (Bernard et al., 2011; Eckel & Neary, 2010; Mayer et al., 2014). Such mechanisms through firms' product varieties and the relationship with multinational firms may potentially dominate the productivity gains of firms in the host country. Therefore, it is important that we establish these mechanisms empirically so that we can better understand the sources behind productivity gains from multinationals. This is the third and final objective of this thesis.

1.2 Overview of the Thesis

The thesis is structured as follows. Chapter 2 presents the extended endogenous growth model which endogenizes FDI, and it derives a set of theoretical predictions that help us to address the potential endogeneity of FDI and to identify the benefits of FDI. Following Chapter 2, the second essay presented in Chapter 3 relaxes the assumptions applied in the existing studies on the identification of vertical spillovers through vertical linkages, and it builds new measures of vertical linkages that will be used to find evidence of vertical spillovers. Then Chapter 4 utilizes a unifying empirical framework to show how multinational firms raise domestic firms' productivity through product range and market competition.

A common feature of the three essays in this thesis is that they try to emphasize the importance of FDI in productivity and put much effort into mitigating potential biases in terms of the omitted variables and endogeneity in the estimation. The first and third essays use a two-stage least squares estimator to overcome the endogeneity, while, in the first essay, system-GMM is also employed in a comparison. Due to data limitations, Ordinary Least Squares (OLS) estimation is used frequently throughout the second and third essays with all sector, country, and time fixed effects controlled for, while, in the first essay, the fixed-effect estimator is mainly used.

Though the econometric identification is similar across the three essays, this thesis uses three distinctive datasets from chapter-to-chapter. In the second chapter, starting with cross-country panel data drawn and combined from the World Development Indicator (2016), World Bank National Account Data, Penn World Table 6.3, UNCTAD, and Barro and Lee (2015). The panel data cover the period 1977-2007 and contain information on 67 countries. In chapter 3, we then use pooled, firm-level survey data drawn from the European Bank for Reconstruction and Development conjoined with World Bank Business Environment and Enterprise Performance Survey (BEEPS) datasets. Chapter 4 uses the cross-sectional, firm-level survey data for the period 2006-2016 across 112 developing countries drawn from the World Bank Enterprise Survey.

The rest of this section provides an overview of each essay in the thesis.

1.2.1 Chapter 2 Overview

This chapter derives a new theoretical model based on the framework of Romer (1990) and Barro and Sala-i Martin (1997). The objective is to show that FDI itself in the growth system is endogenous and the differences in human capital and technology between the countries are the potential factors that attract larger amounts of FDI and therefore trigger the growth effect of FDI. By taking the differences into account, this chapter reconciles the conflicting findings in the FDI-Growth nexus, which is its main contribution to the literature.

In terms of the model set-up, by extending the leader-follower model developed by Romer (1990) and Barro and Sala-i Martin (1997), the chapter analyses a case in which firms in the leader country engage in innovation activities, while firms in the follower country engage in imitation activities, and FDI is not allowed. Then the chapter incorporates FDI, along with firm's adaptation activities and the possibility of FDI flowing from developed into developing countries. Multinational firms can adapt their technologies subject to a cost and local firms can no longer imitate (for simplicity). The chapter explores the role played by technological differences (differences in initial TFP and human capital levels across countries in attracting FDI and in the innovation activities of multinational firms).

Our empirical results show that the positive effects of FDI occur when the endogenous determination of FDI is addressed properly. In other words, the positive effects of FDI on the host country's growth are affected by the extent of the differences in the levels of efficiency between the leader and the follower countries. The implications of this chapter are simple yet important. It shows that the empirical strategies used in the existing literature to estimate the growth effect of FDI do not account adequately for the endogenous determination of FDI, which may obstruct researchers in identifying the benefits obtained from FDI.

1.2.2 Chapter 3 Overview

This chapter investigates the measures the effects of FDI vertical linkages on domestic firms' productivity. We reconstruct FDI backward and forward linkages at the firm level and refine the spillover effects originating from multinational firms and flowing to domestic firms. This contributes to the literature on measuring the spillover effects of FDI vertical linkages.

By relaxing the assumption that domestic firms supply inputs to downstream multinational firms at the same proportions they do to local firms, this chapter reconstructs backward linkage at the firm level. Then, by relaxing the assumption that domestic firms purchase inputs from upstream multinational firms with the same intensity as they do from local firms, the forward linkage is also constructed at the firm level. In addition, we compare the results from using the existing standard measures and the results from using our reconstructed measures to see how the differences in firms' sourcing and supplying behaviours matter to the empirical findings.

The findings show that the differences in sourcing and supplying activities are crucial for identifying vertical spillovers. Using a broad, firm-level dataset across 32 emerging countries, the results suggest that the existing standard measures on both backward and forward linkages could lead to biased spillover effects, and no empirical evidence for the linkage spillovers are found in our data. In contrast, our proposed measures of forward linkages show both negative and positive effects of spillovers on firms' productivity to be significantly important. The measure of backward linkage also identifies successfully the economic importance of the backward spillovers on firms' productivity.

1.2.3 Chapter 4 Overview

Chapter 4 focuses on the mechanisms through which the presence of foreign ownership can raise domestic firms' productivity. The contribution of this chapter is that it utilizes the intuition from the theory of multi-product firms which links FDI to a firm's core product competence empirically.

This chapter presents a set of testable hypotheses that describe the mechanisms through which the within-firm productivity improvement occurs via foreign ownership. By focusing on the case of a firm's core product competence and markups, the two factors act as two important channels that link the within-firm productivity improvements to the presence of foreign ownership.

Based on cross-sectional firm-level data, this chapter discovers that the presence of foreign ownership skews firms' production towards the core varieties, while we find that the presence of foreign ownership exhibits a positive and statistically significant effect on firms' core product competences and that this positive effect contributes ultimately to firms' productivity. Furthermore, this chapter documents empirically that the product market competition increased by the presence of foreign ownership reduces the markups across all product lines and this effect further alters the distribution of firms' core product competences.

Chapter 2

Endogenous Growth Effects of FDI: Theory and International Evidence

2.1 Introduction

Economists and policymakers in many developing economies believe firmly that attracting foreign direct investment (FDI) is the key to the economic convergence process, as inward FDI is expected to bring capital stock, advanced knowledge, know-how, employee training, and management skills to these countries (e.g., Borensztein et al., 1998; Alfaro et al., 2004). These potential benefits from FDI are viewed as important, particularly for in terms of their contributions to improving economic development. The technology transfers resulting from FDI are also expected to close the technology gap and help developing economies catch up to the developed economies.

While the question of whether the aforementioned benefits from FDI (i.e., the growth effect of FDI) are guaranteed has been discussed for a long time, the empirical evidence remains oddly inconclusive. On the one hand, in focusing on the development of domestic financial markets in mediating the flow of imported capital to enhance growth, Durham (2004) finds that FDI does not have a direct positive effect on growth but that its effect is contingent on the absorptive capacity of host countries, while Alfaro et al. (2004) find that FDI alone plays an ambiguous role in growth regression and the gains from FDI are dependent on a well-developed financial market. In addition, Campos and Kinoshita (2002) attempt to address potential within-region and within-period variations; yet, because they treat FDI as exogenous in the model, the growth effect of FDI remains unclear. On the other hand, there is the literature based on the endogenous growth theory, where the role of FDI in the process of technology diffusion is testable. However, based on this theoretical framework, Borensztein et al. (1998) find that FDI has no impact on growth rates and further confirm that the benefits from FDI are restricted by the absorptive capability of the country receiving FDI. They also raise doubts on the direct benefits of FDI in developing countries. One recent study by Jude and Levieuge (2017) even remarks that "FDI flows were particularly encouraged by the government in developing countries, leading to an increasing share of FDI in total capital flows. However, the empirical evidence on the growth-enhancing effect of FDI is less conclusive". The inconsistent empirical findings seem to prevent researchers from understanding what the role of FDI in economic growth is.

Since most inward FDI flows from developed economies to developing countries, the growth effect of FDI through transferred knowledge may be determined by the initial differences in countries' abilities. In the leader-follower endogenous growth theory (Romer, 1990; Barro & Sala-i Martin, 1997), the growth rate of developing countries depends on which technologies that are transferred (i.e., the number of intermediates) from developed countries can be adopted and implemented, associating firms' innovations in the leading country and firms' adaptations in the follower country. The initial efficiency in terms of the differences in human capital and TFP between the leader and follower countries is the key to influencing firms' decisions in innovation and adaptation activities. It indicates the differences in countries' abilities to hinder and prevent FDI from generating a positive growth effect[1]. As existing studies do not consider this mechanism, it may be possible that they may have looked for the growth effect of FDI in the wrong context, which may explain why the inconsistent findings have emerged.

Therefore, this chapter exploits the mechanism of country's efficiency linked to FDI, using country-level panel data from 1977 to 2007. First, we derive a theoretical model based on the frameworks of Romer (1990) and Barro and Sala-i Martin (1997) to show the bi-directional relationship between FDI and growth. Based on our extended leader-follower endogenous growth framework, through which FDI is linked to the innovation and adaptation activities determined by countries' abilities, we show that the relative levels of human capital and technology are the potential factors that can trigger the growth effect of FDI on GDP per capita. We then test our model predictions on whether FDI generates a growth effect on the relative level of GDP per capita empirically. By considering the initial differences between the countries, our analysis reconciles the empirical findings in existing FDI-growth literature. To the best of our knowledge, the use of relative level of abilities predicted by our theoretical model in estimating the growth effect of FDI has not been explored in the FDI literature. This, therefore, stands as the main contribution of the chapter.

The findings can be summarized as follows. The empirical results show that FDI takes place on the relative level of GDP per capita between the leader and follower countries, and there is clear evidence showing that the positive effect of

[1] Also note that a country's abilities may be associated with local policies, environments and infrastructures, which may raise concerns regarding a heterogeneous FDI-growth relationship (McCloud & Kumbhakar, 2012).

FDI occurs when the endogenous determination of FDI is addressed properly. In other words, the positive effect of FDI on the relative level of GDP per capita is affected by the extent of the differences in the abilities between the leader and the follower countries. Moreover, by having a direct link with countries' abilities, FDI and GDP per capita, it mitigates potential bias in the estimation. A simple, but important, implication from our findings is that the empirical strategies used in the existing literature to estimate the growth effect of FDI do not account adequately for the endogenous determination of FDI. The results suggest that the assumptions that FDI is exogenous and countries' abilities are constant may obstruct researchers in their search for the benefits from FDI in a cross-country analysis.

The remainder of this chapter is organised as follows: Section 2.2 presents an overview of relevant studies; Section 2.3 presents the theoretical model and measurements for key variables, and outlines the empirical strategy; and Section 2.4 provides information on the data. The results are presented in Section 2.5, and Section 2.6 presents the conclusions.

2.2 Literature Review

2.2.1 The Benefits from FDI

There has been a long-standing interest in why FDI is important for developing countries, and the answer is straightforward. FDI is expected to be a channel for developing countries to access international knowledge, such as know-how, advanced intermediates, and management skills, through multinational firms - these items are crucial for stimulating productivity and economic growth. For example, Javorcik (2004) explains that FDI can generate potential externalities through different supply chain linkages that connect foreign and domestic firms. Foreign firms may provide technical assistance to domestic firms, allowing them to access foreign resources through the linkages. Foreign firms are also linked to the transfer of superior technologies and are known to be responsible for the world's innovations (Borensztein et al., 1998). In addition, workers' mobility between firms is also linked to FDI as a channel for international knowledge transfer from multinationals to domestic firms (Girma, Görg, & Pisu, 2008). These benefits from FDI have been described intensively in the recent literature.

Over time, the focus has shifted towards estimating the growth effect of FDI linked to trade (Makki & Somwaru, 2004; C. Wang, Liu, & Wei, 2004), absorptive capacities and institutions or financial markets (Hermes & Lensink, 2003; Durham, 2004; Alfaro et al., 2004) in developing countries. However, the growth effect of FDI cannot, or at least only to a very limited degree, be identified by these links alone due to the fact that the existing endogeneity of FDI associated with countries' abilities is not addressed properly in the literature. To better clarify this statement, in the leader-follower endogenous growth model in Barro and Sala-i Martin (1997), innovation is only undertaken by the leader nation, while imitation is only undertaken by the follower country. The growth effect from FDI may take place because the follower can improve their production efficiency by copying a number of intermediates that were innovated and used in the leader country. The growth rate of the follower country may thus be improved. Yet, initial differences in technology across nations may hinder the follower country from obtaining the growth effect through FDI, as the leader country may not transfer knowledge efficiently if the existing level of technology is not high enough in the follower country. This concept has not been emphasized in the FDI-growth literature.

Instead, most studies focus on analysing the relationship between FDI and growth and find inconclusive results. For instance, by extending the assumption under which the fixed set-up costs in the process of technology adaptation mentioned by Barro and Sala-i Martin (1997) depend negatively on the ratio of the number of foreign firms operating in the host country, Borensztein et al. (1998) find an insignificantly positive effect of FDI on growth and conclude that the benefits from FDI only occur when the host country has reached a minimum threshold in its stock of human capital. On the other hand, B. Xu (2000) uses a model developed by Barro and Sala-i Martin (1997) to examine the technology diffusion and productivity-enhancing effects from multinational firms. Xu argues that the benefits of FDI include the growth and competition effects. Using the measures of multinationals' expenditures on royalties and the license to distinguish the two effects from FDI, the author finds that the benefits from FDI on technology diffusion and productivity gains depend on a threshold level of human capital in the host country. By contrast, Campos and Kinoshita (2002), who utilise 25 Central and Eastern European and former Soviet Union transition countries from 1990 to 1998, find positive effects of FDI on growth rates and suggest that the threshold level of human capital is not necessary in triggering the benefits from FDI, while, by using 66 developing countries from 1974 to 2004, Makki and Somwaru (2004) report a weak, but significant, positive association between FDI and growth. In a more recent study, Iamsiraroj (2016), who uses data on 124 countries over the period 1971-2010, confirms that the benefits from FDI in developing countries do not necessarily depend on the threshold requirement.

In addition to the above studies, the benefits from FDI may be distorted by a learning-by-watching effect[2]. New knowledge transferred from the leader nation does not impact growth directly because the new knowledge requires some time to be adapted and absorbed. The host country's abilities will be improved whilst absorb-

[2]Local firms may be able to raise the quality of human capital and improve managerial skills by learning and interacting with foreign firms through FDI (Bengoa & Sanchez-Robles, 2003).

ing knowledge, and this improvement effect will ultimately enhance productivity. As noted by Bengoa and Sanchez-Robles (2003), this learning effect from leader to follower country can take place through FDI, whereby the advanced technologies implemented by the leader nation spill over into the host country. Focusing on the relationship between FDI and growth and departing from a theoretical framework, Walz (1997) suggests that the benefits of FDI may be accompanied by the interregional spillovers of knowledge from developed to the less-developed countries. By assuming that technology is transferred via international capital movements from the North to the South, J. Y. Wang (1990) in a theoretical model shows that the income gap would be reduced with an increase in the growth rate of human capital. Well-known early studies also include Benhabib and Spiegel (1994) and Benhabib and Spiegel (2005), which document the potential relationship between human capital and the growth rate in the host country.

Since the existing findings are inconclusive and no study has attempted to exploit the potential link between FDI and initial differences in country's abilities that may trigger growth, this chapter therefore deals with the endogeneity of FDI, which could potentially distort its true effect in the growth estimation. To the extent that the leader nation may transfer knowledge to the follower country through FDI, the former has an incentive to assist the latter to make sure investment projects can be undertaken efficiently. At the same time, the latter has an incentive to improve their own abilities to make sure that the technologies can be absorbed and copied efficiently. This argument is similar to that in the study by Nelson and Phelps (1966), which shows that the growth rate is dependent on the differences in the level of human capital and the technology between the leading and developing nations. Therefore, obtaining the benefits from FDI may require both the follower and the leader to have a certain level of abilities. Since the current literature rarely ventures in this direction, the first contribution of this chapter is that we focus on the differences among the relative levels of human capital and technology between the leader and follower countries. To build up a theoretical framework, we depart from the models presented in Romer (1990) and Barro and Sala-i Martin (1997) by assuming that the adaptation cost depends on the relative levels of human capital and technology and consider the potential relationship between countries' abilities through which the growth effect of FDI may occur. Our model, therefore, generates some useful and testable predictions that help us to understand more about the mechanism between the growth effect of FDI and countries' abilities.

2.2.2 Empirical Strategy

Parallel to the theoretical literature, many cross-country studies have tried to solve the discrepancy between theory and empirical findings in the FDI-growth nexus. The empirical strategies differ narrowly; typically, just three approaches are used when estimating the impact of FDI on growth. The first is to use Ordinary Least Squares (OLS) to provide estimates for FDI and other determinants of growth. The studies using OLS generally suggest that the growth effect of FDI is contingent on factors within the host country. For example, Durham (2004), among others, argues that previous studies neglect the association between the benefits of FDI and the host country's absorptive capacity. By using data on 80 countries from 1979 to 1998, Durham (2004) examines the growth effect of FDI and absorptive factors, including the host country's property rights, regulations, corruption, and the stock market. The findings suggest that FDI has an unmitigated positive effect on economic growth. Similarly, Olofsdotter (1998), who employs an OLS estimator and treats human capital and trade openness as the factors that may strengthen the benefits from FDI, shows that FDI is positively associated with growth and that the beneficiary effects of FDI are stronger in countries with a higher level of institutional capability. Another empirical study by Blomstrom, Lipsey, and Zejan (1994) uses OLS to analyse the influence of certain interchanges of FDI on growth. By using data on 78 developing countries for the period 1960-1985, the authors suggest that while FDI is positively associated with growth, such an association is only the case for high-income developing countries. Although these studies are informative, their findings are sensitive to the unobserved country-level heterogeneity, e.g., the different unobserved steady states across countries that are fixed over time (Barro & Sala-i Martin, 1997). Since OLS is not able to eliminate these potential biases, these cross-country unobserved variations may thus lead to biased estimates. This criticism is also supported by Bengoa and Sanchez-Robles (2003), who argue that there is within-country heterogenous productivity and thus fixed- and random-effect models can produce more robust estimates compared to OLS.

In addition, there are other strands of the empirical literature which suggest that FDI is endogenous, as the effect of FDI on growth has been widely confirmed to be dependent upon a set of conditions in the host country (C. Wang et al., 2004). In a comprehensive literature review, Li and Liu (2005) point out that there are of two issues regarding the endogeneity of FDI that are usually discussed. The first is the potential bilateral causality between FDI and growth. Being the first to highlight the complex relationship between FDI and growth, Nair-Reichert and Weinhold (2001), who employ a panel of 24 developing countries over 25 years and apply a mixed fixed and random (MFR) coefficient approach that allows for heterogeneity in the causal relationship between FDI and growth, confirm that there is considerable heterogeneity across developing countries. Hsiao and Shen (2003) argue that the feedback effects among FDI and growth may exist, as there are intangible factors, such as bureaucracy, the degree of openness and stability of institutions, that may be important in attracting FDI. To mitigate the bias, the authors set up a two-equation system in which FDI and GDP are the two dependent variables. By using three stages least squares estimates (3SLS) for 23 developing countries from 1982 to 1998, they find that a 1% increase in FDI raises GDP by 0.0485%, while a 1% increase in GDP raises FDI by 2.117%. Similarly, by using 80 countries over the period 1971-1995, Choe (2003) applies a panel VAR model to examine the causal relationship between growth and FDI. The author finds that there exists a two-way causation between FDI and growth, but the effect of growth to FDI is more apparent compared to the effect of FDI to growth. Li and Liu (2005), who investigate whether FDI affects growth based on 84 countries over the period 1985-1999, confirm that FDI has positive effects on growth and GDP growth rates also affect FDI positively. While the above studies draw our attention to the causal link between FDI and economic growth, the causality test requires the panel structure to include a long-term dimension in order to obtain consistent estimates (Baltagi, 2008) and, typically, other relevant variable biases still exist in the model (Sims, 1972).

Another important, but often overlooked, issue is the endogeneity of FDI per se. As Borensztein et al. (1998) remark, "the correlation between FDI and growth could arise from the endogenous determination of FDI...the problem is that there are no ideal instruments available". Some studies, therefore, apply the instrumental variable approach by using the lagged values of FDI to mitigate the bias. Campos and Kinoshita (2002), for instance, by using the lagged stock of FDI, quality of the bureaucracy, number of telephone lines, external liberalization index and OECD growth rates as instruments for FDI, find strong evidence supporting the view that there is a positive effect of FDI on host-country growth. Borensztein et al. (1998), among others, use the lagged value of FDI, total GDP, dummies for East Asia and South Asia, measures of political stability and quality of institutions as the instruments of FDI and find that FDI has no statistically positive effects on growth, and that its positive effects depend on the host country's absorptive capability. Another similar study undertaken by Makki and Somwaru (2004), who use lagged values of FDI, lagged values of trade and the natural logarithm of total GDP as instruments, find no significant positive effects of FDI on growth in developing countries. B. Xu (2000), on the other hand, uses the predicted value of multinational enterprises' (MNEs') value-added divided by the host country' GDP and MNEs' technology transfer expenditures divided by the MNEs' value-added as two instrumental variables for FDI. Based on 40 countries from 1966 to 1994, Xu finds that the host country needs to reach a minimum threshold value in human capital in order to benefit from the technology transfers found in FDI.

While the endogeneity problem can be addressed by applying instrumental variable techniques, a number of studies argue that in the FDI-growth regression, all right-hand side variables may be correlated with the model disturbance (Easterly, Loayza, & Montiel, 1997; Doytch & Uctum, 2011). One solution is to use the dynamic panel technique, namely, the Generalized Method of Moments (GMM) estimator (Arellano & Bond, 1991; Blundell & Bond, 1998; Roodman, 2009[3]). In GMM estimation, all right-hand- side variables lagged two periods or more can be valid instruments and generate consistent and efficient estimates. Carkovic and Levine (2005), for example, apply Arellano-Bond difference GMM estimation to investigate the FDI-growth nexus, while Basu and Guariglia (2007), Doytch and Uctum (2011) and Iamsiraroj and Ulubaşoğlu (2015) implement both the Arellano-Bond and Blundell-Bond estimators to estimate the growth effect of FDI. Since no study

[3]Arellano and Bond (1991) provide dynamic panel estimators designed for solving the predicament of a weak exogenous assumption, which is called the "Difference GMM". Blundell and Bond (1998) then build a system GMM that allows the introduction of more instruments and can improve efficiency. Further, Roodman (2009) implements "xtabond2" (the code used in STATA), which offers unique features, including observation weights, automatic difference-in-Sargan/Hansen testing and the ability to collapse instruments to limit instrument proliferation.

has yet provided ideal instruments, by considering all possible endogeneity and generating a set of instruments, GMM could be a good way to alleviate the bias.

Nevertheless, there are debates over the GMM estimations. First, system-GMM is commonly believed to be more efficient than first-differenced GMM (Bond, Hoeffler, & Temple, 2001). By assuming that the time-varying disturbances in the original level's equations are not serially correlated, the basic idea of first-differenced GMM is to take first differences to remove unobserved time-invariant, country-specific effects and then use the level of the series lagged two periods or more of all right-hand-side explanatory variables in the first-differenced equations as a set of instruments. This procedure makes estimates unbiased because unobserved country fixed effects and any omitted variable biases will no longer exist. It also allows all parameters to be estimated consistently because there is a set of instruments that help to mitigate the endogeneity bias. However, the first-differenced GMM estimator behaves poorly if the sample size is finite and time series are persistent (Bond et al., 2001; Doytch & Uctum, 2011). Blundell and Bond (1998) note that the first-differenced GMM estimator may be subject to a large downward finite bias when the lagged levels of the series are weakly correlated with subsequence first differences.

The system-GMM, on the other hand, is recommended as being a more appropriate estimator in a growth context (Bond et al., 2001). The reason why the system estimator performs better than the first-differenced estimator is because the former includes not only the standard set of instruments in first differences with lagged levels but also an additional set of instruments in levels with lagged first differences. Bond et al. (2001), by estimating Solow growth regressions, show that system-GMM presents more reasonable and efficient results than first-differenced GMM. Another point worth noting is that the disturbances in one-step and two-step system-GMM estimators are different. While they may be the same in some special cases, the former is more efficient than the later in finite samples because the asymptotic standard error in the two-step GMM estimator may be seriously biased and reduce the estimated efficiency (Blundell & Bond, 1998).

2.3 The Model and Estimation Framework

This section presents the theoretical and empirical frameworks used in this chapter. By extending the leader-follower (or innovation-imitation) model developed by Romer (1990) and Barro and Sala-i Martin (1997), we analyse a case in which there is participation in innovation and imitation activities on the part of the firms in the leader and follower nations. FDI is not allowed in this scenario, and technology transfers may be unavailable, as the absence of FDI raises the issue of international patent protection, which implies that countries behind the technological frontier only participate in imitation activities. In the next scenario, we allow FDI to take place in the model, where the frontier countries in the "North" are producing designs for new types of intermediate goods and the firms in the frontier countries can transfer certain technologies abroad by building facilities, licensing and then adapting technology through FDI in the "South" (Helpman, 1993; Jones & Vollrath, 2013). In this scenario, the adaptation activities pursued by the multinational firms involve the relative level of countries' abilities and the cost of adaptation. We then derive an equation that shows how countries' abilities are shaping the growth effect of FDI and how these factors make such impacts on the relative level of GDP per capita between the leader and follower countries.

2.3.1 Theoretical Model Setup

There are two countries, a leader and a follower, denoted by the subscripts $i = 1, 2$, respectively. There is a unique final good produced in perfect competition in both countries using the same technology, as described below. In these economies, the growth of GDP per capita comes through the invention and/or adaptation/imitation of new capital goods. In the leader country, firms in the R&D sector devote resources to creating new capital goods. Once a new capital good has been created, the inventor will be granted with an infinite patent. This patent will be sold to an intermediate producer, which will sell the differentiated good in a monopolistic competition environment. In the follower country, imitation is assumed to be cheaper than innovation; therefore, the follower country prefers to copy rather than to invent. The next subsection describes the fundamentals for the leader country, and the fundamentals for the follower country will be described afterwards.

2.3.1.1 Invention in Country 1 (The Leader)

Final Goods Sector

In the leader country, the final output is produced under perfect competition using the following technology:

$$Y_1 = A_1 H_1^{1-\alpha} \sum_{j=1}^{N_1} (X_{1j})^{\alpha} \tag{2.1}$$

where $0 < \alpha < 1$, X_{1j} is the quantity employed of the jth type of nondurable capital good, and N_1 is the number of types of capital goods available in country 1. Following Jones and Vollrath (2013), we assume that the total human capital of the country is given by $H_1 = e^{(\varphi\mu_1)}L$, where φ is a measure of the quality of human capital and μ_1 is the number of years each worker in the labour force spends in education, and L measures the size of the labour force. The parameter A_1 is an overall measure of technological efficiency, which varies across countries. Individuals in the economy are endowed with h units of human capital[4]. Firms in the final good

[4]For simplicity, I abstract from a household's decision of accumulating human capital.

sector will choose H_1, X_{1j} to maximise profit:

$$\max_{H_1, X_{1j}} \quad Y_1 - w_1 H_1 - \sum_{j=1}^{N_1} P_{1j} X_{1j}$$

where P_{1j} is the price of intermediate j in the leader nation. The first order condition associated with each capital good is given by:

$$A_1 \alpha H_1^{1-\alpha} X_{1j}^{\alpha-1} = P_{1j} \tag{2.2}$$

Which implies that the quantity of the intermediates j input demanded, X_{1j}, is a function of the price P_{1j}

$$X_{1j} = (\frac{\alpha A_1}{P_{1j}})^{\frac{1}{1-\alpha}} H_1 \tag{2.3}$$

equation (2.3) is the demand for j type capital good innovated in country 1.

Intermediate Goods Sector

Each variety of capital goods is produced by a unique producer using 1 unit of final output. Since each producer is the only supplier of that capital good, the producer settles the price that maximizes the profits:

$$\begin{aligned} \max_{P_{1j}} \quad & (P_{1j} - 1) X_{1j} \\ \text{s.t.} \quad & P_{1j} = A_1 \alpha H_1^{1-\alpha} X_{1j}^{\alpha-1} \end{aligned} \tag{2.4}$$

The producer of X_{1j} selects P_{1j} at each date to maximize the current profit at the date. Thus, to solve the problem we substitute of equation (2.3) into equation (2.4) and take the first order condition with respect to P_{1j} to yield the monopoly price:

$$\max_{P_{1j}} \quad \pi_{1j}(v) = (P_{1j} - 1)(\frac{\alpha A_1}{P_{1j}})^{\frac{1}{1-\alpha}} H_1 \tag{2.5}$$

so

$$\begin{aligned} \frac{\partial \pi_{1j}}{\partial P_{1j}} &= \frac{-\alpha}{1-\alpha} P_{1j}^{\frac{-1}{1-\alpha}} (\alpha A_1)^{\frac{1}{1-\alpha}} H_1 - (\frac{-1}{1-\alpha}) P_{1j}^{\frac{-2+\alpha}{1-\alpha}} (\alpha A_1)^{\frac{1}{1-\alpha}} H_1 \\ &= 0 \end{aligned}$$

By simplifying the above equation, we obtain the monopoly price $P_{1j} = \frac{1}{\alpha}$. Note that the monopoly price is constant over time and it is the same for all intermediate goods, because the cost of production for all intermediate goods is the same, and each good enters symmetrically the production function (Eq. (2.1)). Substituting the price into Eq. (2.3) to get the total quantity of the type j intermediate good we obtain:

$$\begin{aligned} X_{1j} = X_1 &= (\frac{\alpha A_1}{P_{1j}})^{\frac{1}{1-\alpha}} H_1 \\ &= \alpha^{\frac{2}{1-\alpha}} A_1^{\frac{1}{1-\alpha}} H_1 \end{aligned} \tag{2.6}$$

Therefore, the level of aggregate output is given by the following equation:

$$\begin{aligned} Y_1 &= A_1 H_1^{1-\alpha} \alpha^{\frac{2\alpha}{1-\alpha}} A_1^{\frac{\alpha}{1-\alpha}} H_1^{\alpha} N_1 \\ &= A_1^{\frac{1}{1-\alpha}} \alpha^{\frac{2\alpha}{1-\alpha}} H_1 N_1 \end{aligned} \tag{2.7}$$

Substitution of Eq. (2.6) into the objective function of (2.4), we obtain the profits that the intermediate producer obtains at each period of time which is given by:

$$\pi_{1j} = \pi_1 = (1-\alpha)\alpha^{\frac{1+\alpha}{1-\alpha}} H_1 A_1^{\frac{1}{1-\alpha}} \tag{2.8}$$

where Eq. (2.8) implies that the profit flow is constant over time across goods.

Research Sector

Let denote with V_1 the value of a patent. This is given by the current discounted value of profits obtained by the intermediate producer. Households in the economy have two options, they can invest in bonds obtaining an interest r_1, or they can invest in innovation. Since the profit flow is constant, the present discounted value of profits associated with the invention of an intermediate good is given by:

$$V_1(t) = \pi_{1j} \int_t^{\infty} e^{\int_t^s -r_1(v)dv} ds \tag{2.9}$$

where $r_1(v)$ is the real interest rate at time v in country 1. As we described, researchers will decide to enter the R&D sector if $V_1(t) > \eta_1$ (η_1 is the innovation cost). Since there is free entry in the R&D sector, in equilibrium the net profit must be equal to zero. In equilibrium:

$$V_1 r_1 = \pi_1 + \dot{V}_1 \tag{2.10}$$

Eq. (2.10) says that the investing V_1 of any resources in bonds will earn $V_1 r_1$; investing in innovation, by contrast, will obtain $\pi_1 + \dot{V}_1$. By using free entry condition, which implies that $\dot{V}_1 = 0$ (since η_1 is constant), we have the following equations:

$$\begin{aligned} r_1 &= \frac{\pi_1}{\eta_1} \\ &= (1-\alpha)\alpha^{\frac{1+\alpha}{1-\alpha}} H_1 A_1^{\frac{1}{1-\alpha}} \eta_1^{-1} \end{aligned} \tag{2.11}$$

where r_1 is the rate of return, which depends on the underlying technology A_1 and H_1.

Households

We close the model by considering behaviour of households. Households maximise a standard inter-temporal utility function, subject to the underlying households' aggregate budget constraint

$$\begin{aligned}
\text{Max} \quad & \int_0^\infty e^{-\rho t} \frac{C_1^{1-\theta} - 1}{1-\theta} dt \\
\text{s.t.} \quad & c_t + \dot{b_t} = w_t h_t + r_t b_t + \pi_t \\
& b_t \geq 0 \\
& b_0 > 0
\end{aligned} \tag{2.12}$$

Where b_t, w_t, h_t and r_t are households' assets, wage rate, labour and the rate of return. In Eq. (2.12) ρ refers to the rate of time preference and $\theta > 0$ so that the elasticity of marginal utility is a constant. To solve the utility maximization problem, we consider the Hamiltonian

$$H(c, b, t, u) = e^{-\rho t} \frac{C_1^{1-\theta} - 1}{1-\theta} + \mu_t [w_t h_t + r_t b_t + \pi_t - c_t] \tag{2.13}$$

The solution to the Hamiltonian is characterized by following first order conditions

$$\begin{aligned}
\frac{\partial H}{\partial c} &= 0 \\
\frac{\partial H}{\partial b_t} &= -\dot{\mu}
\end{aligned} \tag{2.14}$$

and the transversality condition is given by

$$\lim_{t \to \infty} \mu_t b_t = 0 \tag{2.15}$$

and from Eq. (2.14) we obtain

$$\begin{aligned} &e^{-\rho t} C_1^{-\theta} - \mu_t = 0 \\ &r_1 \mu_t = -\dot{\mu} \end{aligned} \tag{2.16}$$

Note that by taking logs and time derivatives in Eq. (2.16) we obtain

$$\frac{\dot{C}_1}{C_1} = \frac{1}{\theta}(\frac{-\dot{\mu}}{\mu} - \rho) \tag{2.17}$$

combining Eq. (2.17) with Eq. (2.16) we have the following equation (the Euler equation)

$$\frac{\dot{C}_1}{C_1} = \frac{1}{\theta}(r_1 - \rho) \tag{2.18}$$

from Eq. (2.18), the growth rate of C_1 is constant since r_1 is constant.

In equilibrium, the households' aggregate assets equal the market value of firms' intermediate goods, so $b_t = \eta_1 N_1$ (implies that $\dot{b} = \eta_1 \dot{N}_1$ as η_1 is constant). The level of consumption is therefore given by

$$C_1 + \dot{b} = w_1 H_1 + r_1 \eta_1 N_1 + \Pi_1 \tag{2.19}$$

In the steady state C_1, y_1 and N_1 are growing at a constant rate and r_1, X_1, π_1, V_1 and b_t are constant (i.e., $\frac{\dot{C}_1}{C_1} = \frac{\dot{y}_1}{y_1} = \frac{\dot{N}_1}{N_1}$). The growth rate of this economy is given by

$$\gamma_1 = \frac{1}{\theta}((1-\alpha)\alpha^{\frac{1+\alpha}{1-\alpha}} H_1 A_1^{\frac{1}{1-\alpha}} \eta_1^{-1} - \rho) \tag{2.20}$$

equation (2.20) shows that $\gamma_1 \geq 0$ if $(1-\alpha)\alpha^{\frac{1+\alpha}{1-\alpha}} H_1 A_1^{\frac{1}{1-\alpha}} \eta_1^{-1} \geq \rho$ holds. It implies that the growth rate of output is consistent with the growth rate of N_1 at the constant rate of γ_1. In other words, the growth rate of the leader nation grows as the number of new types of intermediates increases. The growth rate is increasing in H_1 but decreasing in η_1.

2.3.1.2 Imitation in Country 2 (The Follower)

Final Goods Sector

As country 2 holds a low level of technology, imitation may be the best way for country 2 to improve their efficiency. The follower country can copy the intermediates invented in the leader country and then upgrade their present level of technology. The final output is produced under perfect competition using the following technology:

$$Y_2 = A_2 H_2^{1-\alpha} \sum_{j=1}^{N_2} (X_{2j})^{\alpha} \tag{2.21}$$

where $0 < \alpha < 1$ and H_2 is the level of human capital (skilled labour $H_2 = e^{(\varphi \mu_2)} L$), X_{2j} is the quantity employed of the type j intermediate good, N_2 is the total number of intermediates in country 2. Note that the capital goods currently employed in the follower country are assumed to be the one invented in country 1. The parameter A_2 again is an overall measure of technological efficiency.

Imitating new types of intermediate goods is costly, thus the cost of imitation is set as follows:

$$m_2 = (\frac{N_2}{N_1})^{\sigma} \tag{2.22}$$

where N_1 and N_2 refer to the number of intermediates that are available in the leader and the follower country. Note that the cost of technology transfer rises with the current level of intermediates used by the country, as it is the case in standard growth models of technology transfer (Jones, 1995; Barro & Sala-i Martin, 1997; Jones & Vollrath, 2013, Ch5); this reflects the idea that technologies are transferred from the easiest ones to the most complicated ones (i.e., $\sigma > 0$).

Intermediate Goods Sector

As country 2 will put the same monopoly price of type j intermediate good $\frac{1}{\alpha}$, equations (2.6) and (2.7) therefore provide the equations as follows (parallels with the leader country):

$$X_{2j} = X_2 = \alpha^{\frac{2}{1-\alpha}} A_2^{\frac{1}{1-\alpha}} H_2 \tag{2.23}$$

$$Y_2 = A_2^{\frac{1}{1-\alpha}} \alpha^{\frac{2\alpha}{1-\alpha}} H_2 N_2 \tag{2.24}$$

$$\pi_{2j} = \pi_2 = (1-\alpha)\alpha^{\frac{1+\alpha}{1-\alpha}} H_2 A_2^{\frac{1}{1-\alpha}} \tag{2.25}$$

equation (2.23) is the total quantity of the type j intermediate good, Eq. (2.24) is the total output in the follower country and Eq. (2.25) is the flow of profit of type j intermediate.

Imitation Sector

Through equations (2.23) to (2.25), the present value of profits from imitation of intermediates j in country 2 is

$$V_2(t) = \pi_2 \int_t^{\infty} e^{\int_t^s -r_2(v)dv} ds \tag{2.26}$$

where r_2 is the rate of return in country 2 at time t. Using the free-entry condition, the present value of profit from imitation in equilibrium must be equal to the cost of imitation at each point in time

$$V_2(t) = (\frac{N_2}{N_1})^{\sigma} \tag{2.27}$$

which implies that the profit gained from investing bonds equals the profit gained from imitation

$$r_2 m_2 = \pi_2 + \dot{m}_2 \tag{2.28}$$

Household

Households in country 2 maximise the standard inter-temporal utility function and subject to the budget constraint. The Euler equation is therefore given as below

$$\begin{aligned}\frac{\dot{C}_2}{C_2} &= \frac{1}{\theta}(r_2 - \rho) \\ &= \frac{1}{\theta}((\frac{N_2}{N_1})^{-\sigma}(1-\alpha)\alpha^{\frac{1+\alpha}{1-\alpha}} H_2 A_2^{\frac{1}{1-\alpha}} - \rho)\end{aligned} \tag{2.29}$$

In the steady-state, the growth rate of Y_2 and C_2 equal the growth rate of N_2, which equals γ_1 (as will be seen in Eq. (2.36)). Therefore, the rates of return in the two countries are the same, which implies that

$$\gamma_2^* = \gamma_1 \tag{2.30}$$

Since the preference parameters ρ and θ are the same in both countries, equations (2.11), (2.20) and (2.29) imply the rates of return in the two countries are the same

$$r_2^* = r_1 \tag{2.31}$$

and from (2.28) we obtain

$$\begin{aligned}r_2^* &= \frac{\pi_2}{m_2} \\ &= (\frac{N_2}{N_1})^{-\sigma}(1-\alpha)\alpha^{\frac{1+\alpha}{1-\alpha}} H_2 A_2^{\frac{1}{1-\alpha}}\end{aligned} \tag{2.32}$$

where m_2 is constant as in the steady state. Thus, from Eq. (2.32) we obtain

$$\frac{\pi_2}{m_2} = \frac{\pi_1}{\eta_1} \tag{2.33}$$

where $\frac{\pi_2}{m_2} = r_2$ and $\frac{\pi_1}{\eta_1} = r_1$, as given. We can simplify the Eq. (2.33) as follows:

$$\begin{aligned}(m_2)^* &= \frac{\pi_2}{\pi_1}\eta_1 \\ &= \eta_1 \frac{H_2}{H_1}(\frac{A_2}{A_1})^{\frac{1}{1-\alpha}}\end{aligned} \tag{2.34}$$

from Eq. (2.34) we obtain the steady-state value of $(\frac{N_2}{N_1})^*$

$$(\frac{N_2}{N_1})^* = [\eta_1 \frac{H_2}{H_1}(\frac{A_2}{A_1})^{\frac{1}{1-\alpha}}]^{\frac{1}{\sigma}} \tag{2.35}$$

Substitution of the steady-state value of $(\frac{N_2}{N_1})^*$ to the common growth rate shows that the growth rate of the follower country and the leader country are the same

$$\begin{aligned}(\gamma_2)^* &= \frac{1}{\theta}[((\eta_1 \frac{H_2}{H_1}(\frac{A_2}{A_1})^{\frac{1}{1-\alpha}})^{-1}(1-\alpha)\alpha^{\frac{1+\alpha}{1-\alpha}} H_2 A_2^{\frac{1}{1-\alpha}}) - \rho] \\ &= \frac{1}{\theta}[\eta_1^{-1}(1-\alpha)\alpha^{\frac{1+\alpha}{1-\alpha}} H_1 A_1^{\frac{1}{1-\alpha}} - \rho] \\ &= \gamma_1\end{aligned} \tag{2.36}$$

In the steady state the relative level of GDP per capita for two countries is given by

$$\begin{aligned}(\frac{y_2}{y_1})^* &= (\frac{A_2}{A_1})^{\frac{1}{1-\alpha}} \frac{h_2}{h_1}(\frac{N_2}{N_1})^* \\ &= (\frac{A_2}{A_1})^{\frac{1+\alpha}{(1-\alpha)\sigma}}(\frac{h_2}{h_1})^{\frac{\sigma}{\sigma+1}}\eta_1^{\frac{1}{\sigma}}\end{aligned} \tag{2.37}$$

Thus, the ratio depends positively on the relative values of $\frac{A_2}{A_1}$, $\frac{h_2}{h_1}$ and $\frac{N_2}{N_1}$.

2.3.1.3 Inward Foreign Direct Investment from the Leader

We now consider foreign direct investment in the process of knowledge transfer. Assuming there are two activities the firm in the leader country can undertake: adapting or not adapting their intermediate to the follower economy. We assume that both countries respect legislation regarding international intellectual property and consequently, the intermediate producer can exert the monopoly rights across both countries. Firms from country 1 adopt the products for use in country 2 at d_2 unit costs of adaptation and the rate of return to this adaptation activities through FDI exceeds the rate for innovation (r_1) at the costs η_1 in country 1.

To analyse the role of FDI in the process of technology through firms' adaptation activities, we assume that the adaptation cost depends on the difference in countries' efficiency and the explanation is the following. When multinational firms participate in adaptation activities in the follower country, they are expected to pay for the pre-start-up training cost (Teece et al., 1977). As remarked by Teece et al. (1977), the domestic firm which has more skilled labour is likely to have less difficulty in absorbing new technology in the industry, and so the cost is likely to be lower. Whilst the cost is lower if the local firm has the capability to solve unusual technical problems (Oshima, 1973). Therefore, we assume that the relative level of human capital and technology efficiency are the determinants that have such impacts on technology transfer activities. The cost of adaptation is therefore set as follows:

$$d_2 = (\frac{N_2}{N_1})^{\sigma}(\frac{A_1}{A_2})^{\delta}(\frac{H_1}{H_2})^{\beta}, A_2 \leq A_1 and H_2 \leq H_1 \tag{2.38}$$

A_1/A_2 and H_1/H_2 refer to the relative level of technology and human capital between country 1 and 2. σ, δ and β are the power of the variables that are set to be positive, following the reasons below. The cost of adaptation was lower than those for innovation when little copying has occurred but rose as the pool of uncopied ideas contracted (Barro & Sala-i Martin, 2004, Ch8). In other words, the cost of adaptation rises as technologies are transferred from the easiest to the most complicated (i.e., $\sigma > 0$). In addition, the difference between Eq. (2.38) and Eq. (2.22) is that here we assume that the relative level of technology and human capital have such impacts on leader country's adaptation activity. The cost of adaptation decreases in the increase in the level of human capital and the current level of technological efficiency in the host country; this reflects the fact that multinationals find it easier to transfer technology when the population in the host country is skilled and the level of technology is high (i.e., $\delta > 0$ and $\beta > 0$).

The innovators now have the intellectual property rights over the use of their intermediates in country 1 and country 2. Let us denote V_{1d} for the value of a firm in country 1 that adopts the product in domestic (country 1) and foreign (country 2) and V_{1nd} for the value of a firm which does not adopt the intermediate in the foreign country. If the firm does not adapt the intermediate, the value of V_{1nd} is given by $\frac{\pi_1}{\eta_1}$, as shown in Eq. (2.11). Whilst the value of V_{1d} is given by the sum of the profit π_1 and π_2 divided by the sum of the cost in η_1 and d_2 if the firm decides to adopt the intermediate in the follower economy, which is given by

$$V_{1d} = \frac{\pi_1 + \pi_2}{\eta_1 + d_2} \tag{2.39}$$

where $d_2 = (\frac{N_2}{N_1})^{\sigma}(\frac{A_1}{A_2})^{\delta}(\frac{H_1}{H_2})^{\beta}$. In equilibrium, V_{1nd} and V_{1d} will be the same, which implies

$$\frac{\pi_1 + \pi_2}{\eta_1 + d_2} = \frac{\pi_1}{\eta_1} \tag{2.40}$$

therefore, the ratio of N_2 and N_1 in the steady state is given as follows:

$((\frac{N_2}{N_1})^*(H_1, H_2, A_1, A_2, \eta_1))$:

$$\begin{aligned}(\frac{N_2}{N_1})^* &= [[\frac{\eta_1(\pi_1+\pi_2)}{\pi_1} - \eta_1](\frac{A_2}{A_1})^{\delta}(\frac{H_2}{H_1})^{\beta}]^{\frac{1}{\sigma}} \\ &= [\eta_1(\frac{A_2}{A_1})^{\frac{1+\delta-\alpha\delta}{1-\alpha}}(\frac{H_2}{H_1})^{1+\beta}]^{\frac{1}{\sigma}}\end{aligned} \tag{2.41}$$

Eq. (2.41) implies that the number of varieties of intermediates adapted N_2/N_1 is affected by the cost of innovation η_1, the relative level of human capital parameter H_2/H_1 and the relative level of technology A_2/A_1[5]. It also highlights the fact that a higher cost of innovation would increase the number of intermediates produced in the follower country, which implies that the leader would do more on adapting their intermediates in the follower country. As N_2/N_1 represents the role of FDI in the model, this equation theoretically highlights the endogeneity of FDI, which can be properly addressed by the right-hand side variables - namely H_2/H_1 and A_2/A_1 - in the equation. The common growth rate in country 1 now is given by

$$\tilde{\gamma} = \frac{1}{\theta}(\tilde{r} - \rho) \tag{2.42}$$

where $\tilde{r} = \frac{\pi_1+\pi_2}{\eta_1+\eta_1(\frac{A_2}{A_1})^{\frac{1}{1-\alpha}}\frac{H_2}{H_1}}$.

Eq. (2.42) shows that in equilibrium the growth rate of country 1 is affected by the cost of innovation and the profit gained from the innovation. The relative level of technology and human capital are also the determinants of the growth rate. Note that the growth rates of country 2 and country 1 are the same because the multinational from country 1 will increase the production of country 2 that stimulates the growth rate. In other words, the rate of return in equations (2.28) and (2.29) correspond to a steady state in which N_1, Y_1, C_1, N_2, Y_2 and C_2 all grow at a constant rate $\tilde{\gamma}$. While it shows that the growth rate of country 2 will become larger

[5]The proof is provided in Appendix.

once FDI arrives in the country, it will however slow down when the level of human capital and technology in country 2 increases, as seen in Eq. (2.38). For example, the college enrolment in China increased nearly fivefold after receiving large inward FDI between 1997 and 2007, yet the growth rate slowed down when the level of human capital increased (Whalley & Zhao, 2010).

From equations (2.7) and (2.24) we then obtain the ratio of per-worker product for the two countries

$$\begin{aligned} (\frac{y_2}{y_1})^* &= (\frac{A_2}{A_1})^{\frac{1}{1-\alpha}} \frac{h_2}{h_1} (\frac{N_2}{N_1})^* \\ &= (\frac{A_2}{A_1})^{\frac{1+\delta-\alpha\delta+\sigma}{(1-\alpha)\sigma}} (\frac{h_2}{h_1})^{\frac{1+\beta+\sigma}{\sigma}} (\eta_1)^{\frac{1}{\sigma}} \end{aligned} \tag{2.43}$$

Eq. (2.43) shows that the ratio (GDP per capita in level) depends on the relative level of the productivity parameters A_2/A_1, the relative level of $(N_2/N_1)^*$ and h_2/h_1. Recall from Eq. (2.41) that the number of intermediates available in country 1 and country 2 is determined by the relative level of technology and human capital, while Eq. (2.43) shows that the relative level of GDP per capita is determined by the number of intermediates available in country 1 and 2.

2.3.2 The Role of FDI: Hypotheses

Our model generates a number of testable implications on the growth effect of FDI and the pre-determinants of FDI itself. We present hypotheses describing the mechanisms through which the growth effect of FDI occurs and what factors may hinder the growth effect of FDI.

The Effect of FDI on the relative level of GDP per capita

Past empirical studies have indicated that the growth effect of FDI is controversial. While some studies observe a positive and significant effect of FDI on the host country's economy (Campos & Kinoshita, 2002; Alfaro et al., 2004; C. Wang et al., 2004; Makki & Somwaru, 2004; Delgado, McCloud, & Kumbhakar, 2014), others find ambiguously insignificant effects (Borensztein et al., 1998; Hermes & Lensink, 2003; Durham, 2004; Jude & Levieuge, 2017). Nevertheless, the growth effect of FDI is clearly given by Eq. (2.43). The expression Eq. (2.43) shows that N_2/N_1 may directly affect the growth rates, as the more capital goods that are adopted by the multinational firms, the more advanced technologies can be transferred from the leader to the follower countries. This leads to the first testable implication for the growth effect of FDI from our model:

HYPOTHESIS 1. *The estimated coefficient of N_2/N_1 (FDI) is positively associated with y_2/y_1; an increase in the level of FDI increases the relative income of developing versus developed economies.*

The Effect of Pre-Determination of FDI on GDP per capita

In addition, the concept that the level of human capital in a host country is critical for FDI to generate positive effects has been discussed intensively (Borensztein et al., 1998;Hermes & Lensink, 2003; Durham, 2004). While some studies find that the empirical results are consistent with this argument, our theoretical model outlines that it is the relative level of human capital that matters for the relative level of GDP per capita. The expression in Eq. (2.41) for the pre-determination of FDI shows that the number of intermediates available in both leader and follower countries is influenced by the differences in the relative level of human capital and technology between the two countries (i.e., the indirect effects of A_2/A_1 and h_2/h_1 through N_2/N_1 on y_2/y_1), while Eq. (2.43) shows that the differences in the relative level of human capital and technology also determine the rate of return directly, i.e., the direct effects of A_2/A_1 and h_2/h_1 on y_2/y_1. In other words, FDI enters the equation endogenously with the differences in abilities between the two countries. Therefore, we have the second and the third testable implications from our model:

HYPOTHESIS 2. *An increase in the relative level of human capital increases the relative level of income per capita. This increase comes through both a direct effect (from h_2/h_1 to y_2/y_1) and an indirect effect via FDI.*

HYPOTHESIS 3. *An increase in the relative level of technology increases the relative level of income per capita. This increase comes through both a direct effect (from A_2/A_1 to y_2/y_1) and through an indirect effect via FDI.*

2.3.3 Estimating Technology, Human Capital, FDI and GDP per capita

We rely on our theoretical model to analyse how FDI (N_2/N_1) influences GDP per capita (y_2/y_1). In doing so, three key variables need to be constructed. The first two refer to A_2/A_1 and h_2/h_1, while the third refers to N_2/N_1. We first compute the relative level of human capital h_2/h_1. To construct this variable, we follow Jones and Vollrath (2013):

$$schooling^v = e^{\varphi \mu^v}$$

where the superscript v refers to s and st. The φ is set to be 0.10. The parameter μ^v refers to the average educational attainment of the labour force in years, where the superscript s is the average total schooling and st is the tertiary educational attainment. The parameter φ is assumed to be equal to 10%, which is based on a large body of literature in labour economics that finds that an additional year of schooling increases the wages earned by an individual by something like 10% (Jones & Vollrath, 2013, Ch3).

Having constructed the $schooling^v$, we then compute the relative level of human

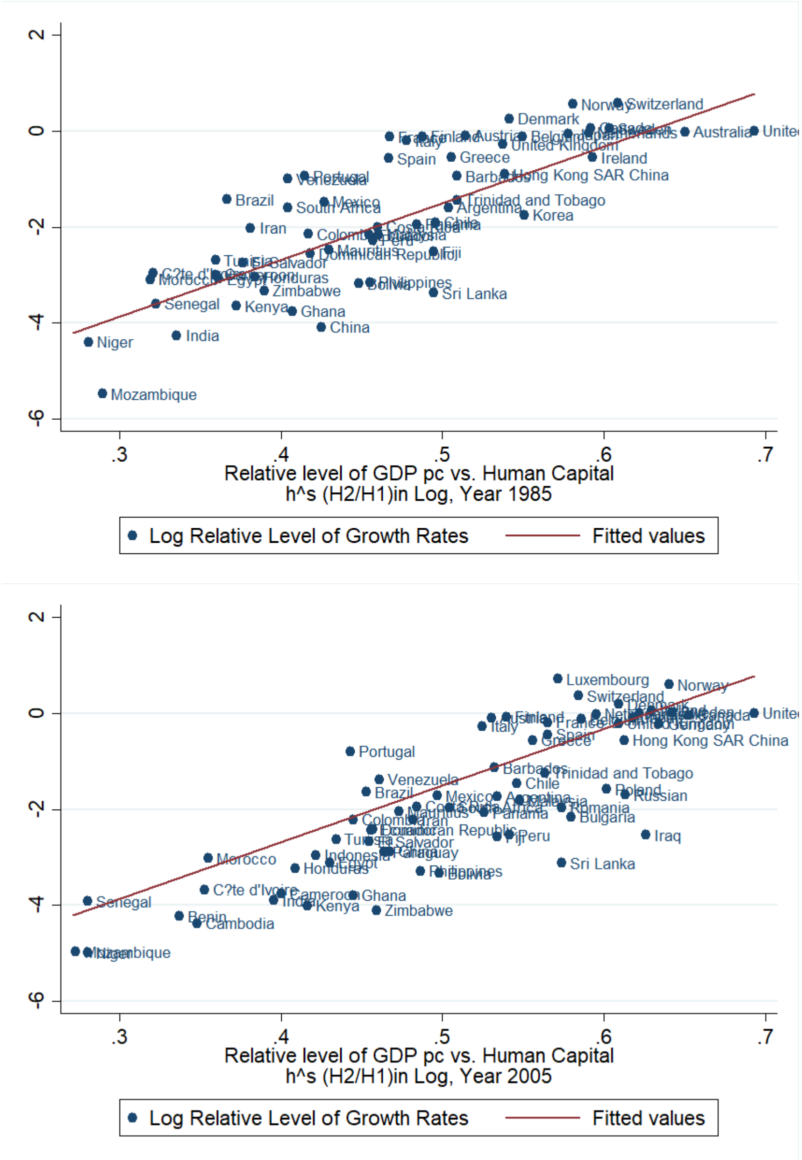

Figure 2.1: The Relationship between the Relative Level of GDP per capita (vertical axis) and Human Capital in Year 1985 and 2005

capital as follows:

$$h^v = \frac{h_2^v}{h_1^v} = \frac{Schooling_2^v}{Schooling_1^v}, v = s, st \tag{2.44}$$

where the superscript 1 refers to the leader country (the US) and 2 refers to other follower country. As specified in Eq. (2.38), the higher the level of human capital in the leader country, the lower the cost of adaptation and the higher the GDP per

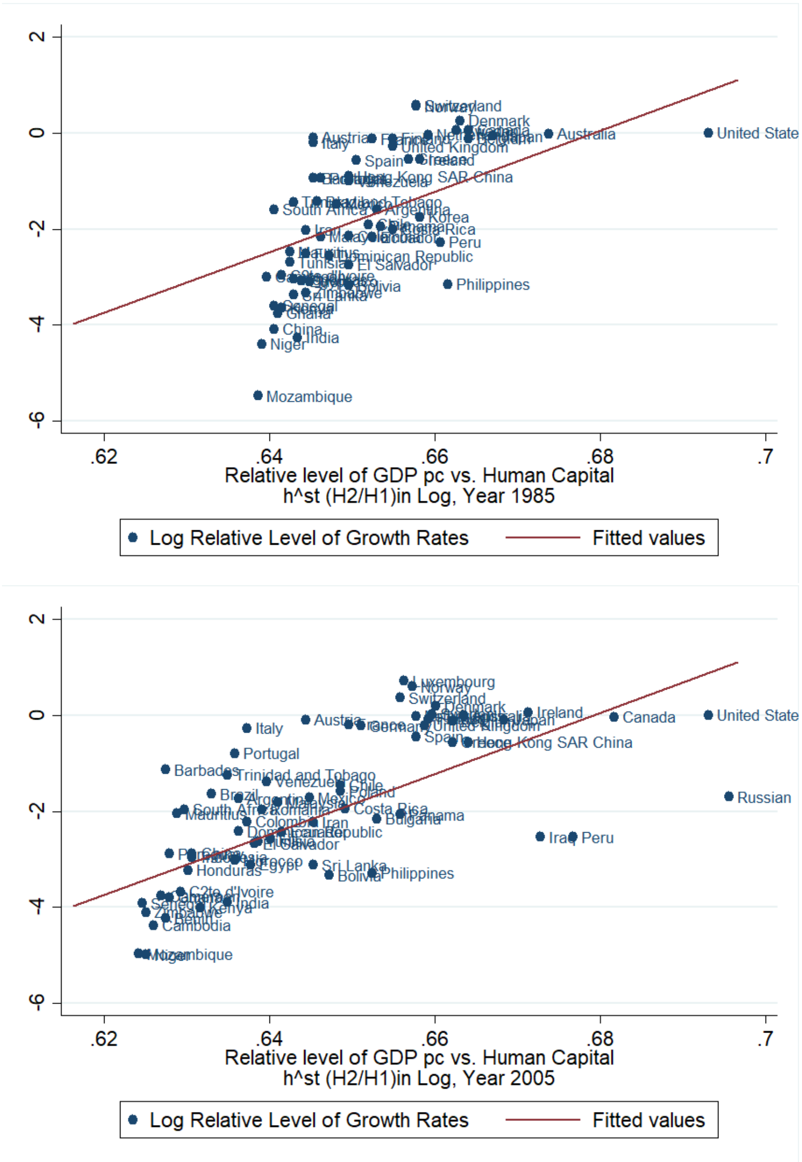

Figure 2.1 (Continued): The Relationship between the Relative Level of GDP per capita (vertical axis) and Human Capital in Year 1985 and 2005

capita in the follower country. This measure in logarithms lies within the range 0.271 to 0.693 for h^s and 0.624 to 0.695 for h^{st}. A large ratio in the measure indicates a high level of human capital in the follower country, which enables firms in the US to transfer knowledge to the recipient economy efficiently. Figure 2.1 shows that the relative level of GDP per capita (in logarithms) and the relative level of human capital (in logarithms) are clearly positive and that an upward trend is displayed through the two-way scatter plots.

The proxy for the relative level of technology A_2/A_1 is constructed by using the TFP in levels. First, we derive the TFP formulation from equations (2.1) and (2.21) for the leader and follower countries:

$$\begin{aligned} A_1^v = TFP_1^v = (\frac{GDPpc_1}{k_1^{\alpha} h_1^{v\,1-\alpha}}) \\ A_2^v = TFP_2^v = (\frac{GDPpc_2}{k_2^{\alpha} h_2^{v\,1-\alpha}}) \end{aligned} \tag{2.45}$$

where the $GDPpc$ refers to the GDP per capita; the coefficient α, which is the human capital share, is set at one-third; h is the investment rates of human capital mentioned above and k is the capital stock per capita. The relative level of technology is then measured by dividing the level of TFP in the country by the level of TFP in the US, which is:

$$\begin{aligned} A^s = \frac{A_2^s}{A_1^s} = \frac{TFP_2^s}{TFP_1^s} \\ A^{st} = \frac{A_2^{st}}{A_1^{st}} = \frac{TFP_2^{st}}{TFP_1^{st}} \end{aligned} \tag{2.46}$$

where TFP_2^s and TFP_1^s refer to the TFP calculated by using the average total schooling in the follower 2 and leader 1 countries, respectively, while TFP_2^{st} and TFP_1^{st} refer to the TFP calculated by using the tertiary educational attainments in these same two countries, respectively. The measure of the relative level of technology lies between 0 and 1, where a value near 1 indicates a slight difference between the leader and follower country. As discussed in the preceding section, the higher the level of TFP in the follower country, the higher the volume of FDI stock and the higher the GDP per capita in the follower country. The relationship between the relative level of TFP (in logarithms) and the relative level of GDP per capita

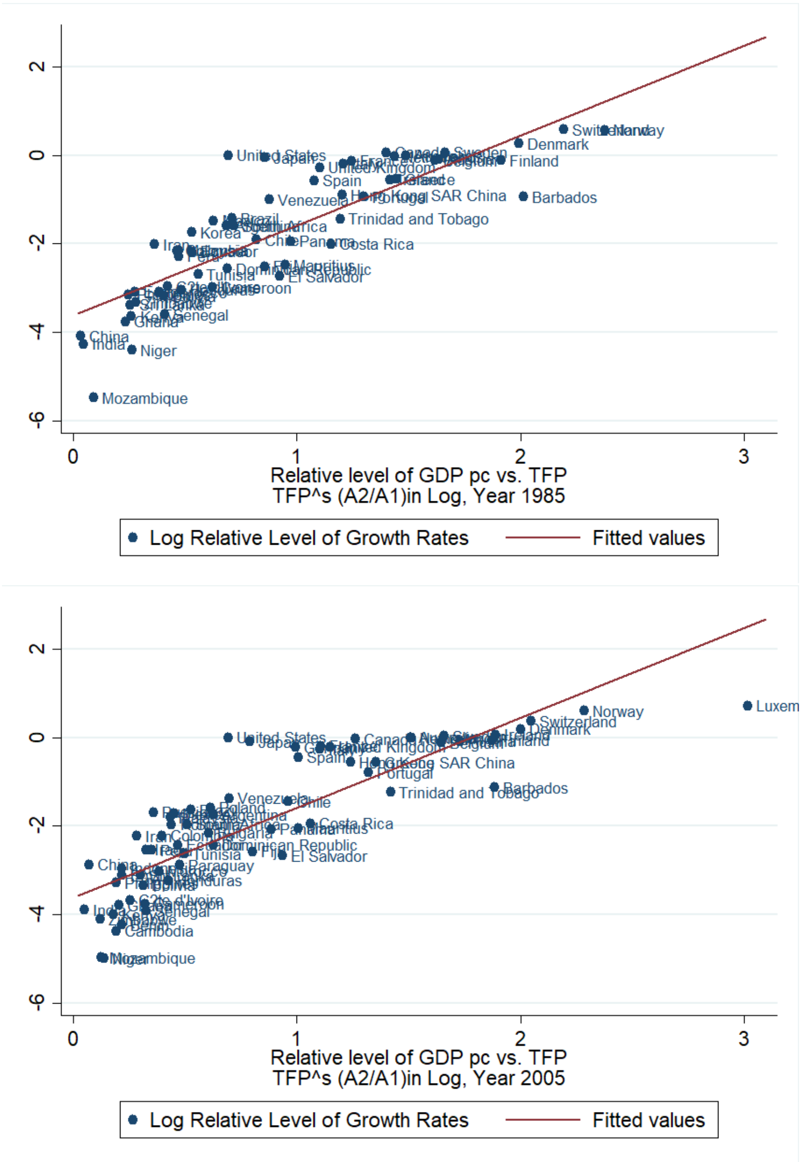

Figure 2.2: The Relationship between the Relative Level of GDP per capita (vertical axis) and TFP in Year 1985 and 2005

(in logarithms) is displayed in Figure 2.2, which shows an upward trend for the developing countries in the years 1985 and 2005.

From Eq. (2.43), the dependent variable y is measured as follows:

$$y = \frac{GDPpc_2}{GDPpc_1} \tag{2.47}$$

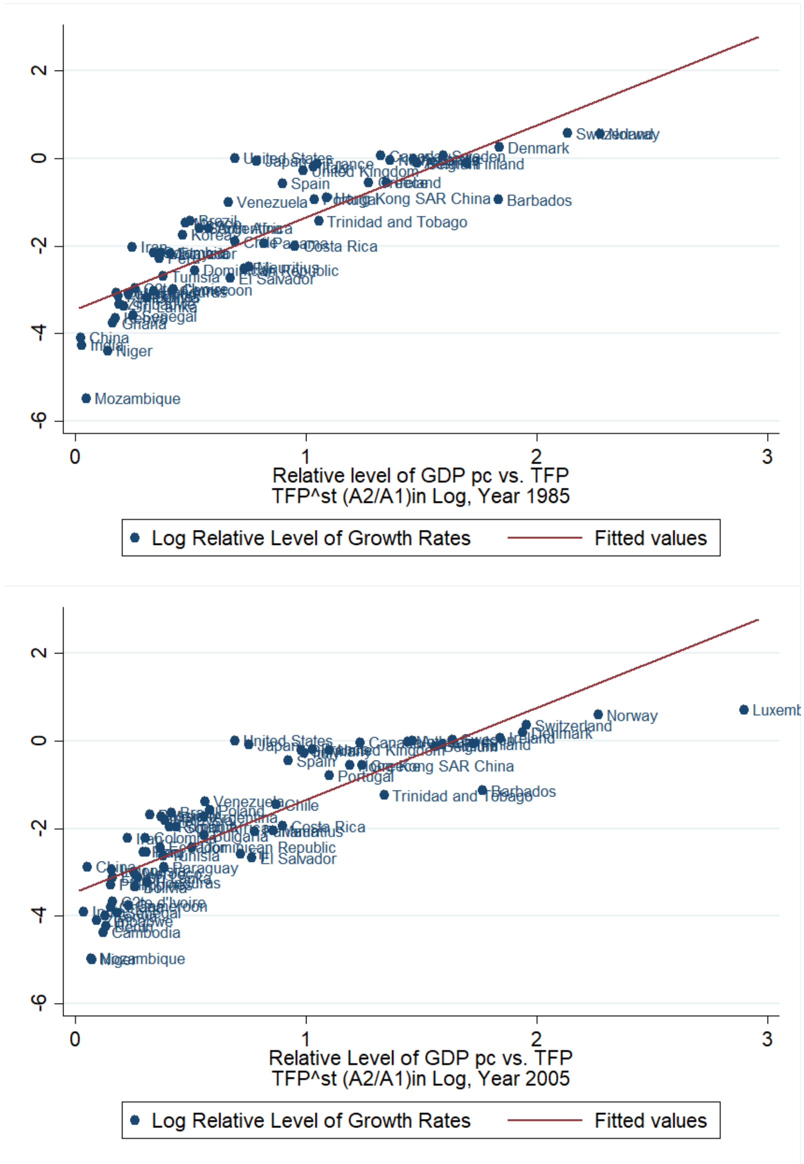

Figure 2.2 (Continued): The Relationship between the Relative Level of GDP per capita (vertical axis) and TFP in Year 1985 and 2005

where the $GDPpc$ is the GDP per capita, and the subscripts 2 and 1 refer to the follower and leader nations, respectively. Whilst most of the literature considers GDP growth rate as the dependent variable (Benhabib & Spiegel, 1994; Azman-Saini, Baharumshah, & Law, 2010; Grijalva, 2011; Alaali, Roberts, & Taylor, 2015), we focus on the relative level of GDP per capita between the developing country

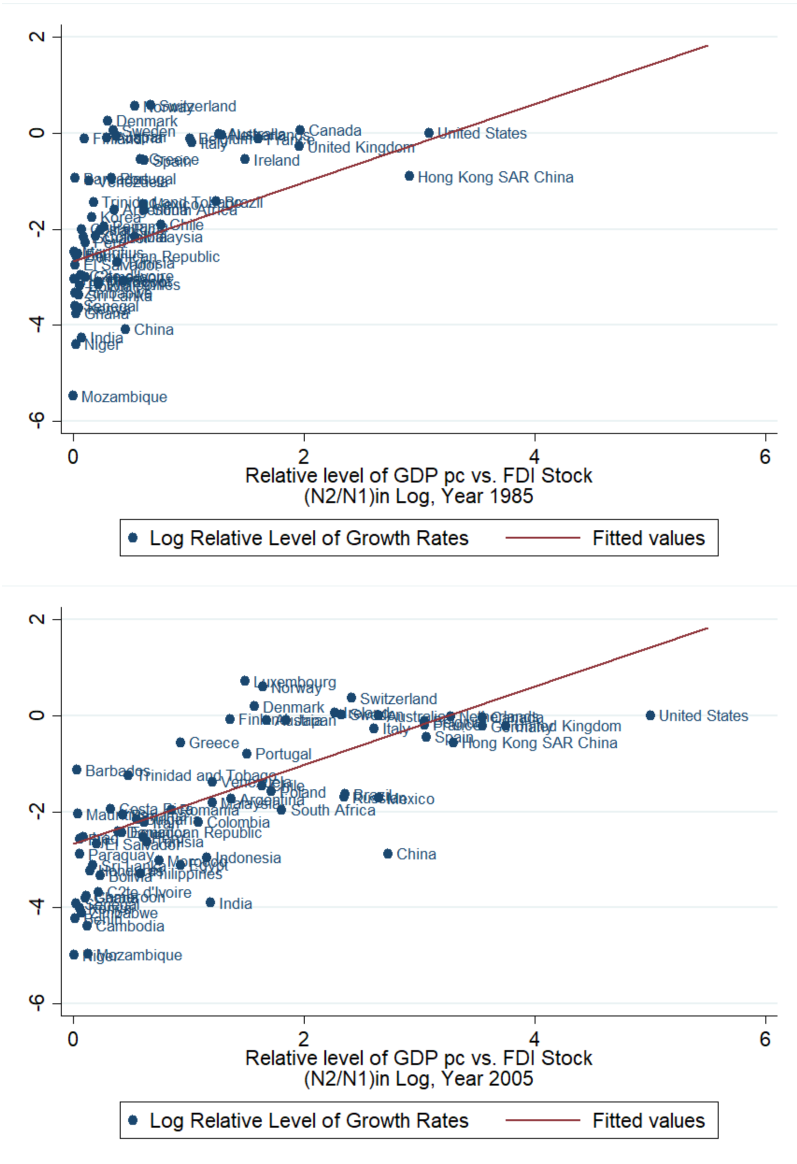

Figure 2.3: The Relationship between the Relative Level of GDP per capita (vertical axis) and the FK in Year 1985 and 2005

and the US, following the theoretical model.

The third proxy, N_2/N_1, reflects the number of intermediates that are either innovated in the leader country N_1 or adapted to the follower country N_2. To capture this concept, we define N_2/N_1 as the FDI stock in the follower country divided by the capital stock in the leader country. We believe that the FDI stock in the follower country is appropriately represented as N_2 and that the capital stock in the leader country is appropriately represented as N_1. For simplicity, we use the notation FK to denote the N_2/N_1. The variable FK is therefore constructed as follows:

$$FK = \frac{N_2}{N_1} = \frac{FDI_2}{K_1} \tag{2.48}$$

where FDI_2 refers to the FDI stock in the follower countries, while K_1 refers to the capital stock (the number of intermediates available) in the leader country (the US). To see how this measure fits our research question and data, Figure 2.3 shows a scatter plot for the relationship between FK and the relative level of GDP per capita in the years 1985 and 2005. As displayed, we find a stepped upward trend with the positive slope in the figure, which allows us to intuit that the firms from the leader nation adopt the products in the follower countries through FDI, which helps followers to move towards catching up with the leader countries.

2.3.4 Econometric Method

The methodology of the empirical investigation follows our theoretical model Eq. (2.43), whilst we are guided by the current empirical literature in in terms of mitigating the potential omitted variable biases by controlling for a set of variables that are not included in the theoretical model, e.g., the population growth rates, the domestic investment rates, the exchange rates and the government expenditures[6].

2.3.4.1 Baseline Specification

We now test our model prediction regarding the impact of FDI stock on the relative level of growth rates. To examine the relationship between y_2/y_1 and N_2/N_1, we use

[6] Borensztein et al. (1998), Li and Liu (2005) and Hermes and Lensink (2003) search for a set of robust variables for modelling growth and therefore provide useful information allowing us to mitigate potential omitted variable biases.

the measures of FK and y, in which FK is used to capture the notion of the number of intermediates available in the country and y stands for the relative level of GDP per capita. In addition to capturing the notion of A_2/A_1, we use the variable A^v, where A_2^v/A_1^v denotes TFP_2^v in country i divided by TFP_1^v in the US. The variable h^v then captures the notion of h_2^v/h_1^v. Note that the superscript differs with the different investment rates of human capital to measure the TFP, i.e., $v = s, st$, where s refers to the total average schooling attainment and st refers to the average tertiary schooling attainment. The regression for 67 countries is specified as follows:

$$lny_{i,t} = \beta_0 + \beta_1 lnFK_{i,t} + \beta_2 lnh_{i,t}^v + \beta_3 lnA_{i,t}^v + \tau^{'} Z^{'} + \delta_i + \rho_t + \varepsilon_{i,t} \tag{2.49}$$

where $lny_{i,t}$ refers to the relative level of GDP per capita in natural logarithms and $lnh_{i,t}^v$ is the relative level of human capital that refers to $lnh_{i,t}^s$ and $lnh_{i,t}^{st}$, respectively. The $lnFK_{i,t}$ refers to the number of intermediates available in the leader country and adapted in the follower countries $N2/N1$ in natural logarithms, while $lnA_{i,t}^v$ is the relative level of technology that refers to $lnA_{i,t}^s$ and $lnA_{i,t}^{st}$, respectively. The term $Z^{'}$ is the set of other control variables and comprises five core explanatory variables, including domestic investment rate (in relative terms), the growth rate of the population, the government expenditures (share of GDP), the exchange rates and the trade openness. They are frequently included as determinants of growth in cross-country studies (Olofsdotter, 1998; Borensztein et al., 1998; B. Xu, 2000; Campos & Kinoshita, 2002; Durham, 2004; Alfaro et al., 2004; Delgado et al., 2014). In addition, in a cross-country study Barro and Sala-i Martin (1997) show that different countries have different steady states, while B. Xu (2000), who studies the effect of technology diffusion from multinationals on TFP, also includes time- and country-specific effects to control for the steady-state differences across countries and across time. Thus, in our model's Eq. (2.49), the terms δ_i and ρ_t are the country and time fixed effects that we set up to control for unobserved heterogeneity across country and across time, respectively. All variables, except the population growth rate, government expenditures, and domestic investment rates, are measured in natural logarithms.

Note that there might be potential correlations between FDI, the relative level of technology, human capital and country-specific characteristics, as it can be argued that FDI affects follower countries primarily, and perhaps exclusively, through countries' relative levels of technology, human capital and country-specific factors, which may not be observed easily from the theoretical model (Borensztein et al., 1998; Durham, 2004). To this end, we examine the extent to which the effect of FDI on the relative level of GDP per capita is: (i) dependent upon certain conditions in FDI recipient countries and/or (ii) influenced by country-specific characteristics in the robustness test. To simplify this, the specifications can be written as follows:

$$lny_{i,t} = \beta_0 + \beta_1 lnFK_{i,t} + \beta_2 lnh^v_{i,t} + \beta_3 lnA^v_{i,t} + \beta_4 ln(h^v_{i,t} \times FK_{i,t}) + \tau^{'} Z^{'} + \delta_i + \rho_t + \varepsilon_{i,t} \tag{2.50}$$

$$lny_{i,t} = \beta_0 + \beta_1 lnFK_{i,t} + \beta_2 lnh^v_{i,t} + \beta_3 lnA^v_{i,t} + \beta_5 ln(A^v_{i,t} \times FK_{i,t}) + \tau^{'} Z^{'} + \delta_i + \rho_t + \varepsilon_{i,t} \tag{2.51}$$

$$lny_{i,t} = \beta_0 + \beta_1 lnFK_{i,t} + \beta_2 lnh^v_{i,t} + \beta_3 lnA^v_{i,t} + (Dummy^{'} \times lnFK_{i,t})\zeta + \tau^{'} Z^{'} + \delta_i + \rho_t + \varepsilon_{i,t} \tag{2.52}$$

where the $Dummy^{'}$ includes a set of dummy variables to group countries into different income groups: the middle and upper income developing countries $MUDC$, the lower-middle-income developing countries $LMDC$, the low-income developing countries LDC, the least-developed countries $LEADC$ and the developed countries *Developed*. Note that in Eq. (2.52) we first run the regression with the *Developed* dummy omitted, then we control for it but leave other dummies omitted to avoid the multicollinearity issue.

2.3.4.2 Dynamic Panel of GMM Estimator

While OLS may present some useful initial insights, it does not address any endogeneity in the model. For instance, the measure of technology used in the early literature may introduce potential endogeneity bias due to the fact that the initial level of efficiency is not controlled for (Borensztein et al., 1998; Durham, 2004). Although we control for the initial differences measured as the level of TFP and human capital, such potential correlation between the lags might still lead biased estimates (Doytch & Uctum, 2011). In addition, the potential reverse causality in the FDI-Growth regression may exist (Coe, Helpman, & Hoffmaister, 1997). It thus implies that OLS estimates may be biased, and all right-hand side variables may correlate with the error term. To avoid these pitfalls, we apply the difference GMM estimator. The advantage of using this approach is that the difference GMM has one set of instruments to deal with the endogeneity along with the explanatory variables, and one set to deal with the correlation between the lagged dependent variable and the error term (Blundell & Bond, 1998; Doytch & Uctum, 2011).

Drawing on the above equations, we can rewrite the growth regression as follows:

$$lny_{i,t} = \alpha lny_{i,t-1} + \beta_1 lnFK_{i,t} + \beta_2 lnh^v_{i,t} + \beta_3 lnA^v_{i,t} + \beta_4 ln(h^v_{i,t} \times FK_{i,t}) + \tau' Z' + \delta_i + \rho_t + \varepsilon_{i,t} \tag{2.53}$$

$$lny_{i,t} = \alpha lny_{i,t-1} + \beta_1 lnFK_{i,t} + \beta_2 lnh^v_{i,t} + \beta_3 lnA^v_{i,t} + \beta_5 ln(A^v_{i,t} \times FK_{i,t}) + \tau^{'} Z^{'} + \delta_i + \rho_t + \varepsilon_{it} \tag{2.54}$$

equations (2.53) and (2.54) are the growth equations that consist of a one-year lagged of the dependent variable and an unobserved country-specific effect δ_i, the error term $\varepsilon_{i,t}$, with respect to time t and country i. Arellano and Bond (1991) propose transforming equations (2.53) and (2.54) into first differences to remove the panel unobserved country-specific effect, the above equations can now be rewritten as follows:

$$\begin{aligned} lny_{i,t} - lny_{i,t-1} = {} & \alpha(lny_{i,t-1} - lny_{i,t-2}) + \beta_1(lnFK_{i,t} - lnFK_{i,t-1}) + \beta_2(lnh^v_{i,t} - lnh^v_{i,t-1}) \\ & + \beta_3(lnA^v_{i,t} - lnA^v_{i,t-1}) + \beta_4[ln(h^v_{it} \times FK_{it}) - ln(h^v_{i,t-1} \times FK_{i,t-1})] \\ & + \tau^{'}(Z_{i.t} - Z_{i,t-1}) + \varepsilon_{it} - \varepsilon_{i,t-1} \end{aligned} \tag{2.55}$$

$$\begin{aligned} lny_{i,t} - lny_{i,t-1} = {} & \alpha(lny_{i,t-1} - lny_{i,t-2}) + \beta_1(lnFK_{i,t} - lnFK_{i,t-1}) + \beta_2(lnh^v_{i,t} - lnh^v_{i,t-1}) \\ & + \beta_3(lnA^v_{i,t} - lnA^v_{i,t-1}) + \beta_5[ln(A^v_{i,t} \times FK_{i,t}) - ln(A^v_{i,t-1} \times FK_{i,t-1})] \\ & + \tau^{'}(Z_{i.t} - Z_{i,t-1}) + \varepsilon_{i,t} - \varepsilon_{i,t-1} \end{aligned} \tag{2.56}$$

now the country-specific effect is eliminated from the equation. However, the first-differencing introduces correlation between the differenced lagged-dependent variable and the new error term. Note that the estimates are biased even when the set of all explanatory variables are strictly exogenous (Easterly et al., 1997). We thereby need an instrument that is correlated with the differenced lagged-dependent variable but not with the error term. With the assumption that ε_{it} are serially uncorrelated, the lagged values of the dependent variable in lagged two periods or more are valid instruments in the above equations. Therefore, for $T \geq 3$, the model implies the following linear moment restriction:

$$E[(\varepsilon_{i,t} - \varepsilon_{i,t-1})lny_{i,t-1}] = 0, j = 2, ..., t-1; t = 3, ..., T \qquad (2.57)$$

Now with the given reverse causality, an assumption that all explanatory variables are strictly exogenous would lead to inconsistent estimates. Rather, we assume that all right-hand variables are weakly exogenous. We, therefore, need another set of instruments to mitigate the potential bias. Based upon equations (2.55) and (2.56), all the right-hand side variables with lagged periods two or more are valid instruments. Therefore, for $T \geq 3$, the model implies the following linear moment restrictions:

$$E[(\varepsilon_{i,t} - \varepsilon_{i,t-1})X_{i,t-1}] = 0, j = 2, ..., t-1; t = 3, ..., T \qquad (2.58)$$

where X refers to all right-hand side explanatory variables. Since we use all right-hand side variables as the set of instruments, the issue of the reverse causation that comes from FDI stock, the relative level of technology and human capital and other factors are solved simultaneously.

However, there are some drawbacks with the difference GMM. First, the lagged level instruments become weak instruments when the explanatory variables are persistent over time. Second, the lagged instrument of the dependent variable becomes a weak instrument when the dependent variable follows a random walk (Alonso-Borrego & Arellano, 1999; Blundell & Bond, 1998). Therefore, we need two further conditions, which are provided by Blundell and Bond (1998), to improve the estimated efficiency by processing the system GMM. The necessary conditions for the system GMM are:

$$E[(lny_{i,t-1} - lny_{i,t-2})(\delta_i - \varepsilon_{i,t})] = 0 \tag{2.59}$$

$$E[(X_{i,t-1} - X_{i,t-2})(\delta_i - \varepsilon_{i,t})] = 0 \tag{2.60}$$

where δ_i is the unobserved country-specific effect with their differences; the above conditions are necessary when the system GMM is employed as the econometric method to overcome the shortcomings of difference GMM. Thus, we use the moment conditions with instruments to process the system GMM (Blundell & Bond, 1998). Note that the consistency of the GMM estimator depends on the validity of the set of instruments, that is, the lagged value of GDP per capita, FDI and other right-hand side variables in our growth specification. It implies the importance of the test for the validity of the instruments. Therefore, the over-identifying restriction will be presented in the tables of the regression results. The xtabond2 with gmm- and iv-style is used in STATA 14.0 with one-step system GMM models Roodman (2009).

2.3.4.3 Two-Stage Least Squares Fixed-Effect Instrumental Variable Estimation

As noted, the determinants of FDI are indirectly distorting the growth effects of FK on y. While the system GMM estimator is appropriate to deal with the endogenous bias, it may be more appropriate to use Two-Stage Least Squares Fixed-Effect Panel Data Instrumental Variable approach since we have derived the equations which show how FK and y are determined by h^v_{it} and A^v_{it} (see equations 2.41 and 2.43). Hence only relying on lagged values of FK would not suffice since it is determined by specific variables. Given that the system-GMM estimator is not available to account for the effect of predetermination of FDI, one way to evaluate this concern is to instrument FDI accordingly to account for the bias. The regression is set up as follows:

$$lny_{it} = \beta_0 + \beta_1 ln\hat{F}K_{it} + \beta_2 lnh^v_{it} + \beta_3 lnA^v_{it} + \tau^{'} Z^{'} + \delta_i + \rho_t + \varepsilon_{it} \tag{2.61}$$

The estimation strategy follows the two-stage least squares process; first, we regress dependent variable FK on its determinants suggested by Eq. (2.41):

$$lnFK_{it} = \pi_0 + \pi_1 lnh^v_{it} + \pi_2 lnA^v_{it} + \vartheta^{'} C^{'} + \gamma_i + \upsilon_{it} \tag{2.62}$$

where $C^{'}$ is the set of other control variables that contain one- and two-year lagged values of FK. The lagged values of FK are suggested as extra instruments by the empirical literature, as FDI itself may be influenced by the process governing growth rates and the reverse causality will raise both the flows and growth simultaneously, which implies that including the lagged may mitigate the bias (Borensztein et al., 1998; Durham, 2004; Iamsiraroj & Ulubaşoğlu, 2015). After estimating the first stage, we extract the predicted value of $F\hat{K}$, as the instrument for FK. We then process several tests to make sure the validity of the instrument, which will be provided in the empirical analysis. We then use the predicted value as the instrument of FK in the second-stage estimation. The estimation fits the model after sweeping out the fixed-effects by removing the panel-level means from each variable. While the assumption that the fixed-effects are correlated with the explanatory variables is assumed, the Hausman test is used to detect whether the assumption is rational.

Finally, an overidentification test is performed in the regression models. The overidentification test involves three steps: first, estimating the structural equation by two-stage least squares estimator and obtaining the predicted residuals; second,

Table 2.1: Summary Statistics 1977-2007

Variable	Definition	Mean	SD	Min	Max	Obs.
lny	The GDP per capita, relative to the US in logarithm	-1.827	1.478	-5.537	0.788	1,732
fdini	The FDI stock, million US dollars$	70,021	243,869	0.01	3,551,307	1,732
lnFK	The number of intermediates between countries in logarithm	0.870	1.021	8.21e-07	5.215	1,732
$Schooling^s$	The average total educational attainment	7.231	2.690	0.65	12.86	1,732
$Schooling^{st}$	The average tertiary educational attainment	0.326	0.271	0	1.49	1,732
ln^{hs}	The relative level of human capital in logarithm	0.476	0.095	0.271	0.693	1,732
ln^{hst}	The relative level of human capital in logarithm	0.648	0.013	0.624	0.695	1,732
lnA^s	The relative level of TFP in logarithm	0.854	0.593	0.025	3.095	1,732
lnA^{st}	The relative level of TFP in logarithm	0.745	0.579	0.017	2.959	1,732
lnFK $\times$ lnA^s	The interaction term of lnA^s and lnFK	0.943	1.313	3.46e-07	6.307	1,732
lnFK $\times$ lnA^{st}	The interaction term of lnA^{st} and lnFK	0.866	1.245	3.14e-07	6.066	1,732
lnFK $\times$ ln^{hs}	The interaction term of lnFK and ln^{hs}	0.473	0.614	4.59e-07	3.615	1,732
lnFK $\times$ ln^{hst}	The interaction term of lnFK and ln^{hst}	0.570	0.677	5.25e-07	3.615	1,732
Pop growth	The population growth rates in level	1.072	3.796	-0.989	65.850	1,732
Gov/GDP	The government expenditures measured in share of GDP	11.872	87.863	0.040	792.416	1,732
lnExchange	The exchange rates in logarithm	1.436	3.611	-23.025	12.992	1,732
Invest/GDP	The domestic investment rates measured in share of GDP	5.121	27.446	-0.0003	396.774	1,732
lntgdp	The trade openness in logarithm	4.077	0.577	1.843	5.983	1,732
Developed	The dummy 1 if developed country, 0 otherwise	0.333	0.471	0	1	1,732
MUDC	The dummy 1 if MUDC, 0 otherwise	0.390	0.488	0	1	1,732
LMDC	The dummy 1 if LMDC, 0 otherwise	0.109	0.312	0	1	1,732
LDC	The dummy 1 if LDC, 0 otherwise	0.099	0.299	0	1	1,732
LEADC	The dummy 1 if LEADC, 0 otherwise	0.066	0.249	0	1	1,732

Notes: lnFK is FDI stock divided by US capital stock. The average year of schooling is computed by using the educational attainment for the population aged 15 and above. lnh^s is constructed by using the average total schooling. lnh^{st} is constructed by using the tertiary schooling. lnA^s is constructed using A^s formulation. lnA^{st} is constructed using A^{st} formulation. Population aged 15-64 across 1977-2007. Government expenditures gov include the expenditures in health and education services. domi is gross capital formation at a constant price. lnExchange is measured by 1 US dollar with local currency (e.g., 1 US dollar to the Local Currency). lntgdp is measured as the sum of exports and imports of goods and services, measured as the share of gross domestic product, the percentage of GDP.

by regressing the residual on all exogenous variables, we can obtain the R^2; third, under the null hypothesis that all instruments are uncorrelated with the residual, we use $nR^2 \sim \chi^2_q$, where q is the number of instrumental variables from outside the model minus the total number of endogenous explanatory variables, to test the hypothesis (Wooldridge, 2012, Ch15).

2.4 Data

2.4.1 Overview

We use data from the World Development Indicator (2016), World Bank National Account Data, Penn World Table 6.3, Barro and Lee (2015), International Monetary Fund (henceforth, IMF) Fiscal Affairs Department, Investment and Capital Stock Dataset (2015), and United Nations Conference on Trade And Development (henceforth, UNCTAD). The dataset we construct contains 67 countries and is organized over the period 1977 to 2007. The selection of countries and time periods is based entirely on data availability. Since some variables are unavailable for some countries in the period, we can only construct an unbalanced panel dataset with a time-period gap. The number of observations is reduced by deleting those with missing values, giving a total of 1,732 observations. Our primary interest is in the estimation of the effect of FDI on the relative level of GDP per capita and how this effect varies with respect to the relative level of technology and human capital in each country and each year. Our secondary interest is in identifying the endogeneity of FDI on the relative level of GDP per capita, a channel through the influence of human capital and technology on FDI and a channel through which the effect of FDI is passed onto GDP per capita in relative terms.

2.4.2 GDP, FDI, Human Capital and Technology

The relative level of GDP per capita, which is the dependent variable throughout the analysis, is measured as GDP per capita (in constant 2010 US dollars) in the US and across other countries. This variable is measured by the GDP divided by midyear population, where GDP at purchaser's prices is the sum of the gross values added by all resident producers in the economy. We collect this data from the World Bank National Accounts dataset.

Our measure of FDI is the FDI stock relative to US capital stock, described in Section 2.3.3, Eq. (2.48). First, the FDI stock variable is from UNCTAD STAT[7] measured in US dollars at current prices in millions. Although there are several sources for data on FDI, it is important to use data on FDI stock rather than flow. The FDI stock measures the total level of direct investment at a given point in time

[7]Access to UNCTAD STAT: https://unctadstat.unctad.org/wds/TableViewer/dimView.aspx.

and is the value of foreign investors' equity in net loans to enterprises operating in the reporting economy. Our model focuses on the diffusion of technology from leading economies to followers, which involves costs of imitation and adaptation, and these costs are assumed to be influenced by the pool of uncopied ideas (technologies); therefore, we prefer using the FDI stock.

Second, in order to construct the variable FK, which represents N2/N1, FDI stock is divided by the US capital stock. Data on the US capital stock and the capital stock across countries and time are from IMF Investment and Capital Stock Dataset (2015), which provides comprehensive data on public investment and capital stock (i.e., general government), private investment and capital stock, as well as investment and capital stock arising from public-private partnerships, across the Fund member countries through the period 1960-2013[8].

Data on human capital, such as the average total educational attainment and average tertiary educational attainment rates, are drawn from Barro and Lee (2015). While early studies normally used enrolment ratios or literacy rates as the measure of the level of human capital, these data do not measure the aggregate stock of human capital available contemporaneously as an input to production adequately (Barro & Lee, 2013). Therefore, we use data on educational attainment only.

Turning to the technology variable, we construct a relative level of technology between the leader (the US) and follower (developing countries) based on equations (2.45) and (2.46). In doing so, we use data from Barro and Lee (2015) and the IMF Investment and Capital Stock Dataset (2015) to construct variables for human capital and FDI, respectively, and to construct a relative level of TFP between the

[8]The accompanying Document "Estimating Public, Private, and PPP Capital Stocks" http://www.imf.org/external/np/fad/publicinvestment/data/info.pdf to the IMF Board Paper "Making Public Investment More Efficient" (http://www.imf.org/external/pp/longres.aspx?id=4959) describes in great detail the series' definitions, the investment series' data sources, as well as the methodology in constructing the stock series. The methodology follows the standard perpetual inventory equation and builds largely on Kamps (2006) and Gupta, Kangur, Papageorgiou, and Wane (2014).

leader and follower countries, which is presented as A2/A1. The data show that the mean values are 0.854 and 0.745 for the TFP (denoted as lnA^s in Table 2.1) when it is calculated via the average total schooling and the tertiary educational attainment, respectively (denoted as lnA^{st} in Table 2.1). The statistics are close to B. Xu (2000), where the TFP is calculated by using the host country TFP divided by the US TFP and the mean is reported to be around 0.720, with 0.110 as the standard deviation.

2.4.3 Other Control Variables

The control variables for our empirical model are guided by the voluminous growth regression literature. National Account data, including government consumption, growth rate of the population, and domestic investment are taken from Penn World Table 6.3[9], which has been long been used in several cross-country studies, e.g., Edwards (1992), Blomstrom et al. (1994), Fischer (1993) and Campos and Kinoshita (2002). First, as the previous empirical studies find the effect of government expenditures on macroeconomic stabilization on growth (Barro & Sala-i Martin, 1997; Borensztein et al., 1998; Makki & Somwaru, 2004), we include this variable in our model. Government consumption is measured by the sum of government expenditures in education and health service at a constant price. We divide it by the GDP to control for its dependence on the size of the country. Second, while early studies generally find a negative effect of the growth rate of a population, Jones and Vollrath (2013) remark that the estimated coefficient of the population growth rate in the growth regression should be positive, as an increase in the population increases the number of people engage in research activities, meaning that technological improvement is associated with the growth rate of a population. The variable for the

[9] Data can be accessed from National Accounts for PWT 6.3: https://cid.econ.ucdavis.edu/pwt.html

population growth rate, which is the average growth rate for the period based on the population aged above 15, is therefore controlled for in the model. Third, it is argued that the positive correlation between FDI, domestic investment market, and subsequent growth may be one of the few consistent results to have emerged (Easterly et al., 1997; Borensztein et al., 1998; Makki & Somwaru, 2004; Alfaro et al., 2004); therefore, we control for the domestic investment rate measured as relative level of gross domestic investment divided by GDP in the follower countries to that of the leader country (the US).

Lastly, trade openness and exchange rate are included. The measure of the former is the sum of exports and imports of goods and services, while the latter is measured as a ratio of US dollars to the local currency. As Iamsiraroj and Ulubaşoğlu (2015) suggest that these two variables are expected to be correlated with FDI, GDP per capita and other macroeconomic variables, we include both in our model to avoid potential bias. Both data are drawn from the World Development Indicator (2016). Table 2.1 provides information on all variables employed in our model.

Note that since there are 21 developed countries and 46 developing countries in the dataset, the income differences that may potentially matter for the relationship between FDI and GDP per capita may need to be considered in the analysis. Therefore, we divide countries into different income groups by using the dummy variables. To group the dummies properly, we follow The World Bank (2011)'s Development Indicator Report and use the following groups: the middle- and upper-income developing countries $MUDC$, the lower-middle-income developing countries $LMDC$, the low- income developing countries LDC and the least-developed countries $LEADC$. The developed dummy is equal to 1 if the country is developed and 0 otherwise. Table 2.2 lists all the countries in our dataset.

Table 2.2: The List of Countries 1977-2007

Developing Country		Developed Country
Argentina	Malaysia	Austria
Barbados	Mauritius	Belgium
Benin*	Mexico	Canada
Bolivia***	Morocco**	Denmark
Brazil	Mozambique*	Finland
Bulgaria	Venezuela	France
Cambodia*	Korea	Germany
Cameroon***	Kenya	Greece
Cote d'lvoire***	Trinidad and Tobago	Hong Kong
Colombia	Niger*	Ireland
Chile	Panama	Italy
China	Paraguay**	Japan
Costa Rica	Peru	Luxembourg
Dominican Republic	Philippines***	Netherlands
Ecuador	Poland	Norway
Egypt**	Romania	Portugal
El Salvador**	Russia	Spain
Fiji**	Senegal*	Sweden
Ghana***	Tunisia**	Switzerland
Honduras***	Sri Lanka**	United Kingdom
India***	South Africa	United States
Indonesia**	Iraq	
Iran	Zimbabwe	
Least Developed Countries (LEADC)	7	
Middle- and Upper-Income Developing Countries (MUDC)	22	
Lower Middle-Income Developing Countries (LMDC)	12	
Low Income Developing Countries (LDC)	5	
Total Developing Countries	46	
Total Developed Countries	21	
Total Countries	67	

Notes: *** refers that the country is assigned as the least developed country; ** refers that the country is assigned as the lower-middle income developing country; * refers that the country is assigned as the lower income developing country.

2.5 Results

We now turn to the regression analysis based on the baseline specification (2.49) to test our model predictions against the data. We first estimate the effect of FDI on the relative level of GDP per capita based on the theoretical model (2.43), and then we rely on Eq. (2.41) to overcome FDI's endogeneity. We will further test whether the effect of FDI on the relative level of GDP per capita differs when the interaction terms with human capital, technology, and income groups are included in the extended model. As it is informative to examine how the results differ from the estimations, the regressions are done by using OLS, fixed-effects and random-effects for the first part of the empirical analysis, while instrumental variable analysis with fixed-effects and system-GMM estimators are employed throughout the second part of the analysis.

2.5.1 Baseline Specification

2.5.1.1 The General Growth Effect of FDI

The analysis starts by estimating empirical specification (2.49) (based on theoretical model 2.43), where the interaction terms are not yet included in the regression models. The results are presented in Table 2.3. We have tried two different specifications, where we use average total schooling with estimated results presented in Columns 1, 3 and 5 and the average tertiary schooling with results presented in Columns 2, 4 and 6 to construct the relative levels of human capital (h^s and h^{st}) and relative levels of technology (A^s and A^{st}), respectively.

For the sample of 67 countries, it is clear that FDI is significant. The results from columns (1) to (2) indicate that FDI (or N_2/N_1) enters significantly with positive coefficients and is statistically significant at the 1% significance level, whilst the relative level of technology and human capital also enter the model significantly at the 1% significance level with a priori expected signs. The estimated coefficients of FDI provided in columns (1) and (2) suggest that FDI has an unambiguously positive sign when estimating the relative level of GDP per capita, which is in line with our model prediction and confirms the hypothesis listed in Section 2.3.2. The estimated coefficients imply that a 1% increase in $lnFK$ increases the relative level of GDP per capita by 0.074% in column (1) and 0.086% in column (2). The relative levels of the technology variables lnA^s and lnA^{st} in columns (1) and (2) are 1.790 and 1.827, which indicate that a 1% increase in the relative level of technology will increase the

Table 2.3: The Impact of FDI on Growth 1977-2007: The General Effects

	OLS		Fixed-Effect		Random-Effect	
	(1)	(2)	(3)	(4)	(5)	(6)
lnFK	0.074***	0.086***	0.074***	0.086***	0.075***	0.086***
	(0.010)	(0.013)	(0.007)	(0.008)	(0.007)	(0.008)
$lnA^s s$	1.790***		1.790***		1.790***	
	(0.051)		(0.041)		(0.041)	
lnA^{st}		1.827***		1.827***		1.827***
		(0.062)		(0.052)		(0.052)
lnh^s	1.897***		1.897***		1.897***	
	(0.142)		(0.149)		(0.149)	
lnh^{st}		0.535		0.535		0.535
		(0.979)		(0.794)		(0.793)
Other Controls						
Pop growth	0.0005	0.0007	0.0005	0.0007	0.0004	0.0007
	(0.0008)	(0.001)	(0.0006)	(0.0007)	(0.0006)	(0.0007)
Invest/GDP	-0.00005	0.0003	-0.00004	0.0003	-0.00004	0.0003
	(0.0001)	(0.00014)	(0.0001)	(0.0002)	(0.0001)	(0.0002)
Gov/GDP	-0.0001	0.0001	-0.0001	0.0001	-0.0001	0.0001
	(0.0001)	(0.0001)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
lntgdp	0.096***	0.129***	0.096***	0.129***	0.096***	0.129***
	(0.023)	(0.024)	(0.013)	(0.013)	(0.012)	(0.013)
lnExchange	-0.008***	-0.009***	-0.008***	-0.008***	-0.009*	-0.009***
	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Hausman			0.000	0.000	0.000	0.000
R-square	0.9960	0.9955	0.6764	0.6142	0.6764	0.6142
Time effect	Yes	Yes	Yes	Yes	Yes	Yes
Country effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,732	1,732	1,732	1,732	1,732	1,732

Notes: Hausman test provides probability $> \chi^2$ to test the null hypothesis that the difference in coefficients is not systematic. We reject the null if the probability is less than 5%, which suggests the favour of the fixed-effect model. Country fixed-effect, year fixed-effect are controlled for in all specifications. Robust standard errors are provided in parentheses except for columns (3) and (4). *, ** and *** indicate the level of statistical significance at 10%, 5% and 1%, respectively.

relative level of GDP per capita by 1.790% and 1.827%, respectively. The human capital variables lnh^s and lnh^{st} are confirmed to be positively associated with lny, where lnh^s is statistically significant at the 1% significance level, whereas lnh^{st} is insignificant. This indicates that the higher the relative level of human capital, the more knowledge is transferred into the follower countries. The results suggest that a 1% increase in the relative level of human capital (measured by lnh^s) increases the relative level of GDP per capita by 1.897%. The signs of other control variables, which are included to strengthen our model's robustness, are just as expected. The results are preliminarily consistent with our model predictions.

Next, we subject the current results to the fixed-effects bias. We turn to the alternative approaches using the fixed-effect and random-effect estimators. Columns (3) to (6) show that the results do not vary across specifications regarding the estimated coefficients and signs, as they are similar to the results presented in columns (1) and (2). Overall, we find that the elasticity of lny with respect to $lnFK$ remains positive and significant at the 1% significance level; from the mean, an increase of 10% in $lnFK$ is associated with a minimum 0.74% and a maximum 0.86% percent increase in the relative level of GDP per capita. The other two variables of interest - the relative level of human capital and technology - are also confirmed as statistically significant with unambiguously positive signs throughout the specifications.

The baseline results imply that our model fits well with the data, preliminarily supporting the hypothesises that FDI, human capital and technology in relative terms are complementary with respect to enhancing the process of technology transfer increasing the rate of return in the follower countries. However, we must exercise caution when interpreting the effect obtained thus far. By ignoring the predeterminants (i.e., endogeneity) of FDI (N_2/N_1) predicted in Eq. (2.41), we may not be able to determine whether the model captures the effect of FDI in transferring knowledge from the adaptation of multinational firms' efforts in the follower countries precisely or whether this is an independent effect of FDI. Recall Eq. (2.41), where the variable N_2/N_1, which is captured by FK, is suggested to be predetermined by the factors A_2/A_1 and h_2/h_1. To further investigate this issue, we apply 2SLS with fixed-effect instrumental variable estimation and the system-GMM in the next section.

Table 2.4: The Endogenous FDI: IV Estimation.

	2SLS IV1 (1)	2SLS IV2 (2)	FE IV1 (3)	FE IV2 (4)	RE IV1 (5)	RE IV2 (6)
First stage						
lnA^s on lnFK	0.155***		0.155***		0.155***	
	(0.052)		(0.044)		(0.044)	
lnA^{st} on lnFK		0.114***		0.114***		0.114***
		(0.055)		(0.050)		(0.050)
lnh^s on lnFK	0.470***		0.469***		0.469***	
	(0.210)		(0.158)		(0.158)	
lnh^{st} on lnFK		3.130***		3.130***		3.130***
		(0.766)		(0.747)		(0.747)
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000
Overidentification(nR^2)	3.855	2.759				
Time-effect	Yes	Yes	Yes	Yes	Yes	Yes
Country-effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,600	1,600	1,600	1,600	1,600	1,600

Notes: The dependent variable is lnFK. All regressions control for the year and country fixed effects. IVs are different in terms of lnA^s, lnA^{st}, lnh^s and lnh^{st}. The observations are reduced by the lagged lnFK variables. Robust standard error in the parentheses in columns (1) and (2). *** indicate the level of statistical significance at the 1% level.

2.5.1.2 The Endogenous FK

We now investigate the pre-determinants of FDI (N_2/N_1) by using instruments. In what follows, we employ 2SLS, two-stage least squares with fixed-effects (2SLSFE), and two-stage least squares with random-effects instrumental variable estimators. Since the idea of applying rational instruments is based on Eq. (2.41), we first run the FDI (N_2/N_1) regression, which regresses $lnFK$ on the relative level of country's abilities (A_2^v/A_1^v and h_2^v/h_1^v) and the lagged values of $lnFK$ and extracts the predicted value of FDI as a valid instrument. The instrument should satisfy the validity requirement; it should be correlated with FDI (relevant condition) but uncorrelated with the error term of the GDP equation (exogeneity condition). The relevant condition can be examined via the estimated results of the first stage in the 2SLS analysis, yet the exogeneity condition is unfortunately not examinable. Nevertheless, since the predicted value of FK rules out the potential pre-determination of FDI, it is believed to be uncorrelated with other potential biases, which implies

Table 2.5: The Impact of FDI on Growth 1977-2007: Taking Endogeneity into Account

	2SLS		2SLS Fixed-Effect	
	(1)	(2)	(3)	(4)
lnFK	0.080***	0.091***	0.080***	0.091***
	(0.011)	(0.014)	(0.007)	(0.009)
lnA^s	1.776***		1.776***	
	(0.054)		(0.043))	
lnA^{st}		1.785***		1.785***
		(0.062)		(0.054)
lnh^s	1.672***		1.672***	
	(0.147)		(0.155)	
lnh^{st}		0.328***		0.328***
		(0.980)		(0.812)
other controls				
Pop growth	0.0002	0.0003	0.0002	0.0003
	(0.0007)	(0.0008)	(0.0007)	(0.0007)
Invest/GDP	-6.61e-06	0.0002	-6.61e-06	0.0002
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Gov/GDP	-0.00007	0.0001	-0.00007	0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0003)
lntgdp	0.092***	0.126***	0.092***	0.126***
	(0.012)	(0.012)	(0.013)	(0.014)
lnExchange	-0.007***	-0.007***	-0.007***	-0.007***
	(0.002)	(0.002)	(0.002)	(0.002)
Time effect	Yes	Yes	Yes	Yes
Country effect	Yes	Yes	Yes	Yes
Observations	1,600	1,600	1,600	1,600

Notes: Robust standard error in parentheses except for columns (1), (2). *, ** and *** indicate the level of statistical significance at 10%, 5% and 1%, respectively.

the satisfaction of the exogeneity condition. For the relevant condition, the first-stage regression results are provided in Table 2.4, where the relevant condition of the two instruments is satisfied by the significant association between $lnFK$, lnA^v and lnh^v as well as the large F statistics in the first-stage regressions. Therefore, we can reject the hypothesis of a weak instrument at the 5% significance level. For the above reasons, we believe that our instruments are valid.

Now, before we move on to estimate the second-stage regression, for comparison purposes, we first highlight the results obtained by using the one-step system-GMM estimator. The results are provided in columns (1) and (2) in Table 2.8 in the Appendix. In terms of the growth effect of FDI, we observe that the estimated coefficient of $lnFK$ is reported to be ambiguous and insignificant. However, we find that the relative level of technology is confirmed as statistically significant with a clear sign. Yet the relative level of human capital is only confirmed as positive and statistically significant in column (1), and its estimated coefficient changes from positive to negative in column (2), although it is insignificant. These results have some implications. First, while GMM can generate prolific instruments, the results reveal that the system-GMM estimator may be less efficient, as it treats all the right-hand side variables as endogenous and uses the lagged terms across all right-hand side variable as their own instruments. Second and perhaps more technically, as Roodman (2009) highlights that instrument proliferation in system-GMM can over-fit endogenous variables and fail to expunge their endogenous components, which weakens the power of the Hansen test and a perfect Hansen statistic of 1.000 may be a telltale sign, the results provided in columns (1) and (2) show that the Hansen J statistic is just 1.000 and so we view the results provided by the system-GMM as potentially biased. Thirdly, while the system-GMM can generate prolific instruments, it seems to underestimate the impact of FDI on GDP per capita because it does not properly take into account the endogeneity of FDI. Lastly, but not least, as remarked by Roodman (2009), GMM estimation performs well only when the analysis is based on a "small T and large N" panel. If T is large, dynamic panel bias become insignificant, and a fixed effect estimator would perform better. Since the samples used here are of the "long T, but not large N" variety, the results may be potentially biased. The above arguments seem to be sufficient grounds for not focusing on the results provided by the GMM estimator.

Next, we estimate the second-stage regression by using 2SLS and 2SLSFE estimators. The results are provided in Table 2.5. From columns (1) to (4), we find that the estimated coefficients of $lnFK$ remain positive and statistically significant at the 1% significance level throughout. It means that a 1% increase in $lnFK$ will generate either a 0.080% or 0.091% increase in lny. The mechanism for generating positive effects from FDI can be described as follows. The high level of country's abilities encourages multinational firms to adapt their intermediates with low adaptation costs in the follower economies. The high level of country's abilities thus helps attract more multinational firms and makes the follower benefit more from FDI. The estimated results are robust to the heterogeneity, and the country and time fixed effects are all controlled for.

Overall, the above results are to be expected given that we estimate our model based on the relative level of GDP per capita using Eq. (2.43), where we use the relative level of technology and human capital based on Eq. (2.41) to overcome the endogeneity bias (the pre-determinants of FDI). It is clear that failing to account for the endogeneity of FDI leads to an underestimation of the gains from FDI (from 0.074 to 0.080 and from 0.086 to 0.091, respectively). The results provided in columns (1) and (2) of Table 2.8 in the Appendix support this concept empirically - the estimated coefficient provided by the GMM estimator is twenty times (or even more than twenty times) lower than the one provided by the two-stage instrumental approach (in absolute value, from 0.004 to 0.080). In a nutshell, it suggests that the general regression that has been used in the early empirical growth regressions might potentially underestimate the benefit from FDI. In addition, given the instrumental estimates, all interested variables are identified as significant and positively associated with the relative level of GDP per capita between the US and follower countries, which implies that our theoretical framework fits the data well and provides new and interesting results.

2.5.2 Robustness Checks

The effect of FDI on the host country may be investigated further in another scenario. We explore whether the results found in the preceding section hold when the interaction terms between $lnFK$ and the relative level of human capital and technology and the interaction terms among the country groups are included, while examining whether there is a "conditional effect" of FDI, i.e., the importance a certain level of development as a prerequisite for the growth effect of FDI (Borensztein et al., 1998; Hermes & Lensink, 2003). In doing so, we focus on the 2SLSFE instrumental estimator and the one-step system-GMM estimator to estimate the impact of FDI on the relative level of GDP per capita. The estimation strategy involves including one interaction at a time in order to avoid the multicollinearity problem.

2.5.2.1 The Role of Countries' Abilities

We now turn to investigate whether the relative levels of human capital, technology and FDI reinforce each other to determine the rate of return in the follower economies. The results are presented in Table 2.6.

Apart from the main concern of the growth effect of FDI, the coefficients of the interaction terms between the FDI, the relative level of technology and human capital are all estimated as statistically significant from columns (1) to (4) in Table 2.6, regardless of which interaction term is included. Columns (1) and (2) in the table correspond to the differential effect of receiving FDI on GDP for the change in the relative level of technology. The elasticity of lny with respect to $lnFK$, which enters interactively with the relative level of technology, is negative and statistically significant at 1% significance level. The estimation of $lnA^s \times lnFK$ and the $lnA^{st} \times lnFK$ suggest that the effect of the change in $lnFK$ on lny depends negatively on the change in the relative level of technology. Column (1) indicates that receiving for-

Table 2.6: Robustness Check: The Interaction between FDI and Countries' Abilities 1977-2007

	2SLS Fixed-Effect			
	(1)	(2)	(3)	(4)
lnFK	0.214***	0.234***	0.563***	3.626**
	(0.011)	(0.012)	(0.061)	(1.673)
lnA^s	1.924***		1.835***	
	(0.040)		(0.042)	
lnA^{st}		2.000***		1.748***
		(0.050)		(0.056)
lnh^s	1.363***		2.130***	
	(0.143)		(0.159)	
lnh^{st}		2.076***		10.063***
		(0.735)		(4.527)
lnFK × lnA^s	-0.142***			
	(0.008)			
lnFK × lnA^{st}		-0.170***		
		(0.009)		
lnFK × lnh^s			-0.827***	
			(0.101)	
lnFK × lnh^{st}				-5.431**
				(2.564)
other controls				
Population	-0.0001	-0.00001	0.0001	0.0003
	(0.0005)	(0.0006)	(0.0006)	(0.0006))
Invest/GDP	-0.0001	0.00002	-0.0002	-0.00002
	(0.0001)	(0.0001)	(0.0001)	(0.00006)
Gov/GDP	0.00008	0.0002	0.0003	0.00003
	(0.0002)	(0.0003)	(0.0002)	(0.0003)
lntgdp	0.049***	0.080***	0.073***	0.113***
	(0.012)	(0.013)	(0.012)	(0.015)
lnExchange	-0.011***	-0.012***	-0.009***	-0.010***
	(0.001)	(0.001)	(0.001)	(0.002)
Time-effect	Yes	Yes	Yes	Yes
Country-effect	Yes	Yes	Yes	Yes
R-squared	0.7218	0.6779	0.6898	0.6131
Pro > F	0.000	0.000	0.000	0.000
Observations	1,600	1,600	1,600	1,600

Notes: *, ** and *** indicate the level of statistical significance at 10%, 5% and 1%, respectively.

eign capital decreases the growth effects of technology in the follower countries by 0.134[10]%, which implies intuitively that the adaptations in the follower nations by

[10]As the sample mean of $lnA^s \times lnFK$ is 0.943, the differential effect of $lnA^s \times lnFK$ on lny is $0.943 \times 0.142 = 0.133906$.

the multinational firms will become more difficult, as the unadopted subset of the intermediates (technologies) from the leader country is limited, and multinational firms are assumed to adopt the goods from the easiest to the toughest. We also find that the absence of FDI reduces the growth effect on GDP per capita by 0.147 $(0.866 \times 0.170)\%$, since the mean of $lnA^{st} \times lnFK$ is 0.866, and its estimated coefficient is confirmed to be -0.170 at the 1% significance level. In terms of the differential effect of receiving FDI on GDP for the change in the relative level of human capital, we find negative and statistically significant estimates in columns (3) and (4). The negative coefficient of $lnh^s \times lnFK$ indicates that the growth effect of $lnFK$ would be reduced by an increase in the level of human capital in the follower countries. This result holds when $lnh^{st} \times lnFK$ is controlled for.

The estimated coefficients of FDI, the relative level of human capital and technology and other core explanatory variables are reported in the table in columns (1) to (4) for the 2SLS IV fixed-effect estimator. The elasticity of lny with respect to $lnFK$ is confirmed as positive and significant at the 1% and 5% significance levels with clear signs throughout the columns. The results are not affected by the interactions, meaning that the effect of $lnFK$ on lny is indeed positive and not necessarily dependent on other conditions. The variables lnA^s and A^{st} are estimated as positive and significant throughout; the positive coefficient for the level of technology implies that a high level of technology would help the follower reduce the gap in GDP per capita compared to the leader nation. The results provided in columns (3)-(6) in Table 2.8 in the Appendix are estimated using system-GMM. Although some of the interesting variables are identified as statistically significant, the results vary with the specifications, especially the significance of the effect of FDI on GDP per capita which disappears in the last column of the table.

In short, the results suggest that while the positive effect from FDI on the relative level of GDP per capita does not necessarily depend on the "certain conditions", which is usually suggested by the empirical literature (e.g., Borensztein et al., 1998, B. Xu, 2000), the increasing levels of human capital and technology would limit the follower countries' abilities to benefit further from FDI. It may reflect the fact that once a certain level of development has been reached in the follower countries in the "South", they may start investing in innovation activities rather than simply relying on technology transfers through FDI carried out by the multinational firms from the leader country.

On the one hand, the existing studies highlight the threshold values for which the growth effects of FDI can occur. Focusing on developing countries, Borensztein et al. (1998) find that only the countries (46 out of the 69 developing countries) with secondary school attainment above 0.52 can benefit from FDI's growth effects. B. Xu (2000), by using cross countries manufacturing data, also finds that only the countries with a threshold level of human capital above 2.3 can benefit from FDI's growth effects. Others suggest that the effect of FDI on growth is contingent on the interaction between human capital, access to foreign financing (Cohen, 1994) and the interaction between secondary school enrolment and machinery imports (Romer, 1993). Although our findings are contrary to some previous studies, we focus on a different intuition by using different measures with a different dataset across different countries; thus, our results may not be completely comparable with others and the results from the interaction terms in our model are only based on the 64 countries. Also note that the negative effects from the interaction terms in our model might differ across countries, as it is likely that the countries with a low-income level might experience less negative effects from the interaction terms. This is because they might still rely on the adaptation activities carried out by the firms from the leading nations in order to absorb technologies and benefit from FDI. On the other hand, our findings can be supported by the studies Hermes and Lensink (2003), Alfaro et al. (2004) and Durham (2004), who find the interaction between FDI and schooling (or education rate) to be statistically insignificant, which might give support to the view that the interaction terms between the relative level of technology, human capital and FDI should be of concern other than the threshold values of the host country. Another possible explanation is that above-mentioned studies do not take into account the endogeneity correctly by instrumenting FDI using the human capital and technology variables.

2.5.2.2 Country-Specific Characteristics

With the results of the positive effects of FDI on the relative level of GDP per capita confirmed, we now subject these findings to the unobservable country-specific characteristics, as our data contains 67 countries with different income levels throughout. To detect it, the dummies of Developed, MUDC, LMDC, LDC and LEADC, that equal one for developed, middle, upper- income, lower-middle-income, low-income and least-developed economies and zero otherwise are generated. Table 2.7 shows the regression results. Columns (1) to (4) provide the estimates when the dummies are included by using 2SLSFE with the instrumental variable estimator, while columns (7) to (10) in Table 2.8 in the Appendix provide the results by using system-GMM.

The overall results are very close to the ones presented previously, which implies that the growth effect of FDI is identical and consistent with our model predictions. To be specific, when the groups of developing countries are controlled for, the estimated coefficients for the elasticity of lny with respect to FDI remain significant at 1% and 5% significance levels with estimated coefficients from 0.038 in column (2) to 0.223 in column (4). The interaction terms are generally confirmed to be statistically significant regardless of the specification estimated. Turning to the results when the developed dummy is controlled for, we repeat our regression of columns

Table 2.7: Robustness Check: Country-Specific Characteristic 1977-2007

	2SLS Fixed-Effect			
	(1)	(2)	(3)	(4)
lnFK	0.045**	0.038***	0.203***	0.223***
	(0.007)	(0.009)	(0.011)	(0.012)
lnA^s	1.730***		1.773***	
	(0.038)		(0.040)	
lnA^{st}		1.718***		1.770***
		(0.047)		(0.050)
lnh^s	1.661***		1.341***	
	(0.141)		(0.147)	
lnh^{st}		3.473***		2.571***
		(0.723)		(0.760)
lnFK × MUDC	0.163***	0.190***		
	(0.010)	(0.011)		
lnFK × LMDC	0.236***	0.355***		
	(0.045)	(0.048)		
lnFK × LDC	0.128***	0.202***		
	(0.030)	(0.032)		
lnFK × LEADC	3.947***	4.287***		
	(0.274)	(0.292)		
lnFK × Developed			-0.173**	-0.200***
			(0.011)	(0.012)
Population	0.0001	0.0002	0.00006	0.0001
	(0.0005)	(0.0006)	(0.0006)	(0.0006)
Invest/GDP	-0.0001	4.83e-06	-0.0002	-0.00001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Gov/GDP	0.0003	0.0005*	0.0004	0.0005
	(0.0002)	(0.0002)	(0.0003)	(0.0003)
lntgdp	0.045***	0.072***	0.062**	0.093***
	(0.012)	(0.013)	(0.012)	(0.013)
lnExchange	-0.013***	-0.014***	-0.013***	-0.014***
	(0.001)	(0.001)	(0.001)	(0.001)
Time-effect	Yes	Yes	Yes	Yes
Country-effect	Yes	Yes	Yes	Yes
R-squared	0.7428	0.7021	0.7095	0.6614
Observations	1,600	1,600	1,600	1,600

Notes: *, ** and *** indicate the level of statistical significance at 10%, 5% and 1%, respectively.

(1) and (2) after dropping off the developing dummies with $lnFK$ but adding the interaction between the developed dummy and $lnFK$ in the model. The results are provided in columns (3) and (4), which show highly similar results compared with the previous findings on the estimated coefficients of FDI, the relative level of human capital, the relative level of technology as well as other control variables.

In terms of the differential effect of lny with respect to the interaction of developing nation dummies, see columns (1) to (2), the coefficients of differential elasticities are significant regardless of whether lnh^v and lnA^v are included. While the differential effect of lny with respect to $lnFK$, which enters interactively with a developed dummy, is confirmed to be negative and significant. If we concentrate on the estimates in which the interaction of the developed dummy and FDI is included, we can observe that the growth effect of FDI on GDP per capita is decreasing with increasing income level, from an estimated coefficient of -0.173 in column (3) to -0.200 in column (4). On the other hand, if we focus on the estimates for which the interaction of developing dummies and FDI are controlled for, it is clear that the positive effect of FDI is the strongest in the least-developed economies, with estimated an coefficient of 3.947 at the 1% significance level, and it is the weakest in the middle and upper developing countries, with an estimated coefficient of 0.163 at the 1% significance level. These results imply that the less-developed economies would benefit more from the innovation activities carried out by the firms from the leader country and the adaptation activities carried out by the firms in the follower economies.

In the following regressions, we repeat the regressions in columns (1) to (4) by using the system-GMM and provide the results in columns (7) to (10) in Table 2.8 in the Appendix. Regressions in columns (7), (8), (9) and (10) show that system-GMM estimation yields qualitatively different results compared to those obtained via 2SLSFE instrumental variable estimation. The estimated coefficients for FDI are significantly positive in the last two columns, but negatively significant in columns (7) and (8). While the relative level of technology is positive and significant throughout the columns, the estimated coefficients of human capital are identified as positively significant in columns (7), (8) and (10) but insignificant in column

(9). We also carried out the Hansen J statistics and, unfortunately, the results remain problematic, as perfect Hansen J 1.000s are found throughout the regressions. Again, in this case, we are more confident with the estimated results provided by 2SLSFE.

2.6 Conclusion

FDI has long been considered an important channel for transferring technologies and promoting economic development in developing countries. Researchers have attempted to establish conclusive evidence showing that FDI contributes positively to the development of a country, yet existing studies that apply growth empirics with FDI generally find less significant or even a negative effect of FDI in growth regression. This study explores, theoretically and empirically, the connection between FDI and economic growth. Unlike the previous literature, we focus on the effects of a country's initial relative efficiency on the effects of FDI on economic growth. Our findings make two major contributions to the literature.

First, the results show a significant and positive association between FDI and the relative level of GDP per capita, which confirms that the growth effects of FDI take place in the host-country economy. The existence of this relationship suggests that FDI contributes to GDP per capita and is indeed an important factor in economic development. While the direct elasticity of GDP per capita to FDI implies that the growth effect of FDI does not necessarily depend upon other growth determinants, it will be smaller if the relative efficiency of a particular country is smaller. Second, the results suggest that the relative level of countries' abilities is important in the FDI-growth regression. The relative level of countries' abilities is identified as positive and significant in the model, which implies that most studies to date have ignored its crucial impacts on growth. Therefore, our model provides a way to address the endogeneity of FDI in the growth regression properly.

The results presented in this chapter have some clear and important implications for both policymakers and researchers. First, policymakers should endeavour to accelerate their country's economy by attracting FDI because doing so is one of the best ways for a country to develop. FDI can bring in advanced knowledge from the world-leading nations, which is the catalyst for knowledge improvement. Therefore, the FDI recipient economies gain not only the growth effects but also an endogenous growth effect from FDI. Second, researchers should be aware of the endogenous determination of FDI, which may not be addressed properly by the system-GMM estimator. Modelling the endogenous determination of FDI may be a good way to mitigate the bias in order to estimate the growth effect of FDI accurately.

The above results lend support to those who, early in the growth-FDI empirics, stressed the importance of FDI for the developing or the transition countries (Campos & Kinoshita, 2002; C. Wang et al., 2004; Li & Liu, 2005; Iamsiraroj, 2016). Although, more recently, the ambiguous role of foreign capital on a country's economy has been discussed intensively, it seems that it is hard to identify the contribution of FDI without an original theoretical framework. At the same time, the above results also warrant the stress put on the econometric strategy with respect to the endogeneity of FDI on growth. Given the limited success in identifying the growth effect of FDI empirically so far, it may also be interesting to extend our theoretical framework to modelling the concept of a country's innovation and adaptation behaviour. As the instruments and an appropriate estimator may admittedly be demanding, more theoretical work in this area could also be done.

2.7 Appendix: Proof of Equation 2.41

As Eq. (40) shows that

$$\frac{\pi_1 + \pi_2}{\eta_1 + d_2} = \frac{\pi_1}{\eta_1} \tag{2.63}$$

which can be simplified as follows:

$$\begin{aligned} (\eta_1 + d_2)\pi_1 = \eta_1(\pi_1 + \pi_2) \\ \eta_1 + d_2 = \frac{\eta_1(\pi_1 + \pi_2)}{\pi_1} \\ d_2 = \frac{\eta_1(\pi_1 + \pi_2)}{\pi_1} - \eta_1 \end{aligned} \tag{2.64}$$

hence

$$\begin{aligned} d_2 = (\frac{N_2}{N_1})^{\sigma}(\frac{A_1}{A_2})^{\delta}(\frac{H_1}{H_2})^{\beta} = \frac{\eta_1(\pi_1 + \pi_2)}{\pi_1} - \eta_1 \\ \frac{N_2}{N_1}^{*} = [\eta_1(\frac{A_2}{A_1})^{\frac{1+\delta-\alpha\delta}{1-\alpha}}(\frac{H_2}{H_1})^{1+\beta}]^{\frac{1}{\sigma}} \end{aligned} \tag{2.65}$$

2.8 Appendix: One-step system-GMM

Table 2.8: One-step system-GMM 1977-2007

	One-Step System-GMM									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
lnFK	-0.004	0.00008	0.025**	0.027**	0.085**	0.039	-0.011*	-0.012*	0.036***	0.032***
	(0.006)	(0.006)	(0.012)	(0.010)	(0.028)	(0.147)	(0.006)	(0.007)	(0.010)	(0.010)
lnA^s	0.405***		0.464***		0.449***		0.502***		0.475***	
	(0.093)		(0.095)		(0.091)		(0.101)		(0.094)	
lnA^{st}		0.361***		0.435***		0.363***		0.451***		0.425***
		(0.080)		(0.098)		(0.078)		(0.096)		(0.089)
lnh^s	0.295*		0.238		0.383***		0.301**		0.137	
	(0.155)		(0.185)		(0.161)		(0.140)		(0.175)	
lnh^{st}		-0.582		-0.056		-0.448		0.431**		0.113**
		(0.760)		(0.658)		(0.862)		(0.677)		(0.716)
lnFK × lnA^s			-0.027***							
			(0.009)							
lnFK × lnA^{st}				-0.030***						
				(0.009)						
lnFK × lnh^s					-0.144***					
					(0.043)					
lnFK × lnh^{st}						-0.060				
						(0.226)				
lnFK × MUDC							0.057***	0.055***		
							(0.013)	(0.012)		
lnFK × LMDC							0.061	0.075*		
							(0.044)	(0.043)		
lnFK × LDC							0.009	0.020		
							0.039)	(0.037)		
lnFK × LEADC							0.880***	0.917***		
							0.212)	(0.221)		
lnFK × Developed									-0.050***	-0.046***
									(0.011)	(0.002)
Population	-0.00008	-0.00009	-0.0001	-0.0001	-0.00007	-0.00009	-0.0001	-0.0001	-0.0001	-0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.010)
Invest/GDP	-6.35e-06	0.00006	-0.00001	0.00001	-0.00007	0.00005	-0.00001	0.00002	0.026***	9.17e-06
	(0.00006)	(0.00005)	(0.00006)	(0.005)	(0.00008)	(0.00005)	(0.00007)	(0.00006)	(0.00007)	(0.00007)
Gov/GDP	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003**	0.0003**	0.0004**	0.0003***
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.00017)	(0.00017)	(0.0002)	(0.0001)
lntgdp	0.043***	0.045***	0.033***	0.037***	0.044***	0.045***	0.037***	0.041***	0.039***	0.043***
	(0.012)	(0.012)	(0.011)	(0.011)	(0.012)	(0.012)	(0.013)	(0.012)	(0.012)	(0.011)
lnExchange	0.001	0.001	-0.0001	-0.0001	0.0003	0.001	-0.003	-.002	-0.001	-0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)
lnlagy	0.860***	0.888***	0.835***	0.861***	0.845***	0.887***	0.798***	0.829***	0.824***	0.855***
	(0.040)	(0.032)	(0.034)	(0.030)	(0.033)	(0.030)	(0.036)	(0.033)	(0.031)	(0.028)
Time-effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
AR(2)	0.102	0.100	0.120	0.112	0.111	0.100	0.172	0.153	0.146	0.127
Hansen J-test	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Observations	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526

Notes: Instruments used for system-GMM are all right-hand side variables with robust to heteroskedasticity and series correlation in errors. Hansen J-test is the test that detects the validity of instruments applied here. The null hypothesis of AR (2) is the first-difference regression exhibit no second-order serial correlation. The null hypothesis of Hansen's J test is that the instrumental variables are just identified. *, ** and *** indicate the level of statistical significance at 10%, 5% and 1%, respectively.

Chapter 3

Refining Vertical Productivity Spillovers from FDI: Evidence from 32 Economies

3.1 Introduction

Productivity spillovers are firmly believed to be triggered by the presence of multinational firms surrounding domestic firms in the host country. To be specific, the literature generally defines productivity spillovers to be the productivity improvements that domestic firms acquire when they have access to the specialized resources of multinational firms through foreign direct investment (henceforth, FDI) (Haskel, Pereira, & Slaughter, 2007). The forms used by, and the motivations for, multinational firms locating activities abroad can be traditionally distinguished as "horizontal" FDI and "vertical" FDI. The "horizontal" FDI refers to the replication of the whole production facility abroad with the aim of being close to the customer base (Markusen, 1984; Brainard, 1993; Alfaro & Charlton, 2009), while "vertical" FDI refers to the reallocation of different stages of the production process abroad with the aim of taking advantage of differences in production costs across countries (Helpman, 1984; Alfaro & Charlton, 2009). In more recent studies, vertical FDI has been distinguished between the input sourcing behaviours of “backward” and ‘forward” linkages, where the backward linkage refers to the inputs supplied by the domestic firms to multinational companies and the forward linkage refers to the inputs supplied by multinational firms to domestic firms (Javorcik, 2004; Newman et al., 2015; Jude, 2016). While existing studies have found the bulk of FDI spillovers to be backward in nature (Javorcik, 2004; Blalock & Gertler, 2008; Barrios, Görg, & Strobl, 2011), in this study, we construct new measures of vertical spillovers that account for the differences in firms’ sourcing and supplying strategies within an industry and refine both types of vertical spillovers. Our new measurements reveal that both backward and forward spillovers are more prevalent than previously thought.

A common challenge which exists in the literature is the absence of firm-level data with which to distinguish the differences in firms’ local sourcing behaviours, which limits the measurement of FDI vertical spillovers at the sectoral level. To account properly for vertical spillovers derived from the presence of multinational firms, ideal measures require data which provide information on a firm’s sourcing behaviour, particularly concerning information on how much a firm is sourcing from, and supplying to, a multinational company. Researchers have instead used input-output data at the sectoral level to construct vertical spillovers measures as proxies for studying domestic firms’ productivity gains from multinational firms. The empirical studies have relied on the assumption that firms’ source inputs do not vary with firms’ ownership status, i.e., domestic and acquired firms within any given sector are homogeneous with regards to sourcing inputs from, and supplying inputs to, multinationals for situations in which productivity spillovers from multinational firms to domestic firms arise (Javorcik, 2004; Gorodnichenko et al., 2014; Newman et al., 2015; Jude, 2016). In doing so, little may be learned about which domestic firms do receive the vertical spillovers originating from multinational firms, as the traditional measurement only measures the strength of sectoral linkages (Görg & Seric, 2016) and the assumptions imposed in the existing literature might be violated (Barrios et al., 2011). Multinationals and domestic firms could, in fact, be heterogeneous in sourcing behaviour or production technology in practice.

A firm-level survey dataset provided by the European Bank for Reconstruction and Development (henceforth, EBRD) in conjunction with the World Bank Business Environment and Enterprise Performance Survey (henceforth, BEEPS) enables us to provide a more nuanced and comprehensive analysis of FDI vertical spillovers, in which we distinguish the differences in sourcing and supplying activities across firms to refine the vertical spillovers, fulfilling the overall objective of this chapter. Because we still do not observe local sourcing activities between multinational firms and domestic firms directly, i.e., the information regarding the number of inputs domestic firms purchased from multinational firms is still absent as a limitation of the dataset, we use a combination of multinational firms' sales to the large domestic firms across sectors[1] in conjunction with the local inputs of each domestic firm and the domestic firm's imported inputs to measure forward linkage spillovers at the firm level. Additionally, we use the actual sales of each domestic firm to multinational firms to measure backward linkage spillovers at the firm level. The horizontal measurement, however, remains at sectoral level. To this end, we construct two proxies for forward-linkage variables and one proxy for a backward- linkage variable to relax

[1]The data used in this chapter only asked each firm to indicate the number of outputs that went to the eight given sectors. Firms' sector assignments were also based on these eight given sectors during the survey periods 2002, 2003 and 2005. This sectoral-level information, which will be used to construct the new forward linkages described in Section 3.3, is based only on multinational firms within the same sector. Therefore, even with this sectoral-level variable, our measure is still less aggregated than the standard measure of forward linkages, which is constructed based on all firms in the sectors.

the assumptions posted in the literature. We refine the vertical spillovers in both backward and forward linkages and verify the accuracy of our constructed measures in a number of ways.

Some of our empirical findings suggest that it might be worthy to reconsider the conventional wisdom in terms of the way in which vertical FDI spillovers are measured. Consistent with the existing literature, we find that backward spillovers occur in those developing countries; additionally, the effects of backward spillovers are considerably more important than the effects of horizontal spillovers on domestic firms' productivity. However, disaggregating the measurement of backward linkages from the sectoral level to the firm level reveals that multinational firms do not have the same sourcing behaviour as local firms in the host country. Differences arise because multinational firms locating abroad are very likely to source input materials differently across nations compared to local firms (Rodriguez-Clare, 1996), whereas the average sourcing behaviour at the sectoral level provided by the input-output data suggests that sourcing behaviour is homogeneous across firms in the host country (Barrios et al., 2011; Görg & Seric, 2016). Contrary to the conventional wisdom, therefore, we find that based on the sample of 32 economies the traditional measurement of backward spillovers do not provide evidence of the spillover effects on domestic firms' productivity, whereas our proposed measurement seems to be able to control for the heterogeneous sourcing activities across multinationals and domestic firms and provides evidence of backward linkage spillovers on productivity.

Another striking empirical finding is that the significant effect of forward linkages might have been previously underestimated and neglected by the existing empirical literature. As the traditional measure of forward linkage remains at the sectoral level, indirect effects are measured by including average sourcing proportion variables capturing spillover potential with ambiguous effects but not direct contact with multinational firms. The way the literature has estimated the forward spillovers relies on the assumption that domestic firms purchase inputs from multinational firms with the same proportion as domestic firms purchase inputs from other domestic firms in the host country. Firms' strategies with regards to undertaking sourcing activity have long been recognized to be complex (Javorcik & Spatareanu, 2008). This debate matters, as the different strategies have bearing on how sourcing activity triggers FDI forward spillovers within firms. As foreign inputs may embody more advanced technologies, the capabilities of foreign inputs buyers may be increased. However, if the bargaining weight, for instance, shifts the input prices in favour of other multinationals' local partners, domestic suppliers' profits will be squeezed and a reduction in productivity will be observed (Girma et al., 2008). On the other hand, positive forward spillovers occur if domestic firms can access foreign inputs at lower costs.

The differences in firms' sourcing behaviours might explain why the literature has been unable to confirm the importance of forward spillovers in terms of productivity. Although our data limitations still impede a more precise estimation of forward linkages, in order to obtain the proximate estimates, we construct new variables that capture the proximity of the spillover effects of forward linkages using the proportion of local inputs and imported inputs across each domestic firm, combining the proportion of production that each multinational firm supplied to the large domestic firms across sectors. We present evidence that the forward spillovers can be both positively and negatively associated with firms' productivity, which depends crucially on the disaggregate measures we employ.

The chapter proceeds as follows. Section 3.2 provides an overview of recent FDI literature on vertical spillovers. Next, Section 3.3 outlines the empirical strategy, while Section 3.4 describes dataset. The results of our various estimations and main conclusions are presented in Section 3.5 and Section 3.6.

3.2 Literature Review

FDI spillovers on the productivity of domestic firms take place when the entry or presence of multinational firms creates positive externalities in a host country. Horizontal spillovers within sectors may arise when domestic firms increase their production efficiency by hiring employees of foreign firms (Javorcik, 2004) or by imitating a new process observed in the local market (Gorodnichenko et al., 2014). Within sectors, however, horizontal spillovers may be less likely to be found, as multinational firms compete with domestic firms and may force domestic firms to contract by stealing business, preventing their knowledge and technologies from leaking to their domestic competitors (Javorcik, 2004; Newman et al., 2015; Kim, 2015). There is a large body of literature, including Haddad and Harrison (1993) on Morocco, Harrison, Aitken, et al. (1999) on Venezuela and Kosova (2010) on the Czech Republic, that has documented that horizontal spillovers in terms of productivity are ambiguous. In contrast, multinational firms have less incentive to prevent technology diffusion between sectors; hence, vertical spillovers occur when multinational firms establish sourcing linkages with local firms in the host country. The empirical literature, therefore, has paid more recent attention to vertical spillovers, particularly backward linkages (Newman et al., 2015).

To measure the vertical spillovers, information on the inputs demanded by each domestic firm from multinational firms and the inputs demanded by multinational firms from each domestic firm is required. However, the unavailability of detailed firm-level information has led researchers to measure the vertical spillovers by using the host countries' input-output tables (i.e., Javorcik, 2004). Javorcik's measurement has been used widely in empirical studies to estimate the spillover effects from forward and backward linkages.

Backward spillovers onto the productivity of domestic firms occur when domestic firms benefit from having foreign customers due to the higher product quality requirements and the technological assistance provided to increase supply quality and efficiency (Rodriguez-Clare, 1996; Giroud, Jindra, & Marek, 2012). However, empirical investigations of FDI backward linkages have not provided strong support for predictions of positive spillovers onto productivity. Using a sectoral-level measurement, MacDuffie and Helper (1997) find evidence of productivity gains on the part of U.S. parts suppliers for the Japanese automobile market. Javorcik (2004) finds that spillovers are more likely to occur when the upstream domestic firms supply inputs to the downstream multinationals throughout 20 sectors in Lithuania . On the other hand, Blalock and Gertler (2008) suggest that multinational firms may establish relationships with different local suppliers to reduce dependency on a single supplier and lower the input price, which results in low measured productivity. Given the benefit of lower-priced inputs, Pack and Saggi (2001), by way of contrast, note that downstream multinationals may increase the demand for the inputs from upstream firms and that the stronger demand downstream may increase the outputs of upstream firms, perhaps helping the technology recipients in the local supplier pool. X. Xu and Sheng (2012), among others, find a negative and statistically significant effect of backward spillovers on Chinese manufacturing firms between 2000 and 2003.[2] Explanations of different findings with regards to backward spillovers also relate to the assumptions regarding firms' sourcing activities. Barrios et al. (2011) argue that the evidence against backward spillovers is a consequence of using aggregate data across sectors from the input-output tables of the host country and find

[2]Papers in the more recent literature also speak of the potential variations in the ownership structure and multinational firms global-sourcing strategies. As noted by Newman et al. (2015), foreign ownership structures across firms might determine firms' local sourcing behaviours; thus, the backward spillovers might be biased unless the variation in ownership structure is controlled for.

that the positive effects of backward spillovers only appear once the input-output tables are switched from the host country to the multinationals' home countries.

Forward spillovers onto the productivity of domestic firms take place when domestic firms gain access to new, improved inputs produced by multinational firms (Javorcik, 2004). Many studies since Grossman and Helpman (1991b) have argued traditionally that the input materials provided by the foreign firms embody advanced technologies, allowing domestic firms to benefit from efficient organization and adopting advanced production processes. Similarly, Javorcik (2004) stresses that domestic firms benefit from the spillovers if the inputs supplied by foreign firms are accompanied by services and other supports, including labour training and know-how, for the domestic buyers. However, empirical studies, including Kim (2015) on South Korea, Newman et al. (2015) on Vietnam and Jude (2016) on countries in Central and Eastern Europe, do not provide support for positive forward spillovers onto productivity. Instead, they find strong evidence for negative forward spillovers onto domestic firms' productivity.

Additionally, Barrios et al. (2011) point out that the measures applied in the existing studies are fully dependent upon the assumption that multinationals from different nationalities have the same supplying behaviours as the domestic firms in the host country, and this assumption might lead to biased estimation of forward spillovers. A slightly different argument presented in Görg and Seric (2016) states that the frictions between customers and suppliers are likely to be different than what is assumed, i.e., the actual frictions between customers and suppliers may provide some guidance on how to better measure the linkage effects. In estimating the forward linkage spillovers, Barrios et al. (2011) use a measurement incorporating input-output tables taken from each multinational firm's own country instead of using the input-output tables of the host country. Due to the lack of data and measurements allowing domestic firms' direct linkages to the multinational firms to be estimated, the authors fail to show the importance of forward spillovers onto productivity. Given that only firm-level data are available on the suppliers of multinationals, Görg and Seric (2016) focus on whether domestic firms receiving assistance from multinationals strengthen the spillovers onto their productivity. They find that supplying inputs to multinationals is positively associated with firms' productivity. As noted by Newman et al. (2015), there is a particularly notable dearth of evidence on the existence of forward linkage spillovers from multinational firms to domestic firms.

The lack of consistent evidence casts doubt on whether such spillover effects exist. More importantly, the empirical literature focused on vertical spillovers relies on sectoral-level measurements in conjunction with input-output tables, which implies that they measure the indirect sector's linkage effects (Görg & Seric, 2016). Doing so may reveal that the differences in sourcing and supplying activities across firms may potentially matter for empirical findings and perhaps explain why the mixed empirical evidence concerning the beneficial vertical spillover influence of FDI on domestic firms' productivity has emerged.

We add to the existing studies on exploiting the measurement of vertical spillovers, providing one further step towards understanding the mechanisms at work. We construct two indirect measures for forward linkages at the firm level based on the reported firm's sales that go to each downstream sector and the sales of multinationals that go to large domestic firms. These data allow us to get away from relying on input-output tables. Most closely related to our empirical analysis is the study by Gorodnichenko et al. (2014), which uses the BEEPS dataset to examine existing hypotheses about the spillover effects of FDI vertical linkages - with sectoral-level input-output tables establishing the vertical linkages - and shows that only backward linkages have a positive, but less significant, effect on domestic firms' productivity. However, as we will show below, it is crucial to distinguish the effect of directly sourcing from, and supplying to, multinationals for firms that experience productivity improvements from those that are just assumed to source inputs from, and supply inputs to, multinational firms.

3.3 Estimation Strategy

Our core focus is on the effect of vertical spillovers through backward and forward linkages on the productivity of domestic firms based on our alternative measures defined at the firm-level. We provide detail information of constructing the main linkage variables in section 3.3.1, while the productivity estimation and our empirical model specifications are provided in sections 3.3.2 and 3.3.3.

3.3.1 FDI Spillovers Measurement

The standard measures on vertical linkages were constructed by Javorcik (2004), whereby she incorporated the input-output tables to collect data on the proportion of inputs purchased by downstream local firms from upstream local firms and data on the proportion of outputs sold by upstream local firms to downstream local firms

$$Forward^{IO}_{j,t} = \sum_{d} \delta^{IO}_{d,j} \times Horizontal_{d,t} \tag{3.1}$$

$$Backward^{IO}_{j,t} = \sum_{u} \delta^{IO}_{u,j} \times Horizontal_{u,t} \tag{3.2}$$

were $\delta^{IO}_{d,j}$ is the proportion of inputs purchased by sector j downstream from sector d upstream , $\delta^{IO}_{u,j}$ is the proportion of outputs sold from sector j upstream to sector

u downstream. $Horizontal_{d,t}$ is therefore the proportion that measures sales of multinationals over the total sales in upstream sector d and downstream sector u (Caves, 1974) defined as follows:

$$Horizontal_{j,c,t} = \frac{\sum_i \rho_{i,j,c,t} \times Sales_{i,j,c,t}}{\sum_i Sales_{i,j,c,t}} \tag{3.3}$$

where $\rho_{i,j,c,t}$ is the foreign ownership of firm i in country c sector j at time t, $Sales_{i,j,c,t}$ is the total sales of firm i in country c sector j at time t.

Perhaps due to data availability, the above measures have been used widely in many papers since, e.g., Gorodnichenko et al. (2014)[3], Newman et al. (2015), Kim (2015) and Jude (2016). However, these measures may have shortcomings since the sourcing behaviour is assumed to be common across firms within the same industry in equations (3.1) and (3.2). They may, in fact, capture the indirect effects other than the direct spillover effects originating from multinational firms and received by domestic firms. To clarify matters, defining $\delta^{IO}_{d,j}$ and $\delta^{IO}_{u,j}$ in measures of backward and forward linkages implies that the following assumptions are held: (i) multinational firms in upstream sectors supply the same proportion of inputs to domestic firms in downstream sectors as do local firms in upstream sectors, and (ii) domestic firms in upstream sectors supply the same proportion of inputs to downstream multinational firms as they do to downstream local firms.

First, it should be clear that multinational firms should arguably have different production technology compared to local firms in the host country, which implies that sourcing and supplying strategies are likely to differ. From our data based on the 32 economies, it suggests that the local sourcing activities between multinational firms and domestic firms, for example, are very different, on average – the

[3] Gorodnichenko et al. (2014) define forward and backward linkages weighted by the share of sales of industry j sold to, and purchased from, industry d.

mean value of the proportion of materials sourced locally by multinational firms is 0.47, whereas it is about 20 percentage points higher for domestic firms with the proportion of input materials sourced locally. These sourcing differences also vary across countries (See columns (8) to (11) in Table 3.9 in the Appendix)[4]. Adhering to the two assumptions above would be contradictory to the idea that vertical technology transfer occurs from multinational to domestic firms through both linkages. Second, it is not realistic that multinational firms and local firms across sectors use the same average proportion to supply inputs to downstream domestic firms. Domestic firms in downstream sectors might purchase more inputs from upstream domestic firms, as the input prices offered by multinational firms could be higher if the multinationals have a large market share (Newman et al., 2015). Since the proportion of inputs that domestic firms require exactly from multinational firms remains unclear, maintaining assumption (i) may only result in the indirect spillover effects from domestic firms purchasing inputs from other domestic firms who copy the inputs produced by multinational firms being measured and not the direct forward linkage effects from domestic firms purchasing inputs provided by multinational firms embodying new and advanced technologies from which they can learn (Grossman & Helpman, 1991b). It may overlook the true importance of forward linkages. Third, it is likely that multinational firms would buy more inputs from other multinational firms (Belderbos, Capannelli, & Fukao, 2001), as the input quality might matter[5]. Assumption (ii) implies that Eq. (3.2) may only capture the competition effect from domestic input suppliers producing products that are similar to the input requirements of multinational firms rather than the direct backward

[4]It is also noteworthy that the multinational firms in Guatemala, FYROM, and Elaslvador tend to source few input materials from local suppliers compared to the multinationals in other developing countries.

[5]Belderbos et al. (2001) provide evidence showing that Japanese affiliates of parent firms belonging to the same Keiretsu tend to have input buyer-supplier relationships with other Keitretsu affiliates.

linkage effect from multinational firms improving the productivity of their suppliers through training, quality control and inventory management.

The assumptions stated above could arguably lead to biased estimates on both backward and forward linkages, and it is not clear a priori whether not being able to distinguish firms' sourcing activities would lead to an upward or downward bias in the estimates. Therefore, the purpose of this chapter is to construct the vertical linkages that may be better able to distinguish sourcing and supplying differences across firms. Our measurement choice, detailed further below, is driven in part by data limitations preventing us, for example, from knowing the number of inputs each firm bought from foreign suppliers. Rather, we infer the number of inputs bought by domestic firms from multinational firms across each sector by using the number of outputs sold by multinational firms to large domestic firms across each sector.

In order to relax assumption (i), data on domestic firm's inputs purchased from multinationals upstream is required. Unfortunately, this data is unavailable. Nevertheless, the BEEPS data set allows the distinction between the sales from multinational firms that go to each downstream sector and the sales from multinational firms that go to the large domestic firms. Therefore, we construct the proportion of outputs sold by each multinational firm to the large domestic firms across downstream sectors as an important proxy indicating the number of inputs domestic firms would approximately purchase from multinational firms:

$$\alpha_{j,h,c,t} = \sum_{m} c_{m,j,h,c,t} \left(\frac{\sum_j \sum_m MultinationalSales^{LD}_{m,j,c,t}}{\sum_j \sum_m MultinationalSales_{m,j,c,t}} \right) \tag{3.4}$$

where $MultinationalSales^{LD}_{m,j,c,t}$ denotes the outputs sold by a given multinational firm m to the large domestic firms (where the superscript LD stands for "large domestic firms"), and $MultinationalSales_{m,j,c,t}$ represents the total sales of multinational firm m. The $c_{m,j,h,c,t}$ is the proportion of sales of multinational firm[6] m that goes to local firms in downstream sector h in country c at time t. Therefore, the variable $\alpha_{j,h,c,t}$ represents a sectoral- level proportion that shows the volume of inputs multinational firms would supply to the large domestic firms across sectors[7].

By combining this information with imported inputs and local inputs across each domestic firm, as we describe below, we are better able to infer the direct contact between domestic firms and multinational firms at the firm level. As BEEPS only provides data for the sales to large domestic firms, Eq. (3.4) also imposes the assumption that domestic firms have the same sourcing behaviour as large domestic firms in their country. While this assumption is strong, it is weaker and less restrictive than the assumption that multinational and domestic firms have the same sourcing behaviour. In addition, it does not contradict vertical spillovers possibly flowing from multinational firms to domestic firms. Nevertheless, we provide robustness checks in the analysis in which we control for a firm's age and export status. If the productivity difference between large and other domestic firms plays a significant role, we would then find that the two additional controls would change the empirical findings. However, we can confirm that this is not the case in our data since we find similar results for the estimated coefficients (see section 3.5.2).

Given Eq. (3.4), it is unclear whether such outputs that come from multinationals to domestic firms would be used as the input materials by the domestic firms. To tackle this uncertainty, we multiply Eq. (3.4) by the proportion of a firm's input

[6]We define a multinational firm as a firm that has foreign ownership of at least 10% (including 10%) by using a dummy variable, following studies Javorcik and Spatareanu (2008) and Yudaeva, Kozlov, Melentieva, and Ponomareva (2003).

[7]Note that $\alpha_{j,h,c,t}$ is constructed based on the eight given sectors and is based entirely on the multinational firms operating in the host country within the same sector instead of all firms operating in the host country. Arguably, this variable is not perfect, but it is more realistic to represent the number of demanded inputs supplied by multinational firms available to domestic firms by using Eq. (3.4), as aggregating all firms' supplying behaviours, which is how the standard measure is constructed, is more aggregate than aggregating just multinational firms' supplying behaviours. Although we are only able to establish linkages for the eight given sectors, it is easier to extend the analysis when more sectors and firms are included in BEEPS.

sourced from the local market. This allows us to identify the output supplied by multinationals to the domestic firms to be used as input materials by domestic firms. In doing so, we construct the forward linkages as follows:

$$Forward_{i,j,c,t}^{proxy-buy} = \sum_{h} \alpha_{j,h,c,t} \times \mu_{i,j,c,t} \tag{3.5}$$

where $\alpha_{j,h,c,t}$ is the proportion of outputs sold by multinational firms in upstream sector j to the large domestic firms in downstream sector h, and $\mu_{i,j,c,t}$ is the proportion of total inputs sourced domestically by firm i in sector j of country c at time t. This measure indicates the proportion of inputs sold by multinational firms in upstream sectors to downstream domestic firms that is now going to firm i measured at the firm level. The measure proposed in Eq. (3.5) lets us investigate how Assumption 1 affects forward spillovers.

Assumption (i) is also relaxed by using the domestic firm's imported inputs. The logic here is that it is likely that domestic firms would purchase the same proportion of inputs from upstream multinationals as they purchase from outside the country (imported). For example, domestic firms would buy 10% of input materials from multinational firms if they import 10% of input materials from abroad. Following this idea, we construct the second forward linkage measure by using imported inputs as follows:

$$Forward_{i,j,c,t}^{proxy-imp} = \sum_{h} \alpha_{j,h,c,t} \times im_{i,j,c,t} \tag{3.6}$$

where $im_{i,j,c,t}^{imported}$ is imported inputs over the total input for firm i in country c and sector j at time t. Note that the imported inputs may be influenced by other factors, for example, by the transportation costs. Therefore, the demand for the imported inputs may be lower, leading to a reduction in the inputs purchased from the multinational firms. Nevertheless, comparing the measures in Eq. (3.5) and Eq. (3.6) would allow us to observe a more accurate effect of forward spillovers on firm productivity, as a range of magnitude would be captured by the two measures. In doing so, an assumption that a firm acquires inputs from multinational firms the same proportion that they acquire (imports) from country c is made. One concern is whether input materials from abroad and input materials from multinationals are substituted at some level. However, because we cannot directly observe the actual amount of input materials purchased by domestic firms from multinationals, we cannot see how different it would be between the imported materials and the materials purchased from multinationals. Therefore, for simplicity, we assume domestic firms would purchase the same amount of input from multinationals as they import from abroad.

Although this assumption may be strong, it can be supported by Halpern, Koren, and Szeidl (2015), who document that foreign-owned firms have better access to low-cost input suppliers abroad and face lower transactions costs and are thus more efficient at using imports than domestic firms. In addition, Rodriguez-Clare (1996) who develops a two-country model in which multinational firms exist, emphasizes that intermediate goods are non-tradable and only multinationals have access to intermediate goods from both countries. Therefore, to avoid inefficiency, domestic firms may thus purchase those inputs from multinational companies instead of imports, which implies that holding the assumption above may not be too problematic[8].

To relax assumption (ii), information on domestic firms' supplies to downstream

[8] Halpern et al. (2015) provide evidence showing that the benefits from imports differ between foreign and domestic firms. They find that foreign-owned firms benefit about 24 percent more than purely domestic firms from each 1$ they spend on imports and offer suggestive evidence that the premium for using imports is caused by foreign ownership. Hence, even if we hold the assumption mentioned above, our empirical results do not imply that domestic firms' productivity gains from imports but rather FDI forward linkages.

multinationals is required. We take this data from BEEPS to estimate backward linkage spillovers at the firm level[9]. The backward linkage is constructed as follows:

$$Backward^{firm}_{i,j,c,t} = \delta_{i,j,c,t} \times a_{i,j,c,t} \times Sales_{i,j,c,t} \times D_{DomesticFirm} \tag{3.7}$$

where $a_{i,j,c,t}$ is the proportion of total sales to the domestic market, while $\delta_{i,j,c,t}$ is the proportion of total domestic sales from firm i in country c and sector j at time t to multinational firms. $Sales_{i,j,c,t}$ represents the total sales of firm i in sector j at time t. $D_{DomesticFirm}$ is a dummy set equal to 1 if the foreign ownership of firm i is less than 10% and 0 otherwise. Using the dummy variable helps us to make sure that the outputs are supplied by domestic firms to multinational firms instead of by the local firms to multinational firms. This variable is constructed using the natural logarithm.

We also construct both backward and forward linkages based on Eq.(3.1) and Eq. (3.2) as the existing standard measures. Doing so allows us to see how alternative measures influence the analysis and lets us determine whether our new measures perform better than the existing ones used in the literature. Lastly, as we mainly focus on the vertical linkages, the horizontal spillover therefore remains unchanged and is measured by using Eq. (3.3).

3.3.2 Productivity Estimation

Ordinary Least Squares (OLS) estimation of the production function assumes that inputs are not determined by firms' efficiency levels, which could be unrealistic. Due to data limitations, the early FDI spillover literature typically pooled data es-

[9]Based on the BEEPS, Godart and Görg (2013) use a dummy variable indicating whether domestic firms' sales are to multinational firms, while Gorodnichenko et al. (2014) use data on the proportion of total domestic sales to multinationals from 2005 as an additional control variable in their model only.

timating the production function using OLS techniques (Gorodnichenko, Svejnar, & Terrell, 2010; Commander & Svejnar, 2011; Gorodnichenko et al., 2014). While we follow these studies to estimate firm-level productivity, we conduct a robustness check by estimating different forms of the production function with additional controls (See Section 3.5.2).

The estimation of the production function involves two steps. The first step is to regress the firms' output on the capital stock, labour and material inputs. The empirical estimation is based upon a Cobb-Douglas production function, as shown below:

$$lnY_{i,j,c,t} = \beta_0 + \beta_L lnL_{i,j,c,t} + \beta_K lnK_{i,j,c,t} + \beta_M lnM_{i,j,c,t} + s_j + \tau_t + z_c + \varepsilon_{i,j,c,t} \quad (3.8)$$

where $L_{i,j,c,t}$, $K_{i,j,c,t}$ and $M_{i,j,c,t}$ are the logarithms of employment, capital and materials used by firm i in country c and sector j at time t, and $Y_{i,j,c,t}$ is the logarithm of a firm's total sales. As we mentioned previously, potential simultaneity bias in input choices may exist and can be addressed by implementing the Olley and Pakes (1996) and Levinsohn and Petrin (2003) types of productivity measures. Nevertheless, the time dimension in our data is insufficient to implement these approaches, as our data relies primarily on the pooled 2002, 2003 and 2005 data. Gorodnichenko et al. (2014), on the other hand, suggest that adding country and industry fixed-effects to the specification may mitigate the endogeneity of the inputs. The s_j denoted sector fixed effects and z_c denoted country fixed-effects are thus controlled for in the model. In addition, following Newman et al. (2015), including a full set of time dummies may mitigate heterogeneity over time in the production function. Thus, time fixed-effects τ_t are also controlled for in the model. Once consistent estimators for β_L, β_K and β_M are estimated, the productivity (the residual $\varepsilon_{i,\hat{j},c,t}$) can be estimated using

Eq. (3.9):

$$\hat{\varepsilon}_{i,j,c,t} = lnY_{i,j,c,t} - \hat{\beta}_L lnL_{i,j,c,t} - \hat{\beta}_K lnK_{i,j,c,t} - \hat{\beta}_M lnM_{i,j,c,t} \tag{3.9}$$

3.3.3 The Empirical Model

3.3.3.1 Pooled OLS Estimation

Given the estimated productivity at the firm level, the benchmark regression for measuring spillovers on firms' performance with pooled OLS across economies, sectors, and firms is given as follows:

$$\begin{aligned} \hat{\varepsilon}_{i,j,c,t} &= \alpha_0 + \alpha_1 Horizontal_{j,c,t} + Forward\beta + Backward\gamma \\ &+ s_j + C^{'}Z + \tau_t + z_c + \omega_{i,j,c,t} \end{aligned} \tag{3.10}$$

where $\hat{\varepsilon}_{i,j,c,t}$ denotes the total factor productivity (henceforth, TFP) in logarithmic form; *Backward* refers to the measure constructed by using input-output tables from the 12 countries as in Eq. (3.2) at the sectoral level, and the logarithm of firm-level backward linkages constructed by Eq. (3.7), respectively; *Forward* refers to the measure constructed by using input-output tables from 12 economies as in Eq. (3.1), and the others constructed via Eq. (3.5) and Eq. (3.6). The s_j sector fixed effects, τ_t time fixed effects and z_c country fixed effects are controlled for. Additionally, it could be argued that multinational firms may be attracted by the host country's stability. Such spillovers may not exist due to the instability of the host country. On the other hand, spillovers may exist because of the attractiveness of a host country's stability, which implies that such estimates of vertical linkages may be overestimated if we fail to control for the potential correlation between multinational firms and the country's stability. The BEEPS asks, "What is the level of the obstacle to the functioning of this establishment?" This question provides information on how firms are obstructed by "political instability", "macroeconomic instability", and "corruption" via assigning 0 to no obstacle, 1 to minor obstacle, 2 to moderate obstacle, 3 to major obstacle and 4 to very severe obstacle. As these data were collected at the firm level, we control these variables in our specification, where C' is a vector of firm-level institutional environmental control variables, including the political instability, macro instability and corruption, in order to increase the accuracy of our estimations. Note that the Correlated Random-Effect (henceforth, CRE) model is also employed to better suit the data structure. The estimation details are provided in Section 3.3.3.2.

In addition to the baseline specification, we are concerned about the potential omitted variable bias (unobserved heterogeneity). First, a well-known problem in FDI spillovers studies is firms' motivations to undertake multinational activity. For example, a firm that is more willing to pursue a joint venture with multinationals may experience more productivity gains, as multinational firms may deliberately transfer technology to their local partners as part of a strategy to build an efficient network for overseas operations (Pack & Saggi, 2001; Blalock & Gertler, 2008). This motivation for joint venture agreements implies that domestic firms experience productivity gains because they receive benefits from multinational firms other than those coming from FDI vertical spillovers. If this is the case, then failing to control for firms' motivations is likely to result in an overestimation of the effect of vertical spillovers on the productivity of domestic firms. Moreover, as highlighted in recent studies, the technological activities of foreign firms themselves may be an important determinant of whether spillovers are realised, which implies that the direct technology transfers between foreign firms and domestic firms might influence the vertical spillovers (Giroud et al., 2012; Newman et al., 2015). To test the extent to which the spillover measures used in the model are related to direct knowledge transfer, we examine the impact of the interaction between being directly linked with multinational firms, along the motivation and technology acquisitions, and the existence of vertical linkages by using data on whether the domestic firm agrees to a joint venture with the foreign partner and whether domestic firm has acquired new production technology in the last 3 years. We construct the following variables and add them to the baseline model:

$$Forward^{Motivated} = Forward \times D_{agree} \tag{3.11}$$

$$Backward^{Motivated} = Backward \times D_{agree} \tag{3.12}$$

$$Forward^{Newtechnology} = Forward \times D_{Newtecnology} \tag{3.13}$$

and

$$Backward^{Newtechnology} = Backward \times D_{Newtechnology} \tag{3.14}$$

where $Backward$ refers to $Backward^{IO}_{j,c,t}$ and $Backward^{firm}_{i,j,c,t}$; $Forward$ refers to $Forward^{IO}_{j,c,t}$, $Forward^{proxy-imp}_{i,j,c,t}$ and $Forward^{proxy-buy}_{i,j,c,t}$; D_{agree} is 1 if the domestic firm agreed to a joint venture with the foreign partner and 0 otherwise and $D_{Newtechnology}$ is 1 if the domestic firm acquired new technology and 0 otherwise.

Second, it can be argued that firms in both upstream and downstream sectors would benefit from the upgrading industry. For example, domestic firms in downstream sectors can benefit from the upstream domestic firms who engage in supplying products to downstream multinationals. It can be seen that downstream multinationals may deliberately transfer technology to their upstream material suppliers and that the suppliers may possibly supply these materials to the other downstream domestic firms. Markusen and Venables (1999) call this a "supply-backward spillover". Schoors and Merlevede (2007) when examining Romania find that the supply-backward spillover is positive but insignificant , while Jude (2016) when examining CEEC countries finds negative and insignificant effects on firms' productivity from the supply-back spillover. In contrast, it may be more likely that domestic firms that purchase inputs from upstream multinationals also supply inputs to other downstream domestic firms. As demanded inputs from multinational firms may involve knowledge spillovers to domestic firms that, in turn, may lead to industry upgrading, other domestic input customers may also benefit from this indirect linkage. Because this potential linkage involves both forward and backward linkages, failing to control for this correlation might lead to an overestimated bias and reduce the accuracy of our measures. We add to the literature by constructing this linkage as follows:

$$Backward^{supply-back} = a_{i,j,c,t} \times Forward \tag{3.15}$$

where $a_{i,j,c,t}$ and $Forward$ are defined as above.

3.3.3.2 Correlated Random Effects Estimation

It is possible that there have been omissions of unobserved individual effects, which may potentially bias the estimates. Haskel et al. (2007) suggests that the firm that has higher-quality management or a better infrastructure in a given region may perform better than the others. Since these factors may be unknown to the econometricians but known to the firm, biased estimates would result. This issue can be addressed by employing the fixed-effect model to remove any fixed plant-specific unobservable variations and the fixed regional and industrial effects.

However, this approach may lead to another econometric concern. First, it leads to aggravate measurement errors in the regression unless longer time differences are applied (Griliches & Hausman, 1986). Second, once an entire cross-section is used up to estimate the fixed-effects, there is inefficiency due to data loss. Third, since the estimator relies on within sample variation, the estimates are imprecisely estimated if the variation is small. The effects of such variables can neither be estimated nor enter the regression if there is no within sample variation at all. Since the time period used in this study is very short, this approach is not followed. Finally, the measurement error becomes worse under differencing/de-meaning, and the bias caused might outweigh the bias from using the Random-Effect model incorrectly (Deaton, 1985).

Instead, the Correlated Random Effects (henceforth, CRE) model is applied to tackle the above concerns. First, the CRE approach still allows the unobserved individual effects to be correlated with the other explanatory variables. Second, the CRE approach provides a simple and formal way of choosing between the Fixed-Effect (henceforth, FE) and Random-Effect (henceforth, RE) estimators. Although Hausman's test is informative in deciding whether the FE is more appropriate than the RE, i.e., whether the unobserved firm's individual effect is correlated with the error term, the literature suggests that the CRE approach provides a more intuitive regression-based test and overcomes the drawbacks[10] of using Hausman's test (Wooldridge, 2012, Ch14). Third, in the FE (or First-Differenced when there are two time periods), the correlation between $x_{i,j,c,t}$ and $\bar{x}_{i,j,c}$ can result in a higher variance for the estimated coefficients. The variance would be even higher when there is little variation in $x_{i,j,c,t}$ across time t, in which case $x_{i,j,c,t}$ and $\bar{x}_{i,j,c}$ tend to be highly correlated. In the limiting case where there is no variation across time for any firm i, perfect collinearity would be present and FE would fail to provide

[10] Any variable that varies by time or by 'individual' only should not be part of the test (Wooldridge, 2012, Ch14).

estimates. On the other hand, the RE estimator has no bearing on the variance and performs better than the FE estimator. Fourth, with an unbalanced panel due to attrition (presumably the firm that is missing in the wave 2005 would probably have gone out of business or have merged with other companies), FE is biased and inconsistent, even though Hausman's test provides a large Chi-squared test statistic rejecting RE in favour of FE. The CRE approach also provides a way to include time-constant explanatory variables, which is not possible when using the FE estimator. Lastly, it should be noted that the RE estimator is more suitable if the data involve a large N, but small T (Wooldridge, 2012, Ch14).

The idea behind the CRE approach is to allow the omitted firm's individual effects to be correlated with the average level of each explanatory variable $x_{i,j,c,t}$ rather than assume that it is uncorrelated - which is the random effects approach. The firm's individual effects can be thus decomposed as follows:

$$a_i = \sigma + \gamma \bar{x}_{i,j,c} + r_i \tag{3.16}$$

where $r_{i,j,c,t}$ is uncorrelated with each $x_{i,j,c,t}$, and $\bar{x}_{i,j,c}$ is the time-averaged variable ($\bar{x}_{i,j,c} = T^{-1} \sum_{t=1}^{T} x_{i,j,c,t}$). As $\bar{x}_{i,j,c}$ is a linear function of the $x_{i,j,c,t}$, the Cov($\bar{x}_{i,j,c}$, r_i)=0. It follows that a_i and $\bar{x}_{i,j,c}$ are correlated whenever $\gamma \neq 0$.

Assuming that Eq. (3.8) suffers from omitted variable bias, we would like to mitigate this bias by allowing firm's individual effects into the model:

$$lnY_{i,j,c,t} = a_i + \beta_L lnL_{i,j,c,t} + \beta_K lnK_{i,j,c,t} + \beta_M lnM_{i,j,c,t} + s_j + \tau_t + z_c + \vartheta_{i,j,c,t} \tag{3.17}$$

substituting Eq. (3.16) into Eq. (3.17) will give the following equation

$$
\begin{aligned}
lnY_{i,j,c,t} = \sigma + \bar{x}^{'}_{i,j,c}\gamma + r_i + \beta_L lnL_{i,j,c,t} + \beta_K lnK_{i,j,c,t} + \beta_M lnM_{i,j,c,t} \\
+ s_j + \tau_t + z_c + \vartheta_{i,j,c,t}
\end{aligned} \tag{3.18}
$$

where $\bar{x}^{'}_{i,j,c}$ refers to the time average variable of employment, capital and material uses.

It is clear that the assumption Cov(a_i,$x_{i,j,c,t}$)=0 holds when a_i is replaced by r_i. Also, because $\vartheta_{i,j,c,t}$ is assumed to be uncorrelated with $x_{i,j,c,t}$, $\vartheta_{i,j,c,t}$ will be uncorrelated with $\bar{x}^{'}_{i,j,c}$. In addition, the correlation between $x_{i,j,c,t}$ and a_i is now controlled by the $\bar{x}^{'}_{i,j,c}$; therefore, r_i is uncorrelated with $x_{i,j,c,t}$. All the assumptions above are added to the model. The estimated parameters of employment, capital and materials will therefore be used to extract firm's estimated productivity (residual).

The same CRE approach on the second step of productivity estimation is applied as follows:

$$
\begin{aligned}
\hat{\vartheta}_{i,j,c,t} = c + \bar{x}^{'}_{i,j,c}\delta + \varphi_i + b_1 Horizontal_{j,c,t} + b_2 Forward + b_3 Backward \\
+ s_j + \tau_t + z_c + \rho_{i,j,c,t}
\end{aligned} \tag{3.19}
$$

where $\hat{\vartheta}_{i,j,c,t}$ is the estimated productivity residual, and all other right-hand side variables are defined above. Wooldridge (2012) notes that "if the panel data set is unbalanced, then the average of variables such as time dummies can change across firms - it will depend on how many periods we have for cross-sectional firms" (Wooldridge, 2012, p. 498). In such cases, the time averages of any variable that changes over time must be included. Therefore, all time average variables are included in the model. To control for omitted variable biases, equations (3.11), (3.12), (3.13), (3.14), (3.15) and the country stability variables will all be included in Eq. (3.10) respectively and re-estimated by CRE approach.

3.4 Data

Our primary data source is the European Bank for Reconstruction and Development (EBRD) in conjunction with World Bank Business Environment and Enterprise Performance Survey (BEEPS), which covers waves from 2002 onwards. Identical questionnaires are used in all countries, which makes the empirical evidence reliable. Firms in both service and manufacturing sectors are covered and rely on the same sampling frames[11]. We matched the waves 2002, 2003 and 2005 based on the variables of interest. Although the dataset contains a panel component consisting of about 605 firms that were surveyed in 2002 and again in 2005, many variables of interest have a retrospective component, and it is difficult to detect robust relationships with a small panel of firms (Gorodnichenko et al., 2014). Hence, our analysis is restricted to relying primarily on the pooled 2002, 2003 and 2005[12]. As BEEPS is a designed survey, trained interviewers conducted face-to-face interviews and all participants were anonymous, thus the individual perception bias can be disregarded (Fries, Lysenko, Polanec, et al., 2003[13]; Godart & Görg, 2013).

The data include the share of the firm's sales, raw material used, number of employees, capital stock and the firm's supplying, sourcing and foreign ownership statuses. To be specific, the survey asks each firm: "How many permanent, full-time employees does your firm have?", "In fiscal year, what were the total annual sales of this establishment?", "What was the net value of assets after depreciation of the machinery and equipment (including vehicles), land and buildings at the end of fiscal?", and "How much raw material was bought in the services?". The answers

[11]The BEEPS approaches a large number of observations with a core 41-page questionnaire module via standard interview supported by the EBRD and the World Bank, and 46- and 44-page questionnaire modules for manufacturing and services sector respectively. Details of these surveys can be found at: http://ebrd-beeps.com/data/.

[12]We provide results showing how the main results would have differed had they been based on the small panel of firms in Table 12 in the Appendix.

[13]Fries et al. (2003) find no significant perception biases across the countries in the sample.

Table 3.1: Number of Firms in Each Sector

Industry(sector)	Code#	No. Domestic firms	No. Multinational firms
Mining, Quarrying	1	71	13
Construction	2	578	51
Manufacturing	3	2,116	389
Transport and storage	4	266	50
Wholesale, Retail trade and Repair of motor vehicles	5	1,374	231
Real estate	6	361	74
Hotels, Restaurants	7	276	49
Other services	8	398	64

Notes: Sector classification is determined by the question "How would you best describe your firm's main area of activity in terms of sales?".

to these questions are therefore used to calculate the measure of firm productivity.

For the proposed measure on backward linkages (Eq. (3.7)), information on "firm sales to multinationals" is used. This information is based on the questions: "What proportion of your total sales is sold domestically?" and "What proportion of your total domestic sales is to multinationals located in your country (not including your parent company, if applicable)?". Meanwhile, to calculate the proposed measure on forward linkages, the information from the following questions is used: "What proportions of total sales are to the sectors Mining and quarrying (sector code 1); Construction (sector code 2); Manufacturing (sector code 3); Transport, Storage and Communication (sector code 4); Wholesale, Retail trade and Repair of motor vehicles (sector code 5); Real estate (sector code 6); Hotel and Restaurants (sector code 7) and Other services (sector code 8)?"; and "What proportion of your total domestic sales is to the large domestic firms (those with approximately 250 plus workers and not including your parent company)?". We also acquire information on firms' domestic sources and imported inputs with the questions: "What proportion of your establishment's material inputs and supplies are purchased from domestic sources" and "What proportion of your establishment's material inputs and supplies are purchased from imported directly?". These data are used for constructing the measures on the firm-level forward linkages shown in Eq. (3.5) and Eq. (3.6).[14].

To calculate the standard vertical linkages, we collected data from input-output

[14]We provide an overview of firms' sourcing and purchasing activities by country and the sector classifications specified in Tables 3.9 and 3.10 in the Appendix.

Table 3.2: Pair-wise Correlations of Spillover Variables

	$Forward^{IO}$	$Backward^{IO}$	$Forward^{proxy-imp}$	$Forward^{proxy-buy}$
$Backward^{IO}$	0.9687			
	(0.000)			
$Forward^{proxy-imp}$	0.0510	0.0446		
	(0.1092)	(0.1618)		
$Forward^{proxy-buy}$	-0.1536	-0.1747	-0.2438	
	(0.0000)	(0.0000)	(0.000)	
$Backward^{firm}$	0.0137	0.0162	0.1423	-0.0382
	(0.6670)	(0.6105)	(0.0000)	(0.1034)

Notes: This table provides the raw correlation coefficients and p-values in columns and parentheses. Although some measures are statistically correlated, the correlation coefficients are lower between the proposed measures and standard measures, perhaps suggesting preliminarily that some differences may exist across firms' sourcing and supplying activities.

Table 3.3: Summary Statistics

Variables	Definition	Obs.	Mean	SD	Max	Min
ρ	The foreign ownership in %	5,440	0.012	0.254	8	0
$\delta_{i,j,c,t}$	The proportion of total domestic sales to multinationals	5,440	0.039	0.133	1	0
a	The proportion of total sales to the domestic market	5,440	0.901	0.221	1	0
$c_{1,c,t}$	The proportion of total sales to sector 1	5,440	0.004	0.060	1	0
$c_{2,c,t}$	The proportion of total sales to sector 2	5,440	0.099	0.286	1	0
$c_{3,c,t}$	The proportion of total sales to sector 3	5,440	0.439	0.460	1	0
$c_{4,c,t}$	The proportion of total sales to sector 4	5,440	0.050	0.209	1	0
$c_{5,c,t}$	The proportion of total sales to sector 5	5,440	0.250	0.398	1	0
$c_{6,c,t}$	The proportion of total sales to sector 6	5,440	0.066	0.241	1	0
$c_{7,c,t}$	The proportion of total sales to sector 7	5,440	0.051	0.213	1	0
$c_{8,c,t}$	The proportion of total sales to sector 8	5,440	0.033	0.154	1	0
α	The proportion of total sales to large domestic firms across sectors	5,440	0.155	0.261	1	0
μ	The proportion of total inputs sourced domestically	5,440	0.707	0.365	1	0
im	The proportion of total inputs imported	5,440	0.131	0.279	1	0
D_{agree}	Dummy in agreed to foreign joint venture	5,440	0.049	0.216	1	0
$D_{Newtechnology}$	Dummy in new production technology acquisition	5,440	0.317	0.465	1	0
$lnSales$	The total annual sales of the firm in logarithmic form	5,440	6.610	2.947	20.484	0.693
Political	Firms reported obstacle generated by political instability; 4 major obstacle	5,440	2.712	1.138	4	0
Macroeconomic	Macroeconomic instability (inflation, exchange rate);4 major obstacle	5,440	2.654	1.154	4	0
Corruption	Corruption; 4 major obstacle	5,440	2.219	1.167	4	0
FDI spillovers						
Horizontal	The horizontal spillovers	5,440	0.201	0.189	0.865	0
$Forward^{proxy-imp}$	The forward linkages using imported inputs	5,440	0.019	0.057	0.561	0
$Forward^{proxy-buy}$	The forward linkages using domestic sources	5,440	0.102	0.094	0.561	0
$Backward^{firm}$	The firm-level backward linkages in logarithmic form	5,440	0.795	2.227	17.257	-0.287
$Forward^{IO}$	The standard forward linkages for 12 countries	3,069	0.257	0.204	0.925	0
$Backward^{IO}$	The standard backward linkages for 12 countries	3,069	0.247	0.184	0.900	0
Production function						
lnL	The number of full-time employees in logarithmic form	5,440	3.116	1.626	9.116	0.693
lnL-3year	The lagged three-year full-time employees in logarithmic form	5,333	3.026	1.669	9.210	0
lnM	The total annual costs of electricity in logarithmic form	5,440	7.544	3.018	19.929	0
lnK	The capital stock in logarithmic form	5,440	5.247	2.747	18.197	0
Age	The firm's age	5,435	16.650	18.380	202	1
Export share	The proportion of total sales exported	5,440	0.080	0.201	1	0

Notes: The values are expressed in U.S. dollars.
Source: Author's calculation.

tables from the Organization for Economic Co-operation and Development (OECD) Structural Analysis (STAN), the I-O 2012 latest Matrix. As surveyed firms are based in the early 2000s (2002, 2003 and 2005) in BEEPS, all input-output tables were taken from the early 2000s, except in the case of Latvia and Lithuania, as data for the early 2000s were unavailable for the two countries. Instead, data from the mid-

2000s was used for Latvia and Lithuania. The input-output coefficients are only for the within-economy intermediate consumption of goods and exclude imports. Due to data limitations, the standard measures are restricted to 12 countries only. They are seven OECD member countries (Czech Republic, Estonia, Hungary, Poland, Slovakia, Slovenia, and Turkey) and five non-OECD countries (Bulgaria, Latvia, Lithuania, Romania, Russia).

Tables 3.1 and 3.2 provide information on the number of firms in each sector and the correlations between the measures of vertical linkages. Table 3.3 provides summary statistics. The key variables display reasonable mean values and significant variation. The sample contains 5,440 observations for the periods 2002, 2003 and 2005. The average firm had 3.116 employees, 7.544 in costs for materials and 5.247 in capital stock, all reported in natural logs. The mean values of the proposed measures are 0.019 and 0.102 for the forward linkages and 0.795 for the backward linkages, while they are 0.257 and 0.247 for the standard forward and backward linkages, respectively. These measures are quite different in terms of magnitude, which preliminarily supports our argument that the differences in sourcing and supplying activities across firms may potentially drive the empirical findings.

3.5 Results

We start by attempting to gain a consistent estimate of firm-level productivity. The results of the first-step production estimation provided by the pooled OLS, fixed-effects and CRE estimators are provided in Table 3.11 in the Appendix. The first step production estimation confirms the significance of capital, materials and employment on firms' productivity. They are all positive and statistically significant at the 1% significance level. The results of the three estimators are similar, implying that firms' time-invariant unobserved variables does not affect firms' performance much.

Having the estimated parameters in hand, the next step is to obtain the predicted value of output which mitigates potential input biases and helps us to estimate the vertical spillovers onto productivity based on the baseline regression model. Due to the data's characteristics, pooled OLS and CRE estimators are preferred over the alternatives to estimate the FDI spillovers in the second-step estimation. In addition, we conduct a robustness check related to the form of the production estimation as an attempt to mitigate potential biases. We add to the analysis the firm's age, its export share and full-time employment lagged three years with the augmented Cobb-Douglas production function to see if the results differ systematically.

3.5.1 FDI spillovers

In the regression analysis, we split the whole sample into two categories based on the types of measurement, i.e., the standard and proposed measures. Table 3.4 reports the results of estimating Eq. (3.10) using pooled OLS and CRE estimators with standard measures. All models include country, sector, and year fixed effects. Note that the standard measures on backward and forward linkages are constructed for only 12 economies due to the data limitations of the input-output tables. The first column of Table 3.4 displays the results obtained when the existing assumptions are held simultaneously. The estimated coefficients of standard forward and backward linkages are confirmed to be statistically insignificant, meaning that no spillover effects on firms' productivity are found in our data. The same result is produced in column (4) using a CRE estimator.

Columns (2) and (3) show the results of controlling for institutional environment, supply-back, technology acquisition and motivation in having joint foreign ownership. The results for vertical linkages remain statistically insignificant. The

Table 3.4: Standard FDI Linkages for Productivity Based on 12 Economies

	OLS			CRE		
	(1)	(2)	(3)	(4)	(5)	(6)
$Horizontal$	-0.024	-0.028	-0.029	-0.024	-0.028	-0.029
	(0.096)	(0.096)	(0.097)	(0.098)	(0.094)	(0.095)
$Forward^{IO}$	0.187	0.184	0.204	0.187	0.185	0.204
	(0.296)	(0.295)	(0.310)	(0.297)	(0.296)	(0.311)
$Backward^{IO}$	-0.200	-0.211	-0.223	-0.200	-0.211	-0.224
	(0.371)	(0.371)	(0.382)	(0.371)	(0.371)	(0.383)
$Backward^{IO}_{Supply-Back}$		0.427**	0.377*		0.424**	0.375*
		(0.198)	(0.199)		(0.198)	(0.199)
$Backward^{IO}_{Motivation}$			-0.885			-0.884
			(0.988)			(0.988)
$Forward^{IO}_{Motivation}$			1.004			1.003
			(0.942)			(0.942)
$Backward^{IO}_{Technology}$			0.505			0.507
			(0.404)			(0.405)
$Forward^{IO}_{Technology}$			-0.511			-0.513
			(0.402)			(0.401)
Political Instability	0.017*	0.017*	0.017*	0.017*	0.017*	0.017*
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Macro Instability	-0.024**	-0.024***	-0.024***	-0.024***	-0.024***	-0.024***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Corruption	0.005	0.005	0.006	0.004	0.005	0.005
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Time	Yes	Yes	Yes	Yes	Yes	Yes
Sector	Yes	Yes	Yes	Yes	Yes	Yes
Country	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.7385	0.7388	0.7391	0.8500	0.8493	0.8498
Observations	3,069	3,069	3,069	3,069	3,069	3,069

Notes: Robust standard errors are reported in parentheses. *, ** and *** are the significance levels at 10%, 5%, and 1%, respectively.

same pattern can be found in columns (5) and (6) under the CRE estimation. These results suggest that assuming homogeneous sourcing and supplying activities across firms using input-output coefficients does not provide any evidence for vertical spillovers in our data. While vertical spillovers onto the productivity of domestic firms are insignificant, the supply-back variable is somehow identified as positive and statistically significant at the 5% and 10% significance levels, which is consistent with Schoors and Merlevede (2007) but in stark contrast to Jude (2016), where a negative effect was predicted to offset the positive effect of backward link-

Table 3.5: Proposed FDI Linkages for Productivity for 12 Economies

	OLS				CRE			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Horizontal$	-0.005	-0.001	-0.006	-0.001	-0.005	-0.001	-0.006	-0.001
	(0.062)	(0.062)	(0.062)	(0.062)	(0.061)	(0.062)	(0.061)	(0.062)
$Backward^{firm}$	0.025***	0.027***	0.026***	0.033***	0.025***	0.027***	0.025***	0.032***
	(0.003)	(0.003)	(0.005)	(0.006)	(0.003)	(0.003)	(0.005)	(0.006))
$Forward^{proxy-imp}$	0.823***		0.959***		0.828***		0.965***	
	(0.208)		(0.286)		(0.211)		(0.290)	
$Forward^{proxy-buy}$		-0.010		0.011		-0.011		0.009
		(0.119)		(0.125)		(0.118)		(0.124)
$Backward^{imp}_{Supply-Back}$			0.577				0.591	
			(1.818)				(1.820)	
$Backward^{buy}_{Supply-Back}$				-1.019				-1.007
				(0.813)				(0.811)
$Backward^{firm}_{Motivation}$			0.003	-0.001			0.003	-0.001
			(0.014)	(0.014)			(0.015)	(0.014)
$Forward^{proxy-imp}_{Motivation}$			-0.129				-0.126	
			(0.524)				(0.526)	
$Forward^{proxy-buy}_{Motivation}$				0.450				0.449
				(0.279)				(0.279)
$Backward^{firm}_{Technology}$			-0.002	-0.004			-0.002	-0.004
			(0.007)	(0.007)			(0.007)	(0.007)
$Forward^{proxy-imp}_{Technology}$			-0.435				-0.438	
			(0.390)				(0.390)	
$Forward^{proxy-buy}_{Technology}$				-0.016				-0.016
				(0.129)				(0.129)
Political Instability	0.017*	0.018*	0.017*	0.018*	0.017*	0.018*	0.017*	0.018
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010))
Macro Instability	-0.025***	-0.025**	-0.025***	-0.025**	-0.025**	-0.025**	-0.025**	-0.025**
	(0.010)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Corruption	0.004	0.005	0.004	0.004	0.004	0.004	0.004	0.004
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Time	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.7416	0.7402	0.7417	0.7405	0.7351	0.7402	0.7417	0.7405
Observations	3,069	3,069	3,069	3,069	3,069	3,069	3,069	3,069

Notes: Robust standard errors are reported in parentheses. *, ** and *** are the significance levels at 10%, 5%, and 1%, respectively.

ages on productivity. Regarding the effect of supply-back, we suspect here that the positive effect of supply-back on productivity could possibly involve part of the vertical spillover effects, as it is likely that the differences in firms' sourcing and supplying activities are correlated with the supply-back linkage. In other words, the finding might be due to measurement errors in the sectoral-level measures in conjunction with the data from the input-output tables.

For the sake of comparison, in the next regression, we employ our newly constructed measures from equations (3.5), (3.6) and (3.7), where we employ information on firms' sourcing and supplying activities that either directly or indirectly links to multinational firms, i.e., we distinguish sourcing and supplying differences across firms. Both assumptions are relaxed under this circumstance. We re-estimate Eq. (3.10) by splitting our regression into 2 parts: The first part of the results is based on the 12 economies, as we want to use the standard measures to compare how those differences in firms' sourcing and supplying behaviours prevent researchers from identifying the importance of vertical spillovers on productivity. The second part of the results is based on all economies.

Table 3.5 provides the first part of the results. We find that the results in columns (1) and (2) suggest statistically significant spillovers of backward linkages onto firms' productivity at the 1% significance level. This finding indicates that inputs demanded by multinational firms from domestic firms increase domestic firms' productivity; the estimated coefficient of 0.025 suggests that a one percent increase in backward linkages would increase domestic firms' productivity by 0.025 percent. The forward measure is also confirmed to be statistically significant in column (1) for Eq. (3.5), where firms' imported inputs are used as the proxy to capture the inputs demanded by the domestic firms from multinational firms. However, it loses its significance when we swap the measure from Eq. (3.5) for the one from Eq. (3.4) in column (2), where firms' local inputs are used as the proxy for the inputs demanded by domestic firms from multinational firms.

Columns (3) and (4) add the firm's motivation for having a joint foreign venture, new technology acquisitions and supply-back variables as additional controls for unobserved heterogeneities. The results are in line with the previous specifications, indicating that inputs demanded by multinational firms from domestic firms induce the positive effects of backward spillovers on domestic firms' productivity, while the

Table 3.6: Proposed FDI Linkages for Productivity for 32 Economies

	OLS				CRE			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Horizontal	-0.065	-0.063	-0.064	-0.062	-0.063	-0.062	-0.062	-0.061
	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)
$Backward^{firm}$	0.020***	0.021***	0.018***	0.021***	0.020***	0.020***	0.017***	0.018***
	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)
$Forward^{proxy-imp}$	0.692***		0.816***		0.701***		0.821***	
	(0.135)		(0.198)		(0.136)		(0.200)	
$Forward^{proxy-buy}$		-0.200***		-0.213***		-0.193***		-0.208**
		(0.086)		(0.094)		(0.086)		(0.094)
$Backward^{imp}_{Supply-Back}$			-0.213				-0.216	
			(0.468)				(0.468)	
$Backward^{buy}_{Supply-Back}$				0.102				0.107
				(0.500)				(0.499)
$Backward^{firm}_{Motivation}$			0.007	0.009			0.007	0.009
			(0.010)	(0.011)			(0.011)	(0.011)
$Forward^{proxy-imp}_{Motivation}$			-0.033				-0.014	
			(0.397)				(0.396)	
$Forward^{proxy-buy}_{Motivation}$				0.040				0.025
				(0.237)				(0.237)
$Backward^{firm}_{Technology}$			0.008	0.006			0.009	0.007
			(0.005)	(0.006)			(0.005)	(0.006)
$Forward^{proxy-imp}_{Technology}$			-0.295				-0.289	
			(0.236)				(0.238)	
$Forward^{proxy-buy}_{Technology}$				0.044				0.052
				(0.105)				(0.106)
Political Instability	0.003	0.003	0.003	0.003	0.003	0.002	0.003	0.003
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Macro Instability	-0.018***	-0.017**	-0.018**	-0.018**	-0.017**	-0.017**	-0.017**	-0.017**
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Corruption	0.014*	0.013*	0.013*	0.013*	0.013*	0.013*	0.013 *	0.013*
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Time	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.9030	0.9026	0.9030	0.9027	0.8636	0.8614	0.8632	0.8613
Observations	5,440	5,440	5,440	5,440	5,440	5,440	5,440	5,440

Notes: Robust standard errors are reported in parentheses. *, ** and *** are the significance levels at 10%, 5%, and 1%, respectively.

inputs demanded by domestic firms from multinational firms also induce the positive effects of forward spillovers onto productivity. The coefficient of backward linkage on column (3), when additional controls are added, is almost identical to what it was in the previous two columns (0.025 versus 0.027 versus 0.026 for columns (1)- (3), respectively). However, the coefficient becomes larger when firms' local inputs are used to proxy the inputs demanded from multinational firms. In the meantime, as we have seen previously, the effect of the forward linkage becomes insignificant when we change the measurement from Eq. (3.5) to that of Eg. (3.4). These findings again remain the same when the CRE estimator is employed to estimate the vertical spillovers shown in columns (5) to (8). These results, therefore, confirm the idea that when all exogenous variables are controlled for, the differences among firms' sourcing and supplying activities, i.e., the assumptions and the standard measures applied in the existing literature, could lead to either overestimation or underestimation of vertical spillovers.

To quantify the magnitude of vertical spillovers for all observed firms, we now turn to the second part of the results shown in Table 3.6. The results in columns (1) and (2) show that our proposed measures capture successfully the economically important effects on firms' productivity through both backward and forward linkages at the 1% significance level. The estimated coefficient is 0.692 for $Forward^{proxy-imp}$ in column (1), which suggests that a 1 percentage point increase in the proportion of demanded inputs from multinational firms leads to a 0.00692 unit increase in the level of domestic firms' productivity. The estimated coefficient is -0.200 for $Forward^{proxy-buy}$ in column (2), which indicates that a 1 percentage point increase in the proportion of demanded inputs from multinational firms reduces domestic firms' level of productivity by about 0.002 unit, other things being equal[15]. Consistent with the main results in columns (1) and (2), the coefficients for backward and forward linkages in columns (3) and (4) remain highly statistically significant when the other variables are included. Again, we find a very similar pattern when the CRE estimator is used in columns (5) to (8). Looking back at the previous findings in Table 3.4, we find statistically insignificant effects of vertical spillovers based on 12 economies by using the standard measure. Hence, comparing results in columns (1), (2), (3) and (4) of Tables 3.5 and 3.6 suggests that the variation in firms'

[15]Following Newman et al. (2015), we divide the estimated coefficients by 100 when the measures of forward linkages are constructed. A one percentage point increase in the proportion of inputs demanded from multinational firms is equivalent to a 0.01 unit increase in the forward measure.

sourcing and supplying behaviours plays a determinant role and holding existing assumptions does not provide evidence of vertical spillovers. In contrast, relaxing the assumptions does make some differences in terms of identifying the economically important effects of vertical spillovers.

In addition to the findings so far, some studies have suggested that positive productivity spillovers may be due to firms deliberately transferring knowledge or know-how to domestic firms (Girma et al., 2008; Newman et al., 2015) or, as we discussed in Section 3.3.3.1, firms being self-motivated to become more productive. Nevertheless, our findings suggest that positive productivity spillovers are not due to a deliberate transfer of new technology from, or intended foreign partnerships with, multinational firms, yet it is the direct linkages between domestic firms and multinational firms, along with the demanded inputs, that are associated with the technology transfer in the case of 32 developing economies. However, as revealed in columns (3), (4), (7) and (8), the coefficients for both the backward and forward linkages are higher than they were in the previous columns. The results therefore suggest that although they are not directly associated with enhancing productivity, failing to control for these variables could still lead to biased estimates.

In terms of the main results, these are the very interesting findings containing both positive and negative effects of forward linkages. From the existing literature, it seems to be more general to support negative spillovers through forward linkages. For example, Newman et al. (2015), by focusing on Vietnam, found a 0.00846 unit decrease in firms' productivity following a one percentage point increase in the proportion of inputs that is supplied by foreign-owned firms. Javorcik (2004), by focusing on Lithuania, found a negative effect of forward linkages on both local and domestic firms' productivity, although the results were insignificance. By using Irish data, Barrios et al. (2011) found that forward linkage spillovers appear to be negative throughout most of their specifications. Focusing on 19 African countries, Görg and Seric (2016) found a negative association with the new product process used by domestic input buyers buying from multinationals. Furthermore, Kim (2015), using South Korea, and Jude (2016), using CEEC countries, found negative forward spillovers on productivity.

The possibility of having both significantly negative and positive effects from forward linkages in our results comes from the fact that multinational firms from upstream sectors might try to dominate market positions, thereby leading to less competition and higher inputs prices for domestic customers (Girma et al., 2008). Additionally, some of the domestic firms might still be able to access those intermediates directly from the upstream multinationals, which may generate some variations across firms and across sectors. The latter may be associated more with the direct forward linkages, which would transfer knowledge directly to the domestic firms. Therefore, using the proportion of imported inputs to proxy the forward linkages seems to capture variations among the inputs that domestic firms obtain directly from multinationals with lower costs and thus produces the positive spillovers onto domestic firms' productivity. On the other hand, with the exception of the likelihood of higher input prices, inputs produced by multinational firms may be complex and may cause difficulties when being implemented into the production processes of domestic firms. Hence, when using the proportion of local inputs to proxy for forward linkages, the negative spillovers are captured.

3.5.2 Robustness checks

Having looked at the effects of both backward and forward linkages and the potential omitted variable biases on firms' productivity, the next question is whether the findings we have found so far are robust, i.e. could other measures of the production

Table 3.7: FDI Spillovers Created by Different Production OLS Estimators

	Cobb-Douglas Production Function				Two-step Production Function			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Horizontal	-0.067	-0.062	-0.064	-0.062	-0.070	-0.069	-0.088	-0.080
	(0.051)	(0.052)	(0.052)	(0.052)	(0.047)	(0.047)	(0.051)	(0.051)
$Backward^{firm}$	0.018***	0.019***	0.018***	0.019***	0.018***	0.018***	0.022***	0.023***
	(0.004)	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
$Forward^{proxy-imp}$	0.730***		0.743***		0.770***		0.658***	
	(0.198)		(0.201)		(0.199)		(0.216)	
$Forward^{proxy-buy}$		-0.200**		-0.197**		-0.178*		-0.300***
		(0.096)		(0.095)		(0.094)		(0.102)
$Backward^{imp}_{Supply-Back}$	-0.197		-0.196		-0.139		-0.721	
	(0.461)		(0.466)		(0.473)		(0.498)	
$Backward^{buy}_{Supply-Back}$		-0.027		-0.029		0.127		-0.188
		(0.461)		(0.461)		(0.496)		(0.472)
$Backward^{firm}_{Motivation}$	0.005	0.007	0.005	0.007	0.005	0.006	0.011	0.014
	(0.010)	(0.011)	(0.010)	(0.011)	(0.010)	(0.011)	(0.010)	(0.011)
$Forward^{proxy-imp}_{Motivation}$	-0.053		-0.058		-0.080		0.211	
	(0.407)		(0.407)		(0.417)		(0.438)	
$Forward^{proxy-buy}_{Motivation}$		-0.062		-0.062		-0.024		-0.014
		(0.237)		(0.237)		(0.245)		(0.259)
$Backward^{firm}_{Technology}$	0.009*	0.007	0.008	0.007	0.009	0.007	0.007	0.003
	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
$Forward^{proxy-imp}_{Technology}$	-0.189		-0.181		-0.281		-0.11	
	(0.233)		(0.235)		(0.235)		(0.250)	
$Forward^{proxy-buy}_{Technology}$		0.040		0.037		0.031		0.300
		(0.104)		(0.104)		(0.105)		(0.114)
Political Instability	0.001	-0.0006	-0.0001	-0.0005	0.003	0.003	-0.005	-0.006
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.009)	(0.009)
Macro Instability	-0.016*	-0.014***	-0.014*	-0.014*	-0.019**	-0.019**	-0.020**	-0.020**
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.009)	(0.009)
Corruption	0.013*	0.013*	0.014**	0.014**	0.013*	0.013*	0.012	0.012
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)	(0.008)
Export share	0.001***	0.001***	0.0009***	0.001***	0.001***	0.001***	0.001***	0.001***
	(0.0004)	(0.0003)	(0.0003)	(0.0003)	(0.0004)	(0.0003)	(0.0004)	(0.0004)
Age	-0.0007	-0.0007	-0.0007**	-0.0007	-0.001***	-0.001***	-0.001***	-0.001***
	(0.0004)	(0.0004)	(0.0004)	(0.0005)	(0.0004)	(0.0004)	(0.0005)	(0.0005)
lnL	0.491***	0.495***						
	(0.032)	(0.032)						
$LnL - 3yearsago$			-0.009	-0.006				
			(0.016)	(0.016)				
LnK	0.092***	0.093***	0.093***	0.093***				
	(0.007)	(0.007)	(0.007)	(0.007)				
LnM	0.469	0.469***	0.468***	0.469***				
	(0.024)	(0.025)	(0.025)	(0.025)				
Time	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector-input	Yes	Yes	Yes	Yes	No	No	No	No
Sector	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.9671	0.9650	0.9651	0.9650	0.9030	0.9027	0.8666	0.8664
Observations	5,435	5,435	5,328	5,328	5,435	5,435	5,328	5,328

Notes: Columns (5), (6), (7), and (8) control for lnL, $LnL - 3yearsago$, LnK, and LnM, respectively, in the first step of the production function. Robust standard errors are reported in parentheses. The sector-input fixed effects are only controlled for in columns (1) to (4). *, ** and *** are the significance levels at 10%, 5%, and 1%, respectively.

function produce similar results? If the results were substantially different, then the serious endogeneity of input choice could potentially bias the results. To answer

Table 3.8: FDI Spillovers Created by Different Production CRE Estimators

	Cobb-Douglas Production Function				Two-step Production Function			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Horizontal$	-0.063	-0.062	-0.059	-0.058	-0.068	-0.067	-0.087*	-0.080
	(0.050)	(0.051)	(0.051)	(0.051)	(0.047)	(0.047)	(0.051)	(0.051)
$Backward^{firm}$	0.017***	0.017***	0.017***	0.018***	0.017***	0.018***	0.021***	0.023***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
$Forward^{proxy-imp}$	0.736***		0.750***		0.775***		0.664***	
	(0.201)		(0.204)		(0.200)		(0.219)	
$Forward^{proxy-buy}$		-0.201**		-0.192**		-0.174*		-0.298***
		(0.094)		(0.095)		(0.094)		(0.102)
$Backward^{imp}_{Supply-Back}$	-0.198		-0.199		-0.142		-0.729	
	(0.463)		(0.468)		(0.473)		(0.497)	
$Backward^{buy}_{Supply-Back}$		0.162		-0.010		0.133		-0.204
		(0.478)		(0.460)		(0.496)		(0.472)
$Backward^{firm}_{Motivation}$	0.004	0.006	0.005	0.007	0.005	0.006	0.010	0.013
	(0.010)	(0.011)	(0.010)	(0.011)	(0.010)	(0.011)	(0.010)	(0.011)
$Forward^{proxy-imp}_{Motivation}$	-0.038		-0.040		-0.063		0.237	
	(0.409)		(0.410)		(0.417)		(0.439)	
$Forward^{proxy-buy}_{Motivation}$		-0.091		-0.076		-0.036		-0.017
		(0.238)		(0.239)		(0.245)		(0.260)
$Backward^{firm}_{Technology}$	0.010	0.008	0.009	0.007	0.009	0.007	0.007	0.003
	(0.005)	(0.006)	(0.006)	(0.006)	(0.005)	(0.006)	(0.006)	(0.006)
$Forward^{proxy-imp}_{Technology}$	-0.182		-0.173		-0.276		-0.103	
	(0.236)		(0.239)		(0.237)		(0.252)	
$Forward^{proxy-buy}_{Technology}$		0.054		0.049		0.039		0.305
		(0.104)		(0.105)		(0.106)		(0.115)
Political Instability	0.001	0.0007	-0.0006	-0.001	0.003	0.003	-0.006	-0.006
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.009)	(0.009)
Macro Instability	-0.015*	-0.015*	-0.013	-0.013	-0.018**	-0.018**	-0.019**	-0.020**
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.009)	(0.009)
Corruption	0.012*	0.012*	0.014**	0.014**	0.013*	0.013*	0.012	0.012
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)	(0.008)
Export share	0.001***	0.001***	0.0009***	0.001***	0.001***	0.001***	0.001***	0.001***
	(0.0004)	(0.0003)	(0.0004)	(0.0003)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Age	-0.0007	-0.0007	-0.0007	-0.0007	-0.001***	-0.001***	-0.001***	-0.001***
	(0.0004)	(0.0004)	(0.0005)	(0.0005)	(0.0004)	(0.0004)	(0.0005)	(0.0005)
lnL	0.493***	0.494***						
	(0.032)	(0.032)						
$LnL - 3yearsago$			-0.007	-0.005				
			(0.016)	(0.016)				
LnK	0.092***	0.093***	0.093***	0.093***				
	(0.007)	(0.007)	(0.007)	(0.007)				
LnM	0.467***	0.468***	0.466***	0.467***				
	(0.024)	(0.024)	(0.025)	(0.025)				
Time	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector-input	Yes	Yes	Yes	Yes	No	No	No	No
Sector	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.6442	0.6412	0.6496	0.6463	0.8638	0.8621	0.8648	0.8632
Observations	5,435	5,435	5,328	5,328	5,435	5,435	5,328	5,328

Notes: Columns (5), (6), (7), and (8) control for lnL, $LnL - 3yearsago$, LnK, and LnM, respectively, in the first step of the production function. Robust standard errors are reported in parentheses. The sector-input fixed effects are only controlled for in columns (1) to (4). *, ** and *** are the significance levels at 10%, 5%, and 1%, respectively.

this question, following Barrios et al. (2011) and Commander and Svejnar (2011), we perform a test by re-estimating Eq.(3.10) in the form of the augmented Cobb-

Douglas production function to obtain estimated coefficients on the variables of backward and forward linkages. As suggested in Commander and Svejnar (2011) for firm's age, the export share and the full-time employment lagged three years are the important predictors in the augmented Cobb-Douglas production function; therefore, we control for these variables in the test.

Columns (1) to (4) in Table 3.7 provide the results for the augmented Cobb-Douglas production function, while columns (5) to (8) are the results provided by the two-step production estimation. Estimation in this instance is by pooled OLS with all country, sector, time and sector-input fixed effects included. All proposed measures enter the model positively, and the coefficients for both backward and forward linkages do not change by much. Firm's age enters negatively and is most statistically significant at the 1% significance level, and we also find that the export share is confirmed as statistically significant throughout the specifications. While the input variables are still confirmed as positive and statistically significant, we do not find any impacts from the three-year lagged employees. As to the vertical linkages, regardless of whether these extra controlled variables significantly enter the models, the effects of vertical spillovers on firms' productivity remain highly statistically significant, even when the CRE estimator is employed in Table 3.8. Thus, we find no evidence that neither the different forms of production estimation nor the extra controlled variables matter in terms of the findings thus far. By employing the BEEPS data set to analyse foreign ownership and firm performance, Commander and Svejnar (2011) also document that the Solow residual approach generates broadly similar results to those obtained by instrumenting the input variables. Since our findings are consistent with the literature, we evidence that the endogeneity of input choice is likely less serious in our data.

3.6 Conclusion

Since Rodriguez-Clare (1996), the literature has highlighted the importance of spillovers from FDI on domestic firms' productivity. To estimate spillovers, the literature incorporates data from the host country input-output tables to establish measures determining the strength of sectoral linkages (Javorcik, 2004). However, existing studies assume homogeneous sourcing and supplying activities across firms and focus on the importance of backward spillovers on firms' productivity. This chapter uses a firm-level survey data set comprising 32 countries to distinguish firms' heterogeneity in sourcing and supplying activities and to refine both backward and forward spillovers on firms' productivity. We construct measures to relax the assumptions used in the literature and compare the results with those obtained using the standard measures. Our identification strategy reveals that the heterogeneity in firms' sourcing and supplying activities to be crucial and that both forward and backward linkages are economically important for improving domestic firms' productivity. We find that backward spillovers occur in these developing countries, whilst forward spillovers can be both positively and negatively associated with firms' productivity, depending crucially on the measures we employ.

Relating the proposed measures to backward and forward linkages, we find a strong and highly statistically significant relationship with domestic firms' productivity, suggesting that buying inputs from, and supplying inputs to, multinational firms induce vertical spillovers. This result holds whether we consider other indirect linkages, factors, or a different form of production function. However, we find no evidence of such spillovers through backward and forward linkages by using the standard measures. Although our findings cannot be directly comparable due to the different data structure that contains different firms, sectors, industries, and countries from the existing literature, it might still be worth concerning about the heterogeneous sourcing and supplying activities across firms, which are assumed to be homogeneous in the existing studies (such as Javorcik, 2004; Barrios et al., 2011; Gorodnichenko et al., 2014; Newman et al., 2015; Kim, 2015; Jude, 2016). It is likely that these differences might play a crucial role in preventing potential spillovers from arising. In contrast to the earlier studies, our proposed measures attempt to distinguish these differences and evaluate the importance of vertical spillovers in terms of the productivity of domestic firms based on the data that we have.

From an economic point of view, our results indicate that policies aimed at attracting FDI and encouraging domestic firms to cooperate with multinationals should be continued, as domestic firms may receive support, assistance, and potential benefits from multinational business partners. However, as highlighted previously, our measures post some assumptions, implying that, although they are not contradictory to the spillovers arising from multinational firms, we cannot explicitly and conclusively address the difference in domestic firms' sourcing activities. In addition, the use of short-term pooled data in our analysis does imply that our estimates may still, more or less, be biased. Further to this point, it would be fruitful for future surveys to cover a more detailed long-term panel's dimensions systematically in order that the impact of such heterogeneity on linkage spillovers can be understood. Therefore, there is still substantial room for improvements via future work.

3.7 Appendix

Table 3.9: Sources and Supplies across Countries

Country	Code	Supply to multinationals		Purchase from multinationals				Local sourcing proportion			
	#	Mean	S.d	Mean	S.d	Mean	S.d	Mean	S.d	Mean	S.d
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Albania	1	0.290	1.080	0.117	0.192	0.160	0.214	0.436	0.391	0.503	0.421
Armenia	2	1.025	1.803	0.015	0.037	0.097	0.049	0.53	0.405	0.697	0.356
Azerbaijan	3	1.566	2.626	0.028	0.064	0.129	0.074	0.700	0.435	0.730	0.386
Belarus	4	0.181	0.804	0.012	0.022	0.044	0.027	0.407	0.397	0.597	0.376
Bosnia	5	0.756	1.860	0.036	0.080	0.089	0.098	0.313	0.420	0.604	0.407
Bulgaria	6	0.482	1.694	0.007	0.017	0.049	0.027	0.550	0.377	0.727	0.340
Croatia	7	0.911	1.993	0.035	0.056	0.098	0.071	0.436	0.416	0.571	0.398
Czech Rep.	8	0.664	1.824	0.031	0.078	0.223	0.141	0.547	0.347	0.750	0.338
Estonia	9	1.309	2.365	0.032	0.058	0.098	0.081	0.520	0.341	0.592	0.423
FYROM	10	0.820	1.932	0.012	0.018	0.026	0.022	0.200	0.324	0.484	0.405
Georgia	11	0.228	1.035	0.012	0.025	0.059	0.031	0.290	0.364	0.756	0.361
Hungary	12	1.636	2.761	0.010	0.022	0.059	0.029	0.526	0.350	0.736	0.343
Kazakhstan	13	0.747	1.845	0.034	0.087	0.160	0.167	0.257	0.359	0.746	0.361
Kyrgyz	14	0.251	0.981	0.005	0.010	0.022	0.013	0.359	0.414	0.630	0.396
Latvia	15	0.379	1.088	0.010	0.026	0.056	0.045	0.350	0.409	0.625	0.417
Lithuania	16	0.582	1.683	0.033	0.061	0.132	0.080	0.565	0.411	0.686	0.396
Moldova	17	0.344	1.310	0.019	0.048	0.068	0.079	0.700	0.402	0.684	0.396
Montenegro and Serbia	18	0.680	1.887	0.050	0.077	0.131	0.087	0.444	0.348	0.595	0.390
Poland	19	0.800	1.994	0.007	0.028	0.123	0.069	0.559	0.375	0.798	0.310
Romania	20	0.606	1.769	0.026	0.072	0.195	0.108	0.606	0.419	0.785	0.325
Russia	21	0.383	1.413	0.006	0.027	0.120	0.076	0.588	0.394	0.784	0.337
Slovakia	23	1.095	2.453	0.030	0.046	0.090	0.055	0.274	0.287	0.602	0.337
Slovenia	24	0.737	1.869	0.030	0.039	0.076	0.045	0.481	0.291	0.647	0.381
Tajikistan	25	0.643	1.359	0.006	0.016	0.029	0.027	0.664	0.413	0.757	0.355
Ukraine	26	0.302	1.182	0.006	0.021	0.082	0.045	0.480	0.406	0.715	0.350
Uzbekistan	27	0.259	1.240	0.013	0.045	0.148	0.067	0.508	0.399	0.854	0.288
Yugoslavia	28	0.572	1.855	0.075	0.096	0.139	0.110	0.340	0.328	0.545	0.407
Turkey	29	0.576	1.788	0.004	0.011	0.056	0.030	0.633	0.352	0.823	0.276
Guatemala	30	2.125	5.518	0.020	0.027	0.032	0.027	0.192	0.222	0.502	0.413
Honduras	31	2.743	5.791	0.017	0.017	0.021	0.018	0.250	0.427	0.540	0.469
Nicaragua	32	1.758	4.457	0.022	0.057	0.131	0.075	0.586	0.396	0.691	0.385
El Salvador	34	2.159	4.897	0.016	0.025	0.050	0.029	0.212	0.268	0.668	0.380

Note: Montenegro and Serbia are not assigned to the same group in any other surveys in the BEEPS dataset. However, for the survey rounds in 2002, 2003 and 2005, they are assigned to one group. Ecuador is eliminated from the sample due to lot of missing values. The codes 22 (Serbia) and 33 (Ecuador) are therefore not included. Columns (4) and (5) represent Eq. (3.5), while columns (6) and (7) represent Eq. (3.6). Columns (8) and (9) represent multinationals' local sourcing proportion, while columns (10) and (11) represent for multinational firms' local sourcing proportion.
Source: Author's calculation.

Table 3.10: Descriptive Statistics by Sourcing from Multinationals

		Supplying to Multinationals?		Purchasing from Multinationals?			
		Yes	No	Yes	No	Yes	No
				by Imported Inputs		by Local Source	
2002	lnK	5.146	4.013	5.073	3.841	4.201	3.844
	lnL	3.888	3.283	4.068	3.112	3.418	2.855
	lnM	9.898	8.802	10.049	8.555	8.985	8.629
	lnSales	6.591	5.505	6.685	5.281	5.692	5.273
	Firm's age	16.366	15.638	17.561	15.077	16.109	12.006
2003	lnK	12.403	11.808	12.922	11.323	11.772	12.910
	lnL	3.509	3.509	4.055	2.920	3.262	3.857
	lnM	14.508	13.773	14.982	13.280	13.783	14.764
	lnSales	15.381	14.848	16.100	14.281	14.808	15.948
	Firm's age	18.262	19.959	21.510	18.669	19.238	23.333
2005	lnK	5.719	4.954	5.868	4.789	5.098	4.736
	lnL	3.311	2.886	3.615	2.717	2.983	2.575
	lnM	6.698	5.822	6.959	5.670	6.034	5.673
	lnSales	6.857	6.043	7.114	5.832	6.194	5.836
	Firm's age	18.353	16.531	19.860	15.735	17.219	12.110

Source: Author's calculation.
Note: The values are expressed in U.S. dollars.

Table 3.11: Production Function Estimation

	OLS	FE	CRE
	(1)	(2)	(3)
lnK	0.096***	0.075***	0.095***
	(0.007)	(0.022)	(0.007)
lnL	0.493***	0.568***	0.496***
	(0.025)	(0.064)	(0.025)
lnM	0.437***	0.283***	0.434***
	(0.024)	(0.026)	(0.024)
Time	Yes	Yes	Yes
Sector	Yes	Yes	Yes
Country	Yes	Yes	Yes
Firm	No	Yes	Yes
R-squared	0.9658	0.6798	0.6479
Observations	5,440	5,440	5,440

Note: Robust standard errors are reported in parentheses in columns (1) and (3). *, ** and *** are the significance levels at 10%, 5%, and 1%, respectively.

Table 3.12: FDI Linkages for Firm's Productivity - Panel Data Check.

	12 Economies				All Economies			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: OLS								
Horizontal	-0.049	0.003	-0.070	-0.038	-0.068	-0.074	-0.017	-0.020
	(0.216)	(0.197)	(0.219)	(0.225)	(0.098)	(0.098)	(0.113)	(0.113)
$Forward^{IO}$	0.327	0.073						
	(0.472)	(0.175)						
$Backward^{IO}$	-0.442		0.111	0.077				
	(0.633)		(0.242)	(0.241)				
$Backward^{firm}$		0.047***			0.029***	0.027***	0.030***	0.027***
		(0.010)			(0.008)	(0.010)	(0.008)	(0.011)
$Forward^{proxy-imp}$			0.799*		0.603***		0.561**	
			(0.485)		(0.254)		(0.251)	
$Forward^{proxy-buy}$				-0.201		0.014		0.035
				(0.315)		(0.178)		(0.174)
Panel B: Fixed-effect								
Horizontal	0.103	0.102	0.018	0.045	0.031	0.011	0.079	0.062
	(0.241)	(0.241)	(0.272)	(0.275)	(0.190)	(0.191)	(0.206)	(0.206)
$Forward^{IO}$	-2.936	0.301						
	(3.759)	(0.675)						
$Backward^{IO}$	3.923		0.249	0.335				
	(4.477)		(0.967)	(0.967)				
$Backward^{firm}$		-0.017			-0.011	-0.026	-0.018	-0.031
		(0.022)			(0.022)	(0.024)	(0.023)	(0.025)
$Forward^{proxy-imp}$			0.498		0.956		0.960	
			(1.061)		(0.617)		(0.626)	
$Forward^{proxy-buy}$				-0.240		-0.126		-0.092
				(0.485)		(0.316)		(0.333)
Panel C: Correlated Random-effect								
Horizontal	0.101	0.066	-0.054	-0.027	-0.052	-0.058	-0.016	-0.021
	(0.183)	(0.169)	(0.192)	(0.199)	(0.093)	(0.093)	(0.111)	(0.111)
$Forward^{IO}$	0.256	-0.025						
	(0.480)	(0.152)						
$Backward^{IO}$	-0.431		0.034	0.006				
	(0.615)		(0.205)	(0.210)				
$Backward^{firm}$		0.028***			0.019***	0.015*	0.027***	0.022***
		(0.009)			(0.006)	(0.008)	(0.008)	(0.010)
$Forward^{proxy-imp}$			0.764		0.575**		0.604*	
			(0.512)		(0.247)		(0.273)	
$Forward^{proxy-buy}$				-0.159		0.039		0.023
				(0.310)		(0.168)		(0.172)
Time	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector-input	No	No	No	No	No	No	Yes	Yes
Observations	691	691	612	612	1,132	1,132	1,131	1,131

Note: The table presents the results based on the small panel of firms. We try to see whether firms and other unobserved time-invariant effects matter in the results. In columns (1) to (4), we regress dependent variable on 12 economies, while columns (5) and (8) show the results for 32 economies. Other controls including Supply-Back , Political Instability, Macro Instability, Corruption, Export share and Age, are controlled for throughout specifications. Robust standard errors are reported in parentheses, except the results reported in Panel B. *, ** and *** are the significance levels at 10%, 5% and 1%, respectively.

Chapter 4

Foreign Ownership, Core Product Competence and Markups

4.1 Introduction

UNCTAD (2017) records that the global flows of foreign direct investment (henceforth, FDI) reached $1.75 trillion in 2016, while 37% of that amount flowed into developing countries. The large volume of FDI inflows received by those developing countries suggests the importance of the participation of multinational firms in their economic development. Indeed, the literature has documented that productivity spillovers from multinational firms often contribute to positive productivity gains for firms in developing countries. For instance, a growing body of work focusing on the productivity spillover effects finds productivity gains occurring typically through vertical linkages (Javorcik, 2004, for Lithuania; Gorodnichenko et al., 2014, for 17 emerging economies; Newman et al., 2015, for Vietnam). Considering the fact that local sourcing decisions may be endogenous, Javorcik and Spatareanu (2008) document that joint-venture foreign projects generate more productivity spillovers to the host country compared to greenfield FDI projects, while studies by Arnold and Javorcik (2009) and Chang, Chung, and Moon (2013), who exploit acquisition decisions and their effects on firms' productivity, find that foreign ownership leads to greater productivity gains for the acquired firms and that these acquire firms outperform local firms ultimately. Besides, foreign firms are also likely to lead to lower marginal production costs and increased product quantities and quality (Stiebale & Vencappa, 2018). Further to this, the theoretical literature also focuses on analysing how multi-product firms' core product competences enhance their productivity.

Recently, it has been pointed out that firms respond to increased foreign competition from international markets by dropping their worst-performing products and reallocating resources towards the most competitive product lines (Bernard et al., 2011; Mayer et al., 2014). By assuming that multi-product firms have their own core competences and that they are less efficient in the production of varieties outside their core competences, Eckel and Neary (2010) highlight that productivity increases as firms concentrate on their core product lines following a decrease in product variety. Following these studies, firms may respond to the increased product market competition induced by the presence of multinational firms by selecting the product lines that are more likely to succeed and experience productivity improvements. This response operates potentially through multinationals increasing product market competition, thus motivating domestic firms to reallocate production towards core products, ultimately improving productivity[1]. Although the theoretical models on multi-product firms have been very well developed (e.g., Bernard et al., 2011; Eckel & Neary, 2010; Mayer et al., 2014), this crucial mechanism has received little attention in the FDI literature, and few empirical studies have attempted to incorporate these theories on FDI.

[1]Note also that multinational subsidiaries tend to invest more in innovation due to access to technology and export opportunities (Guadalupe et al., 2012), whilst domestic incumbents that were close to the frontier initially may be encouraged to innovate via the presence of a highly-productive competitors (Aghion et al., 2015). These related mechanisms may also explain the increase in firms' productivity.

Inspired by the literature on multi-product firms, it is thus the aim of this chapter to identify empirically the mechanisms of productivity gains resulting from the skewness towards core product competence – which we define it as the ratio of a firm's core product sales over the total sales throughout the analysis – via the presence of foreign ownership - a fundamental link that provides local firms with market access (market expansion), improvements of core production processes, and product innovation. We exploit a novel channel through which the foreign ownership increases firms' productivity via the concentration effect within an industry. Doing so allows us to establish a mechanism - variety further from the firm's core competence lowers productivity (Eckel & Neary, 2010)[2] - that may act as an important mechanism in explaining the changes in firms productivity. In addition, we complement our work by also analysing the product market competition linked to the presence of foreign ownership and firm's core product competences. By doing so, we distinguish our work from recent empirical studies by Javorcik and Spatareanu (2008), Borin and Mancini (2016), and Weche (2018). These studies do not analyse product market competition and core product competence, implying that all firms in their studies are assumed to be single-product firms and market competition and core product competence are left in the error term. They only look at the relationship between FDI and firm-level productivity, which makes it impossible to address the issue of differential core competences induced by the multinationals across industries. However, in one of the most prominent studies, Hottman, Redding, and Weinstein (2016) show that 69% of firms supply more than one barcode and that these firms account for more than 99% of output in their sectors, which indicates that multi-product firms are the norm rather than the exception.

[2]The model of multi-product firms suggests that the technology of multi-product firms is characterised by a core competence and flexible manufacturing and the marginal cost is assumed to be the lowest for the core product with most efficient product process produced (Eckel & Neary, 2010).

Our results are based on a cross-country, firm-level dataset drawn from the World Bank Enterprise Survey covering 112 developing countries during the period 2006-2016. Our data suggest that the presence of foreign ownership skews firms' production towards the core product lines, while our empirical results show that both the foreign ownership share and whether the firm is foreign-owned exhibit positive and statistically significant effects on core product competence (i.e., skewness towards the best-performing product) and that this positive effect contributes ultimately to firms' productivity. We further document empirically that the product market competition introduced by the presence of foreign ownership reduces the markups across all product lines and that this effect alters the distribution of a firm's core product competence[3]. The results show a statistically significant and negative effect of the presence of foreign ownership on markups, and this effect is ultimately passed onto the firm's core product competence.

The chapter proceeds as follows. Section 4.2 provides an overview of markups and FDI literature. Next, Section 4.3 presents the theoretical hypotheses that guide the empirical analysis. Further, Section 4.4 outlines the empirical strategy, while Section 4.5 describes the firm-level survey data. The empirical results and conclusions are presented in Ssections 4.6 and section 4.7, respectively.

4.2 Literature Review

A relatively large body of literature now exists which explores productivity differences across both domestic and foreign-owned firms. Guadalupe et al. (2012) suggest

[3]As we illustrated in Section 4.3, the presence of foreign ownership is likely to affect a firm's decision in terms of product market expansion and/or product innovation - for example, by providing an increase in export market access that comes with foreign ownership, the exported product mix might be associated with markups which might further have an impact on altering firms' core product competence. We have not empirically examined these potential mechanisms in this chapter but these mechanisms will be implemented in our future work.

that multinational subsidiaries generally outperform domestic firms because multinational firms provide fundamental links that allow acquired firms to access process and product innovations. They find that multinational subsidiaries innovate more due to the increase in market access promoted by the multinational firms. A number of studies also offer related insight by evaluating the effects of foreign ownership on firms' productivity. For example, Javorcik (2004) shows that the presence of foreign ownership generates positive externalities via backward linkages to local input suppliers in Lithuania. Blalock and Gertler (2008) find evidence of productivity gains for the firms that supply inputs to multinationals in Indonesian manufacturing. While Arnold and Javorcik (2009) focus on the causal relationship between foreign ownership and plant performance, Haskel et al. (2007) focus on whether the productivity of domestic plants is correlated with foreign ownership in these plants. Both studies confirm productivity improvements through foreign acquisition[4].

In addition, there are a number of alternative mechanisms in the theory of multi-product firms that may potentially link productivity improvement and multinational firms. Work done by Bernard et al. (2011), for example, shows that increased product-market competition coming from international trade enhances the zero-profit cut-off and reduces the average prices of varieties supplied by competing firms, which lowers markups and increases within-firm productivity. The surviving firms would respond to this market adjustment by dropping the products that have lower values with respect to product attributes and would experience increases in productivity. Eckel and Neary (2010) and Mayer et al. (2014) also suggest that

[4]Another informative study by Javorcik and Spatareanu (2008) discusses the effect of the endogeneity of a firm's sourcing behaviour on the extent of productivity spillovers. They suggest that affiliates with joint domestic and foreign ownership (those firms having foreign equity of less than 10%) may face lower costs of production, as it is easier for them to find local suppliers of intermediates. Therefore, they tend to engage more in local sourcing activities, perhaps further implying that foreign-owned firms (with more than 10% of foreign equity) may face higher costs of production, as they tend to source materials abroad as opposed to obtaining supplies from domestically-owned firms. Thus, in some circumstances, foreign-owned firms may be less productive.

the tougher market competition shifts down the distribution of markups across all products and induces firms to reallocate resources towards their better-performing products and constitutes an improvement in productivity.

While the literature has emphasized the impact of competition pressure linked to multi-product firms and international trade, similar effects from FDI with ownership advantages (e.g., firm-specific assets and knowledge capital) to the local firms in the host country may also be expected (Markusen, 1995). A number of studies have thus attempted to assess the effect of multinational firms on markups. For instance, in the study by Stiebale and Vencappa (2018), the authors look at the relationship between foreign acquisition, markups, marginal costs, and product quality. Using firm-product-level data for India, they find that while foreign multinational firms increase the quality of products produced by the firms they acquire, acquisitions are associated with high markups and lower marginal costs, on average. The result implies that productivity spillovers may occur through an increase in the quantities of existing products. Using Turkish data, on the other hand, Bircan (2019) finds that foreign competition leads to a reduction in prices following acquisition but the evidence regarding markups is insignificant. Focusing on the competitive effects of trade and FDI on markups, Weche (2018), who uses six European countries comprising 145,477 firm-year observations for 34,895 individual firms through 2006-2013, finds no significant effect of FDI penetration on domestic markups. In contrast, Chung (2001) finds that a foreign presence introduces additional competitors and leads to lower markups in the domestic market. However, Aitken and Harrison (1999) argue that multinational firms have both positive and negative influences on market competition based on an empirical analysis of Venezuelan plants. By introducing additional competitors, foreign firms harm incumbents' productivity by spreading their fixed costs across fewer, increasing the average cost and compressing markups[5] [6] [7].

Although it is clear that the presence of multinationals would increase market competition, the existing empirical findings in the effect of increased competition induced by the presence of multinational firms remain ambiguous, and how the foreign presence alters product market competition and then further alters firms' core product production, which may result as productivity improvement, is still unclear. As mentioned previously, firms respond to increased foreign competition by dropping their worst-performing products, as the increased competition lowers markups across all product lines. Mayer et al. (2014) and Eckel and Neary (2010) further suggest that firms' productivity declines when the product variety increases, as increased variety pulls firms away from their core competences due to the additional customization costs (i.e., the cannibalization effect). Each additional product diminishes the demand for a firm's existing products and thus firms are encouraged to focus on their "core competences" and drop marginal high-cost varieties, resulting in productivity improvements as firms become more concentrated on their core product lines[8].

Given that firms may reallocate resources towards higher-attribute products and

[5] Sembenelli and Siotis (2008) also note that foreign-owned firms (foreign ownership higher than 50%) increase market competition, but the results are limited to R&D-intensive industries in Spain. The study suggests that there is no short-run effect of market competition that can be transferred to productivity improvement.

[6] Another explanation is that the host industry firms are mature enough to meet the foreign firms' competitive challenge (Caves, 1974, p.184). If relatively nascent, incumbents will be unable to reduce inefficiency, borrow technology, or otherwise catch up (Chung, 2001, p.187).

[7] One additional and very informative study focusing on multinational firms and markups is Javorcik and Poelhekke (2017). They examine the effect of ownership changes on markups, TFP, and output in order to investigate whether the positive effect of foreign ownership on firm performance relies on a one-time knowledge transfer or not. The authors use divestment data(divestment occurs when foreign affiliates are sold to local owners) from the Indonesian Census of Manufacturing for the period 1990-2009. Using the difference-in-difference approach, they find that the benefits of foreign ownership are associated with the parent company providing distribution networks. Divested plants experience a large drop in markups, exported outputs, TFP, and imported inputs.

[8] By using a panel data from Brazilian multi-product exporters, Arkolakis and Muendler (2010) also find that firms' productivity declines with each additional variety supplied to a market.

changing product compositions because of the increased foreign competition, by using a cross-country firm-level panel data Alfaro and Chen (2018) offer empirical support to emphasize the mechanisms by which multinational firms could also influence domestic firms' performances through product reallocations. They establish the link between foreign entry and firm's productivity by taking into account the endogeneity of the foreign presence and then estimate its effect on different bins of TFP[9] and the effect of foreign presence on labour, revenue, and R&D[10]. By measuring product space with the average probability of new foreign multinational entry across a domestic firm's product mix, the entry of multinationals in domestic product space leads to a negative market reallocation effect but no effect is found on productivity, while a significant and positive relationship between product dropping and multinational entry is found. Although the authors suggest that foreign entrants increases market competition and hence motivate domestic firms to drop products and reallocate resources towards other remained products, due to the absence of competition effects operate at firm's core product competence in the analysis their findings may only provide evidence of an indirect mechanism for adjusting product composition through multinationals.

As mentioned above, the existing literature on FDI has focused rarely on a firm's core product competence to explain the features of FDI and the firm's improvement in productivity. To the best of our knowledge, there is no evidence on how the presence of foreign ownership affects a firm's core product competence and results in an improvement in productivity or how it affects a firm's core product com-

[9] The authors run the regression on domestic firms' productivity throughout the different levels of TFP distribution, from "All", "less than 25%", "between 25%-50%", "between 50%-75%", to "75% and higher" on the predicted multinational corporation entry, lagged revenue, firm's age, and so forth.

[10] The authors follow the literature and use financial shock to take into account the endogeneity of the foreign presence. They also use different TFPs in quartiles to access the different effects of multinational entry. To analyse the resource reallocation, they employ the variables mentioned above. With technology upgrading, the authors separate different R&D groups via R&D intensity.

petence through product market competition. We believe that establishing these mechanisms empirically is of particular importance in terms of building a better understanding of the sources behind productivity gains from multinational firms.

4.3 The Presence of Foreign Ownership and Within-Firm Productivity

In this section, we present a number of testable hypotheses that describe the mechanisms through which the within-firm productivity improvement occurs via the presence of foreign ownership. We focus on a firm's core product competence and markups as two potentially important mechanisms that may provide links to the within-firm productivity improvement and distinguish which of these two mechanisms the productivity gains occurs through. We discuss how to disentangle these mechanisms by exploiting the predictions of a stylized theoretical framework based on the existing multi-product firms theory.

4.3.1 Framework Illustration and Hypotheses Outlined

The impact of the presence of foreign ownership on firms' productivity in the host country can be established using the theoretical model of multi-product firms found in Eckel and Neary (2010) and Mayer et al. (2014). In these models, consumer preferences are defined over a continuum-quadratic of differentiated varieties. The cases of perfect substitutes and the demand for each good, which is completely independent on other goods, are ruled out (Eckel & Neary, 2010). Consumers are assumed to have a positive demand for any variety, and the price of a given variety is the same everywhere.

To produce goods, all firms are assumed to have a core product that uses the most efficient production process. Thus, each firm is characterized by a core competence and flexible manufacturing. The marginal cost varies across varieties but is constant with quantity produced. As illustrated, the firm's core product uses the most efficient production process so that the marginal cost is the lowest for the core variety. Each additional variety entails additional marginal[11] and customization costs[12] and pulls a firm away from its core competence. As the multinationals operating in the host country are likely to motivate domestic firms to reallocate resources towards more efficient products (Alfaro & Chen, 2018) and lead them to make different decisions in terms of product variety (Brambilla, 2009), we summarize the above as the effect of the presence of foreign ownership on firms' core product competences and therefore formulate the following hypothesis:

HYPOTHESIS 1. Altering Core Product Competence via the Presence of Foreign Ownership: *Foreign ownership facilitates firms access to technology and thereby alters the decision in terms of product variety. The presence of foreign ownership therefore induces host-country firms to drop the least efficient varieties and reallocate resources across surviving varieties.*

In addition, firms' core product competence may further influence firms' productivity, as Bernard, Redding, and Schott (2010), Bernard et al. (2011), Mayer et al. (2014), and Alfaro and Chen (2018) highlight that firms reallocate resources towards higher-attribute product lines and hence further increase productivity. It has also been emphasized that varieties further from the firm's core competence have higher labour requirements and, in the context of price-weighted output, lower productiv-

[11] Eckel and Neary (2010) assume that the marginal production cost of each variety is a strictly increasing function of the mass of products produced, while Mayer et al. (2014) assume that the marginal cost for the varieties produced by a firm with a core marginal cost is increasing in customization costs (competence ladder).

[12] The customization cost is denoted as the cannibalization effect in Eckel and Neary (2010).

ity (Eckel & Neary, 2010), which implies that the effect of the presence of foreign ownership on core product competence may consequently raise firms' productivity. We summarize this effect with the following hypothesis:

HYPOTHESIS 2. Productivity Increases as Firms Skew Production Towards Core Competences: *Firms in the host country become more productive when the alteration of core product competence induced by the presence of foreign ownership occurs, as they may benefit from improvements of core production processes.*

Next, we consider the impact of the presence of foreign ownership on product market competition (markups), as the presence of foreign ownership is likely to affect firms' decision in terms of product market expansion and/or product innovation, which would further increase product market competition. As illustrated in the model of multi-product firms, openness to foreign market increases market competition, markups fall as tougher competition lowers average prices across all products (Mayer et al., 2014). Similarly, the presence of foreign ownership may also induce product market competition and then lower markups across all products, as the firm with high foreign ownership may be more able to access external assistance from its multinational company (getting access export market and/or product innovation, for example), which may also increase competition within an industry. We summarize this mechanism in the following hypothesis:

HYPOTHESIS 3. The Presence of Foreign Ownership Lowers the Markup: *As foreign ownership comes with an increase in market access and/or external sources for product innovation, the presence of foreign ownership thus increases the* *product market competition through reducing markups across all products.*

The extent of the effect of product market competition (reducing markups) induced by the presence of foreign ownership could further alter firms' core product competences, making firms become skewed towards better-performing product lines. Assuming a Cournot competition, as in Eckel and Neary (2010), greater competition results in a negative correlation between industry output and equilibrium output. Given its total output and the symmetric structure of demand, a firm charges higher prices for products when less of each variety is produced. However, greater product market competition from rival firms reduces the prices that firms can charge for their varieties. Therefore, this effect would encourage firms to choose their most valuable product lines to concentrate on based on the assumption that a firm uses the most efficient product process to produce their core products with the lowest marginal cost (Eckel & Neary, 2010). This reflection may be amplified once we consider the multinational competition in the host country, as highlighted in Mayer et al. (2014), which increases the market size, technology improvements (which may occur through the presence of foreign ownership), and product substitutability (within the expanded product range), all of which lead to tougher competition and thus further encourage firms to skew their production towards their better-performing products[13]. We summarize this mechanism in the following hypothesis:

HYPOTHESIS 4. Product Market Competition Induces Firms to Skew Towards Core Variety: *The effect of reduced markups due to the presence of foreign ownership alters the distribution of firms' core product competences ultimately.*

[13]It can also be seen in Eckel and Neary (2010) that the net effect of globalization is a fall in product scope, i.e., it encourages firms to prune their product lines by concentrating on their core competencies in order to respond to the greater market competition effects.

Having established testable hypotheses, we then examine these hypotheses empirically in Section 4.6 with both the stylized facts and econometric analyses.

4.4 Empirical Strategy

Our empirical strategy involves the estimation of the impact of foreign ownership on the changes in firms' core product competences, productivity, and markups following our outlined hypotheses 1 to 4. Therefore, we first examine a firm's core product competence as a function of the presence of foreign ownership and control for firm characteristics and time-invariant factors across countries, sectors, and years. Primarily, we regress the core product competence, as defined below, on the foreign ownership across each firm, sector, and country throughout the 2006-2016 period, whilst controlling for firm size, sector, country, and year fixed effects to mitigate the bias as much as possible. The specification can be written as follows:

$$
\begin{aligned}
CoreProductCompetence_{i,s,c,t} &= \beta_0 + \beta_F F_{i,s,c,t} \\
&\quad + \beta_{size} size_{i,s,c,t} + d_s + d_c + d_t + \xi_{i,s,c,t}
\end{aligned}
\tag{4.1}
$$

where the dependent variable is the core product competence measured as the share of total sales. The F represents the *Foreign Ownership Share* and, alternatively, the *Foreign Dummy* for each firm i across sector s in country c at time t. The former is measured in percents (%), while the latter is defined as a dummy which is equal to 1 if the firm has foreign ownership of at least 50%. The $size$ denotes the firm's size. Given the fact that Eq. (4.1) does not allow us to access the effects of the skewness of core product competence on productivity, namely, examine hypothesis

2, we therefore estimate the following equation:

$$\begin{aligned} TFP_{i,s,c,t} &= \beta_0 + \beta_{core} Core\widehat{ProductC}ompetence_{i,s,c,t} \\ &+ \gamma X'_{i,s,c,t} + d_s + d_c + d_t + \xi_{i,s,c,t} \end{aligned} \tag{4.2}$$

where the $Core\widehat{ProductC}ompetence$ is the index of core product competence instrumented by either the foreign ownership shares or the foreign dummy from the first-stage Eq. (4.1). The vector X denotes the covariates including the firm's age, total sales, and sales three-years lagged. The TFP is the firm's productivity measured by using the two-step production function and also the one by using the value added (Commander & Svejnar, 2011). We discuss the estimation of TFP in subsection 4.4.2.

However, one remaining concern is the issue of selection, i.e., whether multinationals target local firms based on productivity (cherry-picking) or some unobservable characteristics. To address this selection bias, we follow the procedure adopted by Khandker, Koolwal, and Samad (2010), Guadalupe et al. (2012), Mallick and Yang (2013), Borin and Mancini (2016), Javorcik and Poelhekke (2017), and Webster and Piesse (2018) and employ propensity score matching. As noted by Mallick and Yang (2013) and Webster and Piesse (2018), propensity score matching can alleviate the issue of selection bias by creating treatment and control groups with similar characteristics. We discuss this approach in Subsection 4.4.3.

Second, we estimate the effect of the presence of foreign ownership on product market competition using the following equation:

$$Markups_{i,s,c,t} = \beta_0 + \beta_F F_{i,s,c,t} + \beta_{size} size_{i,s,c,t} + d_s + d_c + d_t + \xi_{i,s,c,t} \tag{4.3}$$

where the dependent variable is the mark-up for firm i in sector s and country c at time t and is a preferred competition indicator following the empirical literature (e.g., Weche, 2018). We control for all sector, country, year, year-country, and year-sector fixed effects. For firm-level markups, we follow the mark-up estimation developed by De Loecker and Warzynski (2012). We detail our mark-up estimation in Section 4.4.1. Note that it is important that firms are assigned to the foreign-owned group in a manner not driven entirely by selection bias . As previously mentioned, we use propensity score matching to mitigate this issue. To assess the impact of the market competition due to the presence of foreign ownership on the change in core product competence, we estimate the following equation:

$$\begin{aligned} CoreProductCompetence_{i,s,c,t} &= \beta_0 + \beta_{core}\widehat{Markups}_{i,s,c,t} \\ &+ \gamma X'_{i,s,c,t} + d_s + d_c + d_t + \xi_{i,s,c,t} \end{aligned} \tag{4.4}$$

where $\widehat{Markups}$ represents the markups instrumented by either the foreign ownership shares or the foreign dummy variable from the first- stage Eq. (4.3), and the vector X is as defined above. Again, we control for sector, country, and year fixed effects. Firm clustering is also used in all regressions to allow for the correlations of errors within each firm (Alfaro & Chen, 2018).

4.4.1 Estimated Mark-up based on Output Elasticity

A preferred market competition indicator in the literature is the measured markups at the firm-level (Weche, 2018). However, markup estimation developed in the industrial organization literature often relies on the availability of very detailed market-level data in terms of input prices, physical output, and quantities of firms' products, which makes the markups estimation an intractable and demanding task.

To overcome such difficulties, early studies such as Hall (1986) and Klettle (1999), for example, developed a simple way to estimate markups using production data with information on the firm or industry-level usage of inputs and the total value of shipments. After that, De Loecker and Warzynski (2012) developed a new framework to calculate markups by using the share of expenditures on material inputs in the total value of production. Their mark-up estimation does not require data on the price differences as well as the cost of capital. Instead, only deflated revenue data are required. This approach leads to a flexible methodology and reliable estimates.

The estimation in De Loecker and Warzynski (2012) has been widely applied in the recent FDI literature[14]. For instance, Stiebale and Vencappa (2018) study the effects of the domestic and foreign acquisition on markups, Weche (2018) studies the competitive effects of FDI focusing on the change in markups, and Javorcik and Poelhekke (2017) study the determinants of foreign divestments by estimating the impact of markups, TFP, and output. We therefore follow De Loecker and Warzynski (2012) to estimate firm-level markups.

In order to obtain markups, first we need to calculate the output elasticity for labour, capital, and material. Following De Loecker and Warzynski (2012), we estimate the production function for each firm across sectors using the translog production function. The estimation is done in two-steps. The first step is the

[14]One additional study closely related to De Loecker and Warzynski (2012) is the study De Loecker, Goldberg, Khandelwal, and Pavcnik (2016). Although they do not focus on the relationship between markups and FDI, they provide a simple framework on the estimation of firm's markups, formalizing how markups, prices, and cost components would adjust during the trade liberalization. The approach used in De Loecker et al. (2016) is based on De Loecker and Warzynski (2012), but the authors extend their methodology to address the so-called input price bias. This bias stems from the unobserved allocation of inputs across products within multi-product firms and stems from unobserved input prices. They highlight the importance of assuming non-constant markups in trade models when quantifying the gains from trade. By using data for a large number of firms based on India's trade liberalization, they find a sharp decline in marginal costs due to input tariff liberalization, while prices do not fall by as much (as so-called the imperfect pass-through). They suggest that this result occurs since firms offset the cost declines by raising markups, while trade liberalization has a large effect on marginal costs and markups.

following:

$$
\begin{aligned}
y_{i,s,c,t} = {} & \beta_l l_{i,s,c,t} + \beta_{ll} l_{i,s,c,t}^2 + \beta_k k_{i,s,c,t} + \beta_{kk} k_{i,s,c,t}^2 + \beta_m m_{i,s,c,t} \\
& + \beta_{mm} m_{i,s,c,t}^2 + \beta_{lk} l_{i,s,c,t} k_{i,s,c,t} + \beta_{lm} l_{i,s,c,t} m_{i,s,c,t} \\
& + \beta_{mk} m_{i,s,c,t} k_{i,s,c,t} + \beta_{lmk} l_{i,s,c,t} m_{i,s,c,t} k_{i,s,c,t} + \omega_{i,s,c,t} + \varepsilon_{i,s,c,t}
\end{aligned}
\tag{4.5}
$$

where we obtain estimates of expected output ($\hat{y}_{i,s,c,t}$) and an estimate for $\varepsilon_{i,s,c,t}$. The expected output is then estimated alongside variables potentially affecting input demand, described below:

$$
\begin{aligned}
\hat{y}_{i,s,c,t} = {} & \hat{\beta}_l l_{i,s,c,t} + \hat{\beta}_{ll} l_{i,s,c,t}^2 + \hat{\beta}_k k_{i,s,c,t} + \hat{\beta}_{kk} k_{i,s,c,t}^2 + \hat{\beta}_m m_{i,s,c,t} + \\
& + \hat{\beta}_{mm} m_{i,s,c,t}^2 + \hat{\beta}_{lk} l_{i,s,c,t} k_{i,s,c,t} + \hat{\beta}_{lm} l_{i,s,c,t} m_{i,s,c,t} + \\
& + \hat{\beta}_{mk} m_{i,s,c,t} k_{i,s,c,t} + \hat{\beta}_{lmk} l_{i,s,c,t} m_{i,s,c,t} k_{i,s,c,t} + h_t(m_{i,s,c,t}, k_{i,s,c,t}, z_{i,s,c,t})
\end{aligned}
\tag{4.6}
$$

Where $\omega_{i,s,c,t} = h_t(m_{i,s,c,t}, k_{i,s,c,t}, z_{i,s,c,t})$ (De Loecker, 2011, p.1425; De Loecker & Warzynski, 2012, p.2447). Under a translog production function, the output elasticities for labour, capital and material are computed using the estimated coefficients and current inputs after the first stage:

$$
\hat{\theta}_{i,s,c,t}^M = \hat{\beta}_m + 2\hat{\beta}_{mm} m_{i,s,c,t} + \hat{\beta}_{lm} l_{i,s,c,t} + \hat{\beta}_{mk} k_{i,s,c,t} + \hat{\beta}_{lmk} l_{i,s,c,t} k_{i,s,c,t} \tag{4.7}
$$

$$
\hat{\theta}_{i,s,c,t}^L = \hat{\beta}_l + 2\hat{\beta}_{ll} l_{i,s,c,t} + \hat{\beta}_{lk} k_{i,s,c,t} + \hat{\beta}_{lm} m_{i,s,c,t} + \hat{\beta}_{lmk} k_{i,s,c,t} m_{i,s,c,t} \tag{4.8}
$$

$$
\hat{\theta}_{i,s,c,t}^K = \hat{\beta}_m + 2\hat{\beta}_{kk} k_{i,s,c,t} + \hat{\beta}_{km} m_{i,s,c,t} + \hat{\beta}_{kl} l_{i,s,c,t} + \hat{\beta}_{lmk} m_{i,s,c,t} l_{i,s,c,t} \tag{4.9}
$$

We use these output elasticities to calculate the firm's markups. Following De Loecker and Warzynski (2012) and De Loecker et al. (2016), the markup estimation at the firm-level is described below:

$$\begin{aligned} \mu_{i,s,c,t} &= \hat{\theta}^X_{i,s,c,t} \frac{P_{i,s,c,t} Q_{i,s,c,t}}{P_{i,s,c,t} X_{i,s,c,t}} \\ &= \hat{\theta}^X_{i,s,c,t} (\alpha^X_{i,s,c,t})^{-1} \end{aligned} \tag{4.10}$$

where $X_{i,s,c,t}$ denotes the firm's expenditure on inputs. $\alpha^X_{i,s,c,t}$ is the share of expenditures on input $X_{i,s,c,t}$ in total sales (De Loecker & Warzynski, 2012; De Loecker et al., 2016), $P_{i,s,c,t}X_{i,s,c,t}$ denotes the input allocation, and $\hat{\theta}^X_{i,s,c,t}$ is the output elasticity for firm i in sector s, country c at time t.

As noted by De Loecker and Warzynski (2012), input allocation $P_{i,s,c,t}X_{i,s,c,t}$ is unobservable due the fact that firms do not report this information. No price data are available either[15]. Therefore, following De Loecker and Warzynski (2012), we replace it by using data on input expenditure shares ($\alpha^X_{i,s,c,t}$) and only estimate markups using production data with output elasticity of one input (material) of production and data on the material expenditures share of total revenue. Note that this is important to add one more stage to eliminate any variation in expenditure shares ($\alpha^X_{i,s,c,t}$) that comes from variation in output not related to the elasticity of demand and productivity (De Loecker & Warzynski, 2012). We follow De Loecker and Warzynski (2012) to correct this variation as follows:

$$\hat{\alpha}^X_{i,s,c,t} = \alpha_{i,s,c,t} \times exp(\tilde{\epsilon}_{i,s,c,t}) \tag{4.11}$$

[15]Note that as pointed out by Alfaro and Chen (2018), the relationship between prices and markups would still be unclear even if the price or physical output information were observable. De Loecker and Warzynski (2012) also show that only the level of the markups is potentially affected when such data on physical output are not available. Further to this, Javorcik and Poelhekke (2017), who do not observe any physical measures of output and price data, follow the same markup estimation of De Loecker and Warzynski (2012).

where the $\epsilon_{i,s,c,t}$ is provided by the first stage of the procedure from Eq. (4.15). We take the correction into account by multiplying the expected value of estimated productivity residual and then use the above equations to compute the markups, based on material, labour and capital elasticities, respectively:

$$\mu^{M}_{i,s,c,t} = \hat{\theta}^{M}_{i,s,c,t}(\hat{\alpha}^{M}_{i,s,c,t})^{-1} \tag{4.12}$$

$$\mu^{L}_{i,s,c,t} = \hat{\theta}^{L}_{i,s,c,t}(\hat{\alpha}^{L}_{i,s,c,t})^{-1} \tag{4.13}$$

$$\mu^{K}_{i,s,c,t} = \hat{\theta}^{K}_{i,s,c,t}(\hat{\alpha}^{K}_{i,s,c,t})^{-1} \tag{4.14}$$

Equations (4.12) to (4.14) are therefore the mark-up estimation from the material elasticity, labour elasticity. and capital elasticity. We prefer to use the mark-up estimation from materials Eq. (4.12), as highlighted by Bircan (2019) that material elasticity is less likely to be adjusted compared with the labour's share of expenditure, capital's share of expenditure as well as labour and capital's elasticities. We provide the results of the estimated mark-up in Section 4.6.1.

4.4.2 Estimating TFP

Our analysis requires the estimation of firm-level productivity. The standard approach uses OLS estimation following a two-step procedure to extract the estimated productivity (Marin & Sasidharan, 2010; Van Beveren, 2012; Gorodnichenko et al., 2014). However, there are debates over OLS estimation regarding its assumption of the independence of inputs from firm's efficiency (Wooldridge, 2009; Smeets & Warzynski, 2013; Olley & Pakes, 1992; Ackerberg, Caves, & Frazer, 2006). Nevertheless, data limitation forces our productivity estimation to rely on the standard

OLS estimation, as the approaches including Olley and Pakes (1992), Ackerberg et al. (2006), and Wooldridge (2009) require a long-term panel data structure to be used in the productivity estimation. Therefore, we follow the studies Javorcik and Poelhekke (2017) and Bircan (2019) to estimate the firm-level productivity based on Eq. (4.5), including squared terms, all interactions and year, sector, and country fixed-effects at the first-step to control for any heterogeneity over time in the production function. In the second step, we extract the predicted productivity $\hat{\varpi}_{i,s,c,t}$ once we obtain estimators for each factor by running the following equation

$$\hat{\varpi}_{i,s,c,t} = lny_{i,s,c,t} - \hat{\beta}_l l_{i,s,c,t} - \hat{\beta}_{ll} l^2_{i,s,c,t} - \hat{\beta}_k k_{i,s,c,t} - \hat{\beta}_{kk} k^2_{i,s,c,t} - \hat{\beta}_m m_{i,s,c,t} - \hat{\beta}_{mm} m^2_{i,s,c,t} - \hat{\beta}_{lk} l_{i,s,c,t} k_{i,s,c,t} - \hat{\beta}_{lm} l_{i,s,c,t} m_{i,s,c,t} - \hat{\beta}_{mk} m_{i,s,c,t} k_{i,s,c,t} - \hat{\beta}_{lmk} l_{i,s,c,t} m_{i,s,c,t} k_{i,s,c,t} \tag{4.15}$$

Alternatively, as highlighted by the studies Commander and Svejnar (2011) and Newman et al. (2015), we can use the natural logarithm of value added to check for the robustness of the results. In doing so, the variable $lny_{i,s,c,t}$ is replaced by the log value added, which is defined as the difference between total sales and the material inputs (Commander & Svejnar, 2011, p.313):

$$ValueAdded_{i,s,c,t} = y_{i,s,c,t} - m_{i,s,c,t}$$

We take the natural logarithm of $ValueAdded$ and re-estimate equations (4.15) to obtain the firm-level productivity estimate. For simplicity, we denote the productivity provided by Eq. (4.15) as lnTFP1, whereas the one provided by the value added is denoted as lnTFP2. The distribution of lnTFP1 and lnTFP2 over the foreign-owned and domestic-owned firms is provided in Figure 4.1. The figure shows that foreign-owned firms are more skewed towards the right-tail of the productivity distribution with higher productivity performance, regardless of which TFP measure is used. This is in line with the existing literature, for example, Borin and Mancini

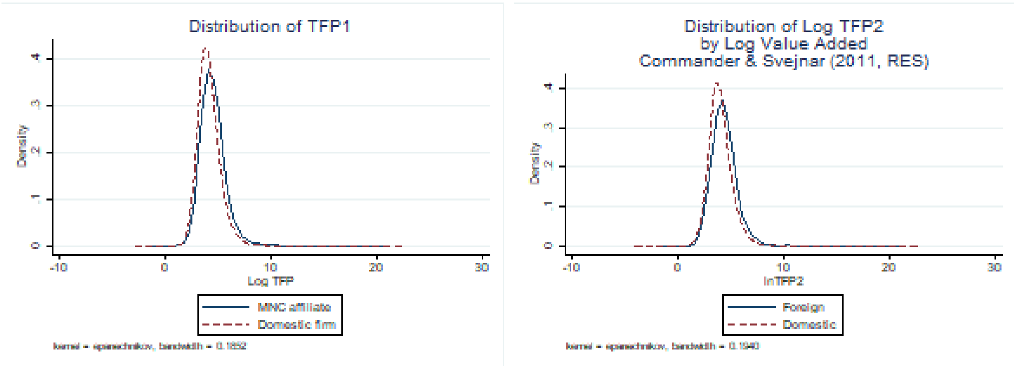

Figure 4.1: The Kernel Density of Productivity across Foreign-Owned Firms and Domestically-Owned Firms

(2016) show that TFP distribution of multinationals dominates that of exporters, which in turn dominates the productivity distribution of domestic firms.

4.4.3 Roy-Rubin Causal Model

One of the features in our empirical analysis is to examine the impact of the presence of foreign ownership on firms' core product competence, TFP, and markups, to the counter-factual had the firm not been foreign-owned. To do this we employ the Roy-Rubin model (Roy, 1951; Rubin, 1974; Caliendo & Kopeinig, 2008).

4.4.3.1 The Average Treatment Effects

We begin by defining a binary random variable $D_i = 0, 1$ with $D_i = 1$ if a firm is foreign-owned and $D_i = 0$ if a firm is domestically owned, and $i = 1, 2, ..., N$. The outcomes of interest include the firm's main products competence, firm-level markups, and productivity, where we denote each alternative outcome as Y_i. For a firm picked at random from the population, the observed outcome is the potential outcome associated with the treatment received:

$$
\begin{aligned}
Y_i &= \begin{cases} Y_{1,i}, & \text{if } D_i = 1 \\ Y_{0,i}, & \text{if } D_i = 0 \end{cases} \\
&= Y_{1,i}D_i + Y_{0,i}(1 - D_i) \\
&= Y_{0,i} + (Y_{1,i} - Y_{0,i})D_i
\end{aligned} \tag{4.16}
$$

A firm is either treated (foreign-owned) or not treated (domestically-owned), so we only observe one potential outcome for each firm. We can now estimate the average difference in observed outcomes by treatment status as follows:

$$
E(Y_i|D = 1) - E(Y_i|D = 0) = E(Y_{1,i}|D = 1) - E(Y_{0,i}|D = 0) \tag{4.17}
$$

We first estimate the average treatment effect (henceforth, ATE) for a firm drawn at random from the population:

$$
\begin{aligned}
\tau &= E(Y_{1,i} - Y_{0,i}) \\
&= E[E(Y_{1,i} - Y_{0,i}|X_i = x)] \\
&= \sum_x E(Y_{1,i} - Y_{0,i}|X_i = x)p(X_i = x)
\end{aligned} \tag{4.18}
$$

In order to identify the ATE, the following conditions should be made:

i. Unconfoundedness (or Conditional independence)

$$
(Y_{0,i}, Y_{1,i}) \perp D_i, X_i
$$

where $Y_{0,i}$ represent outcomes for nonparticipants and $Y_{1,i}$ outcomes for participants. This assumption implies that the uptake of the program is based entirely on observed characteristics. Therefore, given a set of observable covariates, X are not affected by treatment and potential outcomes Y are independent of treatment assignment

D. ii. Overlap

$$0 < p(D_i = 1|X_i = x) < 1$$

This condition ensures that treatment observations have comparison observations nearby in the propensity score distribution (Heckman, LaLonde, & Smith, 1999; Khandker et al., 2010).

iii. Only one treatment occurs for each firm and the potential outcomes for each firm i are unaffected by other firms receiving the treatment.

We then define x as the treatment effects for the firm with a value of the random variable X equal to x:

$$\tau(x) = E(Y_{1,i} - Y_{0,i}|X_i = x) = E(Y_{1,i}|X_i = x) - E(Y_{0,i}|X_i = x) \tag{4.19}$$

under unconfoundedness the treatment is unrelated to potential outcomes conditional on X and therefore we can rewrite above equation as follows:

$$\begin{aligned} \tau(x) &= E(Y_{1,i}|X_i = x, D_i = 1) - E(Y_{0,i}|X_i = x, D_i = 0) \\ &= E(Y_i|X_i = x, D_i = 1) - E(Y_i|X_i = x, D_i = 0) \end{aligned} \tag{4.20}$$

and hence

$$\tau = E(\tau(X_i)) = \sum_x \tau(x)p(X_i = x) \tag{4.21}$$

4.4.3.2 The Average Treatment Effect on the Treated

The average treatment effect on the treated (henceforth, ATET) focus on the effects of treatment for a firm drawn at random from those firms who receive the treatment. It is the average difference in potential outcomes for firms who receive the treatment, hence:

$$\begin{aligned}\tau_{tt} &= E(Y_{1,i} - Y_{0,i}|D_i = 1) \\ &= E[E(Y_{1,i} - Y_{0,i}|X_i = x, D_i = 1)|D_i = 1] \\ &= \sum_x E(Y_{1,i} - Y_{0,i}|X_i = x, D_i = 1)p(X_i = x|D_i = 1)\end{aligned} \tag{4.22}$$

Note that the ATET would be the same as ATE if the treatment effects are homogeneous. The same conditions we described previously should also be made to ensure the validity of ATET.

To define $\tau(x)$ as the treatment effect for a firm with values of the random variables X equal to x and D equal to 1:

$$\begin{aligned}\tau(x) &= E(Y_{1,i} - Y_{0,i}|X_i = x, D_i = 1) \\ &= E(Y_{1,i}|X_i = x, D_i = 1) - E(Y_{0,i}|X_i = x, D_i = 1)\end{aligned} \tag{4.23}$$

and under unconfoundedness the treatment is unrelated to potential untreated outcomes conditional on X so we can write as follows:

$$\begin{aligned}&= E(Y_{1,i}|X_i = x, D_i = 1) - E(Y_{0,i}|X_i = x, D_i = 0) \\ &= E(Y_i|X_i = x, D_i = 1) - E(Y_i|X_i = x, D_i = 0) \\ &= E(\tau(X_i)) = \sum_x \tau(x)p(X_i = x)\end{aligned} \tag{4.24}$$

4.4.3.3 Propensity Score Matching

As for each firm only one treatment outcome can be observed at a time, domestically-owned firms (control group) that are similar to foreign-owned firms (treated group) in everything but treatment receipt is used as proxies for the counter-factual. Therefore, it is important to ensure that the treatment assignment is random. The treatment assignment in survey data may, however, not be random, which might lead to sample selection bias, where firms' observed (measured) and unobserved (unmeasured) characteristics are associated with the likelihood of receiving treatment and with the outcomes. In other words, the performance of being a foreign-owned firm and the probability of being invested by a multinational firm are likely to be co-determined.

Although the two-step Heckman approach helps alleviate the sample selection bias, a strong assumption that error terms in the foreign-owned firms and outcome specifications are jointly normal-distributed with zero means and constant variances is required (Greene, 2003; Mallick & Yang, 2013). This assumption may however be invalid. By contrast, Propensity Score Matching (henceforth, PSM) can be an appropriate estimation strategy when selection bias is likely due to non-random treatment assignment. As noted by Mallick and Yang (2013) and Webster and Piesse (2018), the PSM adjusts for observable differences in firm characteristics between foreign-owned firms and domestically-owned firms, allowing a similar comparison between the two groups. Under certain assumptions, matching on $P(X) = Pr(T = 1|X)$ is as good as matching on the covariates X (Rosenbaum & Rubin, 1983). This is naturally a powerful method to create an unobservable counterfactual outcome using a firm with similar characteristics in all respects but being a foreign-owned firm, whilst increasing the balance between the treatment and control groups (Borin & Mancini, 2016; Webster & Piesse, 2018).

With our cross-section data and within the common support, the treatment effect on the treated with propensity score matching can now be rewritten as follows (Heckman, Ichimura, & Todd, 1997; Smith & Todd, 2005; Khandker et al., 2010):

$$\begin{aligned} ATT_{psm} &= E_{P(X)|T=1}\left[E\left[Y^T|T=1, P(X)\right] - E\left[Y^C|T=0, P(X)\right]\right] \\ &= \frac{1}{N_T}\left[\sum_{i\in T} Y_i^T - \sum_{j\in C} \omega(i,j) Y_j^C\right] \end{aligned} \tag{4.25}$$

where N_T is the number of treated firms i and $\omega(i, j)$ is the weight used to aggregate outcomes for the matched control firms j. The ATT_{psm} refers to the average outcome difference between matched treatment (foreign-owned firms) and control (domestic-owned firms) groups. Y^T refers to outcome of firm i in sector s country c and time t. T denotes a dummy equal to one if firm i is foreign-owned and zero otherwise. The propensity score P of each firm is calculated as below (Mallick & Yang, 2013):

$$P = Pr(T = 1|X_{i,s,c,t}) = \frac{\exp^{\lambda X_{i,s,c,t}}}{1 + \exp^{\lambda X_{i,s,c,t}}} \tag{4.26}$$

where P is the probability of being a foreign-owned firm based on the given firm characteristics. For this matching procedure, we first need to select variables ($X_{i,s,c,t}$) that can be included in the propensity score. As highlighted by Khandker et al. (2010), the samples of treated and non-treated firms should be pooled and the treatment should be estimated on all the observed covariates $X_{i,s,c,t}$ in the data that are likely to determine the treatment. The selection of variables used for the matching procedure is guided by the recent studies of Javorcik and Poelhekke (2017) and Webster and Piesse (2018). The following variables are therefore selected: firm's age, employment, large establishment, direct export, national sales, foreign licensing, production location, product code, net inflow of FDI (% of GDP), GDP growth rate, trade openness and the total natural resources rents (% of GDP). We also consider transformations of age-square, age-cube, employment-square and employment-cube in order to obtain a more precise correspondence in the matching procedure (Mallick & Yang, 2013; Javorcik & Poelhekke, 2017). As the matching covariates for both treatment and non-treatment stem from the same data provider, it is expected to credibly justify the conditional independence assumption (CIA)[16]

[16] Conditional on the observable variables, the performance of the control firm must be equal to that of the treated firm had it not been treated.

and the matching procedure (Heckman et al., 1999). We then provide evidence to support the assumption of common support by showing the results of the Balancing Test (in the Appendix). Formally, we want to check if the following is valid:

$$\hat{P}(X|T=1) = \hat{P}(X|T=0)$$

where $\hat{P}(X)$ is the estimated propensity score. The results of the balancing test are provided in Table 4.15 in the Appendix.

Once we have the propensity score, the inverse probability weighting estimator (henceforth, IPW) is then employed. The IPW estimator is well known and has a long tradition in the literature of missing data, treatment effects, and measurement error (Cattaneo, Drukker, Holland, et al., 2013). The inverse probability weighting tries to correct for non-random sampling. The IPW gives less weight to the outcomes of firms with high productivity in the treatment group, whilst giving more weight to the outcomes of firms with low productivity in the same group. On the other hand, it gives more weight to the outcomes of firms with higher productivity in the control group, whilst giving less weight to the outcomes of firms with low productivity. As can be seen in the study of Busso, DiNardo, and McCrary (2014) which concludes that "reweighting is a much more effective approach to estimating average treatment effects than is suggested by the analysis in Frölich (2004)..., and is often competitive with the more sophisticated matching estimators in data generating processes where overlap is good" (p. 885), we employ this approach and provide results as robustness test.

Following Cattaneo et al. (2013) and Wooldridge (2010), the IPW estimator consists of three steps: the first is to estimate the parameters of the treatment model and compute inverse-probability weights; the second step is to use the estimated inverse-probability weights and fit weighted regression models of the outcome for each treatment level and obtain the treatment-specific predicted outcomes for each

Table 4.1: Example of Sectors s and Products p Classifications

ISIC Rev 3.1	ISIC-sector	4-digit	ProductCode	Description
15	Food, beverage and tobacco, sector(s)		Product(p):	
	1	1541	15	bread production
	1	1541	75916	production of oil
17-19	Textile and apparel, sector(s)		Product(p):	
	2	1712	9	Manufacture yarn
	2	1810	11	Manufacturing Leather Jackets
	2	1810	14857	Female wears
	2	1920	10	Manufacturer of plastic footwear
23-25	Coke, chemicals and plastics, sector(s)		Product(p):	
	4	2519	6	HDPE pipe
	4	2520	15218	Fundas plastics
	4	2520	26535	Manufacturer of plastic materials
26	Nonmetallic mineral products, sector(s)		Product(p):	
	5	2692	3	Constructing Parasitical Products
	5	2695	18	Iron Pieces
27	Basic metals, sector(s)		Product(p):	
	6	2720	16	copper smelt production
	6	2720	58132	Tin frame
28	Fabricated metal products, sector(s)		Product(p):	
	7	2893	7	Iron processing
31-33	Electrical machinery,communications, sector(s)		Product(p):	
	9	3150	4	Devices for illumination
	9	3330	81239	Watch
45-other	Others, sector(s)		Product(p):	
	12	4520	20	roads construction
	12	5122	2	Whole sales of dairy products
	12	5121	62376	Export of Agricultural Products
	12	5211	17	food distribution
	12	5219	64972	cafes
	12	5510	18455	Hotel
	12	5520	44495	Restaurant
	12	5520	14	Retail sale of cup of coffee

Notes: Sector code 45-others includes Construction, Sales, maintenance and repair, Whole trade and commission trade, Retail and household goods, Hotel and restaurant, Land, water and air transport, Auxiliary transport, Telecommunication, insurance and others. The products classification follows ISIC Rev. 3.1. Data version follows WBES November 6th, 2017. Product description follows data initial record. Sectors are 12 in total; the Table only shows some examples, it does not show all sectors.
Source: Author's calculation.

subject; the final step is to compute the means of the treatment-specific predicted outcomes .

4.5 Data

The analysis in this chapter is based on cross-sectional survey data drawn from the World Bank Enterprise Survey (WBES[17]). The WBES dataset has been used in recent FDI studies, e.g., Webster and Piesse (2018). The WBES, which provides a raw, firm-level dataset, collects data from key manufacturing and service sectors cov-

[17]Data version: All Economies 2006-2016 core4 http://www.enterprisesurveys.org/data/survey-datasets.

ering a wide range of firm-level information, including information on competition, innovation, output sales, input supplies, capital, business-government relationships, finances, and labour productivity. The surveys use standardized instruments and a uniform sampling methodology to minimize measurement errors and yield data that are comparable across developing economies. The sample includes firms in rural areas and cities with population levels below 50,000 as well as firms' sizes from 20 employees on up. There are 112 developing countries in the dataset, which are listed in the Appendix (Section 4.8).

The dataset follows a four-digit ISIC Rev. 3.1 classification and provides initial product codes with product descriptions. The product codes describe narrow product categories, and some examples of the product descriptions from the sectors are provided here: 1) Coke, chemicals, and plastics (sectors 23-25) producing the products HDPE pipe (product code 6) and Fundas plastic (product code 15218); 2) Electrical, machinery, communication (sectors 31-33) with products including watches (product code 81239), and so on. Table 4.1 provides examples of the product codes used in our dataset, which are then incorporated into the propensity score matching procedure using the inverse probability weighting approach in an attempt to mitigate potential bias.

We extracted data spanning the period from 2006 until 2016. In our data, 9.248% of the firms are foreign-owned, while 90.752% are domestic. To define the foreign-owned firms, we follow Kokko (2004), Sembenelli and Siotis (2008), Guadalupe et al. (2012), and Weche (2018), who define a foreign-owned firm as a firm that has foreign equity of 50% or more. Guadalupe et al. (2012) further note that a sufficient indicator of foreign control is that at least 50% of a firm's capital is owned by a foreign company. Thus, we define a firm as a foreign-owned if it has foreign ownership of at least 50%; otherwise, it is listed as a domestic firm. The data do not cover any further information related to the types of FDI projects. Instead, our data cover other characteristics of a firm such as whether it is a part of a large establishment and its size. In terms of large establishment, about 18.2% of the firms report being part of a large establishment, and around 3% of large establishments are attributed to foreign-owned firms. About 26% of the firms are large firms (number of employees ≥ 100), 37% are small (number of employees < 20), and the rest are medium (number of employees between 20 and 99). Approximately 73% of the firms are in manufacturing (22,226 firms), and 27% are in the service sector (8,005 firms).

One of the interesting variables is the proxy for "Core Product Competence". The WBES contains a question asking respondents: "What were this establishments' main products as represented by the largest proportion of annual sales?" It then records this variable as percent of total sales. We use this variable to indicate whether the firm is concentrating more on their core product lines. This crucial feature allows us to examine the alteration of a firm's core product competence when the presence of foreign ownership is introduced and causes the local firms' production lines to become skewed towards the most profitable products, reflecting the theoretical prediction found in Bernard et al. (2011), Eckel and Neary (2010), and Mayer et al. (2014). On average, the surveyed firms' main products contribute around 79% to their total sales. If there is a linkage supporting the above theories, we would then expect a positive association between the presence of foreign ownership and firms' core product competences. We plot the distribution of this variable over the domestic firms and foreign firms in Figure 4.2 of Section 4.6.1.

The dataset also contains other informative details regarding firms' activities that allow us to complement this study by mitigating potential endogeneity. In particular, we can see the number of employees that each firm had during the survey year and three years prior to the survey. It also provides records on the total sales

Table 4.2: Summary Statistics based on 112 Developing Countries 2006-2016

Variable	Definition	Mean	SD	Min	Max	Obs
WEBS: Firm-level dataset						
Foreign Ownership Share	The foreign ownership in percent from 0 to 100(%)	9.248	26.943	0	100	30,231
Foreign Dummy	The dummy equals one if the firm has at least 50 percent foreign ownership	0.095	0.293	0	1	30,231
Core Product Competence	The index recorded in share of core product sales over the total sales (in %)	79.324	23.649	0	100	30,231
lnmprod	The natural logarithm of real core product sales	17.053	3.208	0	32.929	30,231
lnSales	The natural logarithm of real sales	17.358	3.185	7.031	33.845	30,231
lnSales3years	The natural logarithm of real sales three years ago	17.015	3.360	-0.377	37.132	30,231
Markups	The natural logarithm of markups for all firms	2.701	0.990	-2.985	10.398	30,231
lnTFP1	The natural logarithm of TFP	4.195	1.200	-2.858	22.711	30,231
lnTFP2	The natural logarithm of TFP measured in value added	4.049	1.239	-4.038	22.708	30,231
lnK	The natural logarithm of capital stock	12.433	5.563	-0.377	28.646	30,231
lnM	The natural logarithm of material uses	12.942	3.286	0	27.170	30,231
lnL	The natural logarithm of labour cost	15.300	3.112	-0.377	27.665	30,231
Industry	Industry denotes 1 for Manufacturing 2 for Service	1.264	0.441	1	2	30,231
Sector	Sector is the ISIC 4-digit sectors classified	6.265	4.339	1	12	30,231
Size	Firm's size; 1 if small firm (<emp20); 2 if medium firm (emp20-99); 3 if large firm (<=emp100)	1.916	0.788	1	3	30,231
Age	Firm's age; the established year (the survey year minus the year established)	27.063	16.354	5	218	30,231
For Matching Procedure						
DExport	The share of direct export over total sales	7.391	21.952	0	100	121,100
FLicenced	The license from foreign-owned firms 1 for yes 0 for no	1.854	0.352	1	2	79,971
mplinelocat	The main product sales location	1.657	0.658	1	3	76,973
emp	The number of employees	119.996	8676.73	0	999,999	106,491
emp3years	The number of employees three years ago.	97.587	815.683	0	170,000	110,650
Sibling	The dummy equals to 1 if part of large establishment	0.178	0.382	0	1	119,314
WBDI: Country-level dataset						
fdini	The FDI net inflows in % of GDP	3.569	4.129	-5.670	37.249	121,855
gdpg	The growth rate of GDP	4.473	4.094	-14.814	20.880	122,042

Notes: mplinelocat refers to the question: From the beginning to the end of fiscal year, what was the main market in which this establishment sold its main product line or main line of services: 1 if Local (products sold mostly in same municipality where establishment is located), 2 if National (products sold mostly across nation where establishment is located), 3 if International (products sold mostly to nations outside country where establishment is located). All real variables are deflated by the consumer price index (2010=100), provided by the World Bank World Development Indicators database.

each firm had three years before the survey took place. In addition, the WBES data includes a variable indicating whether a firm uses a license authorised by multinational firms, and about 13% of the firms held this license. Firms' export shares are also available, with a mean value of 7.291% of the total sales recorded by the firms. Production location is provided, along with the information gleaned from the following survey question: "From the beginning to the end of the fiscal year, what was the main market in which this establishment sold its main product line or main line of services? 1 if Local (products sold mostly in the same municipality where the establishment is located), 2 if National (products sold mostly across the nation where the establishment is located), 3 if International (products sold mostly to nations outside the country where the establishment is located)." The above information is employed for the matching procedure. Additionally, we merged our dataset with the World Bank Development Indicators and used country-level variables for the matching procedure, following the study done by Weche (2018). The variables include FDI net inflows (fdini), the growth rate of GDP (gdpg), the trade openness (Trade), and the share of natural resource rents over GDP (tnrr). See Table 4.2 for the summary statistics.

4.6 Empirical Analysis

The first set of predictions arising from our outlined hypotheses reveals the alteration of core product competence via multinational firms. Our hypotheses suggest that the presence of foreign ownership will alter the core product distribution by skewing production towards the core product lines; the presence of foreign ownership will also induce product market competition and therefore further skew firm's production towards their most profitable products. Thus, we require data on a firm's core product sales, as measured by the share of total sales, to complete our investigation.

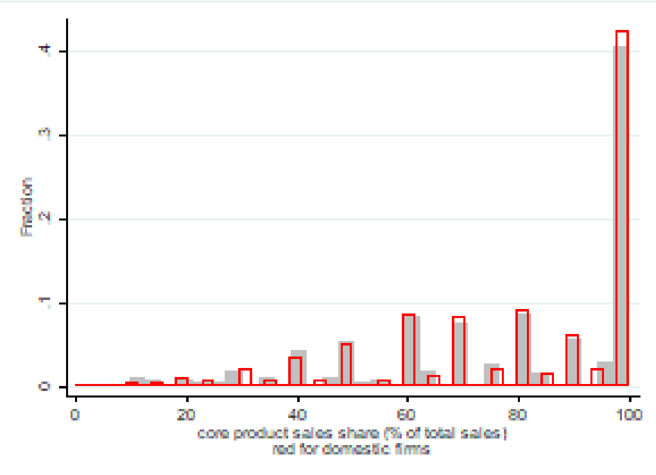

Figure 4.2: Core Product Competence for Foreign and Domestically-Owned Firms
Notes: Core product competence is measured by the core product sales share over the total sales. The figure shows the fraction of core product competence (as the index of core product competence) of foreign-owned firms (the grey bar-chart) and domestic-owned firms (the red bar-chart).

We will also provide some informative, stylized facts regarding our hypotheses before moving onto the econometric analysis.

4.6.1 Some Stylized Facts

4.6.1.1 Skewness of Core Product Competence

Initially, we investigate whether the production of foreign-owned firms is skewed more towards better-performing products than it would have been had these firms been domestically owned.

To first visualise the idea of skewness towards core competence via the presence of foreign ownership, we plot the distribution (with densities and fractions) of core product competence across foreign-owned firms and domestically-owned firms through 2006-2016. The core product competence, measured as a share of firm's total sales, is depicted in Figures 4.2, which shows that the foreign-owned firms do indeed focus more on their core product lines compared to the domestically-owned firms, as, on average, the trend is a bit skewed towards the right-hand side of the

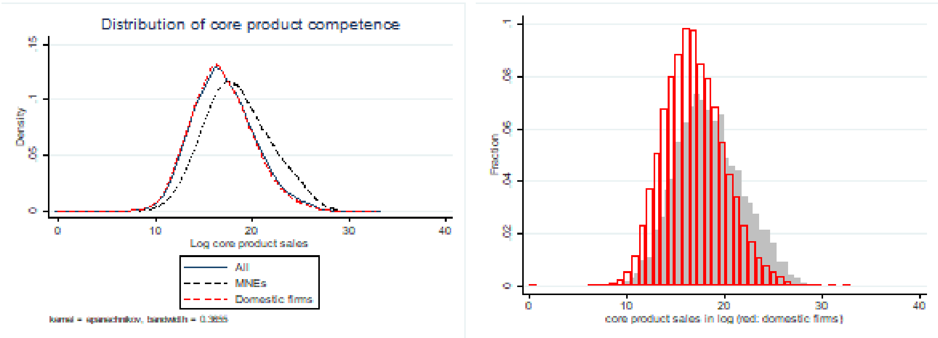

Figure 4.3: Distribution of Core Product Competence for Foreign and Domestically-Owned Firms

Notes: Core product competence is measured by the ppp adjusted real core product sales in natural logarithm. This measure is only used to provide some data feature. The figure on the left red dashed line shows the density function of core product sales in natural logarithm of foreign-owned firms and blue dashed line shows the pdf of domestically owned firms. The figure on the right shows the fraction of core product competence of foreign-owned firms (grey) and domestic-owned firms (red).

distribution for foreign-owned firms (the grey chart). We further plot the density distribution of the core product competences, measured here as the logarithm of real core product sales, of foreign-owned firms and domestically-owned firms in Figure 4.3. This figure shows more clearly that the distribution of real core product sales is skewed towards the core product lines for the foreign-owned firms. Primarily, our data provide stylized facts that are consistent with the literature, for example, Eckel and Neary (2010) and Mayer et al. (2014), although these findings do not rule out unobserved and other time-invariant effects, especially in the case that the net productivity improvement within firms occurs because of the spillovers effects brought by the multinationals.

4.6.1.2 Firm-Level Markups

To see how the presence of foreign ownership influences firms' markups, we need to obtain unbiased estimates of output elasticities, including those for labour, materials, and capital, from our firm-level production function estimations shown in equations (4.7), (4.8), and (4.9), respectively. Further, following De Loecker and Warzynski

Table 4.3: Average Output Elasticities

ISIC 3.1 Rev Sector	ISIC-Sector code #	Observations in Production Function (1)	Labour $\hat{\theta}^l$ (2)	Materials $\hat{\theta}^m$ (3)	Capital $\hat{\theta}^c$ (4)	Returns to Scale (5)
15-16 Food, beverages and tobacco	1	4,750	0.626	0.195	0.132	0.953
			[0.141]	[0.043]	[0.142]	
17-19 Textile and apparel	2	4,798	0.650	0.183	0.112	0.945
			[0.138]	[0.040]	[0.139]	
20-22 Wood, paper and printing	3	1,688	0.618	0.186	0.149	0.953
			[0.135]	[0.041]	[0.128]	
23-25 Coke, chemicals and plastics	4	3,239	0.631	0.190	0.145	0.966
			[0.132]	[0.044]	[0.128]	
26 Nonmatallic mineral products	5	1,330	0.609	0.186	0.147	0.942
			[0.120]	[0.043]	[0.125]	
27 Basic metals	6	535	0.591	0.202	0.176	0.969
			[0.105]	[0.042]	[0.089]	
28 Fabricated metal products	7	2,060	0.613	0.187	0.148	0.948
			[0.130]	[0.044]	[0.119]	
29-30 Machinery and equipment	8	1,130	0.615	0.185	0.149	0.949
			[0.118]	[0.042]	[0.111]	
31-33 Electrical machinery and communications	9	885	0.627	0.188	0.145	0.960
			[0.121]	[0.042]	[0.118]	
34-35 Motor vehicles, trailers	10	431	0.586	0.195	0.183	0.964
			[0.084]	[0.039]	[0.050]	
36-37 Furnitures and recycling	11	1,171	0.639	0.187	0.096	0.922
			[0.154]	[0.043]	[0.152]	
45-others	12	8,214	0.588	0.182	0.181	0.951
			[0.116]	[0.049]	[0.076]	

Notes: Table reports the output elasticities from the production function. Estimation is based on the translog production function used in De Loecker et al. (2016) and Bircan (2017). Product-sector code 45-others includes Construction, Sales, maintenance and repair, Whole trade and commission trade, Retail and household goods, Hotel and restaurant, Land, water and air transport, Auxiliary transport, Telecommunication, insurance and others. Column (1) reposts the number of observations for each production function estimation. Columns (2) to (4) report the average estimated output elasticity with respect to each factor of production for the translog production function for all firms. Standard deviation of the output elasticities is reported in bracket. Column (5) reposts the average returns to scale, which is the sum of the three preceding columns. The products classification follows ISIC Rev. 3.1. Data version follows WBES November 6, 2017.
Source: Author's calculation.

(2012) and De Loecker et al. (2016), we estimate a translog specification with a correction for unobserved input price variation to obtain markups based on Eq. (4.12). We report both the averages and standard deviations of the elasticities in Table 4.3. The variations in the output elasticities are estimated to be reasonably small across all products. A nice feature here is that almost all of the product sectors have their estimates of constant returns to scale close to 1, on average. These results are very similar to the firm-level output elasticities reported by De Loecker et al. (2016), Stiebale and Vencappa (2018), and Bircan (2017) for data involving large Indian manufacturing firms and Turkish manufacturing firms, respectively.

The markups are reported in Table 4.4[18]. The mean markup is 2.701, which is

[18] As stated in Section 4.4.2, we prefer to use the markup estimation based on material elasticities sown in Eq.(4.12)sinceBircan (2019) states that material elasticity is less likely to be adjusted compared with labour's share of expenditures, capital's share of expenditures, and labour and

Table 4.4: Markups, by ISIC Product-Sector

ISIC 3.1 Rev Sector	Markups (Mean)	Markups (Median)
15-16 Food, beverages and tobacco	2.484	2.443
17-19 Textile and apparel	2.718	2.735
20-22 Wood, paper and printing	2.727	2.715
23-25 Coke, chemicals and plastics	2.527	2.531
26 Nonmatallic mineral products	2.658	2.598
27 Basic metals	2.214	2.229
28 Fabricated metal products	2.692	2.690
29-30 Machinery and equipment	2.747	2.710
31-33 Electrical machinery and communications	2.611	2.601
34-35 Motor vehicles, trailers	2.423	2.400
36-37 Furnitures and recycling	2.818	2.815
45-others	2.922	2.972
Total	2.701	2.694

Notes: Table displays the mean and median markups by ISIC product-sector for the sample 2006-2013.
Source: Author's calculation.

very similar to the 2.70 provided by De Loecker et al. (2016), while it is higher than the 1.60 provided by Bircan (2017). We now show how markups are distributed across firms. We begin by pooling data and plotting the distribution of markups for foreign-owned firms versus domestically-owned firms in Figure 4.4. The figure shows that there is little difference in the distribution of markups between foreign and domestic firms, but foreign-owned firms do have a slightly lower mark-up. This finding is consistent with theories in the trade literature (Eckel & Neary, 2010; Bernard et al., 2011; Mayer et al., 2014), suggesting that the presence of foreign ownership does indeed increase the competition in the domestic production market. More competition reduces the prices that firms can charge in the market and so results in reduced product markups for all product lines. However, as a first pass, these results do not control for any sector-specific, firm-specific, time-specific, country-specific, or other factors that could potentially influence markups. Therefore, we control for the above factors and progress to the regression analysis in the next sub-section.

capital's elasticities. Stiebale and Vencappa (2018) is another study that used the material elasticity of output to obtain the markups.

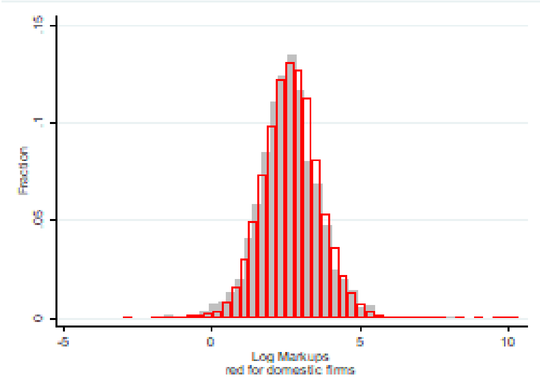

Figure 4.4: The Markups Distribution across Firms

Notes: The gray bar chart represents foreign-owned firms.

4.6.2 OLS Results

In this section, we evaluate the hypotheses outlined in Section 4.3.1. We assess empirically the effect of the presence of foreign ownership on productivity in two steps. First, as we will show in the next sub-section, we regress the change in firms' core product competences on foreign ownership, which is measured in the share of ownership and in the foreign dummy variable (equals 1 if a firm has foreign ownership of at least 50% and zero otherwise). Then we estimate the effect of skewness of the core product competences induced by the presence of foreign ownership on firms' productivity by using the two-stage estimator, where the core product competences are instrumented by the presence of foreign ownership. Doing so allows us to identify one of the mechanisms behind the increased productivity by the multinational firms. We provide results in Sub-section 4.6.2.1. Second, we regress the change in a firm's markups against the change in the firm's foreign ownership and the foreign dummy variable, respectively. Doing so allows us to see if the presence of foreign ownership increases product market competition by reducing markups across all products. To estimate the effect of product market competition on a firm's core product competence induced by the presence of foreign ownership, we again employ the two-stage estimation approach in order to extract the effect generated by the foreign ownership on markups and then regress the firm's core product competence on the extracted variable markups. The results are provided in Sub-section 4.6.2.2.

4.6.2.1 Alteration of Core Product Competence and Productivity

Motivated by the multi-product theories (Eckel & Neary, 2010; Mayer et al., 2014) and the stylized facts found in our data, our empirical strategy begins by examining the relationship between foreign ownership and core product competence. In doing so, it is important to ensure that a firm's core product competence is not driven by the firm's productivity but instead by the presence of foreign ownership. Guadalupe et al. (2012) suggest that firms with a high level of productivity are more likely to be acquired by multinational firms and hence are more likely to concentrate on their core product lines. Thus, we control for a firm's TFP[19], total sales, age, and size in the following specifications.

The first set of results regresses firms' core product competences on firms' foreign ownership and the dummy variable of foreign-owned firms, as shown in Eq. (4.1). Taking into account the potential variation in a firm's productivity, the estimated coefficients reported in columns (1) and (2) of Table 4.5 show that both foreign ownership (Panel A) and the foreign dummy (Panel B) are statistically significant and positively associated with core product competence. The specifications control for firm's characteristics, country, and sector fixed effects, but the year, sector-year, and country-year fixed effects are not included. We find that the presence of foreign ownership indeed alters the distribution of firms' core product competence, perhaps through the mechanism of decision in core product production. The estimated coefficients are 0.011 for panel A and 1.212 for panel B, suggesting that, holding

[19] Note that the TFP is either measured by using the lnTFP1 or lnTFP2. The latter is defined as the difference between the total sales and the material input variable, following studies Commander and Svejnar (2011) and Newman et al. (2015). Please see Section 4.4.2 for information on estimating the TFP.

Table 4.5: Foreign Ownership and Core Product Competence

	Core product competence: share of core product sales over total sales							
Dependent variable:	(1a)	(2a)	(3a)	(4a)	(5a)	(6a)	(7a)	(8a)
Panel A								
Foreign Ownership Share	0.011***	0.011***	0.010**	0.010***	0.009*	0.009*	0.011**	0.011**
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
lnTFP1	0.250		0.070		0.062		-0.119	
	(0.150)		(0.151)		(0.150)		(0.157)	
lnTFP2		0.292**		0.107		0.087		-0.094
		(0.143)		(0.145)		(0.144)		(0.150)
R-squared	0.1452	0.1452	0.1497	0.1498	0.1586	0.1586	0.1733	0.1733
	(1b)	(2b)	(3b)	(4b)	(5b)	(6b)	(7b)	(8b)
Panel B								
Foreign Dummy	1.212***	1.219***	1.061**	1.067**	0.996**	0.999**	1.250***	1.254***
	(0.447)	(0.447)	(0.478)	(0.478)	(0.478)	(0.478)	(0.476)	(0.475)
lnTFP1	0.252*		0.073		0.064		-0.115	
	(0.150)		(0.151)		(0.150)		(0.157)	
lnTFP2		0.294**		0.109		0.089		-0.090
		(0.143)		(0.145)		(0.144)		(0.150)
R-squared	0.1452	0.1453	0.1498	0.1498	0.1586	0.1586	0.1734	0.1734
Firm's age	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm's size	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sales controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Sector-Year FE	No	No	No	No	Yes	Yes	Yes	Yes
Country-Year FE	No	No	No	No	No	No	Yes	Yes
observations	30,231	30,231	30,231	30,231	30,231	30,231	30,231	30,231

Notes: The dependent variable is the share of core product sales over total sales. Foreign dummy equals 1 if the firm has at least 50% foreign ownership and zero otherwise, following the study of Guadalupe et al. (2012). Firm's age and size are always controlled for in all columns. Sales control for total sales. TFP denotes the lnTFP1 and lnTFP2, wherein columns (1), (3), (5) and (7) we control for lnTFP1, whereas lnTFP2 is controlled for in columns (2), (4), (6) and (8). The results are robust to control for the lagged three-year total sales in natural logarithm. Robust standard errors clustered by firms are provided in the parentheses. *, **, *** denote significance at 10%, 5% and 1% levels, respectively.

other variables constant, if foreign ownership changes by one then we would expect core product competence to change by 0.011, or, regarding panel B, foreign-owned firms are about 1.212% higher in core product competence compared to domestic-owned firms. Although currently we cannot see how many product lines a firm has due to the fact that each firm only reported the description of their core product, it is likely that for the firms who participate in the production on "Female wears (product code 14857)", "Bread production (product code 15)", "food distribution (product code 17)", and "Whole sales of dairy products (product code 2)", etc. might tend to have more products then the firms who participate in the more specific production on “tin frame (product code 58132)”, “Copper smelt production (product code 16)”, “HDPE pipe (product code 6)”, and “Fundas plastics (product code 15218)”, etc. Therefore, the 1.212% points resulted from panel B would refer to a large effect on a firm’s core product competence if the firm only has few product lines with few product varieties such as in HDPE pipe, Fundas plastics or tin frame production. By contrast, it would refer to a small effect if the firm has many product lines with many product varieties in terms of foods and dairy products.

In columns (3) to (8), we control for year fixed effects, sector-year fixed effects and the country-year fixed effects step-by-step. The results show that the estimated coefficients are very robust across specifications, with statistical significance throughout the columns. We also find that the effect of the presence of multinational firms (via shared ownership or mere presence) is not influenced by firm’s productivity - regardless of which TFP measure is used, we always find that multinational firms induce firms to skew production towards the core product lines. For example, the estimated coefficients in panel A imply that if foreign ownership share changes by one then we would expect core product competence to increase by 0.009 to 0.012, while the estimates in panel B imply that foreign-owned firms are 0.996 to 1.254 percent more into their core competences compared to domestically-owned firms. It is important to note that a firm’s TFP in the current specifications is confirmed to be an unimportant determinant of a firm’s core product competence. This finding is supported by the theory of multi-product firms, i.e., that a firm’s productivity is influenced by a firm’s core product competence (Eckel & Neary, 2010; Mayer et al., 2014). Overall the skewness effect created by the presence of foreign ownership persists, and the estimates are robust.

While the results in a number of studies point to the skewness of core product concentration being influenced by openness to trade, for instance, as documented

Table 4.6: Foreign Ownership and Core Product Competence

Dependent variable:	Core product competence: share of core product sales over total sales (1)	(2)	(3)	(4)
Foreign Ownership Share	0.010**	0.012**		
	(0.005)	(0.005)		
Foreign Dummy			1.109***	1.370***
			(0.475)	(0.472)
Size	-1.145***	-1.083***	-1.154***	-1.095***
	(0.179)	(0.180)	(0.178)	(0.179)
Sector FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Sector-Year FE	No	Yes	No	Yes
Country-Year FE	No	Yes	No	Yes
R-squared	0.1472	0.1711	0.1473	0.1711
First-stage F-test	20.61	18.80	21.47	20.13
Prob>F	0.00	0.00	0.00	0.00
observations	30,231	30,231	30,231	30,231

Notes: The dependent variable is the share of core product sales over total sales. Robust standard errors clustered by firms are provided in the parentheses. *, **, *** denote significance at 10%, 5% and 1% levels, respectively.

by Bernard et al. (2011) and Eckel and Neary (2010), trade liberalization leads a substantial reduction in the number of varieties managed by firms, on average. To the best of our knowledge, this is the first study demonstrate empirically the effect of foreign ownership on firms' core competence in the FDI literature. Our finding suggests that the skewness of core product competence reflects an underlying complementarity with the presence of foreign ownership, controlling for all firms' observable characteristics. As we will show in the rest of the analyses, this finding has economically significant implications for the theory of FDI and firms' productivity. For now, based on the estimates we have obtained, we want to see how the effect of the skewness of core product competence induced by the foreign multinationals would be passed on to firms' productivity.

In doing so, we adopt the two-stage least squares (henceforth, 2SLS) estimation (see equations 4.1 and 4.2), where a firm's core product competence is instrumented by either the foreign ownership share (columns 1 and 2 in Table 4.6) or the foreign dummy (columns 3 and 4 in Table 4.6), respectively. In the 2SLS estimation,

Table 4.7: Core Product Competence and Change in Firms' Productivity

	Change in firm TFP									
	All		25th quartile		50th quartile		75th quartile		99th quartile	
Dependent variable:	(1a)	(2a)	(3a)	(4a)	(5a)	(6a)	(7a)	(8a)	(9a)	(10a)
Panel A										
CoreProdCom(predicted)	0.020***	0.018***	0.009***	0.008***	0.012***	0.012***	0.018***	0.018***	0.053***	0.052***
	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)	(0.003)
Age	-0.005***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.005***	-0.004***	-0.008***	-0.007***
	(0.0004)	(0.0003)	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0003)	(0.0003)	(0.0009)	(0.0009)
lnSales	0.345***	0.476**	0.275**	0.334***	0.308***	0.404***	0.361***	0.521***	0.578***	0.690***
	(0.004)	(0.014)	(0.002)	(0.004)	(0.002)	(0.004)	(0.002)	(0.006)	(0.010)	(0.011)
Lagged lnSales		-0.140***		-0.060***		-0.099***		-0.168***		-0.136***
		(0.014)		(0.004)		(0.004)		(0.006)		(0.009)
R-squared	0.4161	0.4328	0.2765	0.2932	0.2777	0.2779	0.2846	0.2937	0.4799	0.4892
	(1b)	(2b)	(3b)	(4b)	(5b)	(6b)	(7b)	(8b)	(9b)	(10b)
Panel B										
CoreProdCom(predicted)	0.020***	0.018***	0.008***	0.008***	0.012***	0.012***	0.018***	0.017***	0.053***	0.051***
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)	(0.004)
Age	-0.005***	-0.004***	-0.004***	-0.003***	-0.004***	-0.004***	-0.005***	-0.004***	-0.007***	-0.007***
	(0.0004)	(0.0003)	(0.0001)	(0.0002)	(0.0003)	(0.0002)	(0.0003)	(0.0003)	(0.0008)	(0.0009)
lnSales	0.345***	0.476***	0.275***	0.334***	0.308***	0.404***	0.361***	0.520***	0.577***	0.690***
	(0.004)	(0.014)	(0.002)	(0.004)	(0.002)	(0.005)	(0.0003)	(0.006)	(0.010)	(0.013)
Lagged lnSales		-0.140***		-0.060***		-0.099***		-0.168***		-0.137***
		(0.014)		(0.004)		(0.004)		(0.005)		(0.010)
R-squared	0.4161	0.4340	0.2674	0.2792	0.2777	0.2821	0.2845	0.2937	0.4799	0.4892
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	30,231	30,231	30,231	30,231	30,231	30,231	30,231	30,231	30,231	30,231

Notes: In Panel A core product competence is instrumented by the foreign ownership share and firm's size, while it is instrumented by the foreign dummy and firm's size in Panel B. Robust standard errors clustered by firms are provided in the parentheses. *, **, *** denote significance at 10%, 5% and 1% levels, respectively.

we control for the sector, country, year, sector-year and country-year effects in all regressions, but we do not control a firm's TFP in the first-stage regression since TFP is neither expected theoretically to be a determinant of a firm's core product sales nor empirically supported by our data. Furthermore, a firm's age and sales are not controlled for in the first-stage regression, as they do not affect the firm's concentration on the core product lines. We provide a weak identification test to detect the weak instrumental variable issue. The results provided in Table 4.6 reject the null hypothesis of weak identification. The relevant condition is also satisfied, as the instruments are statistically significant at 1% significance level throughout. We then obtain the predicted values of firms' core product competences, which will be used in the following analysis.

We now move on to the estimation of the effect of core product competences on firms' performances, taking into account the effect of the presence of foreign ownership on core product competences. Table 4.7, panel A provides the results based on core product competence instrumented by foreign ownership, while panel B provides the results based on core product competence instrumented by the foreign dummy. We control for a firm's age, sales, and the sales lagged three years throughout the specifications. Columns (1) and (2) in panel A suggest that, on average, core product competence is positively associated with a firm's productivity. The greater the skew in production towards the most profitable product lines, the higher the firm's productivity. A 1% increase in core product competence would lead a 2% (or 1.8%) increase in productivity. Turning to panel B in Table 4.7, column (1), the estimated coefficient remains highly statistically significant and identical.

We also distinguish our regressions by the quantiles from the 25th to the 99th. The results reveal that firms in the upper middle of the productivity distribution experience substantially more productivity gains from the skewness of core production compared to the firms in the lower middle of productivity distribution. For example, in column (4a), a 1% increase in the core product competence is associated with a 0.8% increase in the lowest productivity group, while, in column (8a), a 1% increase in core product competence would increase the TFP of the 75th quartile group by 1.8%.

The results obtained so far are consistent with the existing literature (Eckel & Neary, 2010; Mayer et al., 2014; Alfaro & Chen, 2018). For example, focusing on the supply side in the model for multi-product firms, Eckel and Neary (2010) suggest that the productivity of a multi-product firm will be reduced by increasing product range. Similarly, Mayer et al. (2014) assume firms face a product ladder, where productivity declines discretely for each additional variety produced. Alfaro and Chen (2018), in one of the most recent studies, suggest that the effect of the entry of multinationals on the survival rate of domestic firms is particularly strong at the left tail of the productivity distribution, indicating that the less productive firms

Table 4.8: The Multinationals Selection Decision: Pooled Linear Probability Model

	Foreign-owned firms dummy					
	(1)	(2)	(3)	(4)	(5)	(6)
The probability of being assigned as foreign-owned during the sample period						
Productivity measured: lnSales	0.032***					
	(0.0009)					
2nd quartile lnSales		-0.023***				
		(0.006)				
3rd quartile lnSales		0.032***				
		(0.004)				
4th quartile lnSales		0.054***				
		(0.004)				
Productivity measured: lnTFP1			0.021***			
			(0.001)			
2nd quartile lnTFP1				0.001		
				(0.007)		
3rd quartile lnTFP1				0.022***		
				(0.004)		
4th quartile lnTFP1				0.010***		
				(0.004)		
Productivity measured: lnTFP2					0.019***	
					(0.001)	
2nd quartile lnTFP2						-0.002
						(0.007)
3rd quartile lnTFP2						0.021***
						(0.004)
4th quartile lnTFP2						0.011***
						(0.004)
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country-Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.1439	0.1258	0.1040	0.1063	0.1035	0.1058
Observations	30,231	30,231	30,231	30,231	30,231	30,231

Notes: Dependent variable is the foreign-owned dummy, where the dummy equals to 1 if foreign-owned and 0 otherwise. Robust standard errors are clustered by firms and provided in the parentheses. *, **, *** denote significance at 10%, 5% and 1% levels, respectively.

are less likely to access the pass-through gains from the multinational firms.

While these findings offer strong support for the mechanism whereby the productivity gains are passed through the presence of foreign ownership, one concern remains, i.e., whether the results are driven by selection bias. As demonstrated by Guadalupe et al. (2012), multinational firms prefer to acquire more productive domestic firms via "cherry-picking"[20]. Since we employ a dummy in some regres-

[20]Note that, in the study by Guadalupe et al. (2012), they show that multinational firms tend to invest in more productive domestic firms and refer to this strategy as "cherry-picking". Therefore, we follow the investigation strategy used by Guadalupe et al. (2012) to examine whether there are

sions to control for the changes in foreign-owned and domestically-owned firms, the estimates provided in Panel B of Table 4.7 may be driven partially by multinational firms' selections. In order to investigate this issue, we examine in more detail the differences between foreign-owned firms and domestically-owned firms. As we focus on the effect of multinational firms on firm core product competence, it is therefore important to ensure that the assignment between foreign and domestic groups is not entirely driven by multinationals' selections.

To perform the test, we follow Guadalupe et al. (2012) to estimate a linear probability model. We first place the ownership dummy variable (1 if foreign-owned and 0 otherwise) as the dependent variable regressed on the measures of firm-level productivity, including firm's sales, lnTFP1, and lnTFP2. All regressions include sector, year, and country fixed effects to control for the time-invariant effects. Table 4.8 provides the results. In column (1), we find that more productive firms are indeed more likely to become foreign-owned, with a coefficient of 0.032 statistically significant at 1% significance level. This estimate suggests that, ceteris paribus, a 1% increase in productivity ($lnSales$) would increase the probability of being foreign-owned by 0.032. In column (2), we replace the productivity $lnSales$ by indicator variables for the 2nd, 3rd, and 4th quartiles. The results indicate that being in the second sales quartile does not increase the probability of becoming foreign-owned, while being in the third and fourth sales quartiles increase the probability by about 3.2 and 5.4 percentage points relative to firms in the first quartile, respectively.

In columns (3) and (4,) we replace the productivity variable by $lnTFP1$. The results do not change by much. For example, in column (3), the coefficient 0.021 implies that, conditional on being domestic the year the firm in the sample, a one standard deviation increase in productivity makes a firm 2.5 percentage points more likely to be assigned as being foreign-owned in the sample, while being in the third

any positive selection patterns across industries.

Table 4.9: Core Product Competence and Change in Firms' Productivity (IPW Estimation)

	Change in firm TFP									
	All		25th quartile		50th quartile		75th quartile		99th quartile	
Dependent variable:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
CoreProdCom(predicted)	0.011***	0.009**	0.003***	0.003***	0.005***	0.005***	0.009***	0.009***	0.034***	0.035***
	(0.004)	(0.004)	(0.0008)	(0.0008)	(0.0009)	(0.0009)	(0.001)	(0.001)	(0.004)	(0.004)
Age	-0.005***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.005***	-0.004***	-0.008***	-0.007***
	(0.0009)	(0.0008)	(0.0003)	(0.0002)	(0.0002)	(0.0002)	(0.0004)	(0.0003)	(0.0009)	(0.0007)
lnSales	0.353***	0.463***	0.261***	0.317***	0.288***	0.371***	0.336***	0.485***	0.556***	0.678***
	(0.013)	(0.029)	(0.002)	(0.005)	(0.002)	(0.004)	(0.003)	(0.007)	(0.010)	(0.011)
Lagged lnSales		-0.117***		-0.056***		-0.085***		-0.153***		-0.147***
		(0.032)		(0.004)		(0.004)		(0.007)		(0.008)
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pscore weighting	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.4009	0.4106	0.2897	0.2923	0.2868	0.2905	0.2898	0.2973	0.4550	0.4657
observations	23,565	23,565	23,565	23,565	23,565	23,565	23,565	23,565	23,565	23,565

Notes: Robust standard errors clustered by firms are provided in the parentheses. *, **, *** denote significance at 10%, 5% and 1% levels, respectively.

and fourth TFP quartiles increase the probability of being foreign-owned by 2.2 and 1 percentage points, respectively, relative to firms in the first quartile. This pattern can be found in the remainder of the analysis using productivity measured by $lnTFP2$. Therefore, the results confirm that firms at the upper end of the productivity distribution are more likely to be selected as the multinational subsidiaries. The finding is consistent with Guadalupe et al. (2012), who find that firms in the upper quartile have a much higher probability of acquisition in Spain.

As shown in Table 4.8, we find evidence of a potential selection effect; thus, one way to alleviate this issue is to use the propensity score matching with inverse probability weighting. We follow empirical studies such as Guadalupe et al. (2012), Mallick and Yang (2013), Weche (2018), Stiebale and Vencappa (2018), and Bircan (2019), to process the matching procedure. We pool foreign-owned and domestically-owned firms and control observations across all years to estimate the probability that a firm is designated a foreign-owned firm as a function of a number of characteristics. Table 4.15 in the Appendix reports on the results of the balancing test for the 23,565 firms for which appropriate matches are found. The t-test indicates that foreign firms and domestic firms are balanced for all the results reported in the following analysis. The results provided in Table 4.9 remain as consistent with the previous findings.

However, in the current specification, product market competition (markups) is assumed to be constant, which makes us unable to determine if the presence of foreign ownership comes with an increase in market access (market expansion) and so indirectly increases product market competition and motivates host country's firms to become skewed towards the most profitable product lines. Therefore, in the following analysis, we examine the impact of the presence of foreign ownership on firm-level markups. Specifically, we want to see if foreign ownership increases product market competition and passes its effect onto firms' core product competences.

4.6.2.2 Product Market Competition and Core Product Competence

Our hypothesis suggests that the presence of foreign ownership would enhance product-market competition by increasing costs and decreasing the average prices of varieties supplied by competing firms and dropping markups across all products. Therefore, we examine this mechanism by regressing firm's markups against the foreign ownership share and the foreign dummy variable. Here we include a firm's total sales measured in the natural logarithm, while we control for all sector, country, year, sector-year, and country-year fixed effects throughout the specifications.

The results are provided in Table 4.10. As before, panel A reports the estimates with foreign ownership shares, while panel B reports the estimates with a foreign dummy variable. In column (1) of panel A, the effect of the presence of foreign ownership is statistically significant at the 1% significance level, with an estimated coefficient of -0.0006. This result implies that a 1% increase in foreign ownership would decrease markups by about 0.06%, other things being equal. This negative effect on markups remains when the independent variable is the foreign dummy used to estimate the effect of the presence of multinationals on product market competition, with an estimated coefficient -0.0005 at the 1% significance level. In

Table 4.10: Foreign Ownership and Change in Markups and Core Product Competence

	Markups (in natural logarithm)					Core product competence share
Dependent variable:	(1a)	(2a)	(3a)	(4a)	(5a)	(6a)
Panel A						
lnSales	-0.015***	-0.012***	0.002			-0.063
	(0.003)	(0.003)	(0.004)			(0.092)
Age		-0.001***	-0.001***			-0.075***
		(0.0003)	(0.0003)			(0.009))
Size			-0.057***	-0.059***		-0.574***
			(0.011)	(0.007)		(0.244)
Foreign Ownership Share	-0.0006***	-0.0006***	-0.0005***	-0.0005***	-0.0008***	
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	
Markups (predicted)						-13.461***
						(6.192)
F-test	18.84	17.80	21.57	37.87	15.36	
Prob>F	0.000	0.000	0.000	0.000	0.000	
Pscore weighting	No	No	No	No	No	No
R-squared	0.1673	0.1677	0.1686	0.1683	0.1665	0.1733
	(1b)	(2b)	(3b)	(4b)	(5b)	(6b)
Panel B						
lnSales	-0.014***	-0.012***	-0.002			-0.067
	(0.003)	(0.003)	(0.004)			(0.092)
Age		-0.001***	-0.001***			-0.075***
		(0.0003)	(0.0003)			(0.009)
Size			-0.057***	-0.059***		-0.578***
			(0.011)	(0.007)		(0.244)
Foreign Dummy	-0.052***	-0.056***	-0.051***	-0.047***	-0.076***	
	(0.020)	(0.020)	(0.020)	(0.020)	(0.019)	
Markups (predicted)						-16.642**
						(6.224)
F-test	18.89	17.84	21.61	37.96	14.83	
Prob>F	0.000	0.000	0.000	0.000	0.000	
Pscore weighting	No	No	No	No	No	No
R-squared	0.1673	0.1677	0.1686	0.1683	0.1665	0.1734
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Ye	Yes	Yes
Sector-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
observations	30,231	30,231	30,231	30,231	30,231	30,231

Notes: The dependent variable in columns (1) to (5) is the markups, while core product competence share is the dependent variable in column (6). Robust standard errors clustered by firms are provided in the parentheses. *, **, *** denote significance at 10%, 5% and 1% levels, respectively.

the rest of the regressions, we control for a firm's age and size, respectively, and both panels A and B show the robustness of the results. The product market competition effect, as anticipated in Hypothesis 3, exists and is perhaps introduced by the presence of foreign ownership accompanied with potential market access and/or product innovation in the host country. This effect lowers markups across all product lines, as the results in panel A suggest that a 1% increase in foreign ownership leads to a 0.05% to 0.08% decrease in markups, while Panel B shows that foreign-owned firms exert a negative effect on the markups by making the markups 0.047% to 0.076% lower than the domestic firms would. In both cases, we find its effect to be statistically significant[21].

This finding is again consistent with the existing literature. De Loecker et al. (2016), for example, find that trade liberalization lowers factory-gate prices. Bernard et al. (2011) suggest that opening a country to international trade increases the number of firms in the market, which enhances product-market competition. Thus, the increase in the product market competition reduces the average price of varieties and markups fall. However, as we outlined previously, such an effect on reducing markups by the presence of foreign ownership may be passed onto firms' production reallocations. When the market becomes more competitive, marginal costs may increase and markups fall. In addition, the falling mark-up means that, in relative terms, greater competition leads those varieties to be produced at higher marginal cost, which implies the marginal varieties become unprofitable and so firms drop those products and become skewed towards their core varieties (Eckel & Neary, 2010; Bernard et al., 2011). In principle, we would expect to find the above prediction from our empirical specification, which describes explicitly how multinational firms alter firms' core product competences through firms' markups. To see this, we again use a two-stage estimator, where we instrument a firm's markups by the foreign ownership share and foreign dummy variable, respectively. The results of the first stage and the weak identification test are provided in columns (4a),(5a), (4b), and (5b) in Table 4.10. The results reject the null hypothesis that all instruments are weakly identified (Staiger & Stock, 1997; Alfaro & Chen, 2018). Based on the estimates,

[21] An alternative explanation for the compressed markups could be the distant investment. If multinationals decide to locate distantly from incumbent firms, such agglomeration benefits might not be available and the competitiveness might reduce markups across firms (Myles Shaver & Flyer, 2000). It might also be the case that investment mode causes the variation in markups. Chang et al. (2013) suggests that investment mode alters firms' output capacity, which might further influence costs and price and result as a shrink in markups.

Table 4.11: Foreign Ownership and Change in Markups and Core Product Competence (IPW Estimation)

	Markups (in natural logarithm)					Core product competence share
Dependent variable:	(1)	(2)	(3)	(4)	(5)	(6)
psm with inverse weighting						
lnSales	-0.018***	-0.016***	0.002			-0.121
	(0.006)	(0.006)	(0.008)			(0.108)
Age		-0.0006	-0.0005			-0.076***
		(0.0006)	(0.0006)			(0.010)
Size			-0.082***	-0.085***		-0.514*
			(0.024)	(0.017)		(0.284)
Foreign Dummy	-0.075***	-0.077***	-0.081***	-0.080***	-0.083***	
	(0.025)	(0.025)	(0.025)	(0.023)	(0.023)	
Markups (predicted)						-11.515*
						(6.186)
F-test	10.17	7.72	9.76	18.58	11.18	
Prob>F	0.001	0.0007	0.00	0.00	0.00	
Pscore weighting	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.1842	0.1844	0.1859	0.1858	0.1832	0.1673
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Ye	Yes	Yes
Sector-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
observations	23,565	23,565	23,565	23,565	23,565	23,565

Notes: The dependent variable in columns (1) to (5) is the markups, while core product competence share is the dependent variable in column (6). Robust standard errors clustered by firms are provided in the parentheses. *, **, *** denote significance at 10%, 5% and 1% levels, respectively.

we then obtain the predicted value of markups and regress a firm's core product competence on the predicted markups to examine the Hypothesis 4 - product market competition induced by the presence of foreign ownership leads firms to skew their production towards the core product lines.

Considering the impact of multinational firms on product market competition, we find that the effect of product market competition is indeed passed on to firms' core product competences. As shown in Table 4.10 in columns (6a) and (6b), the estimated coefficients are statistically significant at 1% significance level, with coefficients of -13.461 and -16.642 in Panels A and B, respectively. Therefore, the results suggest that, holding other things fixed, a 1% decrease in markups would increase a firm's core product competence by 0.13461 to 0.16642 units. To test the robustness of this finding further, we process the propensity score matching with inverse probability weighting approach. The results are provided in Table 4.11. Again, the results remain similar to those of the full sample, shown in Table 4.10.

Our results are remarkably consistent with the existing theories on multi-product firms. Recalling the papers of Eckel and Neary (2010) and Mayer et al. (2014), the models predict that competition alters the distribution of multi-product firms' core product production, as the "core variety" has the lowest marginal cost, and the marginal costs rise with products' distance from the core competence. This result is also in line with De Loecker et al. (2016), who show that marginal costs rise and markups fall as a firm moves away from its core competence. Although such findings are supported theoretically by the literature, we offer one further step to support the mechanisms through which multinational firms alter the firms' core product lines in the host country by assessing the effect of increased product market competition induced by the presence of foreign ownership, i.e., $\widehat{Markups}$, on core product competence.

4.7 Conclusion

In this chapter, we use rich and detailed cross-sectional firm-level data from 112 developing economies over the period 2006-2016 to identify the mechanisms through which the presence of foreign ownership generates productivity improvements through the alteration of firms' core product competence and tougher market competition. Our focus is on the question of how and through which mechanisms does the presence of foreign ownership influence the distribution of host country' firms in terms of productivity and core competence. We incorporate characteristics of multinational firms and utilize our empirical framework, which is based on the theories of multi-product firms from Eckel and Neary (2010) and Mayer et al. (2014) and predicts that firms skew production towards their core varieties, which then increases their productivity when facing pressure from increasing product market competition.

Controlling for a firm's productivity, characteristics, and the sector, country, and year fixed effects, we find that the presence of foreign ownership is a significant source of motivation for firms in the host country to skew their production towards the better-performing products. Our results suggest that the skewness towards main product competence is attributed to the product market competition induced by the presence of foreign ownership. The mechanism behind this finding is that the increase in product market competition is accompanied by the presence of foreign ownership by raising the marginal costs and lowering markups for all products produced. Therefore, firms respond to this effect by altering their product varieties, dropping the low-attribute products and focusing more on the high-attribute product lines, which leads to an increase in overall core product competence. By taking into account the increased product market competition brought on by the presence of foreign ownership, in our empirical results, we observe a statistically negative and significant association between a firm's markups and their core product competence.

The contribution of this chapter is to illustrate empirically the mechanism behind productivity gains and quantify it as works its way from multinational firms to the host-country firms. Since the results show a significantly important effect of the skewness of core product lines on firms' productivity, it implies that such productivity gains are generated within the process in which local firms in the host country respond to the impact of an increase in product market competition from the multinational firms by adjusting in product diversity. Thus, this finding underlines the importance of the product range adjustment and competition in explaining and assessing the productivity gains from multinational firms in developing countries.

Empirically, we showed how foreign ownership alters a firm's core product competence and performance and how such an increase in product market competition contributes to a firm's core product competence. However, how an increase in product market competition induced by the presence of foreign ownership alters firms' performance, and how the presence of foreign ownership alters product market competition through altering firms' decision in market expansion (e.g., to participate in the export market) and product innovation have not been empirically examined in this chapter. Further to this, our analysis can be complemented by building up a theoretical framework that incorporates foreign ownership in the model and extends the model of multi-product firms in Eckel and Neary (2010), Mayer et al. (2014) and Eckel, Iacovone, Javorcik, and Neary (2015), where the quality of core products may be endogenously determined by a firm's profit decisions. Thus, the presence of foreign ownership may motivate local firms to invest more in the quality of their core products and, as highlighted in Eckel et al. (2015), the effect of skewness towards core product competence induced by the multinational firms may therefore have two different effects - the "cost-based" and "quality-based" - on firms' productivity. In addition, it would be useful to investigate the mechanism between multinational firms, product market competition, and core product competence when longer-time and cross-country panel data are available so that such biases can be alleviated. All the points mentioned above will be implemented in our future work in order to provide additional insights into productivity gains from multinational firms.

4.8 Appendix

Table 4.12: Country List

	Domestically-owned	Foreign-owned	Country-code
Albania	585	79	2
Angola	612	173	3
Armenia	662	72	6
Bangladesh	2,878	68	9
Benin	245	55	13
Bhutan	474	29	14
Bolivia	1,174	165	15
Bosni and Herzegovina	662	59	16
Botswana	327	283	17
Brazil	1,144	658	18
Bulgaria	1,419	177	19
Burkina Faso	337	57	20
Burundi	350	77	21
Cambodia	652	193	22
Cameroon	635	89	23
Cape Verde	132	24	24
Chad	106	44	26
Chile	1,844	206	27
China	2,532	168	28
Colombia	1,830	112	29
Costarica	450	88	31
Croatia	899	94	32
Czech Rep	415	89	33
Cote dIovire	700	187	34
Djibouti	224	42	36
Ecuador	1,173	212	39
Egypt	4,325	386	40
El Salvador	1,521	251	41
Estonia	455	91	43
Ethiopia	1,276	216	44
Fiji	133	31	45
Fyr Macedonia	647	79	46
Gambia	124	50	48
Georgia	683	50	49

Notes: This table provides information on the number of domestic-owned and foreign-owned firms across countries.

Table 4.13: Country List

	Domestically-owned	Foreign-owned	Country-code
Ghana	1,073	141	50
Guatemala	976	136	52
Guinea	331	42	53
Guinea Bissau	144	15	54
Honduras	986	142	56
Hungary	508	93	57
India	9,200	81	58
Indonesia	2,531	233	59
Irag	748	8	60
Israel	450	33	61
Jamaica	301	75	62
Jordan	508	65	63
Kazakhstan	1,088	56	64
Kenya	1,259	179	65
Kosovo	470	2	66
Kyrgyz Rep	424	81	67
Lao PDR	858	140	68
Latvia	505	102	69
Lebanon	512	49	70
Lesotho	206	95	71
Lithuania	478	68	73
Madagascar	634	343	74
Malawi	458	215	75
Malaysia	832	168	76
Mali	894	141	77
Mauritania	335	52	78
Mauritius	346	52	79
Mexico	2,704	256	80
Moldova	649	74	82
Mongolia	677	45	83
Montenegro	253	13	84
Morocco	343	64	85
Mozambique	385	94	86
Myanmar	1,188	51	87
Namibia	753	156	88
Nepal	825	25	89
Nicaragua	1,001	146	90
Niger	241	60	91
Nigeria	4,093	474	92
Pakistan	2,080	102	93

Notes: This table provides information on the number of domestic-owned and foreign-owned firms across countries.

Table 4.14: Country List

	Domestically-owned	Foreign-owned	Country-code
Panama	828	141	94
Papua New Guinea	20	45	95
Paraguay	1,190	148	96
Peru	1,438	194	97
Philippines	2,054	607	98
Poland	888	109	99
Romania	917	164	100
Russia	5,028	196	101
Rwanda	368	85	102
Samoa	85	24	103
Senegal	1,009	98	104
Serbia	668	80	105
Slovak Rep	462	81	108
Slovenia	468	78	109
Solomon Islands	80	71	110
South Africa	816	121	111
South Sudan	443	295	112
Sri Lanka	576	34	113
Sudan	648	14	117
Swaziland	301	156	119
Tanzania	1,092	140	122
Thailand	901	99	123
Timor-Leste	248	28	124
Togo	209	96	125
Tonga	127	23	126
Trinidad and Tobago	324	46	127
Tunisia	506	86	128
Turkey	2,375	121	129
Uganda	1,117	208	130
Ukraine	1,702	151	131
Uruguay	1,081	147	132
Vanuatu	83	45	134
Venezuela	278	542	135
Vietnam	1,826	223	136
West Bank and Gaza	421	13	137
Yemen	788	42	138
Zambia	882	322	139
Zimbabwe	974	225	140

Notes: This table provides information on the number of domestic-owned and foreign-owned firms across countries.

Table 4.15: Balancing Test of the Variables: Before and After Matching

	Treated (1)	Control (2)	%bias (3)	t-test (4)	p-value (5)
TFP	4.434	4.444	-0.9	-0.24	0.809
size	2.338	2.326	1.6	0.51	0.613
Sibling	0.304	0.302	0.5	0.14	0.891
age	26.211	26.248	-0.2	-0.07	0.945
age^2	961.74	986.78	-1.6	-0.43	0.670
age^3	51,604	56,513	-2.3	-0.60	0.546
DExport	28.239	27.816	1.3	0.35	0.727
NatSales	65.579	65.72	-0.4	-0.11	0.912
FLicenced	1.649	1.644	1.2	0.33	0.741
mplinelocat	2.034	2.025	1.2	0.35	0.728
fdini	4.421	4.331	2.0	0.59	0.552
gdpg	4.493	4.516	-0.6	-0.16	0.871
trade	77.854	77.628	0.7	0.21	0.831
tnrr	7.648	7.863	-2.6	-0.74	0.457
productcode	40,881	41,842	-3.9	-1.25	0.211

Notes: This table reports t-tests of equality of mean for variables used in the logit estimation for predicting treated firms after constructing our local linear control group. Column (1) reports means for foreign-owned firms, while column (2) reports means for their matched controls. Columns (4) and (5) report the results of a t-test between the two groups. The results indicate that both groups are very similar and the matching was effective in building a good control group (Rosenbaum & Rubin, 1985; Bircan, 2019).

Table 4.16: Three-Step Estimation: Change in TFP

	Core product competence share	All	25th	50th	75th	99th
	(1a)	(2a)	(3a)	(4a)	(5a)	(6a)
Panel A						
lnSales	-0.355***	0.469***	0.413***	0.455***	0.508***	0.673***
	(0.068)	(0.005)	(0.002)	(0.003)	(0.003)	(0.011)
Age		-0.003***	-0.002***	-0.002***	-0.003***	-0.002***
		(0.0003)	(0.0002)	(0.0002)	(0.0002)	(0.0009)
Size		-0.540***	-0.484***	-0.525***	-0.593***	-0.620***
		(0.012)	(0.007)	(0.008)	(0.009)	(0.025)
Markup(predicted)	-15.196***					
	(6.187)					
Core product competence (predicted)		0.007***	0.0006	0.003***	0.006***	0.045***
		(0.001)	(0.0008)	(0.001)	(0.0009)	(0.005)
F-test	14.28					
Prob>F	0.000					
R-squared	0.1708	0.4696				
	(1b)	(2b)	(3b)	(4b)	(5b)	(6b)
Panel B						
lnSales	-0.360***	0.469***	0.412***	0.455***	0.508***	0.672***
	(0.068)	(0.005)	(0.002)	(0.003)	(0.003)	(0.011)
Age		-0.003***	-0.003***	-0.002***	-0.003***	-0.002***
		(0.0003)	(0.0002)	(0.0002)	(0.0002)	(0.001)
Size		-0.540***	-0.484***	-0.526***	-0.593***	-0.618***
		(0.012)	(0.006)	(0.008)	(0.009)	(0.025)
Markup(predicted)	-18.474***					
	(6.220)					
Core product competence (predicted)		0.007***	0.0005	0.003***	0.006***	0.045***
		(0.001)	(0.0008)	(0.001)	(0.0001)	(0.005)
F-test						
Prob>F						
R-squared	0.1709	0.4696				
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observation	30,231	30,231	30,231	30,231	30,231	30,231

Notes: This table reports results by using three-step estimation. In the first-stage regression we regress Markups on foreign ownership across firms controlling for sector- year- and country-fixed effects. In the second-stage regression we regress core product competence on predicted markups extracted from the first-stage regression. In the third-stage regression we regress firms' TFP on predicted core product competence extracted from the second-stage regression.

Chapter 5

Conclusion

We employ three types of data throughout the essays, i.e., panel data at the country level, pooled firm-level data, and data that is cross-sectional at the firm level. Overall, this thesis focuses on three important nexuses that are very relevant to FDI and productivity gains: (1) the impact of FDI on economic growth; (2) the vertical spillovers from multinational firms to domestic firms; and (3) the mechanisms by which the productivity gains occur through core product competences and market competition. By having established an endogenous growth model in which FDI is suggested to be determined by the differences in countries' abilities and is predicted to have a positive growth effect, the first essay addresses the endogeneity of FDI and finds evidence supporting the growth effect of FDI on GDP per capita and demonstrates that countries' abilities play an important role in determining technology transfers from frontier countries (in the "North") to developing economies (in the "South"). After demonstrating the growth effect of FDI and reconciling the findings in the FDI-growth literature, the second essay turns to investigating the vertical spillovers from multinational firms to domestic firms in the host country. By using the newly constructed measures of forward and backward linkages, we find the differences in firms' sourcing and supplying activities to be crucial in terms of the productivity spillovers from multinational firms to domestic firms. We provide three alternative measures in which the assumptions applied in the existing literature are relaxed, and then we provide empirical evidence showing the robustness of the three measures compared to the standard measures used in the literature. In the last essay, we deal with the extensions needed to incorporate multinational firms and firms' production with respect to the concept of product range and product scale and the tougher product-market competition induced by the multinational firms based on the theories of multi-product firms. These potential mechanisms have been much less emphasized in the FDI literature. Thus, the focus of this essay is on identifying the mechanisms through which the presence of foreign ownership influences the distribution of the host country' firms in terms of productivity, core varieties and markups. The results provide insights into how the presence of foreign ownership affects the extent of the alterations in core varieties, competition, and the subsequent productivity gains in the host country.

5.1 Summary of Findings

In Chapter 2, the results show that FDI enters the growth model significantly and with positive estimated coefficients. This finding is consistent with Hypothesis 1 that FDI promotes growth. In addition, the results indicate that the relative levels of technology and human capital enter the model significantly at 1% level with a priori expected signs. It indicates that the higher the relative level of a host country's abilities, the more the knowledge is transferred into the host countries. We find that our theoretical model fits well with the data. Based on our theoretical prediction, FDI is instrumented by the relative levels of human capital and technology between the leader and follower countries to control for the endogeneity of FDI in the model. We then compare the results provided by 2SLS with fixed-effect instrumental variable estimation and the system-GMM. We find that the estimated coefficient provided by the GMM estimator is about ten times (or even more) lower than the one provided by the two-stage instrumental approach. The findings suggest that the general growth regression which has been used intensively in the early empirical studies might underestimate the benefits from FDI due not addressing FDI's endogeneity properly. Our model is better able to mitigate this endogenous bias, providing more consistent results regarding the growth effect of FDI on the relative level of GDP per capita.

To further understand the benefits from FDI, Chapter 3 focuses on the FDI vertical linkage spillovers on domestic firms' productivity. As two strong assumptions applied in the existing literature and measures of FDI vertical linkages remain at the sectoral level, we create alternative measures of spillovers by using a rich dataset containing firms' sourcing and supplying behaviours from BEEPS, in which the FDI vertical linkages are measured at the firm level. We split the whole sample into two categories based on the types of firms, i.e., local and domestic firms, in the empirical analysis, and the results show that the standard forward and backward linkages are found to be statistically insignificant when assumptions 1 and 2 are held simultaneously. We find statistically significant spillovers of backward linkages on firms' productivity when assumption 2 is relaxed and assumption 1 is held fixed. Then when assumption 1 is relaxed but assumption 2 remains fixed, the result shows that our alternative measures capture the positive spillovers on firms' productivity through forward linkages, while we find both linkages to be statistically significant when assumptions 1 and 2 are relaxed. These baseline results suggest that the assumptions applied typically in existing studies lead to biased estimates for vertical linkages. We then focus on whether the spillover effects would be different for the domestic firms in the host country compared to the whole sample. The results show both positive and negative effects of forward linkages on domestic firms' productivity, while backward linkage spillovers are confirmed as positive on domestic firms' productivity. We find that it seems to capture the variation among the inputs that domestic firms obtain directly from the multinational firms when the proportion of imported inputs is used as a proxy for the forward linkages. As the inputs may be accessed freely by the domestic firms, forward linkages are therefore measured to be positive in terms of domestic firms' productivity. On the other hand, we find that multinational firms might try to dominate market positions, which might lead to higher input prices for domestic customers. Therefore, forward linkages are found to be negatively associated with domestic firms' productivity when the proportion of firm's foreign inputs is used as a proxy for the forward linkages.

The last essay utilizes intuitive predictions motivated by multi-product firms and the trade literature. We present a number of testable hypotheses that describe the mechanisms through which the within-firm productivity improvement occurs via multinational firms in the host country. We focus on the case of a firm's core product competence and markups, acting here as two important mechanisms that link to the within-firm productivity improvements via the presence of foreign ownership. Using a rich cross-sectional firm-level dataset, we first provide stylized facts from the data. We plot the distribution of core product competence across foreign-owned firms and domestic-owned firms and find that, indeed, foreign firms have relatively higher core product competences compared to the domestic-owned firms. Our mark-up estimation, overall, is also consistent with the literature. Moving to the empirical analysis, our first step is to regress firms' core product competences on firms' foreign ownership and the dummy variable for foreign-owned firms. The estimated coefficients show that both the extent and incidence of foreign ownership are statistically associated with firms' core product competences. Next, the firm's core product competence is instrumented by the foreign ownership and we then regress the predicted value of the core product competence against firms' productivity. The results suggest that, on average, core product competence is positively associated with firms' productivity. The second set of results then regresses firms markups against foreign ownership. The results suggest that the tougher competition effect exists and is induced by the presence of foreign ownership in the host country. Then, in order to see whether the tougher market competition would further skew firms' production towards the core varieties, we again use 2SLS and regress the predicted value of firms' markups against firms' core product competences. The results show that this effect is passed onto firms' core competences, as lower markups result in firms becoming skewed towards the core varieties.

5.2 Implications, Limitation and Future Research

The results presented in Chapter 2 support the view that FDI is important in terms of economic development for the developing countries. The implication for policymakers in those developing economies is that government policies need to put more effort into improving the stock of human capital and the level of technology, as they are the key determinants of attractiveness for FDI inflows, whilst FDI can bring in advanced knowledge from world-leading nations, and it is still one of the best ways for developing countries to catch up the world's developed economies. On the other hand, as our results highlight that the growth effects of FDI will decrease with the increase of relative level of human capital and technology, it suggests that for those countries who have a relatively high-level ability might need to invest more in innovation process and policy instead of entirely relying on attracting FDI. The limitation of this chapter is that the estimates rely on a few data sources that shorten the time dimensions and reduce the available observations. This limitation might be even magnified by other potential variations across countries. A new dataset with more observations across a longer time period may be preferred in order to enable the data to potentially provide new and interesting results, and these results could perhaps be incorporated into the theoretical model. In addition, when estimating the growth effect of FDI, researchers should understand clearly that the endogenous determination of FDI exists and that to mitigate this bias is not an easy task. Although the role of FDI in growth literature has been investigated for a long time, it remains difficult to identify the contribution of FDI without having a clear idea that guides us in alleviating the difficulty in addressing such biases. Therefore, future work can aim to extend our theoretical model, modelling the countries' innovation and adaptation behaviours together with FDI, which might offer further alternatives for identifying the growth effect of FDI.

In Chapter 3, our findings imply that the differences in sourcing and supplying behaviours among firms are crucial in identifying spillovers arising from both backward and forward linkages. To support this idea, our results demonstrate that the standard measures, in which the variations in firms' sourcing and supplying activities are assumed to be constant, do not provide evidence supporting the vertical linkage spillovers for our data. In contrast, there is evidence supporting the existence of both forward and backward linkages when we consider the variations. Based on the analysis, it may be appropriate to advise policymakers in developing countries to focus on policies aimed at attracting multinational firms, while encouraging domestic firms to have more contact with multinationals in order to benefit more from vertical linkage spillovers. Our findings might be particularly useful and informative for those countries who have multinational firms operating but have seen a lack of linkage between local suppliers and multinationals - namely the countries Guatemala, FYROM, and El Salvador. It is important that these developing nations can improve firms' local sourcing networks, ensuring local firms have the ability to improve their production process so that the input quality required by the multinational firms can be satisfied and so such spillover effects can occur. However, this chapter is not without limitations. First, this chapter includes two important differences between our work and that of Javorcik (2004) that pertain to the data and the way we measure linkages. By applying our new methodology to Javorcik's data, we may be able to understand more about how such differences in firms' sourcing and supplying behaviours influence the benefits received from FDI through vertical linkages. Second, it might be better if we could update our current dataset with more firms observed repeatedly over time, as long-term panel data can eliminate any firm-specific, time-invariant effects, perhaps resulting in a more precise estimation. Thirdly, this study also makes a number of assumptions on the proposed measures of forward linkages, and the forward measurement is limited since it is based on the eight given sectors, which are not disaggregated entirely at the firm level. Therefore, these limitations call for more research to follow our proposed measures with different data and alternative econometric approaches to see whether it is the context, the method, or the measurement that matters most.

In Chapter 4, the results suggest that the presence of foreign ownership is a significant source in motivating domestic firms to skew their production towards the better-performing products, while the skewness of their main products is also attributed to the product market competition created by the presence of foreign ownership. On the one hand, regarding the productivity improvement of domestic firms, it is crucial that policymakers in the developing countries concentrate on creating policies that attract foreign multinational companies, as higher product-market competition induces a highly skewed core product distribution and contributes further to firms' productivity. This concept is particularly important for those developing countries who have more multi-product firms with few product varieties produced across industries, as they might experience a higher productivity improvement effect through foreign ownership compared with other countries who also have multi-product firms operating but with more product varieties produced. Therefore, it might be more important to focus on policies that link to production adjustments between firms (foreign and domestic firms) and industries. On the other hand, the importance of the product range adjustment and product-market competition in explaining and assessing the productivity gains from multinational firms shows that it is important that researchers not ignore these potential sources when searching for mechanisms for within-firm productivity gains from multinational firms, as doing so may lead to underestimating the impact of FDI on productivity and overlook some important theories arising from the estimation. However, this chapter also has some limitations. Our empirical framework cannot distinguish whether the effect of skewness towards core competence on firms' productivity is contributed by the high-quality varieties or simply by the basic-quality varieties. As highlighted by Eckel et al. (2015), the quality of core products may be determined endogenously by a firms' profit decisions. The presence of multinational firms may, therefore, help local firms to invest more in the quality of their core products, and the effect of skewness towards core product competence induced by the multinational firms may have two different effects - the "cost-based" and "quality-based" effects - on firms' productivity. Also, our empirical analysis has not examined how the presence of foreign ownership alters firms' performance and product market competition through market expansion and product innovation. Analyses in these direction may provide additional insights in terms of explaining productivity gains from multinational firms and be able to provide important policy guidelines for governments seeking to promote FDI in developing countries. Also, considering the data limitation, it may be interesting, should a long-term panel data set become available, to better control for other potential variations as well as firm-specific unobservable fixed effects and provide more precise empirical analyses. All the points mentioned above will be implemented in our future work.

Despite all the possible limitations in this thesis, some important contributions to the methodology and theoretical knowledge concerning FDI and productivity were presented.

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