FIRM-LEVEL ANALYSIS OF FOREIGN DIRECT INVESTMENT: DETERMINANTS AND PRODUCTIVITY SPILLOVERS

By

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DECLARATION OF CO-AUTHORSHIP

I hereby declare that chapters 2, 3 and 4 of this dissertation are derived from work undertaken jointly with Professor John Serieux. The extent of co-authorship of these three chapters is explained below.

Chapter 2: "Multilevel Determinants of Foreign Direct Investment: A Regional Comparative Analysis"

In this chapter, I provided the research topic and research questions, identified suitable data sources, cleaned and compiled the data, developed the methodology, estimated and interpreted results, and wrote the first and subsequent drafts of the manuscript.

Professor Serieux refined the research questions, accordingly made some modifications to the methodology, and suggested some new variables to be included in the model. After I made the modifications to the model and manuscript, he reviewed it and aided in further revision of the manuscript, providing detailed comments and re-writing some texts.

Chapter 3: "Foreign-invested and domestic firm attributes and spillover effects: Evidence from Brazil"

In this chapter, I provided the original research topic and questions, identified appropriate data sources, performed data cleaning, developed the methodology, estimated and interpreted results, and wrote the first and subsequent drafts of the manuscript.

Professor Serieux refined the research topic and questions, formulated additional hypotheses, and suggested some modifications to the model, the estimation method, and

the explanation of the results. He further helped to revise the manuscript—providing detailed comments, and adding and rewriting some texts after I made the necessary modifications.

Chapter 4: “Spillovers from Foreign Direct Investment: Do Measures of Firm Size Matter?”

In this chapter, I provided the research topic and research questions, identified appropriate data sources, cleaned and compiled the data, developed the methodology, estimated and interpreted results, and wrote the first and subsequent drafts of the manuscript.

Professor Serieux refined the research topic and research questions, suggested additional theoretical underpinning, and proposed an extension of the methodology. He also aided in interpreting new results. After I made the necessary modifications to the manuscript, he further reviewed the manuscript, helped in editing by providing detailed comments, and added and rewrote some texts.

ABSTRACT

This dissertation consists of three essays on foreign direct investment (FDI), or foreign equity participation, with analyses at the firm-level and beyond. The first essay (Chapter 2) investigates determinants of foreign equity participation at three levels —firm, country, and global region— and analyzes whether these determinants vary across global regions. In this pursuit, a firm-level dataset consisting of 197 surveys from 134 countries (67 of which covered two separate interview years—two surveys) is utilized in a multilevel logit framework. Countries are categorized into eight distinct developing global regions. Results suggest that obstacles faced by firms related to communication, finance, and institutional quality significantly (and negatively) affect foreign equity participation. Surprisingly, however, obstacles related to physical infrastructure actually seemed to attract foreign investment in some regions and those relating to administration uniformly encouraged foreign investment—suggesting that domestic firms may seek foreign equity participation in order to reduce or bypass administrative obstacles. Country-level attributes such as capital account openness, GDP per capita, inflation, and the rate of taxation on profits are shown to have varying impacts across regions—positive in some, negative in others, and statistical irrelevance in others. At the regional-level, intra-regional trade relative to regional GDP, was found to be positively associated with foreign equity participation for the aggregate data model but that relationship could be reproduced for only one region, South Asia, while the opposite seemed to be true for two regions, Central Asia and Middle East and North Africa. A higher (average) quality of governance in a region was found to stimulate the level of foreign equity participation.

The second essay (Chapter 3) focuses on the productivity spillover effects of FDI using firm-level panel data from Brazilian manufacturing firms. Specifically, this study tries to determine what attributes of foreign-invested firms (FIFs) and domestic firms are associated with the transfer and absorption of spillover effects. Results suggest that, when spillover effects are measured at the aggregate level only, (positive) horizontal and backward productivity spillovers can be identified. However, when FIFs are disaggregated, those horizontal and backward spillover effects were found to be most closely associated with majority foreign ownership and high-export profiles. Additionally, we could now identify positive forward spillovers transmitted by low-importing and low-exporting FIFs exclusively to high-technology domestic firms. Finally, this investigation demonstrated that, for domestic firms, low productivity levels and the absence of worker training precluded the absorption of certain types of spillover effects but still allowed for the absorption of other (more passive) types of spillover effects.

The third essay (Chapter 4) explores the effects of firm size on the productivity and spillover effects considering both continuous and discrete measures of size and using three measurement variables—assets, sales, and employment. A plant-level panel data set covering the Chilean manufacturing industries was utilized for the analysis. Results suggest that, when size is measured as a continuous variable, increasing domestic firm size in terms of assets was associated with falling productivity whereas increasing domestic firm size in terms of sales and employment was associated with increasing productivity. For FIFs, increasing size appeared to moderate what was a generalized negative forward spillover effect when assets and sales were used to measure size. For the discrete size measures, size implications for *productivity* largely reproduced the continuous measure results but findings of *spillover effects* were much more frequent. However, the direction and frequency of spillover effects varied with the choice of size measure and, for sales and assets,

the disaggregation criteria. Thus, while all measures of size indicate a relationship between size and spillover effects, the frequency, nature and direction of spillover effects varied substantively with the type of size measure (continuous vs discrete) and the variable used to determine size.

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FIRM-LEVEL ANALYSIS OF FOREIGN DIRECT INVESTMENT: DETERMINANTS AND PRODUCTIVITY SPILLOVERS

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Chapter 1

Introduction

Foreign direct investment (FDI) has long been argued to be an important conduit for the transfer of technology to host economies. The general presumption is that FDI is a vital source of advanced technology, efficient management techniques, and developed networks for international trade. Multinational enterprises (MNEs) (or foreign-invested firms (FIFs) more broadly)[1] bring these propitious advantages with them when entering an economy (Markusen, 1995; Mehta, 1994; Sun & Anwar, 2017) but, in addition, FDI may influence technological development and boost general productivity levels through competition (Ha & Giroud, 2015). Beyond those productivity-related advantages, FDI can increase general investment levels and tax revenues in host economies along with filling gaps in foreign exchange earnings (Zekarias, 2016). If those expected advantages are realized, the presence of FDI can indeed help accelerate growth in host economies.

In addition to the direct productivity effects, it is also argued that FDI can generate indirect productivity impacts in host economies through knowledge and technology spillovers (Blomstrom

[1] Foreign-invested firms (FIFs) refer to: firms with significant equity participation (10% or more according to IMF) by foreign firms, other joint ventures between domestic and foreign firms ownership (more than 10% but less than 100% foreign equity share), and wholly owned foreign firms or those originating from greenfield foreign investment (Tseng & Zebregs, 2002). The term was initially used to describe firms with foreign participation in China but has gained general usage in the literature. When used here, the term can be seen as related to, but more general, than multinational corporations (MNCs) because it includes firms that may not identify as MNCs because the degree of foreign participation is limited. Since, according to the OECD definition, any foreign ownership of firm equity that exceeds 10% of total equity constitutes FDI (lower amounts are classified as portfolio investment), any firm with foreign participation that exceeds 10% of equity is considered a recipient of FDI and, therefore, classified as a FIF.

& Kokko, 1998; Gorg & Greenaway, 2004). The presumption is that MNEs/FIFs cannot fully internalize their firm-specific advantages, hence it is the presence of externalities (spillovers) that can be an important source of technology transmission in host economies (Dunning & Lundan, 2008). The literature has suggested two types of spillovers from FDI: spillovers in the same industry (horizontal spillovers) and in other industries (vertical spillovers) (Godart & Görg, 2013; Havranek & Irsova, 2011; Javorcik, 2004). These hoped-for direct and indirect benefits, in the view of many policy makers, justify the incurrence of real costs, such as tax exemptions and subsidies and policy reforms, to attract FDI (Aitken & Harrison, 1999; Tian, 2007).

The efforts to attract FDI by host economies and the expected higher profitability for investors (along with lower perceptions of risk) in cross-border investment have led to a sharp increase in global FDI flow in the last three decades. In 1990, world FDI flow was US$ 205 billion that increased to US$ 1.36 trillion in 2000. The global financial crisis of 2007-09 disrupted that growth trajectory, but FDI flow surpassed US$ 2 trillion in 2015 and 2016 and remained over US$ 1.5 trillion until 2019. The stock of FDI has also increased substantially since 1990. Starting from US$ 2.2 trillion in 1990, world FDI stock increased to US$ 7.4 trillion in 2000, and was 41.35 trillion by 2020 (UNCTAD, 2021). Thus, between 1990 and 2020, world FDI stock increased by 1,880%.

However, the distributions of FDI flow and stock have been disproportionate across countries. Developed countries have continued to attract the lion's share of total FDI flow, while many developing countries remain marginalized. This has led many academics and policy makers to devote significant efforts into examining what forces drive the decisions of foreign investors in terms of the nature and location of investment. Initial efforts in the empirical analysis of FDI determinants were mainly based on macro (country-level) data (Friedman et al., 1992; Lankes & Venables, 1996; Lunn, 1980; Morsink & Molle, 1991). Macro studies have, thus far, outlined some

variables as catalysts for attracting FDI, such as market size, lower inflation level, lower corporate tax rate, stable exchange rate, trade openness, developed financial market, good institutional quality, availability of natural resources and so forth.

The "eclectic paradigm" theory of MNEs proposed by Dunning (1980, 1993), that outlined three broad types of advantages (i.e., ownership, location and internalization) as incentives for cross-border investment, has encouraged micro (firm-level or establishment-level) analysis of FDI determinants. The availability of firm-level or establishment-level data has further intensified the efforts towards micro analysis of FDI determinants. The firm-level studies have focused on both developed countries (see Braunerhjelm & Svensson, 1996; Carr et al., 2001; Jeon & Rhee, 2008; Wheeler & Mody, 1992) and developing countries (Bhupatiraju, 2019; Kinda, 2010), and the findings have varied across studies. Evidence of multilevel (both firm-level and country-level) determinants of FDI stock is scarce.

In addition to firm- and country-level factors, some differences at the level of global regions may also influence the location choices of MNEs. For example, the volume of international trade (exports and imports) may be high in some regions while other regions may experience only limited amounts of intra-regional trade. Thus, foreign investors whose main objective is to supply regional markets and want to take advantage of supply chain links between subsidiaries located in different countries are likely to choose regions (or country groups) where the volume of intra-regional trade is high. Moreover, some regions may present different macroeconomic, institutional and infrastructural settings than others. For instance, infrastructural challenges in African countries are different from in European countries (Calderon, 2009; Ncube, 2010). Foreign investors, as rational economic agents, take these issues into account while deciding in which country or region

to invest. However, an analysis of FDI stock that explores regional differences within a multilevel framework is still missing in the literature.[2]

The first essay (Chapter 2) takes into account this issue and incorporates differences at the level of global regions into the analysis of FDI determinants. In particular, this essay, using data from 134 countries, investigates determinants of foreign equity participation considering differences at the firm-, country-, and regional-levels in a multilevel logit framework.[3] The dataset covers the period 2006 through 2019, and there are two separate surveys for 67 countries. The countries are assigned eight distinct regions to analyze the regional differences in FDI determinants. The firm-level determinants mainly include operational challenges (i.e., infrastructural, financial, administrative etc.) that firms face, while the country-level determinants are economic and institutional variables that are, according to the literature, expected to affect foreign equity participation. Two regional variables, intra-regional trade relative to regional GDP and the quality of governance, were found to have significant impacts on foreign equity participation. Results from the basic model are supportive of the multilevel framework since the unexplained variances are not negligible at both the country- and regional-levels. Nevertheless, overall results suggest that firm-level factors are more robust and stable, than country- or regional-level variables, in explaining foreign equity participation.

The rapid increase in inward FDI has also led to a surge in the literature investigating the direct and indirect effects of FDI in host economies. Studies that are concerned with direct effects are either macro (country-level) investigations, examining how inward FDI has shaped host

[2] Region is used here to indicate groups of countries clustered on the basis of their geographic proximity, similarities in macroeconomic settings, and intra-regional trade.
[3] See Table A2.1 in Appendix A2 for details on different regions and number of countries in each region.

economies in terms of production, employment, labor quality, job security and so forth (Alfaro et al., 2004; Bailey & Driffield, 2007; Becker & Muendler, 2008; Chakraborty & Nunnenkamp, 2008; Davies & Voy, 2009; Eckel, 2003), or micro (firm-level) investigations exploring the effects of foreign equity share on within-firm productivity, innovation, exporting, and importing tendencies and so forth (Banga, 2004; Marin & Costa, 2010; Tomiura, 2007; Wagner, 2006). Studies investigating indirect effects (spillovers) are mainly firm-level investigations and concerned with outside-firm productivity or technological impacts of foreign equity share (or spillover effects). In the FDI spillovers literature, however, country coverage remains incomplete and, for the countries covered, the results have not been consistent (Bruno, Campos, & Estrin, 2018; Bruno & Cipollina, 2018).

In a meta-analysis, Demena and van Bergeijk (2017) concluded that a large number of developing countries had yet to be studied and suggested that this limits the generalizability of any evidence of spillover effects. Hence, they advocated for further investigations covering more developing countries and for examinations of the underlying mechanisms through which transmission of technological advantages are passed from FIFs to domestic firms. The second essay (Chapter 3), considering this issue, examines FDI spillover effects (horizontal and vertical) in Brazil—a country that has not been extensively studied to this point—using a multi-sector sample of manufacturing firms for the years 2003 and 2009.

In particular, the second essay tries to determine the attributes of both FIFs that are associated with the generation of spillovers and the attributes of domestic firms that are associated with the receipt of spillovers. For FIFs, the attributes examined were the degree of foreign ownership, export orientation, and import dependence. For domestic firms, the attributes examined were size, productivity level, and investment in employee training. It was anticipated that this disaggregation

would help to reveal more precisely the sources and channels of spillover effects. Results indeed suggest attribute-based heterogeneity among foreign-invested and domestic firms in terms of spillover generation and receipt. In particular, FIFs with majority foreign equity share and a high-export profile were found to be the most likely to generate spillover effects, and domestic firms with employee training (suggesting high absorptive capacity) had a significantly higher likelihood of receiving those spillovers.

The FDI spillover literature has outlined some other factors – such as the regional distribution of FDI, market structure, origin country of FDI and so forth – as determining factors for FDI spillovers (Kim et al., 2015; Salike, 2016; Shibata, 2014). However, sizes of both foreign-invested and domestic firms often govern the likelihood and intensity of interaction between foreign-invested and domestic firms in the same industry. In addition, size also determines the scale of production and the degree of supply chain integration (Mitchell, 2002; Nooteboom, 1993; Wang et al., 2018) and, thus, inter-industry linkages as well. Hence, firm size is likely to have an important influence on the nature and extent of FDI spillovers.

Despite that likely connection, the spillover literature focusing on the impact of firm size remains surprisingly small. Among studies that examined the effect of firm size, a few have considered the horizontal and vertical (backward and forward) spillover channels in the analysis (Doan et al., 2015; Dogan et al., 2017; Imbriani et al., 2014; Lenaerts & Merlevede, 2015). Spillover results have varied across these studies. According to Lipsey and Sjoholm (2005) and Smeets (2008) this variation may be attributed to the potential heterogeneity in host country characteristics. It is worth mentioning, however, that all these studies in the spillover literature used only discrete measures of employment as indicators of firm size.

In other strands of the empirical literature (not directly related to spillover effects), however, firms' assets and sales have also been used as measures of size, and both the continuous or discrete size measure has been utilized in the analysis (Blomstrom & Lipsey, 1986; Kumar & Siddharthan, 1994; Patibandla, 1995; Siddharthan & Nollen, 2004). Thus, the third essay (Chapter 4) extends the focus of the analysis of firm size and FDI spillovers by employing both the discrete and continuous size measures and utilizing assets and sales, along with employment, as size-determining variables. Results suggest significant heterogeneity in spillover results (horizontal and vertical) across size measures, size-determining variables, and the choice of continuous or discrete measures with respect to both the generation and receipt of those spillover effects. Therefore, an important inference from this chapter is that, though firm size clearly matters for spillover effects, one should be very judicious in attempting to generalize any evidence of spillovers (generated or received) across various size measures and size-measuring variables.

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Chapter 2

Multilevel Determinants of FDI: A Regional Comparative Analysis

2.1. Introduction

Foreign direct investment (FDI) is generally believed to be an important source of advanced technology and efficient management technique, alongside the potential for further integration into a developed network for international trade.[4] One of the ways in which advanced technologies are expected to be transmitted is through externalities (spillovers) – some firm-specific advantages that multinational enterprises (MNEs) cannot fully internalize (Dunning & Lundan, 2008). These hoped-for benefits, in the view of many policy makers, justify policy reforms and the incurrence of real cost (such as tax exemptions and subsidies) to attract FDI (Aitken & Harrison, 1999). The potential benefits of FDI have become all the more relevant because the rapid increase in FDI flows experienced since the 90s has been followed by two decades of historically high levels, despite fluctuations.

Developed countries have traditionally attracted the lion's share of the total FDI flows (see Figure 2.1) but, in recent years, several developing countries have succeeded in attracting sizable

[4] FDI has its three major modes, namely mergers and acquisition, joint ventures, and new plants (i.e., Greenfield investment). However, Greenfield investments are more likely to be integrated with the parent companies than other modes of FDI (Svensson, 1998).

amounts, though many others remain marginalized. This disproportionate distribution of FDI flow across countries has motivated researchers and policy makers to examine what forces drive the flow of FDI to particular countries or regions. As a result, a large body of research has been directed to exploring the country-level determinants of these FDI flows. The "eclectic paradigm theory" of MNEs proposed by Dunning (1980, 1993) suggests that firms invest abroad on the basis of three types of advantages: ownership, location and internalization (OLI). This approach implicates both firm-level and country-level and, potentially, regional-level variables in determining why and where MNEs invest abroad. If that is the case, a study of FDI determinants demands a multilevel analysis.

Better availability of firm-level data has stimulated efforts towards examining the firm-level determinants of foreign equity participation. However, early firm-level studies of FDI determinants mostly focused on developed countries and some of the firm-specific variables of primary interest were: research and development (R&D), differences in input costs, advertisement cost, financial policies, and taxation.[5] The findings of these studies have, therefore, not necessarily been pertinent to countries where inadequate infrastructure, financial constraints, weak institutions, administrative obstacles, and lack of skilled labor are more immediate challenges. This deficiency has been recognized and some of the more recent firm-level studies of FDI determinants have covered developing countries.[6] These studies have analyzed FDI determinants in a single country context or for a number of countries together but utilizing only firm-level data

[5] See Braunerhjelm and Svensson (1996), Buch et al. (2005), Buch et al. (2014), Carr et al. (2001), Hanson et al. (2001), Wheeler and Mody (1992), Yeaple (2003), Disdier and Mayer (2004), Head et al. (1995), Javorcik and Wei (2009), Jeon and Rhee (2008), Nefussi and Schwellnus (2010), Smith and Florida (1994), Todo (2011), Urata and Kawai (2000) for surveys.

[6] See Belkhodja et al. (2017), De Beule and Duanmu (2012), Bhaumik et al. (2010), Pradhan (2004), Chen et al. (2016), Deichmann et al. (2003), Demir and Su (2016), Dollar et al. (2006), Du et al. (2008), Gelb et al. (2008), Guimarães et al. (2000), Kang and Lee (2007), Kinda (2010), Mahbub and Jongwanich (2019), McCulloch et al. (2013), Nguyen et al. (2018), Tiong et al. (2021) for surveys.

and single-level econometric technique in that analysis. Multilevel analyses (i.e., both firm-level and country-level) of the determinants of FDI stock, in the developing country context, have only recently been added. Bhupatiraju (2019) was the first study to analyze both firm-level and country-level determinants of FDI in a multilevel framework. However, an analysis of FDI stock that explores regional differences within a multilevel framework is still missing in the literature. This essay presents such an analysis.

Considering regional differences in the analysis of FDI determinants is important because some of the attributes faced by MNEs (such as macroeconomic settings, infrastructure challenges, and institutional and administrative constraints) may have regional dimensions. For example, South Asian economies may be seen as presenting a different combination of challenges in terms of infrastructure, financial constraints, institutional weaknesses and so forth in comparison to Central Asian or East Asian economies. This may affect how multinational firms react to, or interpret, firm-level and country-level constraints. This may be of particular importance in the context of regional supply chains and regional trading networks. Accordingly, regional trade agreements that an economy belongs to, good governance (political stability, rule of law, control of corruption etc.), and the importance of intra-regional trade for an economy may also affect the level of foreign equity participation. In effect, regional attributes may be important in firms' decision making with respect to the movement of capital across borders.

This study, using a large multi-regional dataset, investigates multilevel determinants of foreign equity participation considering differences at the firm-, country-, and regional-levels. In particular, this study includes regional-level variables alongside firm- and country-level variables in a three-level hierarchical model to investigate the determinants of foreign equity participation and ascertains whether there are any significant differences in those determinants across regions.

Results provide support for all three levels of determinants (firm, country, and region), with respect to impacts on foreign equity participation, and significant differences in firm and country determinants (in terms of significance and sign) across regions. In other words, some factors that are found to have significant impacts on foreign equity participation in some regions do not appear to be significant in some other regions and vice-versa.

The rest of the essay is structured as follows: section 2.2 presents theories and related literature and section 2.3 provides empirical literature. Section 2.4 presents some stylized facts of worldwide FDI flows. Section 2.5 describes methodology and data. Section 2.6 presents and describes results, while section 2.7 concludes the essay.

2.2. Theory and related literature

Since the middle of the twentieth century, there have been many attempts to uncover why firms invest abroad and become MNEs. Early studies on MNE activities were mainly undertaken in the form of field studies with limited theoretical foundations (e.g., Basi, 1966; Behrman, 1962; Kolde, 1968). The first attempt to explain FDI in a theoretical framework was based on a Heckscher-Ohlin 2x2x2 model.[7] The Heckscher-Ohlin model, an example of neoclassical trade theory, assumed perfect competition, differences in relative factor intensities across commodities and differences in relative factor endowments across countries. The resulting international factor price differentials meant that a capital-abundant country would either export capital-intensive goods or,

[7] Heckscher-Ohlin 2x2x2 model is an economic theory that assumes two countries, two inputs, and two products in analyzing international trade. It suggests that countries export those commodities that they can produce efficiently and plentifully. It basically explains how countries should trade when inherent resources endowments vary.

in the absence of commodity trade, move capital abroad where return on capital was higher until factor price equalization was achieved (e.g., Jasay, 1960; Kemp, 1964; MacDougall, 2009).

The underlying assumption of perfect competition in the neoclassical theory of FDI was criticized by Kindleberger (1969) and Hymer (1976), among others. They argued, instead, that FDI needed structural market imperfections to flourish, and hence introduced the concept of 'monopolistic advantage.[8] Later on, the "eclectic paradigm theory" proposed by Dunning (1977, 1980) identified three special advantages of MNEs in choosing to locate production abroad: ownership (i.e., ownership of the production process, technology, and management and marketing skills), location (i.e., access to protected foreign markets, favorable tax treatments, lower costs of production and transportation, lower risk and competition), and internalization (i.e., benefits perceived by firms due to the club good[9] nature of ownership advantages such as managerial skills, technologies etc.).

An alternative theory argued that firms locate their production abroad only when there are significant differences in factor endowments and factor prices (Helpman, 1984, 1985). Firms access low cost inputs through delocalizing all or a portion of the production process – vertical integration (vertical FDI).[10] Markusen (1984) introduced horizontal integration (horizontal FDI) where MNEs can supply the host countries' market through an affiliate when there is trade friction in place. These two streams of the literature, explaining vertical and horizontal FDI, were integrated in Markusen et al. (1996) and Markusen (1997) to explain FDI in the contexts of trade

[8] Monopolistic advantage refers to product differentiation, managerial expertise, new technology or patents, scale of economies, government incentives etc.

[9] Club goods, sometimes classified as a subtype of public goods, are goods that are excludable but non-rival, at least until reaching a point where congestion occurs.

[10] To reduce overall production costs, MNEs move certain stages of production to some low cost economies and produce products that differ from those that they produce at home (Buch et al., 2005). Moreover, vertical integration also gives control to the parent firms over their suppliers, distributors, and retailers in a way that reduces costs and improves efficiencies.

costs and trade liberalization – the knowledge-capital model. This model argued that similarities in market size, factor endowments, and transport costs determine horizontal FDI, and differences in factor endowments determine vertical FDI. Carr et al. (2001) estimated the knowledge-capital model for the first time and found evidence in support of the model.

More recent studies, working within a similar framework, have mentioned two more justifications for FDI: export platform and vertical interaction. In export platform FDI, MNEs choose some countries to serve as platforms for exports to a group of neighboring countries (Bjorvatn & Eckel, 2005; Ekholm et al., 2007; Ito, 2013). In vertical interaction (or fragmentation) FDI, affiliates of MNEs operate in a number of host countries to supply intermediate goods between them before producing a final or more finished product for the parent enterprise (Baltagi et al., 2007). Notably, and relevant to this paper's objective, regional attributes are made directly pertinent in these models.

Another approach, which emphasized business diversification as an objective, was pioneered in works by Chandler (1962) and Ansoff (1965) and further refined and extended by Wrigley (1970). Later on, Rugman (1975, 1977) introduced the 'risk diversification motive' to this hypothesis. Core skill – firms' ability to efficiently and effectively combine market and technological knowledge to maximize profit, survive, and grow in a competitive market – is central of this conceptualization. This hypothesis suggests that MNEs invest overseas to enjoy factor and product market diversification and reduce profit risk (Hughes et al.1975; Michel & Shaked, 1986; Miller & Pras, 1980).

The seminal work by Krugman (1991) led to a burgeoning theory of FDI under the heading 'new economic geography (NEG)'. As this theory suggests, certain regions or countries possess 'first-

nature' advantages over others, such as a large endowment of natural resources or better transport facilities (i.e., rivers or harbor). Such factors often lead to large concentrations (agglomeration) of economic activity (Schmutzler, 1999).[11] This type of endogenous agglomeration may mean increasing returns to scale and reduced transportation costs to firms that directly impact MNEs' FDI decisions (e.g., Fujita & Krugman, 1999; Fujita & Thisse, 2002; Neary, 2001). As an empirical example of agglomeration, Wang (2018) claimed that the industrial cluster and localization in eastern China is due to favorable regional attributes.

2.3. The empirical literature

2.3.1. Macroeconomic (or country-level) determinants

Faeth (2009), reviewing all the theoretical models of MNEs, argued that the determinants of FDI should not be analyzed based on a single theoretical model. Instead, various theoretical models should be combined to examine FDI determinants more broadly. Early empirical investigations tried to analyze country-level variables to determine why some countries are better able to attract FDI than others. One macro variable that has been examined since early on is market size, in terms of output (e.g., Lunn, 1980; Scaperlanda & Mauer, 1969). Many MNEs tend to locate their plants in larger markets in order to supply the host economies and eventually use them as a base to supply nearby smaller markets as well (Krugman, 1980). Some studies have found a positive effect of market size on FDI inflows (Chakrabarti, 2001; Coughlin & Segev, 2000; Head & Mayer, 2004; Lankes & Venables, 1996; Vijayakumar et al., 2010). Mina (2007), however, found negative impact of market size on inward FDI in Gulf Cooperation Council (GCC) countries.

[11] However, there are examples that many regions developed into economic centers without having obvious natural advantages. Additional arguments are to be invoked to understand this type of concentration.

Among other macroeconomic variables, inflation is expected to have a negative effect on inward FDI. Specifically, high inflation, because it reduces firms' real earnings, is expected to discourage foreign investors, whereas low inflation (a sign of internal stability) is expected to encourage them (Buckley et al., 2007). Coskun (2001) for Turkey, and Trevino et al., (2002) for Latin America found a negative relationship between the rate of inflation and inward FDI. However, Vijayakumar et al. (2010) found no significant effect of the inflation rate on inward FDI in the BRICS countries. Unemployment is also often identified in the theoretical literature as an important factor influencing inward FDI. Countries with higher unemployment rates are believed to attract FDI because it helps MNEs find cheap labor and optimize profits (Blanchard, 2011). In line with this argument, Friedman et al. (1992), Nunnenkamp et al. (2007), and Chidlow et al. (2009), among others, found a positive relationship between a higher unemployment rate and FDI inflows. Yet, a negative relationship is not an impossibility for the following two reasons: (i) high unemployment may be perceived by foreign investors as a signal of macroeconomic disequilibrium and instability, thus the country may not be seen as an appropriate host country for future investment (Brozen, 1958); and (ii) FDI itself generates employment, thus curbing unemployment.

In contrast to employment, a high labor force participation rate (the proportion of working aged people—those aged 15 to 64—who are employed or actively searching for work) is thought to indicate a greater likelihood of an adequate labor supply for the production process and, thus, a driving force for FDI inflows. Sahoo (2012) using data from South Asia found a positive effect of a high rate of labor force participation on FDI inflows. By contrast, a higher profit tax in investors' home country, than other countries, is expected to prompt investors to move their capital to countries where the tax rate is lower (Egger et al., 2014; Morsink & Molle, 1991). Hence, ceteris paribus, a country is expected to induce more FDI than others if it can offer a favorable tax policy

to foreign investors, especially a lower tax on profits. Clegg (1998) found that a high tax rate was associated with lower FDI inflows in European countries. However, Buettner and Ruf (2007) found no predictive power for the marginal effective tax rate on FDI's location choice.

Trade openness is argued to generate a positive investment climate in the empirical literature (e.g., Liu et al., 2001; Mina, 2007; Moosa & Cardak, 2006). In essence, trade openness is presumed to suggest a business-friendly climate that is attractive for FDI (Boateng et al., 2015). Hence, trade openness is expected to be positively associated with FDI inflows. Studies such as Xing (2006) for China, and Liargovas and Skandalis (2012) for 36 developing countries found a positive relationship between trade openness and FDI inflows. However, Wheeler and Mody (1992) found evidence of large FDI inflows in Brazil and Mexico despite low levels of trade openness.

Weak legal protections for property rights, excessive bureaucratic hurdles, and higher level of corruption at the country level are likely to raise MNEs' costs (Wei, 2000). Thus, the institutional quality of a country is often considered an important determinant of inward FDI (Acemoglu et al., 2005; Ali et al., 2010; Naudé & Krugell, 2007; Seyoum, 2011; Sharma & Bandara, 2010). Jadhav and Katti (2012) provided evidence of substantial effects of government effectiveness, regulatory quality, control of corruption, voice and accountability, and rule of law (five variables to derive World Governance Index (WGI)) on FDI inflows in the BRICS (Brazil, Russia, India, China, and South Africa) countries. Generally, good institutions (in terms of the rule of law and low levels of corruption) are found to attract FDI (Busse & Hefeker, 2007; Daude & Stein, 2007; Harms & Ursprung, 2002; Ibrahim-Shwilima, 2015; Pajunen, 2008).

Some other macroeconomic determinants of FDI in the empirical literature are wage level (JEON & RHEE, 2008; Kang & Lee, 2007; Panigrahi & Panda, 2012), ease of doing business (Morris &

Aziz, 2011; Vogiatzoglou, 2016), trade protection in the form of tariffs (Khan & Nawaz, 2010; Kok & Acikgoz Ersoy, 2009; Nunnenkamp, 2002; Rolfe et al., 1993), natural resources (De Beule & Duanmu, 2012), preferential trade agreements (PTA) (Medvedev, 2012), external debt (Gupta, 2018; Kok & Acikgoz Ersoy, 2009), interest rate (Billington, 1999; Boateng et al., 2015; Culem, 1988), exchange rate (Aristotelous & Fountas, 1996; Froot & Stein, 1991) and so forth.

2.3.2. Firm-level determinants

Analyzing firm-level determinants of location choice of MNEs became popular in the 1970s onward, though early attempts were mainly theory-based. Since then, many studies have tested the theoretical underpinning and examined various firm-specific advantages and infrastructural obstacles as determinants of FDI after firm-level data became widely available. Firm size (in terms of either total assets or number of employees) has been found important in the internationalization decision of MNEs. Firm size is generally viewed as an indicator of scale economies and market power (Trevino & Grosse, 2002), and is also seen as important for both horizontal and vertical FDI (Caves, 1971; Horst, 1972). However, Blomstrom and Lipsey (1986) showed, in their analysis of US and Swedish manufacturing firms, that firm size only had a threshold effect on FDI inflows, but no effects thereafter.

In his pioneering work, Knickerbocker (1973) found agglomeration to be an attractive local factor for firms competing in a single industry. As empirical evidence, Ferrer (1998) for French MNEs, Head et al. (1995) and Smith and Florida (1994) for Japanese MNEs, Braunerhjelm and Svensson (1996) for Swedish MNEs, Guimarães et al. (2000) for FDI in Portugal, and Belkhodja et al. (2017) for FDI in China found strong evidence of agglomeration effects on location choice. However, agglomeration effects may not be similar across regions. Disdier and Mayer (2004), for instance,

examined French MNEs in European countries and found that agglomeration effects are less strong in Central and Eastern European (CEE) countries than in EU countries.

MNEs often take into account the state of infrastructures of a particular region or sector in a country before they make any investment decision. Studies employing micro data have generally found a positive effect of good infrastructure on FDI inflows in developing countries (Cheng & Kwan, 2000; Deichmann et al., 2003; Sun et al., 2002; Urata & Kawai, 2000). Financial infrastructure is as important as physical infrastructure since foreign firms may also use financial services for various reasons including overdraft facilities, loans, or payments to their suppliers. Moreover, the growth literature has emphasized that economic growth is fueled by, among other drivers, a developed financial infrastructure (Ghali, 1999; Guru & Yadav, 2019) that provides better business opportunities for customers and firms. Hence, a developed financial infrastructure has been found to have a positive effect on FDI inflows (Deichmann et al., 2003).

Countries or regions inheriting good access to factors of production have an advantage in terms of attracting FDI (Yeaple, 2003). Specifically, vertical MNEs, depending on factor intensities, locate capital-intensive activities in skilled-labor-abundant countries (Markusen & Maskus, 2002). In the same line of argument, firms having skilled labor are better able to attract FDI investment because foreign partners can expect to have access to the skills required to run their production activities. No surprisingly, studies analyzing firm-level characteristics as FDI determinants have demonstrated a positive link between skilled labor and foreign equity participation (Escobar Gamboa, 2013; Pradhan, 2004; Zhao & Zhu, 1998). Access to land has also been found to be correlated with foreign equity participation (Tiong et al., 2021). Morisset and Neso (2002) revealed that obstacles associated with land (for example, delays related to securing land access and obtaining building permits) are some of the most important barriers to FDI inflows.

A good institutional set-up at the micro-level helps markets function properly and efficiently, thereby attracting FDI (Urata & Kawai, 2000). On the other hand, poor institutions that lead to an environment of corruption and poor property rights guarantees levy extra costs on foreign investors and deter FDI inflows (Shleifer & Vishny, 1993). Firm-level analyses have found a positive effect of institutions on FDI inflows (e.g., Disdier & Mayer, 2004; Du et al., 2008). Administrative obstacles may also influence FDI inflows. In particular, the requirement of complex administrative procedures for the commencement of business operations discourages FDI inflows (Morisset & Neso, 2002).

Urata and Kawai (2000) considered low wages as a supply-side factor that works as one of the catalysts for attracting Japanese MNEs in developing countries. A lower wage level is likely to increase firms' profits by providing them with a cost advantage. Sethi et al. (2003) found that US MNEs are reaping the benefits of low wages in Asia and thus increasing their investments in that region. Some other firm-level determinants of FDI that have been investigated in the empirical literature are: technological intensity (Lall, 1980); capital intensity (Pugel, 1981); intangible assets (i.e., R&D intensity and advertising intensity) (Horst, 1972; Özkan-Günay, 2011; Pradhan, 2004); innovation capacity (Özkan-Günay, 2011); return on equity (Buch et al., 2005; Tobin, 1969); export orientation (Pradhan, 2004); productivity (Demir & Su, 2016); and scale economies (Hymer, 1976).

2.4. World FDI flows: some stylized facts

World FDI flows experienced a marked increase during the 1990s. Starting from 205 billion US dollars in 1990, it reached 1.36 trillion in 2000. Annual inflows fell sharply in the following three years, down to 550 million in 2003, but regained its rising trend thereafter, reaching nearly 1.9

trillion US dollars on the eve of the Global Financial crisis in 2007. Since then, annual global FDI flows have fluctuated markedly from year to year but have always remained substantially above one trillion (UNCTAD, 2021).

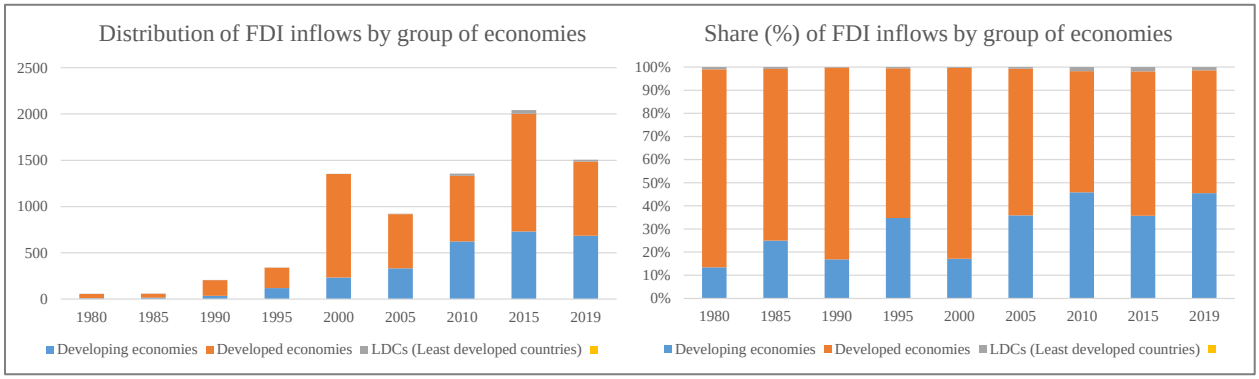


Figure 2.1: FDI inflow by level of economic development (Source: UNCTAD (2021))

If we consider FDI flows in relation to country groupings, we see that developed countries have always attracted the lion's share of FDI flows. Developing countries, as a group, have been able to attract an increased proportion of these flows since 2000 but that proportion has remained stubbornly below 50%. Least developed countries have been able to attract only negligible proportion of FDI flows (Figure 2.1).

When different developing regions of the world are considered, we also observe significant inequality in the distribution of inward FDI across regions (see Table A2.1 in Appendix A2 for details on different regions and list of countries belonging to each region).

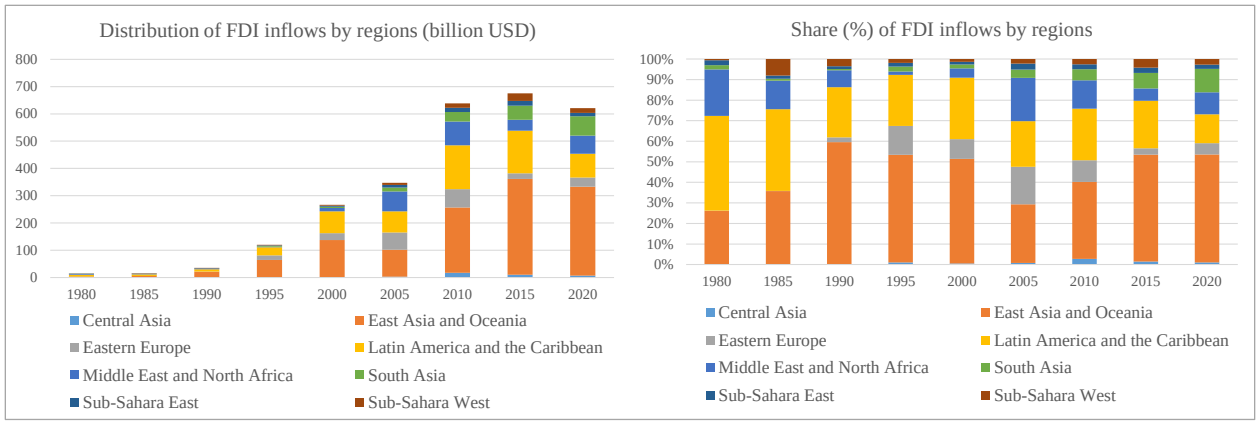


Figure 2.2: FDI inflow by regions (Source: UNCTAD (2021))

In particular, East Asia and Oceanian countries have been attracting the largest share of FDI, among the eight regions considered, since 1990 (Figure 2.2). The second position has been secured by Latin America and the Caribbean, and the third position has been secured alternatively by the Middle East and North Africa, Eastern Europe, and South Asia.

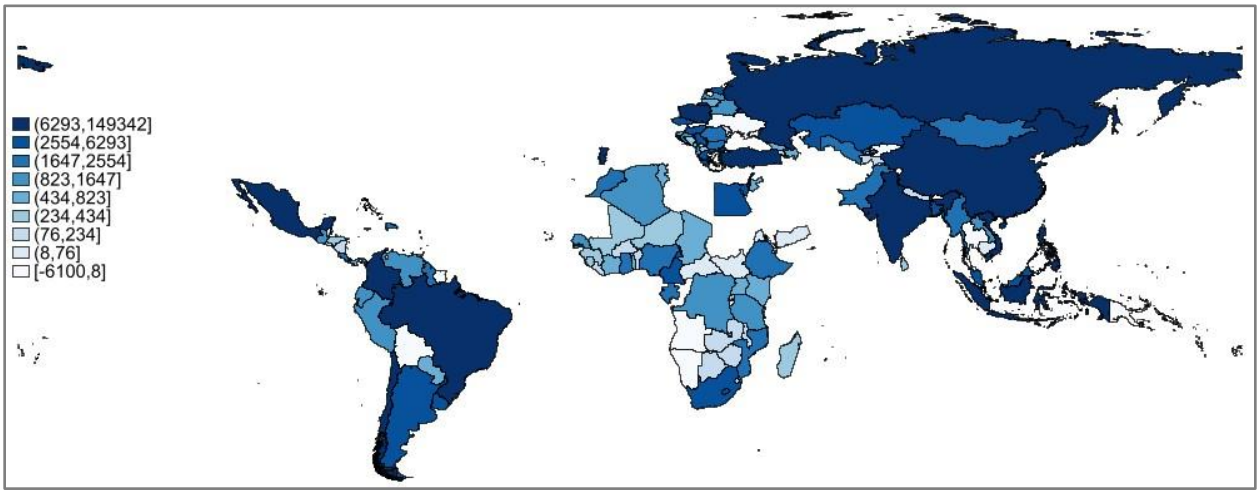


Figure 2.3: Country-wise distribution of FDI inflow in 2020 (Source: UNCTAD (2021))

Note: Numbers in brackets with different colors in the left side of the figure are ranges of FDI inflow in million US$.

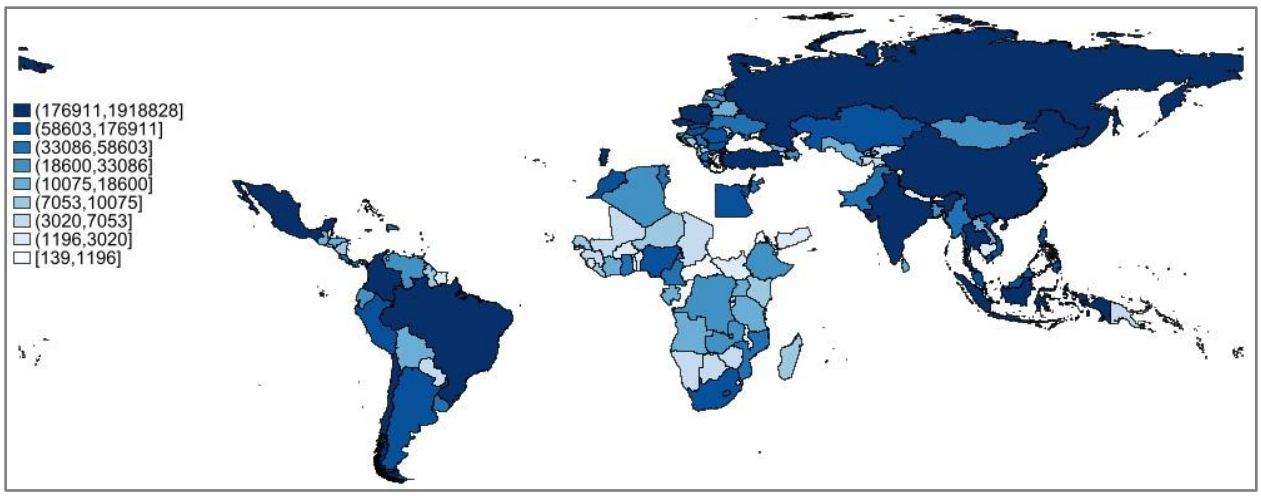


Figure 2.4: Country-wise distribution of FDI stock in 2020 (Source: UNCTAD (2021))

Note: Numbers in bracket with different colors in the left side of the figure are ranges of FDI stock in million US$.

Country-wise distributions of inward FDI flow and stock in 2020 (for developing countries) are shown in Figures 2.3 and 2.4 respectively. Both FDI flow and stock are highly unevenly distributed across countries. The top five countries in terms of FDI flow are China, India, Mexico, Brazil, and Israel; and the top five countries in terms of FDI stock are China, Brazil, Mexico, India, and the Russian Federation. The majority of countries receive very low FDI levels and have low amounts of FDI stock, and only a few countries occupy the medium between those two extremes.

The distribution of inward FDI is also not equal at the industry- or sectoral-level. Some industries or sectors receive a significant share of inward FDI, while others are marginalized. In Figure 2.5, we make use of the World Bank's *Enterprise Survey* data to explore that distribution. Figure 2.5(a) displays sectoral distribution of FIFs in 134 countries (see Table A2.1 in Appendix A2 for the list of countries) by the number of FIFs per sector.[12] The retail and wholesale sector host the largest number of FIFs and the food sector the second largest number. Construction and transportation

[12] The World Bank's *Enterprise Survey* collects data in a broad range of sectors. We re-classified the sectors to avoid having too few observations in a sector. See section 2.5.2 for details.

sector contains the smallest number of FIFs. If we examine the distribution in proportional terms (FIFs as a proportion of firms in that sector), the food sector is found to have the largest share of FIFs, while the wood and furniture, paper, non-metallic, and electronics sector secures the second largest (Figure 2.5(b)). The lowest representation is, again, in construction and transport.

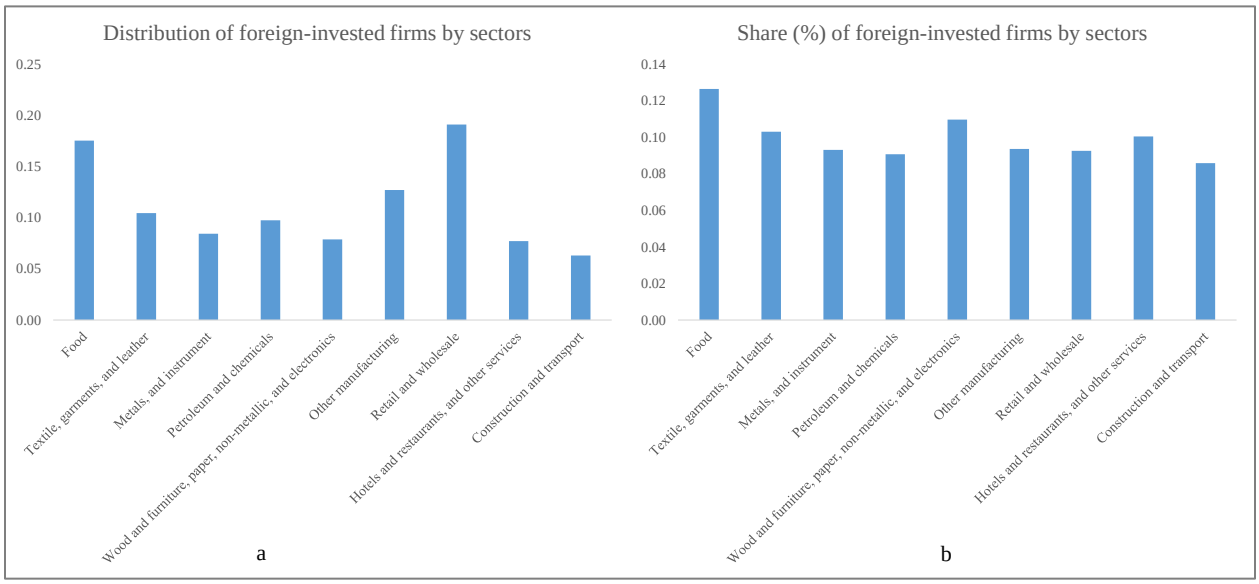


Figure 2.5: Presence of FIFs by sectors (Source: World Bank's *Enterprise Survey*)

This unequal distribution of inward FDI at the regional-, country- and sectoral-level, appropriately, motivate questions regarding the factors, at the level of firm, country, and region, that serve to attract or to discourage FDI inflows or foreign equity participation.

2.5. Methodology

2.5.1. Multilevel logit

The main objective of this investigation is to establish firm-, country-, and world regional-level determinants of foreign equity participation, on the one hand, and to determine whether they differ across these world regions on the other. We need to employ a multilevel (hierarchical) analysis to

account for the nested structure of the dataset (firms or plants are conceived as level-1 units nested within level-2 units, countries, which are themselves nested within level-3 units, world regions).[13] Another advantage of a multilevel model, in our context, is that it allows us to estimate both regional- and country-level effects on firms' FDI decisions. Consistent with the empirical literature, our response variable is a dummy variable indicating whether a firm is foreign-invested (those with 10% or more foreign equity share) or domestic (those with less than 10% foreign equity share). Thus, following Bhupatiraju (2019), Devaney et al. (2019), Farla (2014), Jorgenson and Givens (2014), and Rodríguez-Gulías et al. (2016) among others, we employ a random intercept multilevel logit model (with firm characteristics at level-1, country characteristics at level-2, and world region attributes at level-3) specified as follows:[14]

$$E(FI_{ijk} = 1|\beta, \gamma, \theta) = \varphi_{ijk} \tag{2.1}$$

$$Log\left[\frac{\varphi_{ijk}}{(1-\varphi_{ijk})}\right] = \alpha_0 + \beta X_{ijk} + \gamma Y_{jk} + \theta Z_k + \xi_k + \nu_{jk} + \varepsilon_{ijk} \tag{2.2}$$

where FI_{ijk} indicates whether firm *i* in country *j* and region *k* is domestic or foreign-invested. It takes on a value of 1 if a firm is foreign-invested, and 0 otherwise (domestic). X_{ijk} represents level-1 (firm-level) variables, Y_{jk} represents level-2 (country-level) variables, and Z_k represents level-3 (world regional-level) variables. ξ_k and ν_{jk} are level-3, level-2 random effects respectively; and

[13] The use of a single-level model, by contrast, would lead to overestimation of firm-level variables and incorrect standard errors for country-level and regional-level (group) variables because they depend on the number of countries or regions (Goldstein, 1995).

[14] In a random intercept multilevel logit model, only intercepts are allowed to vary across countries, but slopes are not. In reality, firm-level attributes that are included in the regression may also vary across countries because they often depend on country-specific factors. Hence, allowing slopes of firm-level attributes to vary across countries in a random slope multilevel logit model would be a better econometric framework. However, we could not adopt this model because of estimation challenges. Specifically, the econometric software being used (STATA) could not accommodate that model for this dataset.

ε_{ijk} is the residual that can vary across each firm and is assumed to have zero mean and constant variance (i.e., $\varepsilon_{ijk} \sim N(0, \sigma_{\varepsilon}^2)$).

Information on some explanatory variables in Equation (2.2) are based on firms' own perception. A likely problem with this kind of information is that different firms, in terms of size and ownership, may perceive identical phenomena differently, creating a potential source of endogeneity. The quality of physical infrastructure and financial obstacles faced by firms are two examples of variables that might be perceived differently by different firms (small vs. large, or domestic vs. foreign-invested). In particular, larger firms are more likely to complain about physical infrastructure, while smaller ones are likely to perceive financial obstacles more acutely (Gelb et al., 2008). We address this problem by instrumenting the endogenous (self-perceived) explanatory variables with their own sector-region averages which can be considered exogenous by default (Aterido et al., 2007; Dollar et al., 2005). Generalized structural equation modeling (GSEM) is utilized in instrumenting the endogenous variables with their sector-region averages.

2.5.2. Data

This study utilizes firm-, country-, and regional-level data in the analysis. Firm-level data are drawn from the *Enterprise Survey* database of the World Bank. Data from 134 countries (a mix of developing and recently developed countries) for the period 2006-2019 are compiled to produce the aggregate dataset. Depending on the availability of firm-level data, we utilize single year data for 67 countries and data for two separate years for the remaining 67 countries (see Table A2.1 in Appendix A2). The original data for the 67 countries for which we use two years of data were actually panel. The panel observations were removed from the latest year using panel ID so that the same firm does repeat in both years. We have classified these 134 countries into 8 different

regions on the basis of regional divisions (at the global level) that have been long established in the literature (and International Development practice more broadly) and related to history, geographical proximity and similarities in economic characteristics.[15] The regions are (1) Central Asia (CA), (2) East Asia and Oceania (EAO), (3) Eastern Europe (EE), (4) Latin America and the Caribbean (LAC), (5) Middle East and North Africa (MENA), (6) South Asia (SA), (7) Sub-Saharan Africa East (SSE), (8) Sub-Saharan Africa West (SSW).[16] The final dataset, after omitting missing observations, contains 101,657 firms, of which 91,443 are domestic firms and 10,214 are FIFs. Of the FIFs, about 32% indicated 10-50% foreign ownership and the remaining 68% indicated 51-100% foreign ownership.

The *Enterprise Survey* dataset contains cardinal number estimates of a wide number of variables such as firms' total sales, number of employees, wages, fixed assets, capital, materials, foreign ownership, age, exports, imports and so forth, and ordinal (perception-based) data regarding different kinds of obstacles that firms face. The micro-level explanatory variables used in the analysis are firms' different structural characteristics and the obstacles that they face. The definitions of the explanatory variables are given in Table A2.2 of Appendix A2. To avoid

[15] The division between Sub-Saharan Africa East and Sub-Saharan Africa West is the singular exception to that rule (see the next Footnote).

[16] The three-level logit framework could not estimate the model when we treated Sub-Saharan Africa as a single region. One likely reason is that this region includes 40 countries and around 26,000 observations which is significantly higher than for any other single region. Thus, we divided this region into two parts: Sub-Saharan East and Sub-Saharan West consisting of 20 countries each (see Table A2.1 in Appendix A2). The estimation results support that division by suggesting clear differences between the two Sub-Saharan regions in terms of sign, significance, and magnitude of coefficients. As a robustness check of the results, we also reclassified Sub-Saharan East and Sub-Saharan West shifting Botswana, Namibia, and South Africa from East to West and shifting Central African Republic and Chad from West to East. This reclassification produced the same results as in Table 2.3, 2.4, A2.8, and A2.9—suggesting that the division is not sensitive to the small shifts in country allocation and, therefore, quite robust. The reasons for considering three regions in Asia—Centra Asia, East Asia along with Oceania, and South Asia are differences in economic variables, historical experiences, and geographic proximity. For example, East Asian countries experienced financial crisis, but Central Asia and South Asia did not. The number of observations in Oceania is too small for it to be considered a separate region. Hence, it is included in East Asia considering their geographic proximity.

problems of multicollinearity and to reduce the number of correlated variables, we construct some index variables utilizing principal component analysis (PCA). The methodology is discussed below (section 2.5.3).

The number of sectors under which each firm has been classified in the data differs from country to country. More than 25 sectors were identified across countries. In the analysis, we reclassify sectors to reduce their number so that all sectors in a within-country region will have a sufficient number of firms to make statistical analysis feasible. More specifically, we reclassify sectors into the following nine: (1) food; (2) textile, garments and leather; (3) metals, machinery, and instruments; (4) petroleum and chemicals; (5) wood and furniture, paper and printing, non-metallic product, and electronics; (6) other manufacturing; (7) retail and wholesale; (8) hotel, restaurants, and other services; and (9) construction and transport (see Table A2.4 in Appendix A2 for sectoral distribution of firms).

We create a variable called *FDI Agglomeration*, which is the number of FIFs in a given sector in a given within-country region. It captures the density of the existing network of FIFs in any given region of a country. The inclusion of this variable in the regression thus allows us to control for the direct effect that the (sub-national) regional investment climate may exert on FDI. Another computed variable is *Average wage* which is a sector-region average within a country.[17] This is utilized in the analysis to uncover how the wage level might affect foreign investors' decisions.

Country-level differentials also affect foreign investors' decisions. The theoretical and empirical literature suggests that macroeconomic and institutional conditions account for some of the

[17] To compute average wage, the (within-country) sector-region average of wages per employee is computed first for each country. Then, this sector-region average is converted to US dollar (thousand US dollars) using exchange rate of corresponding country and survey year to express it in a common currency.

differences in FDI inflows across countries. In an attempt to explain the country-level differentials, we use the following macroeconomic variables in the analysis: *GDP per capita* (in thousands of US dollars), *tax rate* which is measured as a percentage of commercial profit, *the inflation rate* (measured as the growth rate of the GDP deflator), *trade relative to GDP* (TRGDP), *KAOPEN* (*de jure* financial openness developed by Chinn and Ito (2008)) which measures the extent and intensity of capital controls as a measure of financial openness, *labor participation* which is the proportion of the working age population that is economically active, and *unemployment* which is the proportion of unemployed people who are actively searching for work to total labor force. Table A2.2 in Appendix A2 describes these variables.

These country-level data, except KAOPEN, are drawn from the *World Development Indicators* of the World Bank, and KAOPEN data is directly used from the Chinn and Ito database. Another macro variable is the *world governance index* (WGI) which is an index constructed from five variables relating to institutional quality. This index is used in the analysis to account for average institutional quality at the country level. The data on these five variables are taken from the World Governance Indicators website of the World Bank (see section 2.5.3 for details). Two regional-level variables, intra-regional trade relative to regional GDP and region-wide governance quality are included in the analysis (see Table A2.2 for definitions).

We also initially considered two other regional variables but removed due to their non-significant coefficients (see section 2.6.2 for details). The underlying argument behind the first regional-level variable is that the higher the intra-regional trade volume, the larger the market for goods and services that foreign-owned firms will produce. Thus, regions with higher intra-regional trade volume are expected to attract more FDI than other regions.

Table 2.1: Descriptive statistics of variables

Variable	Observation	Mean	Std. Dev.	Minimum	Maximum
FDI	101,657	0.1	0.3	0	1
Age	101,657	24.92	15.67	1	220
Agglomeration	101,657	9.24	16.12	0	142
Telecom. problem	101,657	0.51	0.5	0	1
Electricity problem	101,657	1.64	1.48	0	4
Transportation problem	101,657	1.21	1.25	0	5
Financial problem	101,657	1.45	1.31	0	4
Crime and disorder	101,657	1.09	1.24	0	4
Corruption	101,657	1.6	1.47	0	4
Property rights	101,657	2.29	1.08	0	4
Skilled labor problem	101,657	1.31	1.27	0	4
Land problem	101,657	0.95	1.25	0	4
Labor regulation	101,657	1.02	1.14	0	4
Licensing and permit	101,657	1.03	1.19	0	4
Custom and trade	101,657	0.91	1.19	0	4
Tax administration	101,657	1.34	1.27	0	4
Number of workers	101,657	107.27	485.42	0	45,000
Average wage	101,657	8.86	30.27	0	396.60
KAOPEN	134	0.035	1.21	-2	2
GDPPC	134	5.973	5.785	0.275	36.309
Inflation	134	5.476	7.041	-26.7	52.989
Labor participation	134	65.763	10.209	38.515	89.654
Profit tax	134	17.301	8.004	0	58.90
Unemployment rate	134	7.285	5.596	0.398	35.15
Openness	134	-4.724	12.741	-139.365	32.311
WGI difference	134	-0.017	1.298	-5.013	4.592
Regional governance	134	0.052	1.596	-3.547	3.661
IRTRGDP	46	9.12	10.17	0.90	66.23

Note: Average wage is in thousand US dollars. WGI difference is computed by subtracting country-level WGI from regional governance.

The average quality of governance within the region is also a factor to be considered by foreign investors because it is likely to have a significant effect on the perceived certainty of commercial and economic arrangements and perceptions of risk. It is used as the average of WGI values of all countries in a particular region. Higher value of regional governance is expected to attract more

FDI. Table 2.1 presents descriptive statistics of all main variables (firm-, country- and regional-level) used in the analysis.

2.5.3. Principal component analysis

There are some variables in the dataset that include more than one dimension. For example, the physical obstacles faced by firms are of two types: transportation problems and electricity problems. Similarly, institutional obstacles include three variables (i.e., (i) corruption; (ii) crime, theft and disorder; and (iii) property rights). The simultaneous inclusions of all these sub-variables directly in the regression model could produce serious multicollinearity problem. A potential solution to this multicollinearity is to use the Principal Component Analysis (PCA) approach to produce aggregate indices. PCA is a method for transforming multidimensional space into a minimum number of dimensions while preserving the maximum variance of the original spaces (Ait-Izem et al., 2018). Thus, PCA can be defined as a linear transformation of the original correlated data into a new set of uncorrelated aggregate indices.

If x is a m-component random vector having mean vector $E(x) = \mu$ and covariance matrix $E(x-\mu)(x-\mu)' = \Gamma$, the variance of a linear combination $\delta' x$ is

$$E[\delta' x - E(\delta' x)]^2 = E[\delta'(x-\mu)]^2 = E\delta'(x-\mu)(x-\mu)'\delta = \delta'\Gamma\delta \quad (2.3)$$

The linear combination that is normalized by $\delta'\delta = 1$, and has maximum variance, is called the first principal component of x. The linear combination that is uncorrelated with the first one, is normalized similarly and has maximum variance, is called the second principal component. Similarly, other $p-2$ components are defined accordingly.

Following Kinda (2010) and Bhupatiraju (2019), we obtain five index variables from the micro data, and one index variable from macro data. Tables A2.6 and A2.7 in Appendix A2 present principal components (and related Eigen values and percentage of variations explained) for micro and macro indices respectively. The first component in each specification of PCA explains a significant fraction of total variation (last row of Tables A2.5 and A2.6). Hence, we produce one index (component) from each specification of the PCA.[18]

The first index variable is *physical infrastructure* which is derived from two variables: (i) problem of transportation of goods, supplies, and inputs; and (ii) electricity problems. These original variables are categorical, having five values that represent no major obstacle, minor obstacle, moderate obstacle, major obstacle, and very severe obstacle. The second index variable is *infrastructure* (indication of overall infrastructure) constructed with four variables: (i) and (ii) used in the first index variable, i.e., the two variables used in constructing *physical infrastructure*; (iii) telecommunication problems (proxied by whether firms have their own website or not—a binary variable having values of 1 and 0);[19] and (iv) financial constraints (proxied by obstacles faced in accessing finance, which is also a categorical variable that takes on five values ranging from no major obstacle to very severe obstacle). Thus, *infrastructure* explains how overall infrastructural obstacles affect foreign equity participation.

[18]. According to the Eigen value rule, one should produce as many index as the number of components for which Eigen values are greater than 1. This makes sure that significant fraction of total variation is explained by that number of indices. In our case, the Eigen values are greater than 1 only for the first component in each specification of PCA. Thus, we proceed with producing one index from each specification.

[19] There are two other variables in the dataset representing telecommunication problems faced by firms: (i) whether firms currently communicate with clients and suppliers by email; and (ii) obstacles of telecommunications to operations of establishments. *Enterprise Survey* stopped collecting data on the first variable after 2017. Since we use data beyond 2017 for nearly 50 countries, we exclude this variable from the analysis. The second variable cannot be incorporated because of missing data for almost half of the observations in the aggregate dataset.

The third index variable is *institutions* (indication of overall institutional quality) that accounts for the institutional obstacles that firms face. Variables used in constructing this index are: (i) corruption; (ii) crime, theft, and disorder; and (iii) property rights protections (i.e., whether the court system is fair, impartial and uncorrupted). These three variables are also categorical. The first two variables can take on five values ranging from no obstacle to very severe obstacle, while the third variable (property rights) takes on only four values (relating to the obstacles to the full realization of property rights—the rights to acquire, use, and dispose of property freely), namely, strongly disagree, tend to disagree, tend to agree, and strongly agree. The fourth index variable is *factor* which accounts for problems associated with accessing factors of production. Two variables, skilled labor problems (i.e., inadequately educated workforce) and land access problem, are utilized to construct this index. These two variables are also categorical and take on five values ranging from no obstacle to very severe obstacle. The last index variable is *admin* which accounts for administrative obstacles that firms face. Four variables are utilized to construct this index: (i) labor regulation as an obstacle; (ii) business licensing and permits as an obstacle; (iii) customs and trade regulations as an obstacle; and (iv) tax administration as an obstacle. They are all categorical variables taking one of five values ranging from no obstacles to very severe obstacle.

The macroeconomic index variable is the worldwide governance indicator (WGI) constructed utilizing six variables (voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law, and control of corruption). Table A2.3 in Appendix A2 defines these variables.

2.6. Results

First, we estimate a 'null' or 'empty' model which is specified as $Log\left[\frac{\varphi_{ijk}}{(1-\varphi_{ijk})}\right] = \alpha_0 + \xi_k + \nu_{jk} + \varepsilon_{ijk}$, where α_0 is a constant, and ξ_k, ν_{jk} and ε_{ijk} are regional- country- and firm-level random effects respectively. The model can tell us how much regional- and country-level characteristics and firm-level idiosyncrasy separately affect foreign equity participation across countries and regions. The estimates that we are interested in are the random (unobserved) parts of our model. The parameters σ_ξ^2 and σ_ν^2 are the variances of ξ_k and ν_{jk} which are regional- and country-level random intercepts respectively. The log-restricted likelihood ratio (LR) test statistics is used to test *H₀*: random-effects = 0 (i.e., population variance $\sigma_\xi^2 = 0$ and σ_ν^2 = 0) against *Hₐ*: random-effects > 0 (i.e., population variance $\sigma_\xi^2 > 0$ and σ_ν^2 > 0). We estimate nine different regressions for this null model: one for the aggregate dataset and one for each of the eight world regions. Results are reported in Table 2.2 and show that the LR test statistics are significant at the 1% level in all specifications, thus indicating the presence of significant regional and country contexts in explaining foreign equity participation.

Table 2.2: Estimation of null model

	All	CA	EAO	EE	LAC	MENA	SA	SSE	SSW
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Constant	-1.999***	-2.992***	-1.444***	-1.786***	-2.302***	-3.857***	-3.422***	-1.176***	-2.126***
	(0.082)	(0.331)	(0.261)	(0.360)	(0.108)	(0.755)	(0.241)	(0.243)	(0.610)
LR Chi^2	6041.69***	109.71***	349.88***	229.58***	35.33***	278.09***	210***	376.58***	219.30***
ρ_c	0.158	0.106	0.165	0.068	0.016	0.129	0.101	0.110	0.234
ρ_r	0.174								
Observations	101,657	10,073	11,974	15,590	18,553	9,619	13,310	11,491	11,047
No. of countries	134	8	18	22	31	9	6	20	20

Note: Note: ***p < 0.01, **p < 0.05, *p < 0.1. Standard errors are in parentheses. All regressions include sector and year dummies.

The intraclass correlation coefficients (ICC), the correlation of observations within groups (regions and countries), indicate how much the country and regional contexts explain firm-level foreign equity participation.[20] With regard to our model, the values of ICC (ρ_c and ρ_r in Table 2.2) show how much of the FDI decisions can be attributed to country- and regional-level unobserved characteristics. In the aggregate data model (column 1), the values of ρ_c and ρ_r are 0.158 and 0.174 respectively and are significant. These values imply that country- and regional-level characteristics explain 15.8% and 17.4% of foreign equity participation respectively. Although these values are relatively small, they are significant at the 1% level, implying substantive contextual differences between countries and regions receiving FDI. Among regions, the highest value of ρ_c is 0.234 (for SSW), and the smallest value is 0.068 (for EE). In effect, the presumption that differences in country-level and regional-level factors help explain foreign equity participation is validated.

2.6.1. Firm-level analysis

In Table 2.3, firm-level explanatory variables are introduced. The model is estimated for aggregate data as well as for the eight regions separately. Moreover, for both aggregate data and for each region, the model is estimated with two distinct specifications: one with infrastructure (see section 2.5.3 for the definition of infrastructure) as a single variable and another with communication infrastructure, physical infrastructure and financial infrastructure included separately. These two specifications show how much infrastructural obstacle as a whole, and the individual infrastructural obstacles (that make up aggregate infrastructure) affect foreign equity participation.

[20] The ICC at the regional-level is given by ICC=$(\sigma_\xi^2)/(\sigma_\xi^2 + \sigma_\nu^2 + \sigma_\varepsilon^2)$ and country-level by ICC=$(\sigma_\nu^2 + \sigma_\xi^2)/(\sigma_\xi^2 + \sigma_\nu^2 + \sigma_\varepsilon^2)$, where σ_ε^2 is the variance of ε_{ijk}, and σ_ξ^2 and σ_ν^2 are variances of ξ_k and ν_{jk} respectively.

To get rid of the endogeneity issue for the different measures of infrastructure (five index variables—*physical infrastructure, infrastructure, institution, factor, and admin*—as well as telecommunication problem and financial constraints) as discussed in section 2.5.1, they are instrumented with their (within-country) sector-region averages following Dollar et al. (2005) and Lall and Mengistae (2005).[21] As noted earlier, the model is estimated using generalized structural equation modeling (GSEM). See Table A2.8 in Appendix A2 for the same regression results without the instrumental variable approach.

Across specifications, the coefficients for the log of age are negative and significant (except for SA) and the coefficients for size and FDI agglomeration are positive and significant. The negative coefficients for the log of age imply that FIFs are generally younger firms (SA being the exception). The positive significant coefficients for size (medium and large) mean that FIFs are more likely to be larger. This is an expected result since MNEs tend to be large firms with vast assets or prefer to invest in large firms (Kumar, 1982). FDI Agglomeration has a positive impact on foreign equity participation, meaning that the presence of other FIFs in the same sector in a given region of a country attracts further foreign investment (Belkhodja et al., 2017; Ferrer, 1998; Guimarães et al., 2000; Head et al., 1995). It also means congregation of FIFs in specific sectors and region of a country.

[21] Dollar et al. (2005) and Lall and Mengistae (2005) argued that sector-region averages of these endogenous variables are partly exogenous because they represent an investment climate that is, on average, valid for all firms in the particular sector in a given region. Kinda (2010), Bhupatiraju (2019), and Aterido et al. (2007) used this way of instrumenting.

Table 2.3: Firm-level data with an instrumental variable approach

	All		CA		EAO		EE		LAC		MENA		SA		SSE		SSW	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Lnage	-0.308***	-0.348***	-0.351***	-0.405***	-0.451***	-0.469***	-0.566***	-0.577***	-0.43***	-0.476***	-0.408***	-0.466***	-0.202	-0.227	-0.072	-0.129**	0.221***	0.164**
	(0.022)	(0.022)	(0.077)	(0.079)	(0.073)	(0.074)	(0.054)	(0.054)	(0.049)	(0.049)	(0.072)	(0.073)	(0.156)	(0.157)	(0.051)	(0.052)	(0.069)	(0.07)
Medium	0.834***	0.697***	0.856***	0.73***	0.634***	0.582***	0.986***	0.947***	0.816***	0.672***	0.595***	0.488***	0.953***	0.627**	0.804***	0.627***	0.788***	0.601***
	(0.03)	(0.031)	(0.118)	(0.12)	(0.091)	(0.092)	(0.079)	(0.079)	(0.071)	(0.073)	(0.119)	(0.12)	(0.259)	(0.266)	(0.065)	(0.067)	(0.07)	(0.073)
Large	1.94***	1.695***	1.644***	1.418***	1.928***	1.77***	2.258***	2.202***	2.044***	1.8***	1.707***	1.498***	1.921***	1.357***	1.631***	1.31***	1.723***	1.353***
	(0.032)	(0.034)	(0.13)	(0.133)	(0.092)	(0.096)	(0.081)	(0.083)	(0.073)	(0.076)	(0.12)	(0.123)	(0.256)	(0.269)	(0.078)	(0.082)	(0.091)	(0.096)
FDI Agglom	0.018***	0.018***	0.093***	0.089***	0.014***	0.014***	0.075***	0.075***	0.029***	0.028***	0.117***	0.115***	0.203***	0.178***	0.007***	0.006***	0.025***	0.026***
	(0.001)	(0.001)	(0.01)	(0.01)	(0.001)	(0.001)	(0.004)	(0.004)	(0.002)	(0.002)	(0.009)	(0.009)	(0.024)	(0.023)	(0.002)	(0.002)	(0.003)	(0.003)
Infrastructure	-0.136***		-0.053		-0.192***		-0.057*		-0.06**		-0.107**		-0.386***		-0.202***		-0.202***	
	(0.012)		(0.048)		(0.038)		(0.03)		(0.024)		(0.047)		(0.09)		(0.028)		(0.031)	
Communication		-0.623***		-0.835***		-0.382***		-0.139*		-0.597***		-0.768***		-1.351***		-0.739***		-0.848***
		(0.027)		(0.111)		(0.069)		(0.074)		(0.065)		(0.1)		(0.201)		(0.061)		(0.07)
Physical		0.036***		0.063		0.002		0.072**		0.063***		-0.013		-0.224**		0.019		0.037
		(0.012)		(0.049)		(0.038)		(0.03)		(0.023)		(0.048)		(0.09)		(0.03)		(0.034)
Financial		-0.199***		-0.084**		-0.264***		-0.192***		-0.157***		-0.105**		-0.142*		-0.214***		-0.233***
		(0.011)		(0.042)		(0.036)		(0.028)		(0.023)		(0.042)		(0.078)		(0.023)		(0.027)
Institution	-0.081***	-0.085***	-0.153**	-0.165***	-0.007	-0.008	-0.22***	-0.211***	-0.157***	-0.152***	-0.031	-0.044	-0.097	-0.169*	-0.044	-0.053	0.016	0.005
	(0.014)	(0.014)	(0.061)	(0.061)	(0.044)	(0.044)	(0.039)	(0.039)	(0.028)	(0.028)	(0.052)	(0.052)	(0.099)	(0.099)	(0.03)	(0.039)	(0.034)	(0.034)
Factor	-0.016	-0.009	-0.014	-0.032	0.072*	0.078*	-0.072**	-0.06*	-0.087***	-0.084***	-0.023	-0.002	-0.047	-0.054	-0.061**	-0.056*	0.052	0.068*
	(0.013)	(0.013)	(0.051)	(0.052)	(0.043)	(0.043)	(0.034)	(0.034)	(0.029)	(0.029)	(0.052)	(0.052)	(0.089)	(0.09)	(0.03)	(0.031)	(0.034)	(0.035)
Admin	0.151***	0.136***	0.208***	0.189***	0.183***	0.174***	0.102***	0.105***	0.176***	0.163***	0.126***	0.113***	0.27***	0.253***	0.173***	0.153***	0.12***	0.095***
	(0.011)	(0.011)	(0.051)	(0.051)	(0.035)	(0.036)	(0.029)	(0.029)	(0.024)	(0.024)	(0.04)	(0.04)	(0.071)	(0.071)	(0.026)	(0.026)	(0.028)	(0.028)
Ln(Av. Wage)	0.065***	0.058***	0.187***	0.178***	0.093***	0.095***	0.031	0.033	-0.002	-0.007	-0.004	-0.001	0.059	0.0798	0.026	0.006	0.048**	0.029
	(0.011)	(0.015)	(0.061)	(0.064)	(0.028)	(0.028)	(0.032)	(0.031)	(0.034)	(0.035)	(0.056)	(0.057)	(0.073)	(0.077)	(0.029)	(0.029)	(0.022)	(0.023)
Constant	-2.924***	-2.488***	-2.676***	-3.342***	-0.872**	-0.927**	-1.082**	-0.991*	-2.9***	-2.064***	-3.055***	-2.21***	-4.225***	-3.54***	-1.849***	-0.859**	-4.259***	-3.168***
	(0.296)	(0.322)	(0.416)	(0.649)	(0.35)	(0.407)	(0.432)	(0.509)	(0.226)	(0.378)	(0.693)	(0.847)	(0.638)	(0.881)	(0.305)	(0.422)	(0.62)	(0.61)
LR Chi^2	4338***	4620***	95.5***	100.1***	202.2***	189.9***	150.6***	137.1***	25.5***	26.4***	117.7***	124.4***	32.2***	40.7***	161.4***	196.9***	124.3***	112.3***
ρ_c	0.144	0.147	0.132	0.145	0.160	0.144	0.045	0.044	0.012	0.015	0.094	0.100	0.080	0.080	0.095	0.112	0.191	0.163
ρ_r	0.139	0.151																
Observations	101,657		10,073		11,974		15,590		18,553		9,619		13,310		11,491		11,047	
No. of countries	134		8		18		22		31		9		6		20		20	

Note: ***p < 0.01, **p < 0.05, *p < 0.1. Standard errors are in parentheses. All regressions include sector and year dummies.

The coefficients for infrastructure are negative and significant (except for CA), implying that infrastructure-related obstacles, broadly, discourage foreign equity participation. This result is in line with previous findings in the literature (Bhupatiraju, 2019; Kinda, 2010). Communication and financial infrastructure challenges (in the second specifications of the aggregate data model and across regions) have negative impacts on foreign equity participation. The coefficient for physical infrastructure is positive and significant in the aggregate data model as well as EE, and LAC, but negative and significant for SA. A positive (and significant) coefficient for physical infrastructure would seem to suggest that, in those regions, foreign investors have chosen to invest more heavily in countries and/or within-country regions that are more likely to have infrastructural challenges in terms of electricity and transportation (or, perhaps, the most profitable opportunities are in countries or within-country regions where the infrastructure challenges remain). By contrast, the negative coefficient for SA suggests that poor infrastructure *discourages* foreign investment. Given that EE and LAC are regions dominated by upper-middle-income countries, it may well be that firms' main choice is between very good physical infrastructure and moderately good physical infrastructure while for SA, a low-income region, firms may be resigned to modest-to-low quality in terms of physical infrastructure but draw the line at very poor infrastructure. Kinda (2010) and Bhupatiraju (2019) also found a positive relationship between physical infrastructural challenges and foreign equity participation. They argued that the return on investment in countries with weak infrastructure – an indication of lower levels of development – is higher, and that attracts foreign investors.[22]

[22] Countries with the problem of physical infrastructure may possess less bargaining power, and markets in those countries are likely to be less developed. Thus, MNEs or foreign investors in those countries may have significant control over prices as well as additional leverage that they can use to obtain rents.

The coefficients for institutional infrastructure are negative and significant (in both specifications) for CA, EE, and LAC, implying that problematic institutional settings (crime, corruption and limited property rights protection) discourage foreign equity participation. Again, these are upper-middle income regions, typically having only modest levels of corruption and moderate-to-excellent property rights protection. The negative coefficient likely indicates that countries (or within-country regions) that cannot provide these protections stand out and attract less FDI. By contrast, the absence of a significant coefficient for institutional infrastructure in other regions may be an indication that, since institutional challenges are pervasive, a poor record for a particular country (or within-country region) may matter much less as a deterrent for foreign investment decisions.

The coefficient for factors is not significant in the aggregate data model. However, that coefficients are negative and significant in EAO, EE, LAC and SSE, indicating its importance in those regions. In particular, a negative and significant coefficient indicates that problems relating to factors of production (i.e., constrained access to skilled labor and land) discourage foreign equity participation. However, the coefficient for that variable is positive and significant for SSW (although only in the second specification and weakly so), implying that lack of access to factors of production encourages foreign equity participation. This may be more incidental than real. Since FDI in that region is known to be mostly directed at resource exploitation, access to factors of production may simply be negatively correlated with the amount of available resource wealth.

The presence of administrative obstacles is positively associated with foreign equity participation in all regions and the aggregate data model. This result is supported by the findings of Bhupatiraju (2019). Nevertheless, it is, at first blush, counterintuitive because theories and most empirical findings suggest that administrative obstacles tend to discourage inward FDI (Globerman &

Shapiro, 2003; Loree & Guisinger, 1995; Morisset & Neso, 2002; Sin & Leung, 2001). However, this result may be an indication that seeking foreign affiliation (through full or partial ownership) may be one of the strategies used by domestic firms to overcome or mitigate administrative challenges. Child and Rodrigues (2005) and Meyer and Nguyen (2005) showed that administrative and institutional pressures in the domestic economy can lead local investors to seek inward internationalization by means of original equipment manufacture and joint venture entry. Certainly, given the special privileges provided to MNEs in most countries, it is not an unreasonable supposition that FIFs have more leverage in overcoming administrative obstacles.

The coefficients for (log of) average wage are positive and significant in the aggregate data model and for CA, EAO, and the first specification of SSW. A positive and significant coefficient implies a higher wage in the sectors containing FIFs, or a higher wage in FIFs. To a certain extent, and particularly in the developing country context, a higher average wage may be more effect than cause of foreign investment. Even when foreign investors choose to invest in a particular firm within a sector or a within-country region in order to exploit cheap labor, they may, in fact, still find it prudent to offer a higher wage than the (within-country) region or sector average (Conyon et al., 1999; Driffield, 1996, 2000) in order to retain workers, protect privileged technology, and induce higher productivity.

The values of the intraclass correlation coefficients (ICC) at the country– and regional-level (ρ_c and ρ_r) are 0.144 and 0.139 respectively in the first specification and 0.147 and 0.151 respectively in the second specification (both are significant at the 1% level)—implying that country- and regional-level contexts are, although small, not negligible in affecting foreign equity participation. This is also an indication that the multilevel model provides a more complete explanation of foreign investment choices than the firm-level model (single level model).

2.6.2. Firm-, country- and regional-level analysis

We now introduce macro variables (country and regional variables) into the analysis in order to account for the country-level effects and regional contexts, along with the firm-level variables, in the explanation of foreign equity participation. The endogenous firm-level variables are instrumented with their within-country sector-region averages as before. Results, reported in Table 2.4, show that the effects of firm-level variables are the same as in Table 2.3, except for average wage. Results for (the log of) average wage indicate additional significant coefficients, in the second specifications, for MENA and SSW.

With regard to macro variables, the coefficient for KAOPEN (capital account openness) is significant in the aggregate data model, where it has a negative coefficient. It is similarly negative and significant for four of the middle-income regions (CA, EE, LAC and MENA), insignificant for SSE and SSW, and positive significant and large for SA.[23] This suggests that open capital accounts more typically discourage, rather than encourage, foreign equity participation in the developing country context. This is not altogether surprising. Open capital accounts are more important for portfolio investment than FDI, since countries with closed capital accounts typically make provisions to accommodate FDI.[24]

[23] The coefficient estimates for the regional-level variables in the regional-level equations are essentially derived from two-year comparing for subsets of countries in the region (those with two separate surveys), hence those coefficient estimates are significantly less robust than those derived from the aggregate data model (which compares regions across both space and time) and therefore should be given less authority.
[24] China is a perfect example of that archetype.

Table 2.4: Firm-level, country-level, and regional data with instrumental variable approach

	All		CA		EAO		EE		LAC		MENA		SA		SSE		SSW	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
lnage	-0.316***	-0.353***	-0.375***	-0.421***	-0.464***	-0.474***	-0.58***	-0.59***	-0.428***	-0.473***	-0.411***	-0.473***	-0.203	-0.216	-0.06	-0.115**	0.197***	0.151**
	(0.022)	(0.023)	(0.077)	(0.079)	(0.073)	(0.074)	(0.054)	(0.054)	(0.049)	(0.05)	(0.072)	(0.074)	(0.156)	(0.158)	(0.051)	(0.052)	(0.07)	(0.07)
Medium	0.826***	0.698***	0.851***	0.732***	0.65***	0.592***	0.973***	0.935***	0.824***	0.676***	0.609***	0.494***	0.962***	0.626**	0.817***	0.65***	0.76***	0.587***
	(0.03)	(0.031)	(0.119)	(0.12)	(0.091)	(0.092)	(0.079)	(0.08)	(0.072)	(0.073)	(0.119)	(0.121)	(0.276)	(0.283)	(0.066)	(0.067)	(0.071)	(0.073)
Large	1.933***	1.694***	1.659***	1.436***	1.946***	1.776***	2.24***	2.185***	2.058***	1.808***	1.644***	1.414***	1.988***	1.348***	1.656***	1.341***	1.706***	1.362***
	(0.033)	(0.034)	(0.131)	(0.134)	(0.093)	(0.096)	(0.082)	(0.083)	(0.074)	(0.077)	(0.124)	(0.127)	(0.27)	(0.286)	(0.08)	(0.084)	(0.093)	(0.098)
FDI Agglom	0.018***	0.018***	0.091***	0.085***	0.014***	0.014***	0.074***	0.074***	0.03***	0.029***	0.114***	0.112***	0.172***	0.173***	0.006***	0.006***	0.026***	0.027***
	(0.001)	(0.001)	(0.01)	(0.01)	(0.002)	(0.002)	(0.004)	(0.004)	(0.003)	(0.003)	(0.009)	(0.01)	(0.024)	(0.025)	(0.002)	(0.002)	(0.003)	(0.003)
Infrastructure	-0.138***		-0.055		-0.201***		-0.055*		-0.061**		-0.107**		-0.413***		-0.211***		-0.204***	
	(0.012)		(0.048)		(0.038)		(0.03)		(0.024)		(0.048)		(0.091)		(0.029)		(0.032)	
Communication		-0.628***		-0.824***		-0.381***		-0.136*		-0.612***		-0.817***		-1.359***		-0.73***		-0.842***
		(0.027)		(0.112)		(0.069)		(0.074)		(0.065)		(0.101)		(0.204)		(0.061)		(0.07)
Physical		0.035***		0.063		-0.005		0.072**		0.063***		-0.001		-0.208**		0.012		0.034
		(0.012)		(0.049)		(0.038)		(0.03)		(0.024)		(0.049)		(0.093)		(0.03)		(0.034)
Financial		-0.197***		-0.087**		-0.263***		-0.188***		-0.158***		-0.108**		-0.157**		-0.218***		-0.231***
		(0.011)		(0.042)		(0.036)		(0.028)		(0.023)		(0.043)		(0.079)		(0.023)		(0.027)
Institution	-0.079***	-0.084***	-0.159***	-0.168***	-0.009	-0.01	-0.203***	-0.196***	-0.16***	-0.158***	-0.043	-0.054	-0.113	-0.159	-0.039	-0.049	0.013	0.002
	(0.014)	(0.014)	(0.061)	(0.061)	(0.044)	(0.044)	(0.039)	(0.039)	(0.028)	(0.028)	(0.053)	(0.053)	(0.1)	(0.1)	(0.03)	(0.03)	(0.034)	(0.034)
Factor	-0.017	-0.011	-0.017	-0.033	0.075*	0.078*	-0.071**	-0.059*	-0.081***	-0.078***	-0.032	-0.015	-0.034	-0.063	-0.064**	-0.058*	0.053	0.067*
	(0.013)	(0.013)	(0.051)	(0.052)	(0.043)	(0.043)	(0.034)	(0.034)	(0.029)	(0.029)	(0.052)	(0.053)	(0.09)	(0.092)	(0.03)	(0.031)	(0.035)	(0.035)
Admin	0.152***	0.138***	0.209***	0.189***	0.19***	0.18***	0.101***	0.103***	0.173***	0.162***	0.123***	0.104**	0.285***	0.258***	0.174***	0.152***	0.116***	0.092***
	(0.011)	(0.011)	(0.051)	(0.051)	(0.036)	(0.036)	(0.029)	(0.029)	(0.024)	(0.024)	(0.041)	(0.041)	(0.072)	(0.072)	(0.026)	(0.026)	(0.028)	(0.028)
Ln(avwage)	0.064***	0.055***	0.226***	0.217***	0.093***	0.096***	0.045	0.045	0.031	0.027	-0.053	-0.066	0.138	0.096	0.012	-0.011	0.045**	0.026
	(0.011)	(0.011)	(0.055)	(0.056)	(0.028)	(0.028)	(0.035)	(0.035)	(0.038)	(0.038)	(0.06)	(0.061)	(0.09)	(0.091)	(0.027)	(0.028)	(0.022)	(0.022)
KAOPEN	-0.102**	-0.104**	-0.343*	-0.31*	0.234	0.206	-0.207*	-0.209*	-0.124**	-0.131**	-0.663**	-0.813**	3.06**	2.794**	0.002	0.004	-0.168	-0.16
	(0.048)	(0.049)	(0.181)	(0.182)	(0.158)	(0.156)	(0.109)	(0.108)	(0.052)	(0.053)	(0.319)	(0.323)	(1.263)	(1.275)	(0.102)	(0.122)	(0.213)	(0.207)
GDPPC	-0.007	-0.004	-0.219***	-0.221***	-0.172	-0.166	0.058	0.058	-0.009	-0.009	-0.336*	-0.353*	-4.375***	-3.120***	0.038	0.068	-0.026	-0.016
	(0.015)	(0.015)	(0.041)	(0.04)	(0.167)	(0.163)	(0.04)	(0.04)	(0.017)	(0.017)	(0.186)	(0.189)	(0.948)	(0.955)	(0.115)	(0.138)	(0.225)	(0.212)
Inflation	-0.015***	-0.014**	-0.034**	-0.031**	-0.131	-0.115	-0.055*	-0.049*	-0.001	-0.001	0.095**	0.138***	-0.023	-0.024	-0.044***	-0.046***	-0.046**	-0.039*
	(0.006)	(0.006)	(0.015)	(0.015)	(0.081)	(0.08)	(0.028)	(0.029)	(0.009)	(0.009)	(0.047)	(0.048)	(0.2)	(0.201)	(0.01)	(0.011)	(0.021)	(0.02)
Labor parti.	-0.014*	-0.016**	0.021	0.022	-0.026	-0.025	0.003	0.002	-0.005	-0.007	-0.238***	-0.302***	-0.268***	-0.221*	-0.018	-0.023	0.104***	0.097***
	(0.008)	(0.008)	(0.022)	(0.022)	(0.026)	(0.025)	(0.018)	(0.018)	(0.01)	(0.011)	(0.07)	(0.07)	(0.127)	(0.127)	(0.016)	(0.019)	(0.027)	(0.025)
Profit tax	-0.013**	-0.01*	-0.015	-0.012	0.026	0.021	-0.032	-0.034	-0.001	-0.001	-0.464***	-0.518***	0.06	0.069	-0.04***	-0.041**	-0.004	-0.001
	(0.005)	(0.005)	(0.024)	(0.024)	(0.044)	(0.043)	(0.021)	(0.021)	(0.008)	(0.009)	(0.133)	(0.134)	(0.087)	(0.087)	(0.015)	(0.017)	(0.014)	(0.014)

Table 2.4: (continued)

	All		CA		EAO		EE		LAC		MENA		SA		SSE		SSW	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Unemployment	-0.013	-0.01	-0.033	-0.037	-0.059	-0.073	-0.026*	-0.021	-0.064***	-0.073***	-0.655***	-0.757***	-0.091	-0.191	-0.03	-0.042	-0.087	-0.073
	(0.008)	(0.008)	(0.052)	(0.053)	(0.119)	(0.117)	(0.014)	(0.014)	(0.018)	(0.019)	(0.194)	(0.197)	(0.447)	(0.446)	(0.024)	(0.027)	(0.053)	(0.052)
TRGDP	-0.012***	-0.013***	-0.017	-0.019	-0.004	-0.004	-0.007	-0.004	-0.02***	-0.02***	0.395***	0.441***	-0.169	-0.134	-0.002	0	-0.002	-0.003
	(0.003)	(0.003)	(0.014)	(0.014)	(0.007)	(0.007)	(0.013)	(0.013)	(0.007)	(0.007)	(0.112)	(0.114)	(0.168)	(0.167)	(0.006)	(0.008)	(0.012)	(0.012)
WGI difference	-0.105**	-0.088**	-0.346***	-0.305***	-0.371	-0.345	0.116	0.135	-0.047	-0.046	-2.249***	-2.572***	0.205	-0.052	-0.227***	-0.22**	-0.229*	-0.194
	(0.042)	(0.042)	(0.115)	(0.116)	(0.333)	(0.326)	(0.175)	(0.175)	(0.061)	(0.062)	(0.626)	(0.636)	(0.957)	(0.953)	(0.081)	(0.093)	(0.136)	(0.128)
WGI*Medium	0.011	0.013	0.035	0.05	0.059	0.059	-0.033	-0.039	0.039	0.034	0.128	0.131	0.051	0.02	0.13***	0.125***	-0.069	-0.05
	(0.021)	(0.021)	(0.077)	(0.078)	(0.084)	(0.084)	(0.047)	(0.047)	(0.05)	(0.05)	(0.101)	(0.103)	(0.606)	(0.607)	(0.045)	(0.046)	(0.049)	(0.049)
WGI*Large	-0.044**	-0.045**	0.088	0.084	-0.15**	-0.138*	-0.13***	-0.137***	0.009	0.007	-0.106	-0.1	-0.001	0.006	0.115**	0.108*	-0.048	-0.013
	(0.022)	(0.022)	(0.083)	(0.084)	(0.072)	(0.073)	(0.047)	(0.047)	(0.048)	(0.048)	(0.105)	(0.105)	(0.663)	(0.666)	(0.057)	(0.058)	(0.062)	(0.063)
Reg. governance	0.089**	0.078**	1.601***	1.544***	-0.88	-0.861	-0.247	-0.246	-0.714	0.501	-0.33	-0.429**	0.023***	0.021***	0.078	0.255	0.942	0.58
	(0.041)	(0.036)	(0.475)	(0.473)	(1.044)	(1.024)	(0.338)	(0.338)	(1.592)	(1.629)	(0.217)	(0.218)	(0.001)	(0.001)	(0.166)	(0.18)	(2.647)	(2.598)
IRTRGDP	0.018**	0.027***	-0.097**	-0.092**	-0.028	-0.03	0.024	0.025	-0.063	0.14	-3.707***	-4.063***	0.003***	0.004***	-0.004	0.002	0.085	0.088
	(0.007)	(0.008)	(0.042)	(0.042)	(0.034)	(0.033)	(0.041)	(0.041)	(0.295)	(0.302)	(0.751)	(0.755)	(0.001)	(0.001)	(0.015)	(0.016)	(0.099)	(0.094)
Constant	-2.053***	-0.426	-4.465***	-3.911**	0.629	1.355	-1.326	-0.934	-0.796	-2.594	38.969***	46.078***	2.798566	2.499	0.564	2.139	-9.529**	-8.519*
	(0.632)	(1.298)	(1.688)	(1.73)	(2.24)	(2.196)	(1.994)	(2.003)	(4.039)	(4.144)	(7.461)	(7.551)	(7.729733)	(7.713)	(1.706)	(1.995)	(4.651)	(4.596)
LR Chi^2	3405***	3620***	501.4***	569.3***	142.8***	136.0***	40.2***	40.9***	16.2***	17.5***	20.4***	22.9***	80.9***	85.5***	22.5***	34.5***	59.8***	58.3***
ρ_c	0.127	0.129	0.098	0.100	0.126	0.120	0.034	0.034	0.014	0.016	0.021	0.024	0.068	0.067	0.019	0.031	0.151	0.133
ρ_r	0.083	0.091																
Observations	101657		10073		11974		15590		18553		9619		13310		11491		11047	
No. of countries	134		8		18		22		31		9		6		20		20	

Note: ***p < 0.01, **p < 0.05, *p < 0.1. Standard errors are in parentheses. All regressions include sector and year dummies.

However, an open capital account brings with it an increased risk of financial crises that may discourage FDI. It is also not surprising that this question is relevant mostly to middle income regions since open capital accounts are more common in those regions. Its positive association with FDI for SA, a region that continues to maintain a high degree of capital account restrictions (Jongwanich, 2019), can be explained by some unknown factors.[25]

GDP per capita (not relevant in the aggregate data model) seems to have a mostly negative association with foreign equity participation. That is true for the CA, MENA and SA estimates. A negative coefficient for per capita GDP suggests that foreign investors prefer lower-income countries in those regions when they choose to invest. This, of course, belies the broad evidence from the global distribution of FDI, and also implied in Figure 2.1 (above), which indicates that low-income countries receive very little FDI compared to middle- and high-income countries. A potential explanation of this puzzle is that investors will choose the lower-income country if it offers similar advantages (in terms of profile and policy) to other, richer, countries in that region because this may mean higher bargaining power and, potentially, higher profits in the context of lower wages. However, a lower income is unlikely to trump an inferior profile. For those regions where the coefficient is positive and significant, this may be an indication that a higher income is more likely to coincide with other attributes desired by investors (perhaps more so than in those regions where the coefficient is negative). However, the coefficient is not significant in the aggregate data model.

[25] The fact that this effect does not apply to East Asia may be a consequence of the fact that, in the post-Asian Financial Crisis era, these countries have taken precautions to reduce perceived risk by a combination of reduced capital account openness and increased reserve coverage.

Inflation has an overall negative effect on foreign equity participation. In other words, higher inflation discourages foreign equity participation. Coskun (2001) and Trevino et al. (2002) found similar results. However, it does not seem to be important for EAO, LAC, and SA, while it is positively correlated in MENA. Labor participation has an overall negative significant impact on foreign equity participation. It also has a negative impact in MENA and SA and positive impact in SSW—regions where labor participation rates are lower and higher than the global average respectively. A negative impact may be indicated by the fact that foreign equity participation has lowered labor participation rate among youth because they want to increase their educational skills (Cooray et al., 2012; Maqsood & Samiullah, 2014). A negative relationship is indicated between the rate of taxation on profits and foreign equity participation in the aggregate data model. However, that effect seems to be relevant to MENA and SSE and not to other regions.

The rate of unemployment does not have a significant impact on foreign equity participation in the aggregate data model. However, it has a strong negative impact in LAC and MENA and a weakly negative impact in EE. This result suggests that, in those regions, countries having lower unemployment rates are more likely to attract FDI or, alternatively, foreign equity participation has helped curb unemployment. The trade-to-GDP ratio (TRGDP) has a negative association with foreign equity participation in the aggregate equation but that result is confirmed for LAC (e.g., Wheeler & Mody, 1992). A positive coefficient in MENA suggests, of course, that countries with higher trade to GDP ratios in the region attract more FDI (Liargovas & Skandalis, 2012; Sahoo, 2012).

The WGI (World Governance Index) differential (the country score subtracted from the regional average) has a negative significant coefficient in the aggregate data model. The implication is that good institutional quality attracts FDI (i.e., countries that are above the regional WGI average

attracts more FDI). That result is replicated more specifically for the CA, MENA, and SSE regions. When the WGI difference is interacted with firm size (medium and large), the aggregate data model suggests that a high governance index is associated with investment in large firms, but that result is not uniform across regions. A high WGI is associated with a preference for investment in small firms (over medium and large firms) in SSE and large firms over small and medium in EAO and EE.

To take the regional context into account, we initially considered four variables: (1) the density of regional economic integration agreements (average number of regional integration agreements that each country in the region is a member of); (2) the average degree of economic integration across countries;[26] (3) the level of intra-regional trade relative to regional GDP (IRTRGDP); and (4) the average quality of governance in the region. The first two variables were dropped because they did not have significant coefficients in the estimation results. However, the result of IRTRGDP is positive and significant in the aggregate data model, implying an overall positive impact of intra-regional trade on foreign equity participation. Specifically, a one unit increase in the ratio of intra-regional trade to regional GDP increases the probability of a firm being foreign-invested by 1.82% (exp(0.018) = 1.0182) in the first specification and 2.74% (exp(0.027) = 1.0274) in the second specification. But the results are not uniform across regions. The relative volume of intra-regional

[26] The density of regional economic integration agreements is computed by summing the number of regional economic integration agreement (regardless of their level) that each country is member of in a particular region and then averaging it over the number of countries in that region. To compute the average degree of economic integration agreements, economic integrations are assigned values of 1 through 6 based on their level as: (i) multilateral free trade area is assigned the value 1; (ii) customs union is assigned the value 2; (iii) common market is assigned the value 3; (iv) customs and monetary union is assigned the value 4; (v) economic union is assigned the value 5; and (vi) economic and monetary union is assigned the value 6. In the next step, each country's score is computed by multiplying the number of economic integration agreement with the corresponding level value and then summing the total. For example, if a country belongs to three different free trade areas, two different customs unions, and two different economic unions, its score is (3×1)+(2×2)+(2×5)=17. Finally, the variable is computed by averaging the total score of a particular region over the number of countries in that region.

trade is negatively related to foreign equity participation in CA and MENA, regions where FDI is concentrated in resource extraction industries for which intra-regional trade offers little direct advantages. The coefficient is, however, positive and significant for SA. The positive coefficient therefore suggests that there is much to be gained in SA (in terms of attracting FDI) since it started at very low level of intra-regional trade. Precisely, the probability of foreign equity participation in a firm increases by 0.30% (exp(0.003) = 1.0030) in the first specification and by 0.40% (exp(0.004) = 1.0040) in the second specification as the ratio of intra-regional trade to regional GDP increases by 1 unit. The argument is that higher intra-regional trade provides greater access to large market to foreign investors and attracts more FDI (Devadason & Mubarik, 2020; Jaumotte, 2006).

The coefficient representing the regional average of the quality of governance is positively related to foreign equity participation in the aggregate data model, which implies that good governance attracts FDI. It is also positively related to foreign equity participation in CA and SA, regions where the average WGI values are below the overall dataset average—suggesting that these regions gain most from improvements in the average quality of governance within the region. In CA, it is likely that better property rights matter (World Bank, 2021), whereas consistency and credibility in policy development and implementation appear to be important in SA for foreign investors (Sabharwal & Berman, 2013).

For the full multilevel model, the values of the intraclass correlation coefficients are smaller compared to the previous models—implying that the country- and regional-level variables included in the model explain some of the unobserved variations in foreign equity participation in previous results (Tables 2.2, 2.3, and A2.9 in Appendix A2). In summary, the overall results indicate that determinants from all three levels—firm, country, and global region—are important

in explaining foreign equity participation. Results for firm-level variables tend to be consistent across regions but the importance of the country-level variables vary quite considerably across regions. To be specific, firm-level characteristics are more likely to be uniformly significant across regions (and with the same sign), while country-level characteristics tend to vary across regions both in terms of the nature of the effect (positive or negative) and statistical significance. Finally, regional variations, which this study uniquely takes into account, turn out to be important with respect to two variables—intra-regional trade relative to regional GDP and average quality of governance in the region.

2.7. Conclusions

The decision of MNEs to invest in countries outside their own depends on both firm-level and country-level factors in the host countries. In the context of new approaches to production, such as regional supply chains, regional factors may also be important in the determination of FDI investment destinations. Thus, this paper analyzes firm-, country- and regional-level determinants of foreign equity participation utilizing data from 134 countries in a three-level hierarchical modeling framework. Moreover, countries are clustered into eight distinct regions to determine to what degree these determinants might vary across these regions.

First, we find evidence in favor of the multilevel modeling approach in the fact that intraclass correlation coefficients are non-negligible and the value of LR Chi-square test is strongly significant. When considering only firm-level analysis, the infrastructural constraint was found to be negatively correlated with foreign equity participation more broadly, and this is confirmed for the communication constraints (lack of access to own website) and the financial constraints (limited access to formal financial markets), but the constraints imposed by physical infrastructure

(electricity and transportation problems) was found to have varying effects across regions. Among other obstacles faced by firms, institutional obstacles and limited access to factors (land and/or skilled labor) typically discouraged FDI across regions but administrative obstacles were positively related to the stock of FDI. It appears, from this last result, that FDI is often a solution to administrative constraints—likely because most countries favor FIFs in the implementation of administrative protocols. The average wage was found to have an overall positive effect on FDI-participation, suggesting that FIFs pay their workers better than local firms (or FDI is attracted to higher wage industries), but that difference was not significant for most regions individually.

Without exception, the country-level variables suggest that country effects are region specific. Among them, the degree of openness of the capital account, total trade relative to GDP, inflation, and labor participation appear to discourage foreign equity participation in some regions but have the opposite effect (or are irrelevant) in other regions. GDP per capita and unemployment is irrelevance in the aggregate data model but appears to discourage foreign investment wherever the coefficient is significant. For the regional variables, regional (average) governance quality and intra-regional trade relative to regional GDP, were found to positively affect foreign equity participation in the aggregate data model but, like the country-level variables, that did not translate uniformly to the regions. With respect to regional variables, intra-regional trade relative to regional GDP was positively related to foreign equity participation in South Asia but had quite the opposite effect in Central Asia and the Middle East and North Africa—regions that have tended to attract FDI that is mostly directed at resource extraction, which typically finds little advantage in intra-regional trade. The regional average of the quality of governance was found to be positively correlated with foreign equity participation in the aggregate data model and in Central Asia and South Asia.

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Appendix A2

Table A2.1: List of countries and corresponding year when firms were interviewed

Countries	Year	Countries	Year	Countries	Year
Central Asia (1)		Slovak Republic	2013 & 2019	Bhutan	2009 & 2015
Armenia	2013 & 2019	Slovenia	2013 & 2019	India	2014
Azerbaijan	2013 & 2019	Ukraine	2019	Nepal	2009 & 2013
Georgia	2013 & 2019			Pakistan	2007 & 2013
Kazakhstan	2019	*Latin America and the Caribbean (4)*		Sri Lanka	2011
Kyrgyz Republic	2019	Antigua and Barbuda	2011		
Russian Federation	2012 & 2019	Argentina	2010 & 2017	*Sub-Sahara East (7)*	
Tajikistan	2013 & 2019	Bahamas	2011	Botswana	2006 & 2010
Uzbekistan	2019	Barbados	2011	Burundi	2014
		Belize	2011	Djibouti	2013
East Asia and Oceania (2)		Bolivia	2017	Eritrea	2009
Cambodia	2016	Brazil	2009	Eswatini (Swaziland)	2016
China	2013 & 2019	Chile	2006 & 2010	Ethiopia	2011 & 2015
Fiji	2009	Colombia	2010 & 2017	Kenya	2013 & 2018
Indonesia	2009 & 2015	Costa Rica	2010	Lesotho	2009 & 2016
Laos	2018	Dominica	2011	Madagascar	2013
Malaysia	2015	Dominican Republic	2010 & 2016	Malawi	2009 & 2014
Micronesia	2009	Ecuador	2017	Mauritius	2008
Mongolia	2012	El Salvador	2016	Mozambique	2018
Myanmar	2014 & 2016	Grenada	2011	Namibia	2015
Papua New Guinea	2015	Guatemala	2010 & 2018	Rwanda	2019
Philippines	2009 & 2015	Guyana	2011	South Africa	2007
Samoa	2009	Honduras	2016	South Sudan	2014
Solomon Islands	2015	Jamaica	2011	Tanzania	2006 & 2013
Thailand	2016	Mexico	2006 & 2010	Uganda	2006 & 2013
Timor Leste	2009 & 2015	Nicaragua	2016	Zambia	2013 & 2019
Tonga	2009	Panama	2006 & 2010	Zimbabwe	2011 & 2016
Vanuatu	2009	Paraguay	2017		
Vietnam	2015	Peru	2010 & 2017	*Sub-Sahara West (8)*	
		St. Kitts and Nevis	2011	Angola	2006 & 2010
Eastern Europe (3)		St. Lucia	2011	Benin	2009 & 2016
Albania	2019	St. Vincent and the Grenadines	2011	Burkina	2006 & 2009
Belarus	2018	Suriname	2010 & 2018	Cameroon	2009 & 2016
Bosnia and Herzegovina	2013 & 2019	Trinidad and Tobago	2011	Cape Verde	2006 & 2009
Bulgaria	2013 & 2019	Uruguay	2010 & 2017	Central African Republic	2011
Croatia	2009 & 2013	Venezuela	2006 & 2010	Chad	2009 & 2018
Czech Republic	2019			Cote d'Ivoire	2009 & 2016
Estonia	2013 & 2019	*Middle East and North Africa (5)*		Democratic Republic of Congo	2010 & 2013
Greece	2018	Algeria	2007	Gabon	2008
Hungary	2013 & 2019	Egypt	2016 & 2019	Gambia	2018
Kosovo	2013 & 2019	Israel	2013	Ghana	2013
Latvia	2013 & 2019	Jordan	2013 & 2019	Guinea	2016

Table A2.1: (continued)

Countries	Year	Countries	Year	Countries	Year
Lithuania	2019	Lebanon	2013 & 2019	Liberia	2009 & 2017
Moldova	2013 & 2019	Morocco	2013 & 2019	Mali	2016
Montenegro	2013 & 2019	Tunisia	2014 & 2019	Niger	2009 & 2017
North Macedonia	2013 & 2019	Turkey	2019	Nigeria	2009 & 2014
Poland	2013 & 2019	Yemen	2013	Senegal	2007 & 2014
Portugal	2019			Sierra Leone	2009 & 2017
Romania	2013 & 2019	*South Asia (6)*		Togo	2009 & 2016
Serbia	2013 & 2019	Bangladesh	2013		

Table A2.2: List of variables and descriptions

Variable	Definitions
Micro Variables	
FDI	Dummy variable; 0 = domestic firms, and 1 = foreign-invested firms
Lnage	Log of age of the firm
Size	Firm size: small (base) = 0 – 19 employees; medium = 20 – 99; large = 100 or more
Agglomeration	Number of foreign-invested firms in the same sector and within-country region
Telecom. Problem	Access to website for business
Electricity problem	Business obstacle: electricity
Transport problem	Business obstacle: transport
Financial	Business obstacle: finance
Crime	Business obstacle: crime, theft, and disorder
Corruption	Business obstacle: corruption
Property rights	Is judicial system fair to uphold property rights
Wage	Sector-region average wage per employee. It is converted to USD using the exchange rate in the particular year, and then converted to natural logarithm.
Skill	Business obstacle: skilled workforce problem
Land problem	Business obstacle: access to land
Labor regulation	Business obstacle: labor regulations
Licensing and permits	Business obstacle: licensing and permits
Custom and trade	Business obstacle: custom and trade regulations
Tax administration	Business obstacle: tax administration
Macro Variables	
LGDPPC	Log of GDP per capita in current USD
Tax Rate	Total tax rate as percentage of commercial profit
Inflation	Growth rate of GDP deflator
TRGDP	Total trade relative to GDP. This is the sum of exports and imports divided by GDP
KAOPEN	"Extent and intensity" of capital controls measuring financial openness
Labor Participation	Proportion of working age population that is economically active
Unemployment	Unemployment rate, which is the proportion of unemployed people who are actively searching for work to total labor force.
WGI difference	This variable is the difference between regional governance (average of WGI at regional level for each year) and countries' WGI.

Table A2.2: (continued)

Variable	Definitions
Regional Variable	
IRTRGDP	Intra-regional trade relative to regional GDP. To compute this variable, first the sum of intra-regional merchandise and service trade (for each country) for each of previous five years (to the survey year) is divided by 2 (since each country's exports and imports are counted twice) and averaged over five years for each country and year. Then, the results are summed up for each year within regions. The sum of regional GDP for each year is computed in the same way (i.e., the sum of the previous five-year average GDP for each country and year in a given region is computed, and then they are summed up for each year within regions). Finally, the regional trade is divided by regional GDP.
Regional governance	This is the average value of WGI at regional level for each year.

Table A2.3: World Governance Index (WGI)

Variables	Indicators
Voice and accountability	Citizen's perception regarding their freedom to participate in selecting their government, freedom of speech, and freedom of press
Political stability and absence of violence	Perceptions of political instability and related violence, and terrorism
Government Effectiveness	Perceptions of the quality and independence of public and civil services, as well as effective policy formulation and credibility of the government's commitment to such policies
Regulatory quality	Perceptions of how government can stimulate private sector development through sound policies and regulations
Rule of law	Perceptions of the quality of contract enforcement, property rights, the police, and the courts, as well as the possibility of crime and violence
Control of corruption	Perceptions of how public power is exercised for private gain, as well as capture of the state by elites and private interests

Table A2.4: Distribution of firms across sectors

	Observation	Percentage	Cumulative
Food	13741	13.52	13.52
Textile, garments and leather	10221	10.05	23.57
metals, machinery, and instrument	9188	9.04	32.61
petroleum and chemicals	10972	10.79	43.40
wood and furniture, paper and printing, non-metallic product, and electronics	7243	7.12	50.53
other manufacturing	13869	13.64	64.17
retail and wholesale	21020	20.68	84.85
hotel and restaurants, and other services	7893	7.76	92.61
construction and transport	7510	7.39	100.00
Total	101657	100.00	

Table A2.5: Principal components of all index variables (micro-level)

Variables	Physical infrastructure	Infrastructure	Institution	Factor	Admin
Website		0.144			
Electricity	0.707	0.582			
Transportation	0.707	0.587			
Financial		0.544			
Corruption			0.700		
Crime			0.699		
Property rights			-0.146		
Skilled labor				0.707	
Land				0.707	
Labor regulations					0.498
Licensing & permits					0.524
Customs & trade					0.456
Tax administration					0.519
Eigen value	1.393	1.689	1.387	1.254	2.207
Explained (%)	69.69	0.423	46.23	62.71	55.20

Table A2.6: Principal component of World Governance Index

Variables	WGI
Voice and accountability	0.396
Political Stability and Absence of Violence	0.394
Government Effectiveness	0.464
Regulatory Quality	0.447
Rule of Law	0.469
Control of Corruption	0.231
Eigen value	4.009
Explained proportion %	66.82

Table A2.7: Correlations between explanatory variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
(1) Infrastructure	1.00																
(2) Communica.	0.19	1.00															
(3) Physical	0.91	0.04	1.00														
(4) Financial	0.71	0.11	0.37	1.00													
(5) Institution	0.49	0.01	0.45	0.36	1.00												
(6) Factor	0.46	-0.03	0.40	0.38	0.48	1.00											
(7) Admin	0.52	-0.05	0.49	0.38	0.58	0.55	1.00										
(8) GDPPC	-0.15	-0.23	-0.11	-0.11	-0.10	-0.00	-0.02	1.00									
(9) Inflation	0.03	0.00	0.02	0.04	0.01	0.05	0.02	0.01	1.00								
(10) Lab parti.	-0.04	-0.04	-0.04	-0.02	-0.12	0.00	-0.05	0.27	0.06	1.00							
(11) Profit Tax	0.13	0.13	0.12	0.05	0.12	0.05	0.11	-0.34	-0.01	-0.09	1.00						
(12) Unem. Rate	-0.07	-0.07	-0.09	0.01	-0.01	-0.01	-0.04	0.08	-0.06	-0.29	-0.24	1.00					
(13) TTRGDP	-0.04	-0.08	-0.02	-0.04	-0.03	0.00	0.02	0.36	0.03	0.18	0.02	-0.20	1.00				
(14) KAOPEN	-0.09	-0.12	-0.06	-0.07	-0.02	-0.00	-0.01	0.46	-0.11	0.22	-0.21	0.05	0.07	1.00			
(15) Country WGI	0.03	0.08	0.01	0.03	0.10	-0.01	0.02	-0.41	-0.02	-0.14	-0.04	-0.02	-0.18	-0.28	1.00		
(16) Reginal WGI	-0.21	-0.21	-0.16	-0.15	-0.07	-0.02	-0.04	0.46	-0.03	0.03	-0.22	0.28	0.04	0.37	-0.03	1.00	
(17) IRTRGDP	-0.13	0.00	-0.12	-0.09	-0.17	-0.08	-0.12	-0.06	-0.09	0.37	0.03	-0.18	0.03	-0.07	0.00	0.02	1.00

Table A2.8: Firm-level data without instrumental variable approach

	All		CA		EAO		EE		LAC		MENA		SA		SSE		SSW	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17	18
Lnage	-0.310***	-0.346***	-0.351***	-0.400***	-0.451***	-0.462***	-0.566***	-0.576***	-0.430***	-0.476***	-0.408***	-0.466***	-0.202	-0.237	-0.072	-0.128**	0.221***	0.169**
	(0.022)	(0.022)	(0.077)	(0.079)	(0.073)	(0.073)	(0.054)	(0.054)	(0.049)	(0.049)	(0.072)	(0.073)	(0.156)	(0.157)	(0.051)	(0.052)	(0.069)	(0.070)
Medium	0.833***	0.701***	0.856***	0.728***	0.634***	0.576***	0.986***	0.949***	0.816***	0.672***	0.595***	0.488***	0.953***	0.608**	0.804***	0.631***	0.788***	0.607***
	(0.030)	(0.031)	(0.118)	(0.119)	(0.091)	(0.092)	(0.079)	(0.079)	(0.071)	(0.073)	(0.119)	(0.120)	(0.259)	(0.265)	(0.065)	(0.067)	(0.070)	(0.072)
Large	1.939***	1.698***	1.644***	1.416***	1.928***	1.757***	2.258***	2.203***	2.044***	1.799***	1.707***	1.498***	1.921***	1.317***	1.631***	1.308***	1.723***	1.363***
	(0.032)	(0.034)	(0.130)	(0.133)	(0.092)	(0.096)	(0.081)	(0.083)	(0.073)	(0.076)	(0.120)	(0.123)	(0.256)	(0.268)	(0.078)	(0.082)	(0.091)	(0.096)
FDI Agglom	0.018***	0.018***	0.093***	0.087***	0.014***	0.014***	0.075***	0.075***	0.029***	0.028***	0.117***	0.115***	0.203***	0.196***	0.007***	0.006***	0.025***	0.026***
	(0.001)	(0.001)	(0.010)	(0.010)	(0.001)	(0.001)	(0.004)	(0.004)	(0.002)	(0.002)	(0.009)	(0.010)	(0.024)	(0.024)	(0.002)	(0.002)	(0.003)	(0.003)
Infrastructure	-0.135***		-0.053		-0.192***		-0.057*		-0.060**		-0.107**		-0.386***		-0.202***		-0.202***	
	(0.012)		(0.048)		(0.038)		(0.030)		(0.024)		(0.047)		(0.090)		(0.028)		(0.031)	
Communication		-0.627***		-0.841***		-0.384***		-0.137*		-0.599***		-0.768***		-1.382***		-0.742***		-0.858***
		(0.027)		(0.111)		(0.069)		(0.074)		(0.065)		(0.100)		(0.202)		(0.061)		(0.070)
Physical		0.038***		0.064		0.003		0.072**		0.063***		-0.013		-0.210**		0.020		0.038
		(0.012)		(0.049)		(0.038)		(0.030)		(0.023)		(0.048)		(0.090)		(0.030)		(0.034)
Financial		-0.197***		-0.085**		-0.261***		-0.191***		-0.157***		-0.105**		-0.144*		-0.215***		-0.233***
		(0.011)		(0.042)		(0.036)		(0.028)		(0.023)		(0.042)		(0.078)		(0.023)		(0.027)
Institution	-0.082***	-0.086***	-0.153**	-0.165***	-0.007	-0.008	-0.220***	-0.213***	-0.157***	-0.153***	-0.031	-0.044	-0.097	-0.162	-0.044	-0.052	0.016	0.004
	(0.014)	(0.014)	(0.061)	(0.061)	(0.044)	(0.044)	(0.039)	(0.039)	(0.028)	(0.028)	(0.052)	(0.052)	(0.099)	(0.100)	(0.030)	(0.035)	(0.034)	(0.034)
Factor	-0.016	-0.009	-0.014	-0.031	0.072*	0.076*	-0.072**	-0.060*	-0.087***	-0.084***	-0.023	-0.002	-0.047	-0.058	-0.061**	-0.055*	0.052	0.066*
	(0.013)	(0.013)	(0.051)	(0.052)	(0.043)	(0.043)	(0.034)	(0.034)	(0.029)	(0.029)	(0.052)	(0.052)	(0.089)	(0.090)	(0.030)	(0.031)	(0.034)	(0.035)
Admin	0.152***	0.137***	0.208***	0.190***	0.183***	0.173***	0.102***	0.105***	0.176***	0.165***	0.126***	0.113***	0.270***	0.243***	0.173***	0.151***	0.120***	0.096***
	(0.011)	(0.011)	(0.051)	(0.051)	(0.035)	(0.036)	(0.029)	(0.029)	(0.024)	(0.024)	(0.040)	(0.040)	(0.071)	(0.071)	(0.026)	(0.026)	(0.028)	(0.028)
Ln(Av. Wage)	0.067***	0.056***	0.187***	0.175***	0.092***	0.095***	0.029	0.033	-0.002	-0.007	-0.004	-0.001	0.059	0.078	0.026	0.005	0.048**	0.029
	(0.000)	(0.011)	(0.061)	(0.063)	(0.028)	(0.028)	(0.031)	(0.031)	(0.034)	(0.035)	(0.056)	(0.057)	(0.073)	(0.073)	(0.029)	(0.029)	(0.022)	(0.022)
Constant	-2.668***	-1.770***	-2.676***	-2.053***	-0.872**	-0.225	-1.082**	-0.715	-2.900***	-2.106***	-3.055***	-2.218***	-4.225***	-3.008***	-1.849***	-0.802**	-4.259***	-2.947***
	(0.151)	(0.157)	(0.416)	(0.432)	(0.350)	(0.356)	(0.432)	(0.436)	(0.226)	(0.238)	(0.693)	(0.722)	(0.638)	(0.661)	(0.305)	(0.330)	(0.620)	(0.602)
LR Chi^2	5098.66	4598.90	91.84	100.77	213.61	198.97	145.89	131.04	24.47	25.67	142.54	146.71	125.59	147.94	195.67	223.40	154.33	134.54
ρ_c	0.194	0.206	0.134	0.145	0.150	0.144	0.046	0.044	0.013	0.015	0.094	0.100	0.067	0.074	0.090	0.112	0.178	0.163
ρ_r	0.141	0.148																
Observations	101657		10073		11974		15590		18553		9619		13310		11491		11047	
No. of countries	134		8		18		22		31		9		6		20		20	

Note: ***p < 0.01, **p < 0.05, *p < 0.1. Standard errors are in parentheses. All regressions include sector and year dummies.

Table A2.9: Firm-level and country-level data with instrumental variable approach

	All		CA		EAO		EE		LAC		MENA		SA		SSE		SSW	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Lnage	-0.314***	-0.35***	-0.375***	-0.421***	-0.464***	-0.474***	-0.58***	-0.59***	-0.428***	-0.473***	-0.411***	-0.473***	-0.203	-0.216	-0.06	-0.115**	0.197***	0.151**
	(0.022)	(0.023)	(0.077)	(0.079)	(0.073)	(0.074)	(0.054)	(0.054)	(0.049)	(0.05)	(0.072)	(0.074)	(0.156)	(0.158)	(0.051)	(0.052)	(0.07)	(0.07)
Medium	0.826***	0.697***	0.851***	0.732***	0.65***	0.592***	0.973***	0.935***	0.824***	0.676***	0.609***	0.494***	0.962***	0.626**	0.817***	0.65***	0.76***	0.587***
	(0.03)	(0.031)	(0.119)	(0.12)	(0.091)	(0.092)	(0.079)	(0.08)	(0.072)	(0.073)	(0.119)	(0.121)	(0.276)	(0.283)	(0.066)	(0.067)	(0.071)	(0.073)
Large	1.93***	1.691***	1.659***	1.436***	1.946***	1.776***	2.24***	2.185***	2.058***	1.808***	1.644***	1.414***	1.988***	1.348***	1.656***	1.341***	1.706***	1.362***
	(0.032)	(0.034)	(0.131)	(0.134)	(0.093)	(0.096)	(0.082)	(0.083)	(0.074)	(0.077)	(0.124)	(0.127)	(0.27)	(0.286)	(0.08)	(0.084)	(0.093)	(0.098)
FDI Agglom	0.018***	0.018***	0.091***	0.085***	0.014***	0.014***	0.074***	0.074***	0.03***	0.029***	0.114***	0.112***	0.172***	0.173***	0.006***	0.006***	0.026***	0.027***
	(0.001)	(0.001)	(0.01)	(0.01)	(0.002)	(0.002)	(0.004)	(0.004)	(0.003)	(0.003)	(0.009)	(0.01)	(0.024)	(0.025)	(0.002)	(0.002)	(0.003)	(0.003)
Infrastructure	-0.139***		-0.055		-0.201***		-0.055*		-0.061**		-0.107**		-0.413***		-0.211***		-0.204***	
	(0.012)		(0.048)		(0.038)		(0.03)		(0.024)		(0.048)		(0.091)		(0.029)		(0.032)	
Communication		-0.626***		-0.824***		-0.381***		-0.136*		-0.612***		-0.817***		-1.359***		-0.73***		-0.842***
		(0.027)		(0.112)		(0.069)		(0.074)		(0.065)		(0.101)		(0.204)		(0.061)		(0.07)
Physical		0.034***		0.063		-0.005		0.072**		0.063***		-0.001		-0.208**		0.012		0.034
		(0.012)		(0.049)		(0.038)		(0.03)		(0.024)		(0.049)		(0.093)		(0.03)		(0.034)
Financial		-0.198***		-0.087**		-0.263***		-0.188***		-0.158***		-0.108**		-0.157**		-0.218***		-0.231***
		(0.011)		(0.042)		(0.036)		(0.028)		(0.023)		(0.043)		(0.079)		(0.023)		(0.027)
Institution	-0.08***	-0.085***	-0.159***	-0.168***	-0.009	-0.01	-0.203***	-0.196***	-0.16***	-0.158***	-0.043	-0.054	-0.113	-0.159	-0.039	-0.049	0.013	0.002
	(0.014)	(0.014)	(0.061)	(0.061)	(0.044)	(0.044)	(0.039)	(0.039)	(0.028)	(0.028)	(0.053)	(0.053)	(0.1)	(0.1)	(0.03)	(0.03)	(0.034)	(0.034)
Factor	-0.016	-0.01	-0.017	-0.033	0.075*	0.078*	-0.071**	-0.059*	-0.081***	-0.078***	-0.032	-0.015	-0.034	-0.063	-0.064**	-0.058*	0.053	0.067*
	(0.013)	(0.013)	(0.051)	(0.052)	(0.043)	(0.043)	(0.034)	(0.034)	(0.029)	(0.029)	(0.052)	(0.053)	(0.09)	(0.092)	(0.03)	(0.031)	(0.035)	(0.035)
Admin	0.151***	0.137***	0.209***	0.189***	0.19***	0.18***	0.101***	0.103***	0.173***	0.162***	0.123***	0.104**	0.285***	0.258***	0.174***	0.152***	0.116***	0.092***
	(0.011)	(0.011)	(0.051)	(0.051)	(0.036)	(0.036)	(0.029)	(0.029)	(0.024)	(0.024)	(0.041)	(0.041)	(0.072)	(0.072)	(0.026)	(0.026)	(0.028)	(0.028)
Ln(Av wage)	0.066***	0.058***	0.226***	0.217***	0.093***	0.096***	0.045	0.045	0.031	0.027	-0.053	-0.066	0.138	0.096	0.012	-0.011	0.045**	0.026
	(0.011)	(0.011)	(0.055)	(0.056)	(0.028)	(0.028)	(0.035)	(0.035)	(0.038)	(0.038)	(0.06)	(0.061)	(0.09)	(0.091)	(0.027)	(0.028)	(0.022)	(0.022)
KAOPEN	-0.083*	-0.091*	-0.343*	-0.31*	0.234	0.206	-0.207*	-0.209*	-0.124**	-0.131**	-0.663**	-0.813**	3.06**	2.794**	0.002	0.004	-0.168	-0.16
	(0.046)	(0.047)	(0.181)	(0.182)	(0.158)	(0.156)	(0.109)	(0.108)	(0.052)	(0.053)	(0.319)	(0.323)	(1.263)	(1.275)	(0.102)	(0.122)	(0.213)	(0.207)
GDPPC	0.007	0.008	-0.219***	-0.221***	-0.172	-0.166	0.058	0.058	-0.009	-0.009	-0.336*	-0.353*	-1.375	-1.12	0.038	0.068	-0.026	-0.016
	(0.013)	(0.013)	(0.041)	(0.04)	(0.167)	(0.163)	(0.04)	(0.04)	(0.017)	(0.017)	(0.186)	(0.189)	(0.948)	(0.955)	(0.115)	(0.138)	(0.225)	(0.212)
Inflation	-0.016***	-0.014**	-0.034**	-0.031**	-0.131	-0.115	-0.055*	-0.049*	-0.001	-0.001	0.095**	0.138***	-0.023	-0.024	-0.044***	-0.046***	-0.046**	-0.039*
	(0.006)	(0.006)	(0.015)	(0.015)	(0.081)	(0.079)	(0.028)	(0.029)	(0.009)	(0.009)	(0.047)	(0.048)	(0.2)	(0.201)	(0.01)	(0.011)	(0.021)	(0.02)
Labor parti.	-0.013*	-0.014*	0.021	0.022	-0.026	-0.025	0.003	0.002	-0.005	-0.007	-0.238***	-0.302***	-0.108	-0.082	-0.018	-0.023	0.104***	0.097***
	(0.008)	(0.008)	(0.022)	(0.022)	(0.026)	(0.025)	(0.018)	(0.018)	(0.01)	(0.011)	(0.07)	(0.07)	(0.127)	(0.127)	(0.016)	(0.019)	(0.027)	(0.025)
Profit tax	-0.012**	-0.009	-0.015	-0.012	0.026	0.021	-0.032	-0.034	-0.001	-0.001	-0.464***	-0.518***	0.06	0.069	-0.04***	-0.041**	-0.004	-0.001
	(0.005)	(0.005)	(0.024)	(0.024)	(0.044)	(0.043)	(0.021)	(0.021)	(0.008)	(0.009)	(0.133)	(0.134)	(0.087)	(0.087)	(0.015)	(0.017)	(0.014)	(0.014)

Table A2.9: (continued)

Unemploy. Rate	-0.007	-0.003	-0.033	-0.037	-0.059	-0.073	-0.026*	-0.021	-0.064***	-0.073***	-0.655***	-0.757***	-0.091	-0.191	-0.03	-0.042	-0.087	-0.073
	(0.008)	(0.008)	(0.052)	(0.053)	(0.119)	(0.117)	(0.014)	(0.014)	(0.018)	(0.019)	(0.194)	(0.197)	(0.447)	(0.446)	(0.024)	(0.027)	(0.053)	(0.052)
TRGDP	-0.012***	-0.012***	-0.017	-0.019	-0.004	-0.004	-0.007	-0.004	-0.02***	-0.02***	0.395***	0.441***	-0.169	-0.134	-0.002	0	-0.002	-0.003
	(0.003)	(0.003)	(0.014)	(0.014)	(0.007)	(0.007)	(0.013)	(0.013)	(0.007)	(0.007)	(0.112)	(0.114)	(0.168)	(0.167)	(0.006)	(0.008)	(0.012)	(0.012)
WGI	-0.030***	-0.019***	-0.346***	-0.305***	-0.371	-0.345	0.116	0.135	-0.047	-0.046	-2.249***	-2.572***	0.205	-0.052	-0.227***	-0.22**	-0.229*	-0.194
	(0.009)	(0.003)	(0.115)	(0.116)	(0.333)	(0.326)	(0.175)	(0.175)	(0.061)	(0.062)	(0.626)	(0.636)	(0.957)	(0.953)	(0.081)	(0.093)	(0.136)	(0.128)
WGI*Medium	0.01	0.012	0.035	0.05	0.059	0.059	-0.033	-0.039	0.039	0.034	0.128	0.131	0.051	0.02	0.13***	0.125***	-0.069	-0.05
	(0.021)	(0.021)	(0.077)	(0.078)	(0.084)	(0.084)	(0.047)	(0.047)	(0.05)	(0.05)	(0.101)	(0.103)	(0.606)	(0.607)	(0.045)	(0.046)	(0.049)	(0.049)
WGI*Large	-0.046**	-0.047**	0.088	0.084	-0.025	-0.038	-0.13***	-0.137***	0.009	0.007	-0.106	-0.1	-0.001	0.006	0.115**	0.108*	-0.048	-0.013
	(0.022)	(0.022)	(0.083)	(0.084)	(0.093)	(0.093)	(0.047)	(0.047)	(0.048)	(0.048)	(0.105)	(0.105)	(0.663)	(0.666)	(0.057)	(0.058)	(0.062)	(0.063)
Constant	-2.225***	-1.341**	-2.509	-2.025	0.522	1.211	-1.502	-1.102	-2.174***	-1.106	25.223***	31.119***	2.799	2.499	0.585	2.277	-10.7***	-9.099***
	(0.618)	(0.632)	(1.703)	(1.745)	(2.218)	(2.174)	(1.448)	(1.453)	(0.821)	(0.846)	(5.455)	(5.542)	(7.73)	(7.713)	(1.734)	(2.027)	(2.031)	(1.941)
LR Chi^2	3628***	3886***	249.4***	243.2***	142.8***	136.0***	40.2***	40.9***	16.2***	17.5***	26.4***	23.5***	41.9***	43.8***	22.5***	34.5***	59.8***	58.3***
ρ_c	0.124	0.127	0.120	0.137	0.119	0.114	0.032	0.032	0.015	0.016	0.030	0.035	0.072	0.077	0.018	0.029	0.151	0.133
ρ_r	0.147																	
Observations	101657		10073		11974		15590		18553		9619		13310		11491		11047	
No. of countries	134		8		18		22		31		9		6		20		20	

Note: ***p < 0.01, **p < 0.05, *p < 0.1. Standard errors are in parentheses. All regressions include sector and year dummies.

Chapter 3

Foreign-invested and domestic firm attributes and spillover effects: Evidence from Brazil

3.1. Introduction

Theory suggests that a major source of the growth-enhancing attributes of foreign direct investment (FDI) is likely to be knowledge spillovers that increase the productivity and competitiveness of domestic firms (Aitken, Hanson, & Harrison, 1997; Blomstrom & Kokko, 1998; Gorg & Greenaway, 2004; Haskel, Pereira, & Slaughter, 2007). This perspective certainly helps explain why countries are often willing to incur real costs (from the provision of subsidies, tax breaks and other incentives) to attract FDI. The expectation is that FDI inflows will not only help address capital scarcity and employment challenges, but also provide domestic firms with access to new technologies and/or management techniques that can provide an additional boost to growth (Aitken & Harrison, 1999).

To date, though the empirical literature on FDI spillovers is well beyond its infancy, country coverage remains incomplete and, for the countries covered, the results have not been consistent (Bruno, Campos, & Estrin, 2018; Bruno & Cipollina, 2018; Demena and van Bergeijk, 2017). Based on a meta-analysis of 74 studies from 31 developing countries, Demena and van Bergeijk (2017) argued that the precise nature and extent of the measured productivity spillover effects of

FDI cannot, to this point, be generalized across developing countries because: (1) empirical results have varied quite widely across studies; and (2) a large number of developing countries have not yet been studied. They suggest further investigations that cover more developing countries and examine the underlying mechanisms through which spillovers are generated. This investigation is, in part, a response to this challenge and, in that regard, it proposes to examine a country (Brazil) that has not been extensively studied to this point and tries to determine what attributes of foreign-invested and domestic firms are associated with spillover effects. The analysis and approach are not only directly relevant to policy formulation but, in addition, offer some clues to the underlying mechanisms of spillover transmission.

Brazil, the Latin American member of the BRICS[27] group of countries, accounts for the bulk of high-technology FDI flows into Latin America, and FIFs in this country are significant exporters of high-technology products (Chudnovsky & López, 2007). Yet, despite its prominence in attracting high-technology FDI and producing and exporting high technology goods, Brazil remains a developing country both in terms of per capita income levels and institutional structure (Alston et al, 2016). This country thus presents a unique and economically important context for the examination of spillover effects. Moreover, the three studies that have previously sought to examine the Brazilian experience (Bruhn & Calegario, 2014; Marin & Costa, 2010, Moralles & Morena, 2020), though informative in their own right, were limited in scope in terms of both coverage and the questions asked.[28] This study, employing a robust estimation approach, takes the

[27] BRICS refers to Brazil, Russia, India, China and South Africa – a group of large, regionally important economies, and also members of the G20 group of countries, that have accounted for an increasing share of the world economy (particularly relative to the OECD countries) in the 21st century.

[28] The Bruhn and Calegario (2014) study, covered only the processing industry. The Marin and Costa (2010) study, used data for only a small number of industries and investigated only intra-industry (horizontal) spillovers (leaving vertical spillovers unexplored). The sample used by Moralles and Moreno (2020) was limited to firms listed in the Brazilian Stock Exchange and that study did not attempt to disaggregate spillover effects (horizontal and vertical).

empirical exercise one step further by expanding both the sample size and the range of questions asked.

In the first instance, this investigation seeks to determine whether there is evidence of FDI-induced horizontal or vertical productivity spillover effects across a multi-sector sample of Brazilian manufacturing firms and, secondly, whether particular attributes of foreign-invested and domestic firms were associated with the nature and size of observed spillover effects. For FIFs, the attributes examined were: degree of foreign ownership, export orientation, and import dependence. For domestic firms the attributes examined were: size, productivity level, and investment in employee training.

In this study, disaggregation by firm type allowed us to: reveal more precisely the sources of spillover effects; identify spillover effects not uncovered at higher levels of aggregation; and discriminate between the strength and the scope impacts of absorptive capacity. FIFs, when treated as a single group, were shown to be more productive than domestic firms and generated positive horizontal and backward spillover effects. No evidence of forward spillover effects was found at that level of aggregation, but disaggregation revealed that forward spillover effects were also in evidence. When FIFs were disaggregated, the horizontal and backward spillovers were found to be associated with majority-foreign-ownership, high export concentration, and high import dependence. However, while minority-foreign-ownership was associated with no spillover effects (and no productivity differential), low export concentration was associated with positive forward spillover effects and low import dependence was associated with positive backward and forward (but not horizontal) spillover effects.

With respect to domestic firm attributes, the analysis revealed that firm size (in terms of employees) was not an important determinant of the absorption of spillover effects and the level of technology (or productivity) of domestic firms was not important in the receipt of horizontal and backward spillover effects. However, only high-technology domestic firms benefitted from forward spillovers. Improving absorptive capacity through the training of workers did not appear to be a factor in the transmission of horizontal spillover effects but was a determining factor in the transmission of backward spillover effects. Thus, low absorptive capacity on the part of domestic firms (if defined as low-technology and a lack of investment in worker training) did not disadvantage them with respect to the absorption of intra-industry (horizontal) spillovers, but inter-industry (backward and forward) spillover effects required at least one of these attributes to facilitate absorption—worker training for backward spillovers and high technology for forward spillovers.

The rest of this essay is organized as follows. Section 3.2 presents related literature and different channels through which spillovers take place. The overview of FDI inflow in Brazil is presented in section 3.3. The data used and econometric models applied to derive spillovers results are discussed in section 3.4. Section 3.5 presents and discusses the main results, while section 3.6 concludes the essay.

3.2. Foreign direct investment in Brazil

Total FDI flow worldwide in 2019 was $1.5 Trillion, of which the Latin America & Caribbean region received $164 billion, with $72 billion going to Brazil.[29] As shown in Figure 3.1, Brazil stood 6th in terms of the absolute value of inward FDI flows in the world in 2019 (2nd among

[29] Based on data published in UNCTADSTAT (https://unctadstat.unctad.org/).

BRICS nations, after China). The 2019 FDI inflow was the equivalent of 4.0% of Brazilian GDP (compared to a 3.0% regional average). However, for Brazil, the size of FDI flows relative to GDP has varied widely over the years, both temporally and in relations to the regional average (Figure 3.2). In the 1970s, FDI inflows were low, as a percentage of GDP, remaining just above 1% for most of the decade, but still above the Latin America & Caribbean average. However, from 1980 to 1995, inflows remained mostly below 1% of GDP, and mostly below the Latin America & Caribbean average. There was a sharp rise in the FDI/GDP ratio between 1995 and 2000 (when it reached a peak of 5%). This was a much faster rate of growth than the regional average. The rate of FDI flows (relative to GDP) has remained more modest since, with no particular trend, but significantly higher than the rates of the 70s, 80s and 90s and mostly above the regional average.

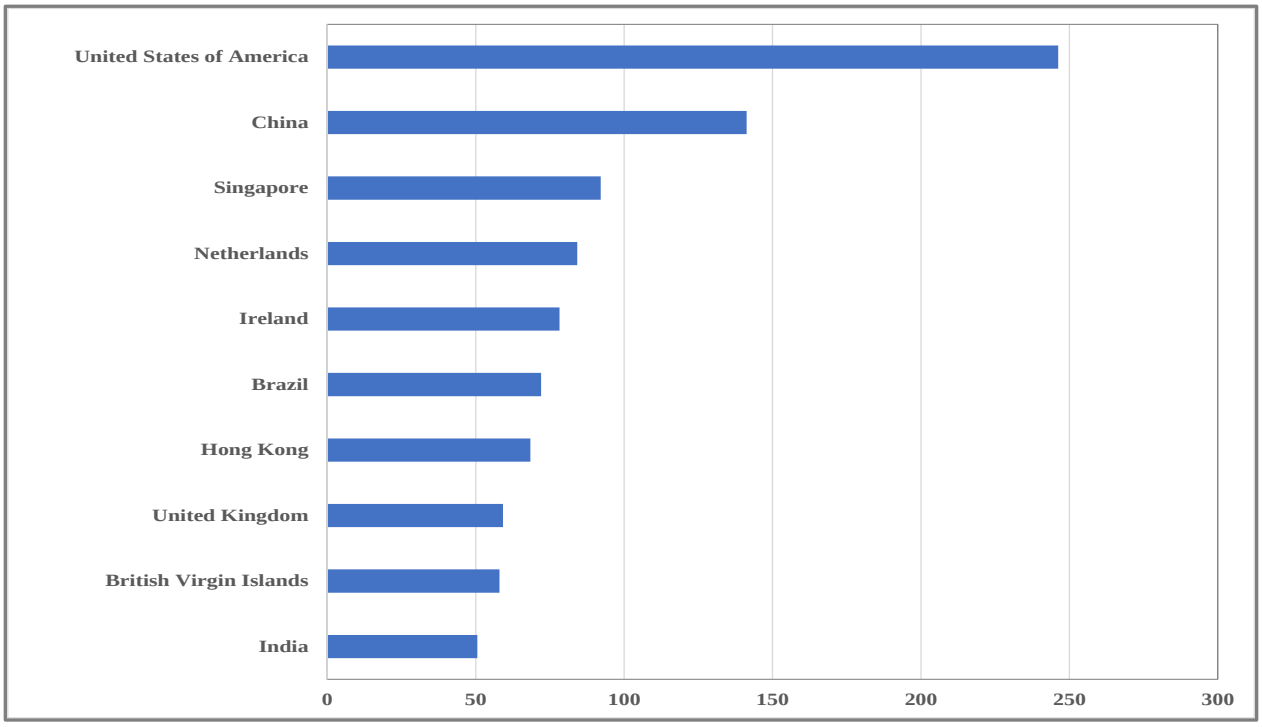


Figure 3.1: Top 10 host nations in terms of FDI inflows, 2019 ranking (billions of current US$)

Source: UNCTADSTAT (https://unctadstat.unctad.org/)

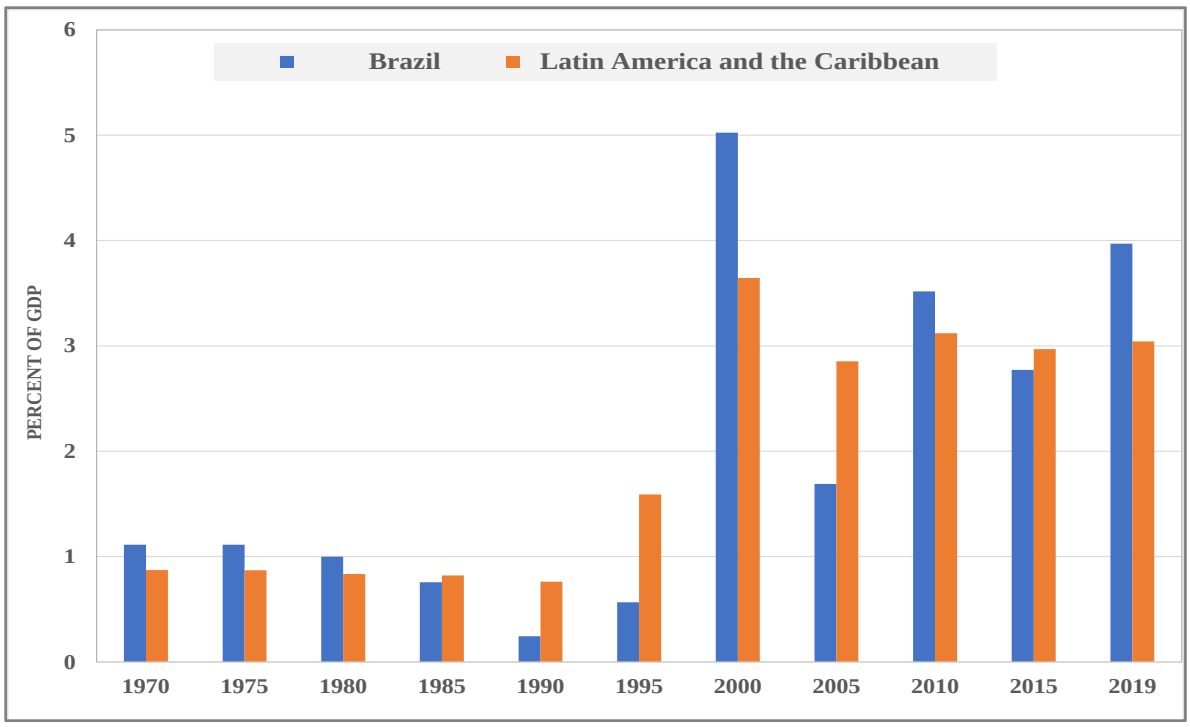


Figure 3.2: FDI inflow in Brazil and Latin America & Caribbean Region as percentage of GDP

Source: UNCTADSTAT (https://unctadstat.unctad.org/)

The stock of FDI in Brazil, in 2019, was valued at $641 billion and was 28% of the total stock of FDI in the Latin America & Caribbean region (see footnote 29 for data source). Though, at 35%, Brazil's FDI stock-to-GDP ratio was not particularly high relative to the world and Latin America & Caribbean averages (both equal to 42%), among the BRICS countries only South Africa had a higher FDI stock-to-GDP ratio. FIFs in the manufacturing sector accounted for 32.43% of the value of that stock in 2019, with service sector FIFs accounting for the largest proportion (at 57.43%) and agriculture, fishing and mining taking up the remainder (at 10.14%).[30] Within the manufacturing sector, the subsectors with the highest concentration of FDI stock (in terms of absolute value) were: food and beverages, metallurgy, auto parts, and chemical products (Figure 3.3).

[30] Based on Data published by the Central Bank of Brazil (https://www.bcb.gov.br/en/statistics/specialseries).

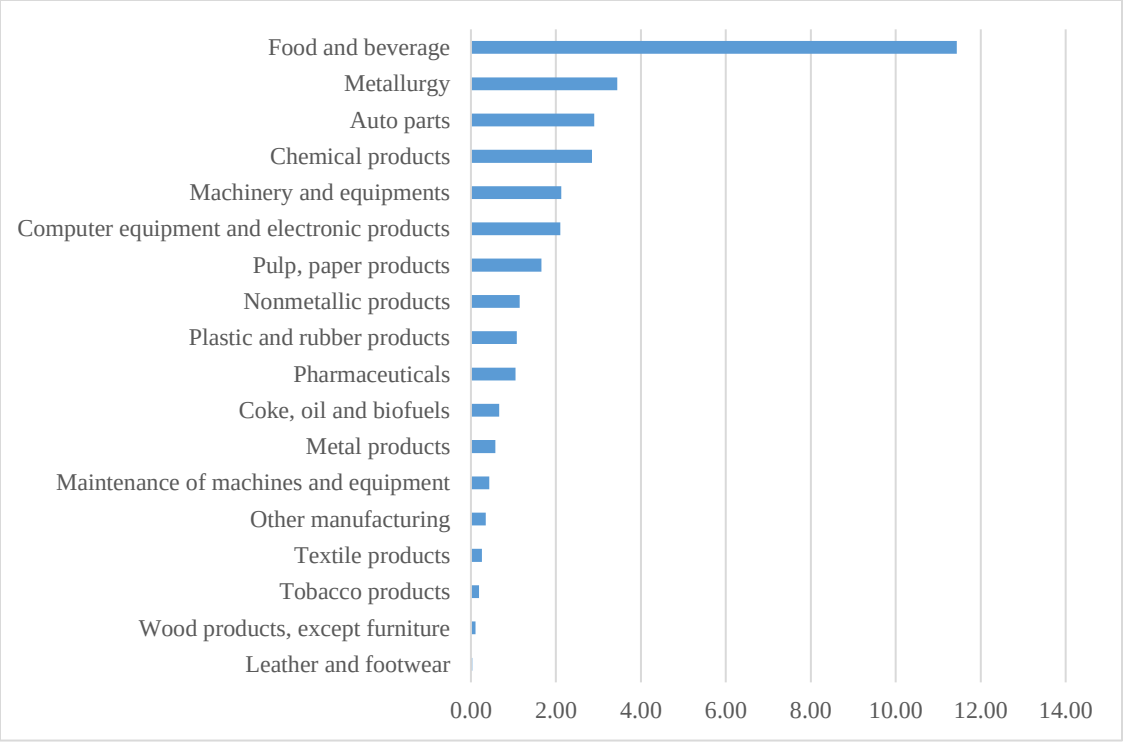


Figure 3.3: FDI stock by sector as a percentage of total FDI in manufacturing

Source: Central Bank of Brazil (https://www.bcb.gov.br/en/statistics/specialseries)

3.3. Foreign direct investment and productivity spillovers

An important part of the development strategy in many developing countries is the implementation of policies that attract FDI (Liu, 2008). This is motivated, in large part, by the presumption that MNCs, (and FIFs more broadly) will bring, along with new capital, superior technology and managerial knowhow that can enhance the productivity of domestic firms through knowledge spillovers (Aitken & Harrison, 1999; Blomstrom & Kokko, 1998). The various channels through which these spillovers can occur can be subdivided into intra-industry effects (horizontal spillovers) and inter-industry effects (vertical spillovers), and it is a reasonable presumption that various attributes of both FIFs and domestic firms can affect the likelihood of transmission and capture of spillover effects (Aitken & Harrison, 1999; Marin & Giuliani, 2011).

3.3.1. Horizontal Spillovers

Horizontal spillovers from FDI are the productivity spillovers that domestically owned firms realize while operating in the same industry alongside FIFs (Alfaro & Rodriguez-Clare, 2004). Horizontal spillovers may take place through several channels. For example, local firms can realize productivity spillovers by reverse engineering the production technology and management techniques used by FIFs (Das, 1987). Alternatively, the productivity and technology spillovers can take place through labor turnover from FIFs to domestic firms (Haacker, 1999). In particular, domestic firms can employ workers previously employed and trained by FIFs, thereby accessing the skills and knowledge acquired from FIFs while minimizing costs related to training and R&D (Balsvik, 2011; Kaufmann, 1997).

Competition between FIFs and their domestic counterparts in the same industry can also generate spillover effects by forcing the latter to use their existing resources more efficiently or forcing them to adopt more advanced production technologies (Blomstrom & Kokko, 1998; Gorg & Greenaway, 2004). Yet another avenue for spillover effects can be provided by access (of domestic firms) to the export-platforms used by FIFs (Jabbour & Mucchielli, 2007). However, if multinational firms can prevent their technologies and business strategies from leaking to local firms (through trade secrecy, formal protection, and locating in industries where domestic firms do not have much imitative capacity) and pay higher wages to their employees to reduce labor turnover, these spillovers may not occur (Javorcik, 2004). Intense competition from FIFs could also harm domestic firms by reducing their productivity in the short-run and forcing them to increase fixed cost – the market-stealing effect of FDI (Leahy & Montagna, 2000; Ni et al., 2017). Domestic firms may also experience a rise in variable costs as they try to retain their market share by spending more on advertising their products and prices in the face of the competition exerted

by FIFs (Bester & Petrakis, 1995; Nelson, 1990). This upward pressure on total cost may drive the least productive and less profitable domestic firms out of the market. These negative effects are called 'crowding-out effects' (Lin et al., 2009).

Not surprisingly, empirical studies exploring horizontal productivity spillovers have yielded mixed results. For example Iršová & Havránek (2013), Sari et al. (2016), Dries and Swinnen (2004), and Yanping Bai and Zhang (2013) found positive horizontal spillovers, while Aitken and Harrison (1999), Djankov and Hoekman (2000), Haddad and Harrison (1993), Jeon et al. (2013), Konings (2001), and Ni et al. (2017) found negative horizontal spillovers. However, some studies, including Lin et al. (2009), Du et al. (2012), Yan-ping Bai (2012), and Barrios et al. (2011), have found no evidence of horizontal spillovers from FDI.

3.3.2. Vertical spillovers

FIFs can generate productivity spillovers in industries outside their own – through their interaction (linkages) with input suppliers in upstream industries and customers in downstream industries. It has been argued in the literature that vertical spillovers are likely to take place, even when there are no horizontal spillovers. These vertical spillovers have been categorized into two types: backward spillovers and forward spillovers (Marcin, 2008).

Backward spillovers refer to the productivity and/or technology spillovers of FDI realized by domestic firms in upstream industries. These spillovers can be generated through many channels. First, advanced production technologies and management techniques may be transferred from FIFs to domestic firms located in other industries through supply chains. Second, FIFs may impose standardization requirements on domestic input suppliers to improve the quality of their products. Third, FIFs may provide some direct assistance, such as technical, management, training, and

distributional assistance to prospective suppliers in order to get cheaper and/or higher quality inputs (Lall, 1980).

However, the entry of FIFs can reduce the productivity of domestic firms through backward linkages (negative backward spillovers) if they impose restrictions on the inputs supplied by domestic firms (Barge-Gil et al. 2019; Kinuthia, 2016; Lin & Saggi, 2005). Domestic firms' absorptive capacity—ability to recognize and assimilate new information and external knowledge and to apply it for their own commercial purposes (Cohen & Levinthal, 1990)—is crucial for backward spillovers to take place (Blalock & Simon, 2009; Ha & Giroud, 2015). Its absence may negate the potential for backward spillover effects. Moreover, significant backward linkages may be missing if the domestic suppliers are far behind in terms of productivity level (Smarzynska, 2002)..

Given this range of possibilities, it is not surprising that empirical studies have not yielded unanimous results with respect to backward spillovers. For example, evidence of positive backward spillovers was found by MacDuffie and Helper (1997) for the US auto parts industries; Driffield et al. (2002) for UK firms; Blalock and Gertler (2003) for Indonesian firms; Javorcik (2004) for Lithuanian firms; Gorodnichenko et al. (2007) for Eastern European firms; and Lin et al. (2009) for Chinese firms. By contrast, evidence of negative backward spillovers from FDI was found by Kinuthia (2016) for Kenyan firms and Barge-Gil et al. (2019) for Spanish firms. Beyond those results, Anwar and Nguyen (2014), using regional panel data in Vietnam, found evidence of positive backward spillovers for some regions, but no evidence of backward spillovers for the other regions.

Forward spillovers are the productivity gains of domestic firms in downstream industries when they have access to new, high quality, and/or cheap inputs from FIFs in upstream industries (Markusen & Venables, 1999; Rodríguez-Clare, 1996). The sale of inputs by FIFs to domestic firms may be accompanied by some complementary services (additional to what would be available with imported goods) that are technology enhancing (Javorcik, 2004; Peng & Hong, 2013). Thus, forward linkages may be accompanied by transfers of technological know-how, intentionally or unintentionally, from foreign-invested sellers to domestic customer firms (Markusen & Venables, 1999; Orlic et al., 2018; Rodríguez-Clare, 1996).

However, some factors may limit the magnitude of forward spillovers or create negative (forward) spillovers. For instance, Crespo and Fontoura (2007) and Orlic et al. (2018) argued that the monopoly power of foreign-invested sellers may exert negative productivity effects on domestic firms through the imposition of higher prices for inputs (see also, Huynh et al, 2019 and Sari et al, 2016). Moreover, heterogeneity in absorptive capacity and the different levels of competition faced by both foreign-invested and domestic firms may also influence the magnitude of forward spillovers (García et al., 2013).

In line with this theoretical uncertainty, the evidence for forward spillovers in the empirical literature is mixed. Barge-Gil et al. (2019), Zeyong Tian (2010), Mariotti et al. (2013), Du et al. (2012), Newman et al. (2015), and Hanousek et al. (2011) found evidence of positive forward spillovers. On the other hand, Huynh et al. (2019), Sari et al. (2016) found evidence of negative forward spillovers. Some other studies, for example, Gorodnichenko et al. (2014), Barrios et al. (2011), Alvarez and López (2008), and Anwar and Nguyen (2010) could find no evidence of forward spillovers.

3.3.3. FIF characteristics, productivity and spillovers

Spillovers are transmitted through the interaction (direct and indirect) between FIFs and domestic firms. Given that the nature and intensity of those interactions are shaped, at least in part, by the characteristics of these firms, it would seem to follow that firm attributes are likely to govern the type, strength and direction of those effects. Attributes such as the intensity of foreign ownership, export orientation and import intensity imply certain FIF capacities and constraints that influence, or are indicative of, both the level of the technology utilized by FIFs and the nature and intensity of their interaction with domestic firms, thereby delineating the avenues for spillover effects. Though there have been studies that examined the role of particular attributes in determining spillover effects, that literature is still quite small in relation to certain characteristics and virtually nonexistent in relation to others.

The relevant theoretical literature typically allows for more than one possible relationship between FIF attributes and spillover effects, and the empirical literature has similarly reported a range of outcomes. Even where theory suggests singular outcomes, the empirical literature is either too thin or too indeterminate to support prognostic confidence. As is the case in much of the spillover literature, it appears that the context (both in terms of the country setting and motive for FDI) matters a great deal. Thus, in the case of Brazil, though we postulate that FIF characteristics matter for spillover effects, we will allow the data to indicate the precise nature and strength of those effect.

3.3.3.1. Degree of foreign ownership

There are three different strands in the literature relating to the FDI-ownership-spillover relationship. One part of the literature addresses the factors that motivate MNEs to choose to invest

abroad rather than export and, when they do, the choice is between greenfield investment, mergers and acquisitions (M&As) and joint ventures (Raff et al, 2009, 2012; Bhattacharya et al, 2012). Another part of the literature is concerned with the effect of different levels of foreign ownership (majority vs minority or full vs partial ownership) and/or different types of FDI (greenfield, M&As, and joint ventures) on the productivity of FIFs, and on the rate of technology transfer to local firms (Javorcik & Spatareanu, 2008; Hampl et al, 2020; Liu et al, 2020). A third part of the literature is concerned with the nature of the foreign investment regime (regulated or unregulated) and its effects on the mode and rate of FDI-related technology transfer (Görg et al, 2010; Ishikawa et al, 2009, 2011).

Our interest relates to the second strand of that literature – how the degree of foreign ownership (using the majority/minority dichotomy) affects the productivity levels of FIFs and, correspondingly, the nature, direction and extent of spillover effects.[31] The general presumption has been that multinational firms' desire to maintain control of proprietary technology will increase with the superiority of the technology to be transferred to domestic affiliates (Javorcik & Spatareanu, 2008). As a result, majority-foreign-owned FIFs should be, on average, more productive and generate stronger spillover effects than minority-owned FIFs. However, to this point, the empirical literature has generated no consensus on either the productivity or spillover question. With respect to productivity, Blomström and Sjöholm (1999) found no significant relationship between the degree of foreign ownership and firm-level labor productivity for a sample of Indonesian firms, but Dimelis and Louri (2002) found, for a sample of firms in Greece, that majority and fully-foreign-owned FIFs were more productive than locally-owned firms, but

[31] Though the greenfield/M&A/joint venture division may be equally interesting, the database did not provide sufficient information to accurately identify which firms belonged to these categories. Also, the proportion of FIFs that was fully owned was too small to allow statistical comparison using the fully vs partially owned dichotomy.

minority-owned FIFs were not. With respect to spillover effects, Blomström and Sjöholm (1999), as they found with regard to productivity, could uncover no relationship between majority or minority foreign ownership and the strength of spillover effects for their sample of Indonesian firms. However, Fatima (2016), for a sample of Turkish firms, found that the majority-owned FIFs had stronger horizontal spillover effects on domestic firms than minority-owned FIFs. By contrast, Malik (2015), for a sample of Indian firms, found that horizontal spillover effects were stronger for minority-owned FIFs.

3.3.3.2. Export orientation of FIFs, productivity and spillovers

There is a substantial literature that argues that the productivity levels are higher in export-oriented than in non-exporting FIFs (see, for example, Clerides et al., 1998; Delgado et al., 2002). Further, the export activities of FIFs may provide particular opportunities for technology spillovers to domestic firms (Barrios & Strobl, 2002). Domestic firms may reduce their entry costs into export markets by imitating or collaborating with FIFs that, through their foreign ties and foreign capital, typically have an advantage in export markets (Gorg & Greenaway, 2004; Greenaway et al., 2004). Avenues for spillover effects may also arise out of direct commercial interactions, such as through sub-contracting or the sale of inputs to export-oriented FIFs (Blomström & Kokko, 1998; Crespo & Fontoura, 2007).

Though the importance of exports in generating spillover effects has been often studied, few investigations have compared the spillover effects of exporting and non-exporting FIFs directly. Of the two that did, one found a differential in type and the other a differential in strength of spillover effects. Girma et al. (2008) found, for the UK manufacturing sector, that export-oriented FIFs generated horizontal spillovers while domestic-market-oriented FIFs generated backward

spillovers. Baltagi et al. (2015) found that exporting FIFs generated horizontal spillover effects while non-exporting FIFs generated none.

3.3.3.3. Import intensity of FIFs, productivity and spillovers

FIFs that introduce superior technologies may have a greater need to import intermediate goods and services from the home country, making import intensity a correlate of FIF productivity. This is a testable hypothesis, but if it is indeed the case, then import intensity can also imply stronger spillover effects because the potential for spillover effects in the form of labor turnover, imitation and competition may all be enhanced with the application of that superior technology (Ali et al., 2017; Coe & Helpman, 1995; Grossman & Helpman, 1991; Kathuria, 2002). However, evidence with respect to the relationship between FIFs import intensity and spillovers is scarce. Kathuria (2002), using Indian manufacturing data, divided firms into two subgroups, scientific and non-scientific, and found a positive productivity impact of imports on the scientific subgroup but a negative impact on the non-scientific subgroup.

3.3.4. Domestic firm characteristics and spillovers

In much the same way that the attributes of FIFs are expected to influence the nature and intensity of spillover effect, the characteristics of domestic firms, because they are coincident with certain firm-level constraints and capacities or influence the nature of the interaction with FIFs, can also be indicative of domestic firms' ability to capture potential spillover effects (Sinani & Meyer, 2004). Similar to FIF characteristics, the literature on domestic firm characteristics and spillover effects is both quite small and accommodative of multiple outcomes. In the case of the size characteristic, for example, the theoretical literature argues for contradictory effects while, in relation to absorptive capacity, the measurement of the term itself remains uncertain. In this study,

we try to allow for all projected outcomes and to accommodate alternative definitions in order to allow the data to speak for itself.

3.3.4.1. Domestic firm size and spillovers

Firm size (in terms of the number of employees) is one attribute that can potentially affect both the form and scale of the interaction between domestic firms and FIFs and, consequently, the potential for various types of spillovers (Aitken & Harrison, 1999). However, from a theoretical perspective, size may elicit both positive and negative outcomes. The scale of production and the technical capacity of small domestic firms may not be sufficient for the imitation of advanced technologies, but these firms may have an advantage in seizing productivity-enhancing opportunities and technologies from elsewhere because they are less bureaucratically encumbered (Acs et al., 1994; Rogers, 2004). Large firms are more likely to be bureaucratically encumbered and also more likely to be squeezed by competition from FIFs, but they are less likely to suffer from competency or scale problems and may invest more in capturing spillovers (Schumpeter, 1950).

With respect to the size impact, though the empirical literature overwhelmingly supports the small-firm advantage, that support is not absolute. Aitken and Harrison (1999) for Venezuela, Sinani and Meyer (2004) for Estonia, Imbriani et al. (2014) for Italy, and Doan et al. (2015) for New Zealand, all found positive spillover effects for small domestic firms but none for large firms. Dogan et al. (2017) actually found negative spillover effects for large firms in Malaysia. However, Le and Pomfret (2011) found evidence of positive spillovers for large firms and none for small firms in Vietnam.

3.3.4.2. Spillovers and absorptive capacity – technology gap and human capital

Absorptive capacity refers to firms' proficiency in recognizing, assimilating, and exploiting knowledge created externally (Cohen & Levinthal, 1990). Firms with higher absorptive capacity are, therefore, expected to be the main recipients of spillovers (Girma, 2005). The technology gap faced by the firm and access to, and use of, human capital are two recognized dimensions of absorptive capacity. However, though there is general agreement in the literature that absorptive capacity increases with the quality of human capital, there is less agreement on the precise effect of a firm's level of technology on absorptive capacity. Some investigators argue that absorptive capacity is highest when the technology gap between domestic firms and FIFs is relatively small, because a higher level of technology increases the ability of firms to identify and absorb outside knowledge (Borensztein et al., 1998; Glass & Saggi, 2002; Keller, 1996). Others argue, instead, that firms facing a large technology gap experience the strongest spillover effects, possibly because the opportunities for technology transfer are greater (Kokko, 1994; Wang & Blomström, 1992). We take an agnostic approach to the technology level (or gap) question by dividing the sample into high- and low-technology groups based on the total factor productivity of domestic firms in 2003. We look for evidence of the impact of the human capital dimension of absorptive capacity by dividing domestic firms into those that finance worker training and those that do not.

Unlike the empirical literature relating to firm size, the literature relating to absorptive capacity has produced very mixed results. For instance, Demena and Murshed (2018), using data from eight African countries, found that domestic firms with high technology levels (implying smaller technology gaps) benefitted more from spillovers transmitted through the demonstration and competition effects, but firms with low technology benefitted more from spillovers transmitted through labor mobility. Kokko et al. (1996) found FDI spillovers for domestic firms facing small

technology gaps (vis-à-vis FIFs) but no spillovers for firms facing large gaps in the Uruguayan manufacturing sector. However, Haskel et al. (2007), using data from U.K. manufacturing firms, found that firms that were further away from the technology frontier received the most horizontal spillovers. Castellani and Zanfei (2003) found that firms facing large (intra-sectoral) productivity gaps were more likely to experience spillovers. Girma and Wakelin (2001) found that a high proportion of skilled workers (interpreted as a positive indicator of absorptive capacity) enhanced the ability of small firms to experience spillover effects in the U.K. electronics sector. However, Demena and Murshed (2018) found that investment in employee training (which they associated positively with absorptive capacity) was associated with reduced spillover transmission through the demonstration effect and negative transmission from the competition effects.

3.4. Model and data

3.4.1. Estimating within-firm productivity effects of foreign ownership

Within-firm productivity effects of foreign ownership can be demonstrated in two ways: (1) at any point in time FIFs are more productive than comparable domestic firms; or (2) FIFs demonstrate a higher rate of growth in productivity than comparable domestic firms. A comparison of group averages (FIFs vs domestic firms), though helpful, is not sufficient to demonstrate foreign-ownership induced productivity differentials. To ascertain the presence of within-firm productivity impacts of FDI, we need to compare the productivity (or growth in productivity) of FIFs and domestic firms that otherwise share similar characteristics. We thus apply the propensity score matching (PSM) approach developed by Rosenbaum and Rubin (1983) to compare the productivity levels (and the rate of change in productivity) of FIFs and domestic firms that share

similar characteristics.[32] The underlying idea is that the bias arising from differential characteristics of the treated and control group is reduced if the comparison of outcomes is performed using similar subjects in both groups (Huttunen, 2007). In this context, the treated group is FIFs and the control group is those firms that remain domestically owned. Foreign purchase of equity is the treatment.

The two parameters most often used in the PSM literature are the population average treatment effect (ATE) and the average treatment effect on the treated (ATT). The ATE, the expected difference in outcome if the entire population was treated, can be defined as follows:

$$ATE = E[Y(1) - Y(0)|X] \tag{3.1}$$

where $Y(1)$ is the expected outcome of receiving the treatment (foreign acquisition of firm equity of 10% or higher) and $Y(0)$ is the expected outcome of not receiving the treatment (less than 10% foreign ownership of equity). The relevant outcome is alternatively defined as an increase in the firm's productivity level (static case) and the change in productivity between 2003 and 2009 (dynamic case) (see Section 3.4.6 below for more detail description of data). X is a vector of pre-treatment characteristics of the firms. The ATT, the average effect of the treatment for those subjects that actually received the treatment, can be defined as:

$$ATT = E[Y(1) - Y(0)|T = 1, X] \tag{3.2}$$

[32] Another option is difference-in-difference (DiD) estimation that considers the productivity differences of firms in the treated group (FIFs in this case) and control group (domestic firms in this case) before and after the foreign acquisition year. However, the fact that the data covers only two time periods (see the data description in Section 3.4.6. below) makes this approach unfeasible. Also, it is important to compare similar firms with each other, otherwise DiD estimation is also biased (Karpaty, 2007).

where T is a treatment indicator that takes on a value 1 if a firm is treated (foreign-invested) and 0 if it is untreated (domestically-owned). $E[Y(0)|T = 1]$ is the counterfactual to be estimated. Following Arnold and Javorcik (2009) and Lenaerts and Merlevede (2015), the pre-treatment characteristics used in determining propensity scores are the log of real sales, the log of employment and its square, the log of capital per unit of labor, the share of inputs imported, firm age and its square, industrial sector, and region (see Table B3.3 of Appendix B for regional distribution of firms). The matching technique employed is nearest-neighbour matching with replacement.

We use this technique to determine whether foreign ownership is associated with a higher productivity level, and/or a higher rate of productivity growth, even after other relevant firm characteristics are accounted for. This technique is also used to determine whether higher productivity levels (and/or higher rates of productivity growth) are associated with certain characteristics of FIFs. The characteristics examined are: the level of foreign ownership (majority vs minority foreign-owned), the degree of export dependence (high exporters vs low exporters) and the degree of import dependence (high importers vs low importers).[33]

3.4.2. Estimating spillovers

The horizontal and vertical (i.e., backward and forward) spillover variables are defined following Javorcik (2004). The horizontal spillover variable is meant to measure the incidence of foreign equity participation at the industry level and is defined as follows:

[33] See Table B3.1 (Appendix B3) for a description of the determination of various categories of FIFs.

$$Horizontal_{jt} = \frac{\sum_{i \in j} FS_{it} \times Y_{it}}{\sum_{i \in j} Y_{it}} \quad (3.3)$$

where FS_{it} is firm *i*′s total equity share owned by foreign investor(s), and Y_{it} is the real value of the total sales of firm *i* at time *t* (and operating in industry *j*). It thus measures the intensity of foreign participation in each industry. $Backward_{jt}$, is meant to measure vertical spillovers that occur through backward linkages (of FIFs). Accordingly, it measures the density of foreign presence in downstream industries using the formula:

$$Backward_{jt} = \sum_{k \neq j} \eta_{jk} Horizontal_{kt} \quad (3.4)$$

In that formula: η_{jk} represents the proportion of industry *j*'s output purchased by industry *k*[34]; and $Horizontal_{kt}$ (as above) measures the density of foreign presence in industry *k* at time *t*. Since the dataset used does not include any information about actual backward linkages, either at the firm- or industry-level, the coefficient η_{jk} is taken from the 2005 input-output matrix of Brazil.[35] The forward spillover variable is meant to measure vertical spillovers that occur through forward linkages with upstream industries. It is defined as:

$$Forward_{jt} = \sum_{n \neq j} \varphi_{jn} \frac{\sum_{i \in n} FS_{it} \times (Y_{it} - X_{it})}{\sum_{i \in n} (Y_{it} - X_{it})} \quad (3.5)$$

[34] For example, if an industry A sells its output to four other industries, namely B, C, D and E and, for simplicity, suppose industry A sells 20% of its output to industry B, 15% to industry C, 30% to industry D, and 35% to industry E. If industries B, C, D and E have 20%, 30%, 10% and 25% share held by foreigners respectively (as measured by $Horizontal_{kt}$), the *Backward* variable for industry A would be calculated as: $(0.2 \times 0.2) + (0.15 \times 0.3) + (0.3 \times 0.1) + (0.35 \times 0.25) = 0.2$.

[35] In Table 8 of the 2005 input-output matrix of Brazil, 55 sectors have been reported, whereas the data used in this study has information on eight (manufacturing) sectors. The first four of them (15, 17, 18, 19) coincide with the reported sectors in the input-output matrix and, therefore, the coefficients for these four industries are taken directly from the input-output matrix. However, for the other four sectors, the input-output matrix covers more disaggregated subsectors. The sectoral coefficient is thus calculated as a weighted average of the coefficients for relevant subsectors.

In that formula: φ_{jn} represents the proportion of industry *j*'s inputs purchased from industry *n* (and is also taken from the 2005 input-output matrix for Brazil); [36] FS_{it} is as above; Y_{it} is the (real) value of the total sales, including exports, of firm *i* in period *t* (and in industry *n*); and X_{it} is the sum of actual direct and indirect exports of these firms.[37] Exports must be extracted from total sales because domestic market sales are the only part of output relevant for measuring forward spillovers through domestic linkages (see Table B3.2 of Appendix B3 for the distribution of spillover variables across sectors).

3.4.3. Estimating the impact of particular FIF characteristics on spillovers

In order to analyze whether, and to what extent, particular FIF characteristics matter for spillover effects, the spillover variables are redefined for binary classifications of FIFs. The binary classifications are:

- Minority vs majority foreign ownership: 10 to 50% foreign equity share vs >50% foreign equity share; [38]

- Low-exporting vs high-exporting: FIFs whose proportion of output exported is below the total sample mean vs FIFs whose proportion of output exported is above the total sample mean;

[36] For example, if industry A purchases 20% of its intermediate inputs from industry F, 30% from industry G, 15% from industry H, and the remaining 35% from industry I respectively, where industry F, G, H and I's average foreign share weighted by firms' domestic sales are 50%, 40%, 55% and 60% respectively. Here, the *Forward* variable of industry $A = (0.2 \times 0.5) + (0.3 \times 0.4) + (0.15 \times 0.55) + (0.35 \times 0.6) = 0.51$.

[37] Some firms export directly and the others sell a part of their output to local agents who export.

[38] The choice of 50% as the cutoff is, of course, dictated by the fact that ownership above 50% implies control of the firm while 50% or less implies less than controlling ownership. This division is the norm in the empirical literature and aligns with the commercial definition of 'controlling ownership' (for example, see Blomström and Sjöholm, 1999).

- Low-importing vs High-importing: FIFs whose proportion of inputs imported is below the total sample mean vs FIFs whose proportion of inputs imported is above the total sample mean.

In this pursuit, Equations (3.3), (3.4), and (3.5) are modified as follows:

$$Horizontal_{jt}^{m} = \frac{\sum_{i \in j} FS_{it}^{m} \times Y_{it}}{\sum_{i \in j} Y_{it}} \tag{3.6}$$

$$Backward_{jt}^{m} = \sum_{j \neq k} \eta_{jk} \, Horizontal_{kt}^{m} \tag{3.7}$$

$$Forward_{jt}^{m} = \sum_{n \neq j} \varphi_{jn} \frac{\sum_{i \in n} FS_{it}^{m} \times (Y_{it} - X_{it})}{\sum_{i \in n} (Y_{it} - X_{it})} \tag{3.8}$$

where *m* takes on the values of 1 and 2 indicating variously: minority-owned and majority-owned FIFs; low-exporting and high-exporting FIFs; and low-importing and high-importing FIFs respectively.

3.4.4. Correcting for endogeneity and selection bias

To assess the spillover effects of FDI, we estimate the following equation for domestic firms.[39]

$$lnTFP_{ijt} = \theta_0 + \theta_1 Horizontal_{jt} + \theta_2 Backward_{jt} + \theta_3 Forward_{jt} + \theta_4 H_{jt} + \theta_5 Z_{ijt} + \delta_t + \delta_r + \delta_j + \varepsilon_{ijt} \tag{3.9}$$

[39] Many investigators use the full sample (foreign-invested and domestic firms) and run a similar regression that includes a variable that indicates foreign ownership of firm equity. This is a valid approach that combines questions regarding both the within-firm productivity effect (of foreign ownership) and the spillover effects. Since the within-firm productivity effect is already addressed here, using the propensity score analysis (which, we believe, is more precise), we can limit this econometric exercise to answering the second question.

In this equation $lnTFP_{ijt}$ is the (natural) log of the total factor productivity (TFP) of firm i in industry j at time t. $Horizontal_{jt}$, $Backward_{jt}$, and $Forward_{jt}$ denote horizontal, backward, and forward spillover variables respectively (as defined in Equations 3.1-3.3 above). H_{jt} is the Herfindahl-Hirschman index representing the level of competition in industry j,[40] and Z_{ijt} represents a set of covariates that are expected to influence a firm's TFP. Symbols δ_t, δ_r, and δ_j denote time, regional, and industry dummies respectively.

As observed by Griliches and Mairesse (1995), however, the TFP suffers from endogeneity problems in input choice. Some inputs that are considered exogenous while estimating production levels are actually endogenous because producers may choose them on the basis of current productivity. This endogeneity, observed by firms but not by the econometrician, violates the OLS assumption of independence between the the error term and the right-hand-side variables. If not corrected, coefficient estimates will be biased. Several methods have been proposed for correcting for this endogeneity problem. These include: Olley and Pakes (1996) (OP), Levinsohn and Petrin (2003) (LP), and Wooldridge (2009). Recently, Ackerberg, Caves, and Frazer (2015) (ACF) stressed that the OP, LP, and Wooldridge methods may suffer from a functional dependence problem while inverting the unconditional input demand function, and proposed an alternative, but related, estimator to avoid this problem. This estimator, unlike the OP or LP estimators, inverts the input demand functions conditional on labor input choice. In addition, this estimator is strictly more general than even the Wooldridge estimator, in that it allows unobserved heterogeneity in

[40] To incorporate the approach taken by Nickell (1996) with regards the impact of competition on corporate performance, the Herfindahl-Hirschman index is used in this study. The index is basically used to show the degree of market concentration and is calculated as the sum of the squared market shares of the firms in a given industry. A value close to 0 indicates high degree of competition, whereas a value very close to 1 indicates a high degree of concentration in an industry.

wages across firms, allows labor to have dynamic implications, and further allows labor to be chosen prior to materials. Considering the aforementioned advantages of the ACF method over OP, LP and Wooldridge methods, this study employs the ACF method to obtain endogeneity-corrected firm-level TFP measures (see appendix A3 for more details). We follow a two-step procedure for estimating spillover results: first, we obtain endogenity corrected firm-level total factor productivity (TFP) employing the ACF method, and then run Equation (3.9).

Selection bias is another challenge deriving from the nature of available data (Greene, 2003). Selection bias may result from using non-randomly selected samples (Heckman, 1979) or if the dependent variable is not observed for some of the firms over the entire period. To avoid the sample selection bias, we utilize the Heckman (1979) two-step procedure. First, we apply a probit regression to compute the probability that a firm is included in the sample and calculate the resulting "inverse Mills ratio." Then, the "inverse Mills ratio" is included in the main analysis as an explanatory variable. First-stage selection regression results are reported in Table B3.5 of Appendix B3.

3.4.5. Estimating the impact of particular domestic firm characteristics on spillovers

In the same manner that we investigate the importance of FIF attributes on the nature and magnitude of spillover effects, we wish to investigate the importance of specific attributes of domestic firms on spillover effects. Since domestic firms make up the sample of firms whose productivity responses (to FIF presence) are examined using Equation 3.9, we can ascertain the importance of particular domestic-firm attributes by dividing the sample (of domestic firms) into attribute-based dichotomous groups. These dichotomous groups are:

- Small-to-medium vs large – where small-to-medium firms are defined as those having less than 100 employees in 2003 and large firms are those having 100 or more employees in 2003;[41]

- Low-technology vs high-technology – where low-technology firms are those whose total factor productivity (TFP) measure was below the median for domestic firms in 2003 and high-technology firms are those above the median.

- Non-training vs Training – where non-training firms are domestic firms that report no spending on the training of employees in either of the two sample years (2003 and 2009) and training firms are those that report financing the training for their employees in either or both of those years.

All three of the factors being examined through these divisions (size, productivity level, and investment in training) relate, in some form, to absorptive capacity. Therefore, the finding of significant difference in the spillover coefficient estimates can help define both the nature of the effect and the degree of importance of absorptive capacity in the Brazilian context.

3.4.6. Data

This study uses a firm-level panel dataset of double-digit subdivisions of the manufacturing sector (International Standard Industrial Classification (ISIC) Rev. 3.2) in Brazil obtained from the Enterprise Survey database of the World Bank. The dataset contains information on 1190 firms for 2003 only, 1350 firms for 2009 only, and 452 firms in panel format for 2003 and 2009 (a total

[41] Many investigators use a cutoff of 50 to separate small firms from medium-to-large firms. However, that division resulted in an overly small sample for small firms. The 100-employee cutoff is often used to divide medium from large firms (Leung et al., 2008).

of 904 observations). As this study is concerned with the panel dataset, the cross-sectional observations of 2003 and 2009 are not considered. In addition, the data cleaning process led to the exclusion of six firms in each of the years 2003 and 2009 (because of incomplete responses), making a balanced panel dataset of 892 observation with 446 firms in each year.

The dataset contains information on numerous variables. The ones of most immediate relevance to this study are: the value of total sales for both years (adjusted for inflation using the consumer price index); the number of workers (which is the sum of production and non-production employees); the value of capital (which is the net book value of capital in each year deflated using the GDP deflator due to the unavailability of an investment price index); materials (which is the sum of the expenses for raw materials, intermediate goods and electricity[42] deflated using industry specific intermediate input price indices); the age of the firm; the foreign share of firm equity (if 10% or more); and the degree of competition in the sector (using the Herfindahl-Hirschman index). The study also uses information on direct exports and indirect exports for calculating net domestic sales for the *Forward* variables defined in Equation (3.5) and Equation (3.8).

Table 3.1 reports descriptive statistics of the main variables (across domestic firms and FIFs) used in this study (see Table B3.4 of Appendix B3 for measures of the correlation among variables). The important finding here is that FIFs, on average, produce more output, employ more labor, use more materials, possess more capital, and have a higher TFP than do domestic firms. This profile broadly matches that for most developing countries.

[42] Expenses for electricity are treated as part of inputs costs used by a firm. For more details, see Bell (1973), and Chen and He (2013) page 110.

Table 3.1: Descriptive statistics of the main variables

Variable	All firms		Domestic firms		FIFs	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Sales (in logs)	14.954	2.207	14.704	2.195	15.459	2.147
Labor (in logs)	3.988	1.187	3.914	1.199	4.148	1.147
Material (in logs)	12.540	2.421	12.285	2.427	13.085	2.322
Value of Capital (in logs)	13.520	2.368	13.357	2.354	13.850	2.367
lnTFP	4.123	0.768	4.056	0.779	4.260	0.726
Herfindahl–Hirschman Index	0.174	0.088	0.171	0.083	0.181	0.097
Firm age (in logs)	2.902	0.772	2.895	0.779	2.917	0.759
Export-Sales Ratio	0.073	0.192	0.068	0.184	0.083	0.207
Assets per employee	0.670	2.336	0.627	2.283	0.758	2.445
Leverage (Debt/Assets Ratio)	0.364	1.085	0.357	1.133	0.379	0.985
Sales per employee	10.964	1.680	10.776	1.682	11.365	1.606
Skill/Unskilled labor ratio	1.837	4.563	1.865	4.638	1.778	4.404

Notes: Asset per employee is in 100,000 local currency (Brazilian real).

3.4.7. FIFs versus domestic firms

Theoretically FIFs are presumed to use more capital (or sophisticated capital), pay higher wages to their workers, and produce higher output (sale). Higher wages obviously mean more skilled workers, which translates to higher value added per worker. Thus, to take into account the effects of foreign investment, Equation (3.10) is estimated for each dependent variable (firms' output, value addition, wages[43], and intensity of capital) and for each year (2003 and 2009) separately on foreign share (*FS*) following Lin *et al* (2009):

$$lnR_i = \theta_0 + \theta_1 FS_i + \theta_r + \theta_j + \varepsilon_i \qquad (3.10)$$

[43] Wages are considered as average across all employees and adjusted for inflation using the consumer price index.

where R_i denote firm *i*'s output (sale), labor productivity in terms of value addition, wages, and intensity of capital. FS_i is a dummy variable representing 1 if the equity of a firm held by foreign investor(s) is at least 10%, and zero otherwise. In each regression, θ_r and θ_j represent regional and industry dummies respectively.

The estimation results of Equation (3.10) are displayed in Table 3.2. The results suggest that the output (sales) and labor productivity of FIFs differ significantly from their domestic counterparts, while wages differ only in 2009 (at the 10% level of significance), but capital intensity of FIFs is not different from that of domestic firms. For the regression including observations for both years, the first three variables are significantly influenced by foreign share, but capital intensity is not. The non-significance of capital intensity in the context of higher labor productivity implies that FIFs are using superior technologies or are managed better.[44]

Table 3.2: Characteristics' differentials of foreign firms from domestic firms

Dependent variables	2003		2009		All	
	Coefficient	Difference in Value (%)	Coefficient	Difference in Value (%)	Coefficient	Difference in Value (%)
ln*Sale*	0.3815* (0.1957)	46.45	0.7275*** (0.2477)	106.99	0.0080** (0.0034)	0.80
ln(*Value added per worker*)	0.2241* (0.1252)	25.12	0.4909** (0.1991)	63.38	0.0084*** (0.0026)	0.84
ln(*Wage per worker*)	0.0655 (0.0896)	-	0.3728* (0.1974)	45.18	0.0044* (0.0024)	0.44
ln(*Capital per worker*)	-0.0893 (0.1793)	-	0.1115 (0.2279)	-	-0.0011 (0.0039)	-

Notes: "***", "**", and "*" denote significance at the 1%, 5%, and 10% level respectively. The robust standard errors are presented in parentheses. The independent variable is foreign share of the firms. All regressions include a full set of regional and industry dummies. The '-' means insignificant values of the corresponding coefficients.

[44] However, the coefficient on *FS* (foreign share), θ_1, is used to calculate the differentials between FIFs and domestic firms as $(\exp(\theta_1) - 1) \times 100$, which shows the percentage differential. For more details, see Lin et al. (2009) page 683. As an example, output (sales) of a foreign-invested firm in 2003, on average, was 46.45% $((\exp(0.3815) - 1) \times 100)$ higher than that of a domestic counterpart.

3.5. Estimation results

3.5.1. Within-firm productivity effects

The results from Table 3.2 suggests that the theoretical presumption that FIFs use more productive capital (though not necessarily more capital), pay higher wages to their workers, and produce higher output (sales) than their domestic counterparts is likely the case for Brazil. However, we cannot be certain that the difference in average productivity is wholly due to the fact of foreign ownership and not to other factors that are inherent to the firms themselves. For example, if foreign investors target domestic firms that are already more productive, the above results might be produced even if foreign ownership is more the effect, rather than the cause, of higher productivity and larger size. Hence the need for the more discriminating comparison that is provided by the propensity score method (PSM).

Table 3.3 reports propensity score method (PSM) results that take firm attributes into consideration when comparing single-year, firm-level, productivity (the static case).[45] The table presents results using several permutations of the "treatment" in order to determine how various attributes, additional to FDI participation, affect FIFs' productivity relative to comparable domestic firms (the control group).

- When the treatment is defined as all foreign ownership that qualifies as FDI (foreign participation that accounts for at least 10% of firm equity), the propensity score analysis

[45] These are within-year comparisons using the sample of 446 firms that make up the panel data set. Comparisons are made for the productivity levels across comparable firms within each year (2003 and 2009).

indicates that this treatment is consistent with a higher productivity level (with better than the 1% significance level for both the ATE and ATT measures).

- When we define the treatment as minority foreign ownership (foreign participation that accounts for 10% to 50% of firm equity), the propensity score analysis indicates that minority foreign ownership does not result in a statistically significant productivity differential relative to comparable domestic firms (the control group). However, when we define the treatment as majority foreign ownership (foreign participation that accounts for more than 50% of firm equity), the propensity score analysis indicates that there is a statistically significant difference (at the 1% level) between the productivity levels of majority-owned FIFs and comparable domestic firms.[46]

- Defining the treatment as foreign ownership and a low-export profile (i.e., exports below the FIF average) leads to the finding of a statistically significant, and positive, differential between those FIFs and comparable domestic firms. This remains the case when the treatment is defined as foreign ownership with a high-exports profile (exports above the FIF average). Though the ATE and ATT coefficients were substantially larger in the latter case, suggesting that the degree of export concentration matters, there is a sizable overlap in the 95% confidence intervals (not shown) for the two coefficient measures across the treatment groups. We, therefore, cannot pronounce, with any confidence, that the 'true' values of the ATE and ATT are different for high and low exporters.

[46] For robustness and greater clarity, we also applied definitions of the "treatment" based on narrower divisions relating to the level of foreign ownership (10-25%, 26-50%, 51-75% and 76-100%). However, the lower levels of ownership offered similar results to minority ownership and the higher levels also offered similar results to majority ownership – indicating that it is the majority-minority division that matters.

- Defining the treatment as a low-import profile in addition to foreign ownership did not elicit a substantively different result from defining the treatment as a high-import profile and foreign ownership. Both treatments generated significant but similar ATE and ATT coefficients, indicating higher productivity than comparable domestic firms but no substantial difference between high and low importers.

Table 3.3: Propensity score matching of differences in productivity (the static case)

Treatment	Average treatment effect			Average treatment on the treated		
	Treated group	Control group	ATE	Treated group	Control group	ATT
Foreign ownership (FIFs)	4.335	4.063	0.271***	4.236	4.034	0.268***
FIFs with minority ownership	4.152	4.084	0.067	4.137	4.084	0.021
FIFs with majority ownership	4.741	4.043	0.697***	4.741	4.043	0.675***
FIFs with low exports	4.161	4.025	0.136*	4.007	4.184	0.231***
FIFs with high exports	4.584	4.155	0.429**	4.584	4.155	0.369**
FIFs with low imports	4.298	4.036	0.261***	4.239	4.031	0.261***
FIFs with high imports	4.342	4.121	0.221***	4.418	4.065	0.397***

Notes: ***, ** and * denote significance at the 1, 5, and 10% level respectively. The outcome variable is ln(TFP). The explanatory variables used in the matching equation are log of real sale, log of labor and its square, log of capital per labor, imported input share, age and its square. ATE and ATT in the table refer to "average treatment effect" and "average treatment on the treated". Here, treated group is FIFs, whereas control group is domestic firms.

The PSM results clearly indicate that the higher productivity level of FIFs is particular to majority-owned FIFs. The degree of exporting or importing activity could not be shown to reinforce or contradict that ownership effect (see Table B3.6 of Appendix B3 for average export and import intensities).

When the comparison relates to productivity in a dynamic sense (the change in productivity between 2003 and 2009), the picture remains the same (Table 3.4). The propensity score analysis indicates a productivity growth differential between majority-owned FIFs and comparable domestic firms, but no such differential is found for minority-owned FIFs. The division of FIFs in

terms of export and import concentration do not eliminate the growth differential of FIFs relative to their domestic counterparts in the way ownership level does. Though the ATE and ATT measures are higher for high-exporting and high-importing FIFs (compared to that for low-exporting and low-importing FIFs) the confidence intervals of these measures overlap too substantively to support interpretations of actual differences in magnitude. Thus, as for the static case, the productivity differential of FIFs is shown to be exclusive to majority-owned FIFs.

Table 3.4: Propensity score matching of differences in productivity growth (the dynamic case)

Treatment	Average treatment effect			Average treatment on the treated		
	Treated group	Control group	ATE	Treated group	Control group	ATT
Foreign ownership (FIFs)	0.450	0.155	0.294**	0.148	0.289	0.300**
FIFs with minority ownership	0.289	0.180	0.108	0.289	0.180	0.114
FIFs with majority ownership	0.815	0.212	0.603*	0.797	0.139	0.631**
FIFs with low exports	0.269	0.201	0.168**	0.252	0.191	0.190**
FIFs with high exports	0.770	0.193	0.577**	0.770	0.193	0.437**
FIFs with low imports	0.471	0.241	0.229**	0.338	0.222	0.177**
FIFs with high imports	0.464	0.163	0.301***	0.466	0.027	0.568**

Notes: ***, ** and * denote significance at the 1, 5, and 10% level respectively. The outcome variable is the sixth difference of ln(TFP). The explanatory variables used in the matching equation are log of real sale, log of labor and its square, log of capital per labor, imported input share, age and its square. ATE and ATT in the table refer to "average treatment effect" and "average treatment on the treated". Here, treated group is FIFs, whereas control group is domestic firms.

The PSM estimation results thus lead to some very clear conclusions with regard to the relationship between foreign ownership and productive superiority. In the Brazilian case, FIFs as a group, are more productive and have enjoyed more rapid productivity growth than domestic firms. Past empirical results suggest that this finding is not unique to Brazil but it is far from universal (see section 3.3.3.1). However, on its face, this result hides some very stark differences between FIFs with minority foreign participation and those with majority foreign participation. Minority foreign participation is not associated with any productivity advantage. The productivity advantage associated with foreign ownership relates only to majority foreign-owned firms. In the case of

Brazil, therefore, positive spillover effects from FDI can be treated as a reasonable prospect only with respect to majority foreign-owned firms because only these firms demonstrate a measurable differential in productivity that offers potential for transfer (intentional or unintentional) to domestic firms. This does mean that spillover effects are not possible from specific minority foreign-owned firms (since a few minority-foreign-owned firms may demonstrate above-average productivity), but it does mean that an *a priori* expectation in that regard may not be a reasonable one. Additionally, the productivity differential remains for FIFs (relative to comparable domestic firms) regardless of the degree of export or import concentration.

To explore the underlying productivity spillover effects of FDI on domestic firms, Equation (3.9) is estimated using fixed effects (the random effects model results were not radically different but the Hausman test selected the fixed effects model). The results are reported in Table 3.5. The sample used in the regression is all domestic firms. Standard errors are clustered at the industry-year level to avoid spurious findings of statistically significant coefficients for aggregate variables.[47]

3.5.2. Spillover effects - baseline specification

The coefficients of the *Horizontal* and *Backward* variables are positive and significant – implying that FIFs generate productivity spillovers in the same sector (horizontal spillovers) and in upstream sectors (backward spillovers). The coefficient of the *Forward* variable is not significant – suggesting that foreign ownership in one sector has no impact on domestic firms in downstream

[47] Incorrect application of OLS can lead to seriously downward biased standard errors (Moulton, 1990). Moulton showed that regressing micro level data (firm TFP in this case) including aggregate market variables (industry-level spillover variables in this case) leads to underestimated standard errors that in turn produce spurious significant coefficients of aggregate variables.

sectors. The significance of the coefficient of the inverse Mills ratio suggests that there was, indeed, a need for correction of sample selection bias.

Table 3.5: Estimation results for Equation 3.9

Variables	Domestic firms
Horizontal	0.104***
Backward	1.403***
Forward	-0.004
Inverse Mills Ratio	1.223*
Herfindahl-Hirschman Index	-0.426
Firm age of 5 to 9 years in 2003	0.286*
Age of more than 10 years in 2003	0.318
Exports (as % of total firm sales)	0.014
Value of assets per employee	0.019**
Total revenue (in logs)	-0.004
Leverage (debt to asset ratio)	0.039
Sales per employee (in logs)	0.038
Skill-to-unskilled labor ratio	-0.001
Constant	-4.354***
Observations	505
R-squared	0.849

Notes: ***, **, and * denote significance at the 1, 5, and 10% level respectively. The dependent variable is ln(TFP). All specifications include year, industry, and regional dummies. The standard errors in parentheses are clustered at industry-year level. All specifications are estimated with fixed effects. The sample size is restricted to domestic firms only (i.e., firms with less than 10% foreign equity share).

The competition variable, as measured by the Herfindahl-Hirschman Index (HHI), is not significant, suggesting that concentration or competition is not of considerable importance for productivity in Brazilian industries.[48] Age of the firm—included to control for the fact that experience is generally expected to improve firm performance (Cucculelli et al, 2014)—is not

[48] Since the Herfindahl-Hirschman index is calculated as the sum of the squared market shares of the firms in a given industry, its value is higher when only a few firms possess most of the market share (implying a higher degree of market concentration). The insignificant coefficient for that variable is consistent with Girma and Görg (2003) who found the same result for engineering sector in the UK.

significant as a continuous variable, but when it is represented by two dummy variables, the first indicating firms that are young but not new (5-9 years in 2003) and the second representing firms that are mature (10 years or more in 2003), the former has a significant coefficient suggesting that firm age does matter but the relationship is nonlinear (and likely quite complex).

The inclusion of export concentration is meant to control for the fact that domestic exporting firms are expected to be larger and more productive than non-exporting firms (also see Bigsten & Gebreeyesus, 2009; Greenaway et al, 2005). However, the insignificance of the coefficient for this variable suggests that, other things being equal, this is not necessarily true for Brazilian domestic manufacturing firms. As expected, the variable indicating the value of assets per worker (a measure of the capital intensity of production) is significant, but other measures of the production ecosystem (revenue, leverage, sales per employee and the relative abundance of skilled labor) are not significant.

As noted earlier, findings with respect to spillover effects have varied substantially across developing countries (Demena & van Bergeijk, 2017). Thus, no particular set of findings for Brazil would likely have been unprecedented. However, previous results for Latin American countries, have typically been less optimistic. While there have been findings of positive spillover effects, there have also been findings of negative spillover effects, which we did not encounter. For Mexican firms, for example, López-Córdova (2001) found negative horizontal spillovers and positive backward and forward spillovers, while Armas and Rodríguez (2017) found no evidence of spillover effects.

3.5.3. Spillover effects by FIF attributes

To determine whether particular FIF characteristics were important in determining the presence and strength of spillover effects, we re-estimate Equation (3.9) replacing spillover variables (i.e., *Horizontal*, *Backward*, and *Forward*) by those specified in Equations (3.6), (3.7), and (3.8). Results of the regressions, using the full sample of domestic firms, are reported in Table 3.6. The findings, with respect to spillover effects (which is our main concern in this section) is quite unequivocal. All significant coefficients were significant at the 5% level or better. In fact, all but one coefficient was significant at the 1% level or better. These results allow us to add a great deal of nuance to that derived from the baseline specification.

With respect to the degree of foreign ownership, the results more or less follow from the PSM results – minority-owned FIFs appear to generate no spillover effects, but majority-owned FIFs generate both positive horizontal and positive backward spillover effects. With respect to exporting profiles, high-exporting FIFs, similar to majority-owned FIFs, generate positive horizontal and backward spillover effects, but low-exporting FIFs do not. More interestingly, however, low-exporting FIFs generate positive forward spillover effects that are not generated by high-exporting FIFs. The implication here is that low-exporting FIFs, because of their greater focus on the domestic market, are able to transmit productivity-enhancing benefits to their customers in downstream industries, but the more export-oriented FIFs have no such influence. With respect to import profiles, high-importing FIFs generate positive horizontal and backward spillover effects (similar to majority-owned and high-exporting FIFs). Low-importing FIFs generate positive backward and forward spillovers.

Table 3.6: Regression results of FDI spillovers by type of FIFs

Variables	FIF characteristics					
	Minority Ownership	Majority Ownership	Low-Exporting	High-Exporting	Low-Importing	High-Importing
	(1)	(2)	(3)	(4)	(5)	(6)
Horizontal	0.003	0.011***	-0.008	0.081***	0.000	0.443***
	(0.004)	(0.001)	(0.007)	(0.002)	(0.002)	(0.093)
Backward	-0.003	0.097***	-0.371	0.327***	0.155***	3.535**
	(0.054)	(0.019)	(0.286)	(0.045)	(0.024)	(1.412)
Forward	0.129	0.004	0.203***	0.148	0.052***	0.710
	(0.159)	(0.013)	(0.064)	(0.115)	(0.009)	(0.442)
Herfindahl-Hirschman Index	0.297	1.908***	-1.606*	0.909***	-3.479***	-0.027
	(1.022)	(0.679)	(0.882)	(0.261)	(0.460)	(0.434)
Exports (as % of total sales)	0.232	0.097	0.205	0.011	0.095	0.128
	(0.180)	(0.080)	(0.179)	(0.049)	(0.088)	(0.089)
Assets per employee	-0.027*	-0.007	-0.023	-0.009**	0.004	-0.006
	(0.014)	(0.006)	(0.014)	(0.004)	(0.007)	(0.007)
Firm age of 5-9 years in 200	0.053	0.032	0.077	-0.021	-0.028	0.032
	(0.170)	(0.076)	(0.168)	(0.046)	(0.083)	(0.084)
Firm age of 10+ years in 200	0.078	0.042	0.071	0.004	-0.015	0.046
	(0.159)	(0.071)	(0.157)	(0.043)	(0.077)	(0.078)
Total Revenue (in logs)	-0.062**	-0.014	-0.053*	-0.011	-0.030**	-0.023
	(0.029)	(0.013)	(0.029)	(0.008)	(0.014)	(0.015)
Leverage (debt-to-asset ratio)	0.029	0.011	0.028	0.015**	-0.001	0.010
	(0.027)	(0.012)	(0.027)	(0.007)	(0.013)	(0.013)
Sales per employee (in logs)	0.309***	0.060***	0.289***	0.016	0.103***	0.087***
	(0.038)	(0.018)	(0.038)	(0.011)	(0.019)	(0.020)
Skilled/Unskilled labor ratio	0.006	0.001	0.005	-0.002	0.001	0.001
	(0.006)	(0.003)	(0.006)	(0.002)	(0.003)	(0.003)
Constant	1.054**	-3.417***	2.432***	-2.102***	-0.771***	-1.944***
	(0.414)	(0.493)	(0.620)	(0.166)	(0.214)	(0.345)
Inverse Mills ratio	0.325	0.148	0.200	-0.165	-0.086	0.142
	(0.593)	(0.264)	(0.588)	(0.160)	(0.289)	(0.291)
Observations	518	518	518	518	518	518
Chi-square	224.73	3143.86	232.91	9559.96	2560.73	2493.11
Prob.> Chi^2	0.000	0.000	0.000	0.000	0.000	0.000

Notes: ***, **, and * denote significance at the 1, 5, and 10% level respectively. The dependent variable is ln(TFP). All specifications include year, industry, and regional dummies. The standard errors in parentheses are clustered at industry-year level. All specifications are estimated with fixed effects. The sample size is restricted to domestic firms only (i.e., firms with less than 10% foreign equity share).

The backward spillover effects generated by low-importing FIFs is an expected result but the backward spillover effects generated by high-importing FIFs is not (since that attribute would suggest limited local purchase of inputs). If high-import concentration was shown to be more

typical of high-technology FIFs, that result would have been less surprising, but the PSM results have already shown that import concentration is not related to productivity level. One possible explanation is that firms with high import concentration are more likely to insist on high-quality local inputs to match that of imported inputs, thus generating spillover effects upstream despite limited linkages. The reasons for the generation of forward spillover effects by low-importing FIFs is also not very obvious and not predicted by theory. We explored the possibility that low-importing might be a characteristic that was highly correlated with low-exporting but the estimated correlation coefficient for these two groups of firms is not high (0.25). We should also note that, more broadly, the correlation across the three characteristics of interest (ownership, export concentration and import concentration) is never high.

As we noted earlier (in Section 3.3.3.1), previous studies have not been sufficiently consistent to develop a consensus regarding the impact of the degree of ownership, but our results clearly indicate that the Brazilian case is quite stark compared to the more nuanced results found for other countries (Fatima (2016) for Turkey and Malik (2015) for India are good examples). With respect to export orientation, our findings are closer to that of Girma et al. (2008) who found that export orientation affected the nature of spillover effects rather that its strength or presence. Interestingly, the singular Latin American study that considered export orientation of FIFs (Albornoz & Kugler, 2008) found that exporting FIFs in Argentina generated backward spillover effects but non-exporting FIFs generated no spillovers. With respect to import orientation, the literature on this attribute is too thin to offer comparisons. However, our results introduce some findings (the relationship between high import dependence and backward spillovers and low import dependence and forward spillovers, for example) that argue for further investigation.

3.5.4. Spillover effects and domestic firm characteristics

Table 3.7 presents estimation of the unrestricted version of Equation 3.9 for various subsamples of domestic firms. Each pair of subsamples defines contrasting elements of various characteristics of domestic firms. These characteristics are size (small vs large), productivity (low vs high technology) and spending on employee training (no training vs training). The results relating to spillover variables indicate which firms benefit from the various types of spillover effects but also offer some clues as to which transmission mechanism might be at play.

In the Brazilian manufacturing sector, firm size does not appear to be a critical factor in determining which firms benefit from spillover effects. The coefficients for both horizontal and backward spillovers are significant for both groups of firms. While it is true that, for large firms, the degree of significance of the coefficient for horizontal spillovers is more marginal (at 10%) and size of the coefficient for backward spillovers is larger (than it is for the same variable in the small firm sample), it would still be hard to make a compelling case that size is a critical factor in the transmission of spillover effects based on these results. With respect to the level of technology, low-technology (less productive) firms are shown to benefit from both horizontal and backward spillovers while high-technology (more productive) firms are shown to benefit from backward and forward spillovers. The fact that a low level of technology accommodates the absorption of horizontal spillovers but a high level of technology does not, suggests that some transmission mechanisms such as imitation or competition (which would favour firms facing a low technology gap relative to FIFs) are not dominant. The fact that forward spillover effects are exclusive to the most productive domestic firms indicates that the transmission mechanism requires domestic firms to be particularly capable. The use of more technologically advanced inputs from upstream FIFs would be a transmission mechanism that would generate such a finding.

Table 3.7: Regression results of FDI spillovers for various samples of domestic firms

Variables	Domestic Firm Characteristics					
	Small Firm	Large Small	Low Technology	High Technology	No Training	Employee Training
	(3)	(4)	(5)	(6)	(7)	(8)
Horizontal	0.045**	0.052*	0.120***	0.097	0.064***	0.097***
	(0.019)	(0.027)	(0.010)	(0.083)	(0.023)	(0.011)
Backward	0.925**	1.336***	1.393***	1.515***	-2.065	1.170***
	(0.393)	(0.459)	(0.234)	(0.227)	(1.491)	(0.224)
Forward	0.129	-0.035	0.064	0.137**	0.079	-0.004
	(0.087)	(0.138)	(0.055)	(0.057)	(0.054)	(0.040)
Herfindahl-Hirschman Index	-1.104	-2.202	0.678	2.160*	1.331	0.424
	(1.652)	(2.553)	(0.938)	(1.186)	(1.529)	(1.071)
Exports (as % of total sales)	1.232	-2.824**	-2.112***	0.854	-8.783***	0.056
	(1.110)	(1.080)	(0.643)	(0.722)	(3.317)	(0.943)
Assets per employee	1.748**	0.735*	0.326	0.023	-0.944	0.039
	(0.716)	(0.378)	(0.242)	(0.346)	(0.814)	(0.303)
Firm age of 5-9 years	-0.032*	-0.162***	-0.007	0.017**	-0.095	0.015*
	(0.018)	(0.050)	(0.036)	(0.009)	(0.068)	(0.009)
Firm age of 10+ years	0.187	0.628*	0.135	0.248***	0.473*	0.050
	(0.592)	(0.341)	(0.161)	(0.093)	(0.265)	(0.163)
Total Revenue (in logs)	0.021	0.131	0.219	0.212	0.505	0.083
	(0.686)	(0.401)	(0.199)	(0.161)	(0.329)	(0.166)
Leverage (debt to asset ratio)	-0.125	-0.151	-0.038	0.011	0.034	-0.020
	(0.098)	(0.117)	(0.051)	(0.076)	(0.104)	(0.058)
Sales per employee (in logs)	0.148	0.035	0.062**	0.029	0.066	0.049
	(0.118)	(0.055)	(0.026)	(0.048)	(0.087)	(0.040)
Skilled-unskilled labor ratio	0.429***	0.231**	0.055	0.041	-0.047	0.063
	(0.113)	(0.093)	(0.057)	(0.075)	(0.103)	(0.060)
Constant	-0.010	-0.030**	0.001	0.008	0.050***	-0.013
	(0.018)	(0.015)	(0.009)	(0.014)	(0.018)	(0.010)
Inverse Milles Ratio	-1.435	-1.192	-4.313***	-4.528***	0.544	-3.750***
	(1.107)	(0.837)	(0.506)	(0.610)	(2.105)	(0.626)
Observations	393	112	279	202	176	329
Chi-square statistic	0.394	0.724	0.902	0.831	0.930	0.852
Prob.> Chi^2	0.045**	0.052*	0.120***	0.097	0.064***	0.097***

Notes: ***, **, and * denote significance at the 1, 5, and 10% level respectively. The dependent variable is ln(TFP). All specifications include year, industry, and regional dummies. The standard errors in parentheses are clustered at industry-year level. All specifications are estimated with fixed effects. The sample size is restricted to domestic firms only (i.e., firms with less than 10% foreign equity share).

With respect to training profiles, the results indicate that both firms that invested in employee training and those that did not benefitted from horizontal spillovers. The implication is, of course,

that the training of employees is not critical to the transmission of advantages from FIFs in the same industry. Like the result relating to the level of technology of domestic firms, this result augurs against transmission channels such as imitation and competition and in favour of more passive channels (such as labor turnover) that requires little prior investment. Backward spillover effects are absorbed by firms that invest in employee training but not by those that do not. This result strongly supports employee training as a strategy for increasing absorptive capacity (for backward spillovers in particular). This channel of transmission requires the upstream firm to be willing and able to train its employees as part of the provision of inputs for downstream FIFs—a situation that would occur if FIFs set strict requirements for the procurement of inputs.

The results for the Brazilian manufacturing firms mildly contradicts some parts of the literature and reinforces others. As noted earlier, past investigations have overwhelmingly found small size to be an advantage for domestic firms seeking to benefit from spillover effects. The Brazilian case does not fit that narrative. Previous findings, such as Moralles and Moreno (2020) for Brazil, have typically found absorptive capacity to be important for spillover effects but they have differed on which dimension of absorptive capacity mattered. For example, while Demena and Murshed (2018) found that the level of technology of domestic firms mattered for the nature and extent of spillover benefits but investment in employee training had less dramatic effects, Girma and Wakelin (2001) found that skilled labor mattered for absorption. Our results suggest that, in the Brazilian case, not only do both the dimensions of absorptive capacity matter, high and low levels of both attributes dictated the types of spillover effects that were transmitted. Thus, level of absorptive capacity did not simply determine the magnitude of spillover effects. The strength (or weakness) of each dimension of absorptive capacity determined which type of spillover effect could be accessed.

3.5.5. Robustness

To check the robustness of the spillover results presented in section 3.5.3 and 3.5.4, we applied the Heckman (1979) two-step method based on maximum likelihood estimation. This method involves estimation of the probability of observing (the log of) the firms' TFP in step one and regression of (the log of) the firms' TFP on the spillover variables (horizontal, backward, and forward) and other explanatory variables in step two. The same variables that were used in the probit regression to compute the inverse Mills ratio (Table B3.5 of Appendix B3) are used in step one (the selection model). Maximum likelihood estimation results (from the step two regression) are presented in Table B3.7 (FIFs attributes and spillovers) and Table B3.8 (domestic firms' attributes and FDI spillovers) of Appendix B3. This estimation method produced nearly identical spillover results to those presented in Table 3.6 and Table 3.7 (in terms of the significance of spillover coefficients).

3.6. Conclusion

This investigation sought to determine whether there was evidence of FDI-induced horizontal or vertical (forward and backward) productivity spillover effects across a multi-sector sample of Brazilian manufacturing firms between 2003 and 2009. Beyond that, the study examined the role of particular attributes of FIFs and domestic firms in determining the nature and extent of any measured spillover effects. For FIFs, the attributes examined were degree of foreign ownership, export orientation, and import dependence. For domestic firms the attributes examined were size, the productivity level, and investment in employee training.

Prior to disaggregation, the study found that FIFs, as a group, were more productive than domestic firms and generated positive horizontal and backward spillover effects. No evidence of forward spillover effects was found at that level of aggregation. When FIFs were disaggregated, the horizontal spillovers were found to be associated with majority-foreign-ownership, high export concentration and high import concentration. Backward spillovers were similarly associated with majority-owned and high-exporting FIFs but, paradoxically, while both high and low import concentration were also associated with backward spillover effects, the coefficient for high-import concentration was much larger. Forward spillover effects were generated by both low-exporting and low-importing FIFs. The later was an unexpected result, especially since these two characteristics were not found to be highly correlated. That result was also a clear indication that forward spillover effects were being generated within the manufacturing sector but could not be picked up without disaggregation. The irrelevance of minority-foreign-owned firms with respect to the generation of spillover effects was not an unexpected outcome, given the fact that these firms had been shown to be no more productive, on average, than domestic firms.

With respect to the attributes of domestic firms, the analysis revealed that firm size (in terms of employees) was not an important determinant of the receipt of any spillover benefits. The potential for the receipt of horizontal spillovers remained about the same regardless of firm size or the level of investment in the training of workers but was not available to the most productive domestic firms. Backward spillover effects were significantly enhanced by investment in worker training but unaffected by firms' size or productivity level. Forward spillover effects were only available to domestic firms at higher levels of productivity. In effect, disaggregation made it clear that the effect of improvements in absorptive capacity (if defined as improvement in productivity and human capital) was quite nuanced in the Brazilian context. Increased productivity improved the

capacity for absorbing forward spillovers but reduced the likelihood of horizontal spillovers. Investment in worker training was necessary for absorbing backward spillover effects but did not change the potential for absorption of horizontal spillovers and was not relevant to the absorption of forward spillover effects.

The data from this research came from an Enterprise survey that covered firms in the manufacturing sector of Brazil. This means that firms in the services sector (the largest sector) and mining, forestry and fishing (also important sectors in Brazil) were not included. Our results, therefore, cannot be extrapolated to those other sectors without further study and should be understood as descriptive of only the manufacturing sector in Brazil. Also, we have only scratched the surface in terms of understanding the intricacies of spillover effects, the transmission mechanisms, and how firm attributes fit into that picture. Many questions remain to be answered. For example, why exactly does domestic firm size appear to be irrelevant for spillover effects and why does low import concentration matter for forward spillover effects? We hope that these and several other question will spur the additional research that is necessary in the Brazilian context and beyond.

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Appendix A3

To elicidate and address the endogeneity problem in input choice discussed in section 3.4.4, let us suppose that the firm's production can be described by a Cobb-Douglas equation of the form:

$$y_{it} = \beta_0 + \beta_1 L_{it} + \beta_2 M_{it} + \beta_3 K_{it} + \omega_{it} + \eta_{it} \quad \text{(A3.1)}$$

where y_{it} is the log of output, L_{it}, M_{it}, K_{it} are the log of labor, intermediate inputs, and capital respectively, and $\omega_{it} + \eta_{it} = \varepsilon_{it}$. Thus, $\beta_0 + \varepsilon_{it} = l\,n(A_{it})$ in the typical log-linear production function. Here ω_{it} denotes unobserved productivity, and η_{it} is either a measurement error or a shock to productivity which is also unobserved but has standard white-noise properties. The variable ω_{it} is a state variable in the decision making problem of the firms and thus affects input demand, while η_{it} does not. Hence, if we do not take into account ω_{it} in the estimation of input coefficients, our result would be biased because the variable inputs like labor and intermediate inputs are endogeous to the productivity indicator ω_{it}.

In the ACF method, inputs in Equation (A3.1) are assumed to be of two types: variable and state. Variable inputs are those (such as intermediate inputs (M_{it})) that are chosen in the current period after observing current productivity. In contrast, state inputs are those (such as capital (K_{it})) that depend on the last period's productivity or are chosen before the current period. In terms of estimation, the ACF model assumes that the observable characteristic (proxy variable) is a strictly monotonic function of unobserved productivity. Since in equilibrium, the proxy demand function depends on the state variables, we can write that function (with intermediate inputs as the proxy variable) as:

$$M_{it} = M_{it}(\omega_{it}, L_{it}, K_{it}) \quad \text{(A3.2)}$$

To express unobserved productivity ω_{it}, we need to invert Equation (A3.2) to get ω_{it} as a function of observable intermediate inputs (M_{it}) , labour (L_{it}), and capital K_{it} as:

$$\omega_{it} = h_{it}(L_{it}, M_{it}, K_{it}) \tag{A3.3}$$

Now substitution of Equation (A3.3) into Equation (A3.1) produces the first-stage estimation equation as:

$$y_{it} = \phi_t(L_{it}, M_{it}, K_{it}) + \eta_{it} \tag{A3.4}$$

where $\phi_t(L_{it}, M_{it}, K_{it}) = \beta_0 + \beta_1 L_{it} + \beta_2 M_{it} + \beta_3 K_{it} + h_{it}(L_{it}, M_{it}, K_{it})$. We can now observe the unobserved productivity ω_{it} by estimating Equation (A3.4). Thus, this procedure removes the endogeneity problems. In the first stage of this estimation, only an estimate of ϕ_t ($\hat{\phi}_t$) can be obtained. In the second stage of the estimation procedure, productivity (ω_{it}) is decomposed into its conditional expectation at time *t* – 1, and a deviation from that expectation as:

$$\omega_{it} = g(\omega_{i,t-1}) + \xi_{it} = g(\phi_{t-1} - \beta_0 - \beta_1 L_{i,t-1} - \beta_2 M_{i,t-1} - \beta_3 K_{i,t-1}) + \xi_{it} \tag{A3.5}$$

where $g(.) = E(\omega_{it} \backslash \omega_{i,t-1})$. Plugging Equation (A3.5) into (A3.1), we obtain the following equation.

$$y_{it} = \beta_0 + \beta_1 L_{it} + \beta_2 M_{it} + \beta_3 K_{it} + g(\emptyset_{t-1} - \beta_0 - \beta_1 L_{i,t-1} - \beta_2 M_{i,t-1} - \beta_3 K_{i,t-1}) + \xi_{it} + \eta_{it} \tag{A3.6}$$

Thus,

$$TFP_{it} = \beta_0 + g(\emptyset_{t-1} - \beta_0 L_{i,t-1} - \beta_2 M_{i,t-1} - \beta_3 K_{i,t-1}) + \xi_{it} + \eta_{it} \tag{A3.7}$$

where $TFP_{it} = y_{it} - \beta_1 L_{it} - \beta_2 M_{it} - \beta_3 K_{it}$, which is used in the estimation. Since Equation (A3.1) contains *ln* in each variable, TFP_{it} in Equation (A3.7) is actually $lnTFP_{it}$, which is used as dependent variable in Equation (3.9) in section 3.4.4 to assess the spillover effects of FDI.

Appendix B3

Table B3.1: Definition of variables

Variables	Description
FIFs	Firms with foreign equity participation of at least 10% or more (Aitken & Harrison, 1999; Chudnovsky et al., 2008; Kinuthia, 2016)
Herfindahl-Hirschman Index (HHI)	as the sum of the squared market shares (in terms of total sale) of the firms in a given industry
Lnage	Log of the age of firms
Export	Export as ratio of firm's total sales
Size	Total asset (in 100,000 unit) per employee
Age_5 to less than 10 years	Firms aged between 5 and less than 10 years
Age_More than 10 years	Firms aged over 10 years
Ln(Proceeds)	Log of total real earnings of firms
Leverage	Ratio of total debt to total asset (Amato et al., 2021)
Ln(sales per employee)	Log of the ratio of total sales to number of employees
Skill	Ratio of skilled employees to unskilled employees
Small-to-medium vs large firms	Firms are small if the number of employees is 99 or less and large if number of employees is 100 or more (Leung et al., 2008)
Low technology vs high technology firms	Low technology firms are those domestic firms whose TFP is below the median TFP and high technology firms are those above the median TFP in 2003
Training vs no-training firms	Non-training firms are domestic firms that do not spend on the formal training of employees in either of the two sample years (2003 and 2009) and training firms are those that do in either or both years. (Cheng, 2012; Binyam Afewerk Demena & Murshed, 2018)
Minority vs majority foreign ownership	10 to 50% foreign equity share vs >50% foreign equity share
Low-exporting vs high-exporting	FIFs whose proportion of output exported is below the sample mean vs FIFs whose proportion of output exported is above the sample mean
Low-importing vs High-importing	FIFs whose proportion of inputs imported is below the sample mean vs FIFs whose proportion of inputs imported is above the sample mean.

Table B3.2: Distribution of spillover variables by industries

Code	Industries	Horizontal		Backward		Forward	
		2003	2009	2003	2009	2003	2009
15	Food and beverage	1.35	0.00	2.16	1.51	0.01	0.02
17	Textiles	23.04	25.07	9.43	9.12	1.38	2.46
18	Garments	13.67	13.24	0.02	0.01	12.8	16.9
19	Shoes and leather	11.03	4.88	0.08	0.08	2.06	3.00
24	Chemicals	7.28	16.73	6.34	6.33	0.91	0.76
29	Machinery and equipment	34.33	34.45	1.1	1.15	0.58	1.04
34	Auto parts	10.13	5.02	0.58	0.77	1.22	1.4
36	Furniture	6.02	11.26	0.33	0.35	1.92	2.91
	Average	13.36	13.83	2.51	2.42	2.61	3.56

Source: Authors' own calculation from Enterprise Survey Data.

The last row shows the average of the relevant columns. Here the spillover variables are reported as percentages, and this format is used throughout this essay for the sake of simplicity and explanation of the estimated results.

Table B3.3: Regional Distribution of firms

Regions	Frequency	Percent	Cumulative
1	178	19.96	19.96
2	104	11.66	31.61
3	96	10.76	42.38
4	96	10.76	53.14
5	110	12.33	65.47
6	102	11.43	76.91
8	22	2.47	79.37
9	50	5.61	84.98
11	6	0.67	85.65
12	54	6.05	91.70
13	16	1.79	93.50
14	30	3.36	96.86
15	28	3.14	100.00
Total	892	100.00	

Table B3.4: Correlation matrix for main variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) Sales (in logs)	1.000											
(2) Labor (in logs)	0.689	1.000										
(3) Material (in logs)	0.927	0.665	1.000									
(4) Value of Capital (in logs)	0.756	0.626	0.740	1.000								
(5) lnTFP	0.342	0.051	-0.029	0.082	1.000							
(6) Herfindahl–Hirschman Index	0.147	0.081	0.102	0.097	0.138	1.000						
(7) Firm age (in logs)	0.215	0.269	0.167	0.290	0.108	0.032	1.000					
(8) Export-Sales Ratio	0.304	0.355	0.281	0.276	0.068	-0.027	-0.002	1.000				
(9) Assets per employee	0.283	0.064	0.263	0.376	0.097	0.178	0.042	0.065	1.000			
(10) Leverage (Debt/Assets Ratio)	-0.004	0.029	-0.008	-0.252	0.038	0.028	-0.104	0.000	-0.065	1.000		
(11) Sales per employee	0.840	0.186	0.759	0.556	0.426	0.139	0.090	0.146	0.336	-0.027	1.000	
(12) Skill/Unskilled labor ratio	0.028	0.107	0.011	0.031	0.027	-0.027	0.044	0.033	-0.034	0.048	-0.042	1.000

Source: Authors' own calculation

Table B3.5: First-stage selection regression results

R&D	0.000014
	(0.000021)
Capital per worker	0.000018
	(0.000013)
Age	0.018258
	(0.020682)
Age^2	-0.000151
	(0.000185)
Value added	-0.000000**
	(0.000000)
Value added per worker	0.000001
	(0.000002)
Constant	1.656895***
	(0.333391)
Observations	758
Pseudo R^2	0.132863

Notes: ***, **, and * denote significance at the 1, 5, and 10% level respectively. Standard errors are in parentheses.

Table B3.5 reports probit regression results from the first-stage selection equation that is used to compute inverse Mills ratio included in the main regression analysis. The value of dependent variable in the probit regression is one if we observe lnTFP in the dataset, and zero otherwise. The regression also includes year fixed effects.

Table B3.6: Average export and import ratios across firms with different foreign ownership

	Variable	Mean	Std. Dev.
Domestic firms	Average import ratio	0.100	0.198
	Average export ratio	0.064	0.180
FIFs with 10 to 50% foreign equity share	Average import ratio	0.067	0.121
	Average export ratio	0.047	0.053
FIFs with more than 50% foreign equity share	Average import ratio	0.264	0.364
	Average export ratio	0.304	0.322

Table B3.7: Heckman two-step correction (maximum likelihood estimation) of spillovers results with different levels of foreign investment, export intensity, and import intensity of FIFs.

	FIFs with 10-50% FS	FIFs with more than 50% FS	Low export FIFs	High export FIFs	Low import FIFs	High import FIFs
	(1)	(2)	(3)	(4)	(5)	(6)
Horizontal	0.003	0.011***	-0.008	0.081***	0.000	0.443***
	(0.004)	(0.001)	(0.007)	(0.002)	(0.002)	(0.093)
Backward	-0.003	0.097***	-0.371	0.327***	0.155***	3.535**
	(0.054)	(0.019)	(0.286)	(0.045)	(0.024)	(1.412)
Forward	0.129	0.004	0.203***	0.148	0.052***	0.710
	(0.159)	(0.013)	(0.064)	(0.115)	(0.009)	(0.442)
HHI	0.297	1.908***	-1.606*	0.909***	-3.479***	-0.027
	(1.022)	(0.679)	(0.882)	(0.261)	(0.460)	(0.434)
Export	0.232	0.097	0.205	0.011	0.095	0.128
	(0.180)	(0.080)	(0.179)	(0.049)	(0.088)	(0.089)
Size	-0.027*	-0.007	-0.023	-0.009**	0.004	-0.006
	(0.014)	(0.006)	(0.014)	(0.004)	(0.007)	(0.007)
Age_5 to less than 10 years	0.053	0.032	0.077	-0.021	-0.028	0.032
	(0.170)	(0.076)	(0.168)	(0.046)	(0.083)	(0.084)
Age_More than 10 years	0.078	0.042	0.071	0.004	-0.015	0.046
	(0.159)	(0.071)	(0.157)	(0.043)	(0.077)	(0.078)
Ln(Proceeds)	-0.062**	-0.014	-0.053*	-0.011	-0.030**	-0.023
	(0.029)	(0.013)	(0.029)	(0.008)	(0.014)	(0.015)
Leverage	0.029	0.011	0.028	0.015**	-0.001	0.010
	(0.027)	(0.012)	(0.027)	(0.007)	(0.013)	(0.013)
Ln(sales per employee)	0.309***	0.060***	0.289***	0.016	0.103***	0.087***
	(0.038)	(0.018)	(0.038)	(0.011)	(0.019)	(0.020)
Skill	0.006	0.001	0.005	-0.002	0.001	0.001
	(0.006)	(0.003)	(0.006)	(0.002)	(0.003)	(0.003)
Constant	1.054**	-3.417***	2.432***	-2.102***	-0.771***	-1.944***
	(0.414)	(0.493)	(0.620)	(0.166)	(0.214)	(0.345)
Mills	0.325	0.148	0.200	-0.165	-0.086	0.142
	(0.593)	(0.264)	(0.588)	(0.160)	(0.289)	(0.291)
Observations	518	518	518	518	518	518
Chi^2	224.73	3143.86	232.91	9559.96	2560.73	2493.11
Prob.> Chi^2	0.000	0.000	0.000	0.000	0.000	0.000

Notes: ***, **, and * denote significance at the 1, 5, and 10% level respectively. The dependent variable is ln(TFP). All specifications include year, industry, and regional dummies. The sample size is restricted to domestic firms only (i.e., firms with less than 10% foreign equity share). Results for selection model (step one results) are not shown here. FS in first two column headings stands for foreign share.

Table B3.8: Heckman two-step correction (maximum likelihood estimation) of different subsamples of domestic firms

	All		Small	Large	Low tech	High tech	Low AC	High AC
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Horizontal	0.108***	0.106***	0.105***	0.103**	0.127***	0.036	0.104***	0.110***
	(0.007)	(0.007)	(0.008)	(0.049)	(0.028)	(0.254)	(0.011)	(0.008)
Backward	1.542***	1.453***	1.427***	1.445**	1.470**	1.217**	1.613	1.399***
	(0.121)	(0.126)	(0.158)	(0.653)	(0.599)	(0.536)	(1.310)	(0.148)
Forward	-0.003	-0.004	-0.006	-0.068	0.056	0.125**	0.013	-0.016
	(0.019)	(0.018)	(0.021)	(0.012)	(0.074)	(0.060)	(0.030)	(0.024)
HHI	0.366	0.319	0.561	-1.159	-1.199	-0.714	-1.425*	0.892**
	(0.366)	(0.369)	(0.439)	(0.266)	(2.022)	(0.635)	(0.853)	(0.443)
Lnage	0.007							
	(0.016)							
Export	0.009	0.021	0.447***	0.435***	-0.015	0.249	-0.056	0.026
	(0.067)	(0.070)	(0.119)	(0.129)	(0.320)	(0.293)	(0.180)	(0.079)
Size	0.004	0.003	-0.032*	-0.162***	-0.007	0.017**	-0.095	0.015*
	(0.006)	(0.006)	(0.018)	(0.050)	(0.036)	(0.009)	(0.068)	(0.009)
Age_5 to less than 10 years		0.014	-0.024	0.231	0.005	0.048	0.134	-0.056
		(0.066)	(0.073)	(0.101)	(0.263)	(0.124)	(0.110)	(0.083)
Age_More than 10 years		0.042	0.005	0.174	0.048	-0.036	0.152	0.006
		(0.062)	(0.069)	(0.693)	(0.241)	(0.124)	(0.106)	(0.077)
Ln(Proceeds)		-0.010	-0.012	-0.009	-0.105*	-0.068**	-0.009	-0.014
		(0.011)	(0.020)	(0.435)	(0.056)	(0.030)	(0.025)	(0.014)
Leverage		0.008	-0.001	0.043	-0.001	0.077	0.021	0.005
		(0.010)	(0.014)	(0.348)	(0.046)	(0.986)	(0.033)	(0.011)
Ln(sales per employee)		0.036**	0.041*	0.051**	0.032**	0.232	0.030**	0.036*
		(0.016)	(0.023)	(0.025)	(0.015)	(0.687)	(0.013)	(0.019)
Skill		0.003	0.002	0.002	-0.000	0.000	0.010	0.002
		(0.002)	(0.003)	(0.838)	(0.015)	(0.010)	(0.008)	(0.003)
Constant	-4.20***	-4.20***	-4.40***	-2.859	-4.26***	0.506	-4.20***	-4.18***
	(0.286)	(0.296)	(0.376)	(0.596)	(1.472)	(0.427)	(0.857)	(0.337)
Mills	0.085	0.130	0.125	0.616	-0.775	0.656	-0.002	0.147
	(0.220)	(0.230)	(0.352)	(3.987e+12)	(0.853)	(0.825)	(0.312)	(0.202)
Observations	518	518	404	113	283	203	179	339
Chi^2	4220.90	4316.64	3779.20	530.98	277.53	768.56	1654.03	2968.24
Prob.> Chi^2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Notes: ***, **, and * denote significance at the 1, 5, and 10% level respectively. The dependent variable is ln(TFP). All specifications include year, industry, and regional dummies. The sample size is restricted to domestic firms only (i.e., firms with less than 10% foreign equity share). Results for selection model (step one results) are not shown here. AC in last two column headings stands for absorptive capacity.

Chapter 4

Spillovers from Foreign Direct Investment: Do Measures of Firm Size Matter?

4.1. Introduction

The presumption of the majority of theoretical models is that multinational enterprises (MNEs) (or FIFs more broadly), bring with them much needed capital, advanced technology, and improved management skills (Markusen, 1995; Mehta, 1994; Sun & Anwar, 2017; Sussangkarn, 2011). In that regard, foreign direct investment (FDI) is expected to play a crucial role in filling gaps in foreign exchange, investment, and tax revenue in the host economies (Zekarias, 2016). In addition to these direct effects, FDI is expected to enhance the productivity of local firms through knowledge spillovers that increase these firms' competitiveness and productivity (Blomstrom & Kokko, 1998; Gorg & Greenaway, 2004; Haskel et al., 2007). These expected FDI-related benefits certainly help explain why countries implement policies that often include costly incentives (such as subsidies and tax reductions and exemptions) to attract FDI (Aitken & Harrison, 1999).

The rapid increase in FDI flows, especially during the early 2000s, spurred researchers to investigate whether the technology and/or productivity of domestic firms improve as the stock of foreign-owned capital increases (Kokko et al., 1996).[49] That literature has outlined some

[49] For a survey, see Bruno and Cipollina (2018), Demena and van Bergeijk (2017), Fan, He, and Kwan (2019), Hanousek, Kočenda, and Maurel (2011), Iršová and Havránek (2013), Iwasaki and Tokunaga (2016), Mebratie and van Bergeijk (2013), and Wooster and Diebel (2010).

determining factors for spillovers such as: absorptive capacity, export intensity, labor quality, technology gap faced by host country firms, regional distribution of FDI, market structure, origin country of FDI and so forth (Aitken & Harrison, 1999; Girma, 2005; Girma et al., 2008; Greenaway et al., 2005; Imbriani et al., 2014; Kim et al., 2015; Kneller & Pisu, 2007; Wooster & Diebel, 2010). Sizes of both foreign-invested and domestic firms are also likely to be an important determinant of FDI spillovers because size often governs other relevant factors (such as the level of firms' technology and the likelihood and intensity of interaction between domestic firms and FIFs). Despite this, the literature relating firm size to spillover effects remains surprisingly small.

To date, only a few studies have examined the role of the host-country firm size in determining FDI spillover effects and we could find only one published study of the impact of FIFs' size on spillovers.[50] All of these studies used the number of employees as a measure of firm size, and utilized the discrete size measures (i.e., they explicitly divided firms into different size categories based on the number of employee).

In the broader empirical literature (relating to firm productivity), however, firms' assets and sales have also been used as measures of firm size, and in most cases these size measures have been continuous variables (Blomstrom & Lipsey, 1986; Kumar & Siddharthan, 1994; Patibandla, 1995; Siddharthan & Nollen, 2004). However, a few studies have employed discrete size measures using assets and sales (Kumar, 1985; Kumar & Siddharthan, 1994; Patibandla, 1995; Siddharthan & Nollen, 2004). The main contribution of this study is an assessment of the effect of the choice of the measurement variable for firm size (assets, sales or employees), as well as the choice of

[50] Studies that considered domestic firm size to be a determinant of FDI spillover effects are: Aitken and Harrison (1999), Anwar and Sun (2014), Doan et al. (2015), Dogan et al. (2017), Imbriani et al. (2014), Lenaerts and Merlevede (2015), and Sinani and Meyer (2004). Lenaerts and Merlevede (2015) was the first and only study we could find that also considered size of FIFs in the spillovers analysis.

continuous vs discreet versions of the measurement variable, on the detection of spillover effects of FDI. We do so in the particular context of Chile, for the period 1995 to 2007, and consider size effect for both FIFs and domestic firms.

We find statistical evidence that sizes of both foreign-invested and domestic firms matter in terms of both generating and receiving spillovers. The crucial finding is that spillover results vary significantly between continuous and discrete measures and also across the measures of size. In other words, the form of measure (continuous vs discrete) and the firm attribute used to determine size (assets, sales, or employment) matter substantively in determining what is revealed by the data with respect to FDI spillovers.

The rest of the essay is organized as follows. Section 4.2 provides a review of related literature. Section 4.3 gives an overview of FDI inflows in Chile. Section 4.4 describes econometric methodology and data. Section 4.5 presents and discusses the empirical results. Section 4.6 concludes the essay.

4.2. Related Literatures

4.2.1. FDI and Spillovers

The FDI spillover literature has outlined three broad channels through which the positive transmission of externalities (spillovers) may arise: (i) demonstration effects arising from the imitation or reverse-engineering of FIFs' technologies by domestic firms; (ii) worker mobility between FIFs and domestic firms that allows employees trained by the former to apply their knowledge in the latter; and (iii) upstream and downstream linkages that allow for knowledge spillovers from FIFs to their suppliers and buyers (Saggi, 2006). In addition to these channels, FIFs

may also potentially intensify competition in the local market, thus forcing domestic firms to increase efficiency and improve technology in order to survive.

Spillover effects in the same industry are referred to as horizontal spillovers, whereas spillovers generated by upstream and downstream linkages are called vertical spillovers (backward and forward spillovers respectively). The presence of FIFs in an industry, however, may not necessarily engender spillover effects if: (i) domestic firms are unable to take advantage of opportunities created by FIFs (Gorg & Greenaway, 2004); and (ii) FIFs can prevent their technology from being leaked (by taking such measures as formal protection, trade secrecy, locating in industries where domestic firms do not have much imitative capacity etc., or paying higher wages to reduce labor turnover) (Javorcik, 2004).[51] The presence of FIFs can also generate negative (market-stealing) effects if they use market power and other advantages to eliminate competition from domestic firms—negative horizontal spillovers (e.g., Djankov & Hoekman, 2000; Haddad & Harrison, 1993; Ni et al., 2017). As for backward spillovers (from upstream linkages), they are likely to be positive when FIFs impose standardization requirement on the domestic suppliers and/or provide direct technical and management assistance (Lall, 1980). However, FIFs may use their greater size and global reach to negotiate for low-priced inputs and better terms of sourcing (than offered to domestic firms) that lead to the disruption, rather than enhancement, of production for suppliers (Graham et al., 1999; Klein et al., 1978). In this case, the entry (or existence) of FIFs in downstream industries may actually coincide with a decline in the productivity of firms in upstream industries—negative backward spillover effects (e.g., Barge-Gil et al., 2019; Kinuthia, 2016; Lin & Saggi, 2005). With respect to forward spillovers (generated by

[51] There are several evidences, including those documented by Aitken et al., (1996) and Girma et al. (2001), that multinational firms (or FIFs) pay higher wages to their employees than domestic firms.

downstream linkages), if the presence of FIFs generates increased competition that may certainly engender positive spillovers but monopoly power of foreign-invested sellers, as argued by Crespo and Fontoura (2007) and Orlic et al. (2018), can generate negative productivity effects for domestic firms by imposing higher prices (or less product-related assistance) for inputs (see also, Huynh et al., 2019 and Sari et al., 2016).

4.2.2. Measures of Firm Size

Of course, spillovers can occur only if there is some degree of interaction between domestic firms and FIFs. Firm size is likely to be an important factor in determining both the nature and extent of the interaction between domestic firms and their foreign-invested counterparts and, therefore, the potential for various types of spillovers (Sinani & Meyer, 2004). In the spillover literature, specifically, only discrete size in terms of the number of employee has been used (Doan et al., 2015; Dogan et al., 2017; Imbriani et al., 2014; Lenaerts & Merlevede, 2015). However, in the wider FDI-related literature, the continuous size measures (in terms of assets, sales and employment) have also been used (Kumar, 1985; Kumar & Siddharthan, 1994; Patibandla, 1995; Siddharthan & Nollen, 2004). Additionally, some studies have employed the discrete size measures in terms of quintiles of these variables or arbitrarily divided firms into different categories based on various scales (Amato & Amato, 2007; Ijiri & Simon, 1974; Wakasugi, 1997).

4.2.2.1. Size of domestic firms

Studies that have explicitly included firm size as a determinant of the nature and size of spillover effects have based that proposition on a variety of factors. For example, it has been argued that, though small domestic firms do not have the scale of production or sufficient technical ability to emulate advanced technologies, they are likely to be less bureaucratically encumbered, which may

give them an advantage in seizing productivity-enhancing opportunities made available by FIFs (Doan et al., 2015). Acs et al. (1994) suggested that small domestic firms appear to be better at exploiting R&D spillovers from their larger counterparts, and adopting outside technology where they have a comparative advantage (Rogers, 2004). In line with these arguments, Aitken and Harrison (1999), Sinani and Meyer (2004), Imbriani et al. (2014), and Doan et al. (2015) found positive spillovers for small domestic firms.

Medium domestic firms are also seen to have some advantages in benefitting from FDI spillovers. Since most FIFs specialize in certain core products, outsourcing production of non-core products and services to a select group of modern, medium-sized firms (and a few atypical small firms that possess contemporary technology and a professional management) may lead to opportunities for spillover effects (Altenburg, 2000). Imbriani et al. (2014) and Sinani and Meyer (2004) found that medium domesitc firms benefit from FDI spillovers in the same industry (horizontal spillovers).

At the theoretical level, larger domestic firms are seen to have the potential to gain most from the presence of FIFs, because they are less likely to suffer from competency or scale problems (Schumpeter, 1950), and can more actively and efficiently generate the capacity to capture spillovers. Larger firms enjoy the benefits of superior information, greater risk-bearing capacity, lower unit cost and price setting power that can allow them to capture FDI spillovers more easily (Bonaccorsi, 1992; Christensen et al., 1987). Notably, however, they are also the firms most likely to be squeezed by competition from FIFs. The empirical literature has, so far (but not including this dissertation), found no evidence of positive spillovers for large domestic firms. For example, Aitken and Harrison (1999), Sinani and Meyer (2004), Imbriani et al. (2014), and Doan et al. (2015) found no evidence of positive spillovers for large domestic firms; Anwar and Sun (2014)

found evidence of falling productivity of larger firms when FDI rose in the manufacturing sector; and Dogan et al. (2017) found evidence of negative spillovers for them.

4.2.2.2. Size of FIFs

Large FIFs may possess advantages such as economies of scope, extensive information, risk bearing capability, and brand names that put them in a superior position in terms of productivity and turnover relative to medium and small FIFs (Siddharthan & Nollen, 2004). Thus, large FIFs can be expected to generate more spillovers for domestic firms than small and medium FIFs. However, the impact of size of FIFs on spillovers has been examined only by Lenaerts and Merlevede (2015) employing Romanian firm-level data. That study found that only medium-sized FIFs generated spillover effects, whereas micro, small and, more surprisingly, large ones did not. To explain these results, they argued that small firms do not have enough scale to transmit any productivity spillovers, and large ones mostly import their materials instead of sourcing locally and tend to have higher export intensities.

Precisely, how sizes of both foreign-invested and domestic firms affect spillovers across various countries is still unclear because it has, thus far, not been examined extensively. In any case, in examining that effect, which measure of size (assets, sales or employees) should be applied? Do different measures of size imply differences in measured impacts or are they interchangeable? Moreover, do the use of continuous measures offer the potential for more precise and interpretable results or do discrete measures work similarly with the additional potential of uncovering nonlinear effects? In the specific context of Chile, this study tries to determine how the choice of size measure and the form of that measure affect the outcome of spillover effects estimation. In short,

we do not simply ask whether firm size matters, but whether the nature of the measure of size has an impact on the answer to that question.

4.3. FDI in Chile: Some Stylized Facts

Chile presents an excellent setting for investigating the research question presented in this paper. The country underwent major reforms in the 1970s and 1980s as part of its outward-looking economic policies. Government enacted a new law, called Law Decree 600, to promote and protect FDI. That law, along with debt conversion programs (from public foreign debt to domestic assets) led to a gradual increase in inward FDI through the second half of the 1970s and the 1980s (French-Davis & French-Davis, 1990; Alatorre & Razo, 2010). Nevertheless, the flow of FDI to the country remained modest until the 1990s, as shown in Figure 4.1. Starting from 1994, the absolute value of FDI inflows increased noticeably. After falling in the early 2000s, inward FDI recovered (even through the Global Financial Crisis years) and increased further after Chile became an OECD member in 2010. The OECD membership-related surge has since dissipated but inflows remain largely above the levels of the 1990s.

As a result of these flows, Chile holds a considerable share of the total stock of FDI in Latin America and the Caribbean (see Figure 4.2). In 2020, 12.2% of the total stock of FDI in Latin America and the Caribbean was in Chile. This is much higher than Chile's 5.35% share of the region's GDP. In that year, Chile stood 4th in Latin America and the Caribbean in terms of the value of the domestic stock of FDI and that stock was valued at 107.67% of its GDP (UNCTAD, 2021).

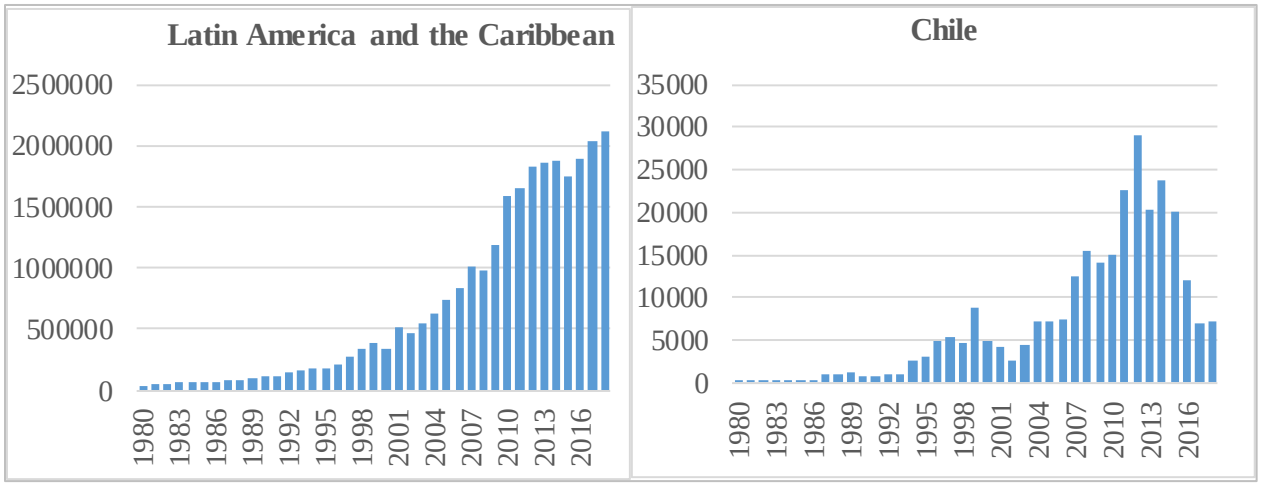


Figure 4.1: FDI inflows in the OECD, Latin America and the Caribbean, and Chile

Source: UNCTAD (2019)

Considering the significant stock of FDI in Chile, it is worth asking whether the substantive presence of FIFs has resulted in measurable levels of productivity spillovers to domestic firms. Several studies have sought to answer that question with a diverse set of results.[52] Most of these studies have found evidence of either forward spillovers or horizontal spillovers or both, but evidence of backward spillovers have typically not been found or it has been found to be negative. However, none of these studies included consideration of the possible role of firm size (however measured) in explaining those FDI spillovers. Firm size effects and its relationship to the choice of size measure will be the concern of this study.

[52] The details of the studies that investigated FDI spillovers in Chile using data from Annual National Industrial Survey (ENIA) are as follows: Björk (2005) used cross-section data from the year 2000 and found evidence of positive horizontal spillovers from FDI; López (2008) used panel data for the period 1990-1999 and found evidence of positive forward and negative backward spillovers from foreign technology licensing; Ramondo (2009) used panel data for the period 1995-2001 and found evidence of positive horizontal spillovers from FDI; Fernandes and Paunov (2012) used panel data for the period 1992-2004 and found evidence of positive forward spillovers from FDI, Alvarez and López (2008) used panel data for the period 1990-1999 and found evidence of positive horizontal and backward spillovers from exporting FIFs.

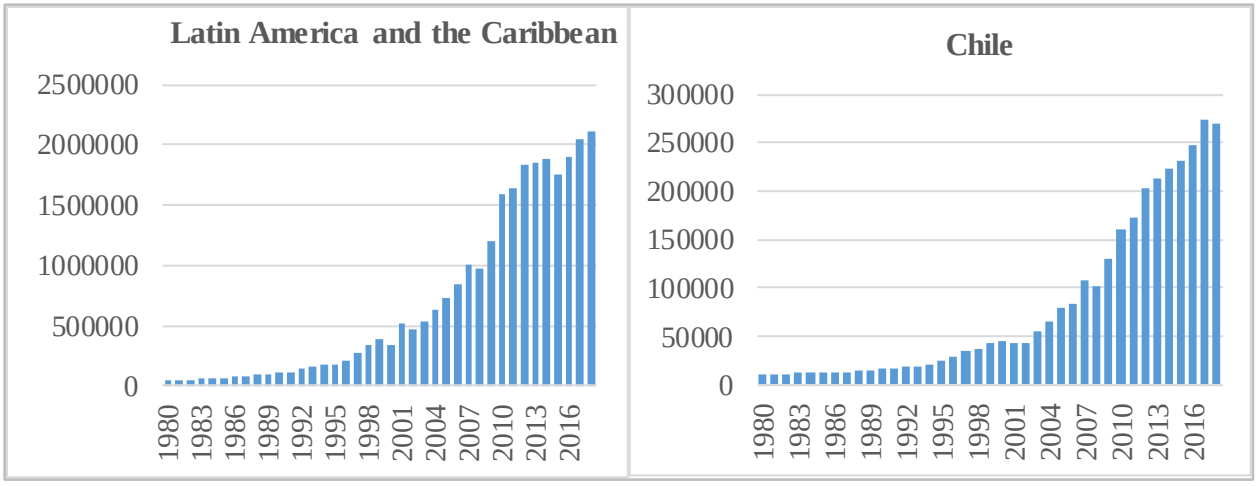


Figure 4.2: FDI stock in the OECD, Latin America and the Caribbean, and Chile

Source: UNCTAD (2019)

4.4. Model and Data

4.4.1. Spillover variables

The transmission of externalities from FIFs occurs through horizontal and vertical (backward and forward) linkages that raise the efficiency and productivity of domestic firms. The spillover variables (horizontal and vertical) are defined following Javorcik (2004).[53] They have been defined in Chapter 3 but we will repeat the definitions here because they relate directly to the additional measures that will be introduced later.

The incidence of horizontal spillover effects can be measured using the following variable:

$$Horizontal_{jt} = \frac{\sum_{i \in j} FS_{it} \times Y_{it}}{\sum_{i \in j} Y_{it}} \quad (4.1)$$

[53] Spillover variables are simply indicators of the intensity of foreign presence at the industry level. In the regression analysis, if the terms are significant, it means that domestic firm productivity is positively related to the intensity of the presence of FIFs in the relevant industry or industries (same industry for horizontal spillovers, downstream for backward spillovers and upstream for forward spillovers). That impact is taken to be spillover effects.

where FS_{it} is the total equity share owned by foreign investor(s), and Y_{it} is the total real value of sales (revenue) of firm *i* operating in industry *j*. It, therefore, measures the intensity of foreign participation in each industry. Vertical spillovers are of two types, backward and forward. The variable used to identify backward spillover effects is:

$$Backward_{jt} = \sum_{k \neq j} \eta_{kj} Horizontal_{kt} \quad (4.2)$$

This variable measures the density of foreign presence in downstream industries (where *j* refers to industry and *t* refers to year). Since the dataset used in this study does not include any information about actual backward linkages, either at the firm- or industry-level, the coefficient η_{jk}, which is the proportion of industry *j*'s output purchased by industry *k*, is taken from the time varying input-output matrix of Chile (see footnote 34 for explanation). Finally, forward spillover effects are identified using a measure of the density of foreign presence in upstream industries:

$$Forward_{jt} = \sum_{n \neq j} \varphi_{jn} \frac{\sum_{i \in n} FS_{it} \times (Y_{it} - X_{it})}{\sum_{i \in n} (Y_{it} - X_{it})} \quad (4.3)$$

where symbol φ_{jn} is the proportion of industry *j*'s materials that are sourced from industry *n* (see footnote 35 for explanation). Y_{it} is the total (real) sales, including exports, of firm *i* in industry *n*, and X_{it} is the firm's actual exports. The reason for excluding exports from the total sales is that the domestic market sales is the only part of output relevant for measuring forward spillovers in the domestic economy.

4.4.2. Firm size by assets, sales, and employees: the continuous approach

Typical variables used as measures of firm size in the empirical literature are: total assets, total sales, and the total number of employees (Dang et al., 2018). One of the ways the empirical

literature has tried to assess the effect of firm size (particularly with respect to productivity) is by simply including these variables, in continuous form, in the regression analysis and interpreting the coefficient, if found significant (Anwar & Sun, 2014; Cichello, 2005; Damijan et al., 2003; Hale & Long, 2011; Herrera & Sánchez-González, 2013; Kumar, 1985; Wakasugi, 1997). Following this broad literature, we include domestic firm size (defined, alternatively, in terms of assets, sales, and employees) in the spillover equation in order to assess whether size of a domestic firm has any effect on its receipt of spillover effects. Because both the typical firm size and size range vary across industries we use an industry-specific index to represent firm size.

$$SDF_{ijt} = ln\left(\frac{S_{ijt}}{S_{jt}^{M}}\right) \tag{4.4}$$

That index defines size of a domestic firm *i* in industry *j* and year *t* as the ratio of firms' assets, sales, and employees to the industry median (in a particular year).[54,55]

To assess the effect of size of FIFs (in terms of assets, sales, or employees) within an industry, we define an average size variable (SFF) in a particular industry, and in a particular year, as the average (log) distance of FIFs from the industry median as a proportion of that median.

$$SFF_{jt}^{H} = \sum_{i \in j}\left(D_{it}^{FI} \bullet ln\left(\frac{S_{it}}{S_{jt}^{M}}\right)\right) / \sum_{i \in j} D_{it}^{FI} \tag{4.5}$$

In that equation, D_{it}^{FI} is a dummy variable that takes on a value 1 if a firm is foreign-invested and 0 otherwise. S_{it} denotes total assets, total sales, or total employees of firm *i* in industry *j* and year

[54] The ratio is logged to remove the exponential nature of the differential ratio at the upper end (which exaggerates the effect of very large firms).

[55] We use the median as the measure of centrality, rather than the mean, because the mean is overly influenced by extreme values (which are common when we are measuring assets and sales).

t, and S_{jt}^{M} is the industry-year median of the relevant variable. Equation (4.5) therefore indicates where the average size of FIFs sits in relation to the industry median – below it, above it or close to it.

To define an average size variable for FIFs that is relevant to backward linkages (for FIFs), and therefore to backward spillover effects, we utilize the following equation:

$$SFF_{jt}^{B} = \sum_{k \neq j} \eta_{jk,t} \left[\sum_{i \in k} \left(D_{it}^{FI} \bullet ln\left(\frac{S_{it}}{S_{kt}^{M}}\right)\right) / \sum_{i \in k} D_{it}^{FI} \right] \quad (4.6)$$

Here, η_{kj} is taken from the input-output matrix and is as defined in Equation (4.2). That coefficient is, essentially, a weighting factor in determining the importance of each industry relative to industry *j* (based on the proportion of industry *j*'s output purchased by that industry) and the term in square brackets is a measure of the average size of FIFs' within each industry relative to the industry median.

Finally, the importance of FIF size (in terms of assets, sales, or employees) in relation to forward linkage (and thus, potentially, forward spillover effects) is measured by the equation:

$$SFF_{jt}^{F} = \sum_{n \neq j,t} \varphi_{jn,t} \left[\sum_{i \in n} \left(D_{it}^{FI} \bullet ln\left(\frac{S_{it}}{S_{nt}^{M}}\right)\right) / \sum_{i \in n} D_{it}^{FI} \right] \quad (4.7)$$

Here φ_{jn} is taken from the input-output matrix and is as defined in Equation (4.3). That coefficient weighs the importance of each industry in terms of the proportion of industry *j*'s inputs sourced from that industry, and the term in brackets is, again, an indicator of the average size of FIF relative to the industry median.

4.4.3. Firm size by assets, sales, and employees: the discrete approach

Another branch of literature has integrated the effects of firm size into the analysis by categorizing firms into different groups, as mentioned in Section 4.1. This approach has the advantage of being able to identify nonlinearities in the effect of firm size (FIFs and domestic) on spillover effects.[56] Although a few studies (in the broader FDI literature) have attempted discrete classification of assets and sales (Amato & Amato, 2007; Ijiri & Simon, 1974; Moss & Stine, 1993), both the number of categories and the boundaries that define these categories have been largely idiosyncratic and, to a large extent, arbitrary.[57] The interpretive meanings of these divisions are further complicated by the great difference in average firm size (based on assets and sales) across industries. This study uses percentile of assets and sales to categorize firms into small, medium, and large. Three different combinations of percentile are considered: (i) 1-25 percentiles for small firms, 26-75 percentiles for medium firms, and 76 or higher percentiles for large firms; (ii) 1-33 percentiles for small firms, 34-66 percentiles for medium firms, and 67 or higher percentiles for large firms; (iii) 1-40 percentiles for small firms, 41-80 percentiles for medium firms, and 81 or higher percentiles for large firms. Based on these size categories, spillover variables are decomposed into three size categories (small, medium, and large).

[56] We also tried two other ways to incorporate size into our analysis. First, we used average and median measure to categorize firms into two discrete size groups based on assets and sales: one including those firms having below average or median and another above average or median. Second, we utilized another percentile disaggregation measure to categorize firms into three discrete groups: small (1-60 percentile); medium (61-90 percentile); and large (91-99 percentile). We dropped them because they did not add anything more to the disaggregation results.

[57] Ijiri and Simon (1974), Moss and Stine (1993), and Amato and Amato (2007) classified firms into 10, 5, and 12 categories respectively based on firm assets. However, spillover literature examining the effect of firm size has classified firms into two or three broad categories based on employment: either SME and large (Dogan et al., 2017), or small and large (Aitken & Harrison, 1999; Doan et al., 2015), or small, medium, and large (Anwar & Sun, 2014; Dogan et al., 2017; Imbriani et al., 2014).

Using the number of employees to determine discrete categories, however, has a more proven record. The empirical literature (both within economics and other disciplines) has developed well-established delimiting criteria for firm size based on employment using definitions such as micro, small, medium and large. Therefore, this study decomposes each of the three spillover variables (*Horizontal, Backward,* and *Forward* in Equations 4.1, 4.2 and 4.3 respectively) into three size categories (small, medium, and large) based on the definition of firm size given in Imbriani et al. (2014)[58]. Thus, the spillover variables for each firm size category is computed as follows:

$$Horizontal_{jt}^{m} = \frac{\sum_{i \in j} FS_{it}^{m} * Y_{it}}{\sum_{i \in j} Y_{it}} \tag{4.8}$$

$$Backward_{jt}^{m} = \sum_{j \neq k} \eta_{kj} Horizontal_{kt}^{m} \tag{4.9}$$

$$Forward_{jt}^{m} = \sum_{n \neq j} \varphi_{jn} \frac{\sum_{i \in n} FS_{it}^{m} * (Y_{it} - X_{it})}{\sum_{i \in n} (Y_{it} - X_{it})} \tag{4.10}$$

where *m* takes on values 1, 2, and 3 and indicates one of three firm size categories: small, medium, and large respectively.

4.4.4. The Empirical model

Panel data estimation techniques are employed to determine whether the total factor productivity (TFP) of domestic firms rises with the density of foreign capital stock in relevant industries—indicative of spillovers from FIFs. First, we obtain an unbiased estimate of firm-level TFP because

[58] The Imbriani et al. (2014) study classified firms into three categories (small, medium, and large) based on the number of employees: small firms are those that employ 1-49 workers, medium firms 50-249 workers, and large firms 250 or more workers. This is a slight deviation from EU definition of firm size that has classified firms into four categories: micro, small, medium, and large. According to EU definition, micro firms are those that employ less than 10 workers, small firms 10-49 workers, medium firms 50-249 workers, and large more than 250 workers. We eschewed the use of the micro category because the number of FIFs in that category was quite small in the later years of the survey, reducing the credibility of statistical estimates. We did the same for domestic firms to maintain symmetry in the categorization.

the one estimated with a typical production function formula suffers from an endogeneity problem in input choice (see Section 3.4.4 for endogeneity issue in input choice raised by Griliches and Mairesse (1995)). To correct for that endogeneity, a firm-level TFP is computed from a log-log transformation of a traditional Cobb-Douglas production function employing the Ackerberg et al. (2015) approach (see Appendix A3 for details).

For the case where size is measured as a continuous variable, in the first instance, the endogeneity-corrected firm-level TFP measure is regressed on spillover variables (*Horizontal*, *Backward*, and *Forward*), a set of control variables, and the variables defined in Equation 4.4, 4.5, 4.6, and 4.7 respectively, for all domestic firms, as shown in equation (4.11) below.

$$lnTFP_{ijt} = \alpha + \beta_1 Hor_{jt-1} + \beta_2 Back_{jt-1} + \beta_3 For_{jt-1} + \gamma SDF_{ijt-1} + \delta Z_{jt-1} + \theta_1 SFF^{H}_{jt-1} + \theta_2 SFF^{B}_{jt-1} + \theta_3 SFF^{F}_{jt-1} + \alpha_j + \alpha_r + \alpha_t + \varepsilon_{ijt} \quad (4.11)$$

The spillover variables are lagged one year because the entry of FDI may take time to produce productivity spillover effects for domestic firms (Haskel et al., 2007).[59] X_{ijt-1} represents size variables (assets, sales or employment) in time $t-1$; and Z_{jt-1} represents industry-level control variables. These control variables are: the Herfindahl-Hirschman index (HHI_{jt-1}) to control for industry concentration, industry import concentration (IM_{jt-1}), and industry export intensity (EX_{jt-1}). The variable SDF_{ijt-1}, as shown in Equation (4.4), represents firm size (in terms of total assets, sales, or employees) measured in continuous form for domestic firm *i* in industry *j* and time $t-1$. For time $t-1$, the average size of FIFs in the same industry (relative to the industry median)

[59] Using long lag shrinks sample size which may lead to survivor bias by estimating impact on only surviving firms. Thus, we will miss possible negative impacts of FDI on firm survival. Hence, only one year lagged spillover variables are used.

is indicated by the variable SFF_{jt-1}^{H}, the weighted average size of FIFs in downstream industries is indicated by SFF_{ijt-1}^{B}, and the weighted average size of FIFs in upstream industries is indicated by SFF_{ijt-1}^{F}.[60] The parameters α_j, α_r, and α_t denote industry, regional, and time dummy variables respectively (included in the regression to control for unobserved industry-, region-, and time-specific factors).[61] The effect of size on spillover effects is determined by interacting each of the spillover variables with the size variable for domestic firms and the relevant size variables for FIFs.[62]

To address the case where size is measured discretely, the endogeneity-adjusted TFP is regressed on spillover variables (*Horizontal*, *Backward*, and *Forward*) defined in Equation 4.8, 4.9, and 4.10 respectively and a set of control variables (as shown in equation (4.12) below) for three different groups of domestic firms, where each represents one of three size categories (small, medium and large) based on assets, sales, or employment levels. In that equation, *m* indicates the firm-size categories (small, medium, or large).

$$lnTFP_{ijt} = \alpha + \beta_{1m}\sum_{m=1}^{3} Hor_{jt-1}^{m} + \beta_{2m}\sum_{m=1}^{3} Back_{jt-1}^{m} + \beta_{3m}\sum_{m=1}^{3} For_{jt-1}^{m} + \delta Z_{jt-1} + \theta_1 S_{ijt-1} + \alpha_j + \alpha_r + \alpha_t + \varepsilon_{ijt} \quad (4.12)$$

The term Z_{jt-1} represents industry-level control variables as in Equation (4.11); and, S_{ijt-1} indicates total assets or sales of (domestic) firm *i* in industry *j* and time $t-1$ (sales is included in every model of the discrete size measure except for the equation that uses sales as the chosen size

[60] The weight is determined by the relative strength of industry links, as indicated by the input-output coefficient.
[61] Examples of these factors include high-quality management accrued to a particular firm and better socioeconomic infrastructure in a given region.
[62] The relevant size variables are: SFF_{jt-1}^{H} for horizontal spillovers; SFF_{ijt-1}^{B} for backward spillovers; and SFF_{ijt-1}^{F} for forward spillover effects.

measure where asset is used instead).[63] In both Equations (4.11) and (4.12), standard errors are clustered at the industry-year level to control for the spurious significance of coefficients and the downward biases of standard errors, as suggested by Moulton (1990) (see footnote 47). Selection bias can be a serious problem in econometric estimation since it leads to inaccuracies in parameter estimation (Greene, 2003). This problem may arise from the use of non-randomly selected samples (Heckman, 1979) or datasets for which we do not observe the value of the dependent variable for the entire period. We apply the Heckman (1979) two-step approach to correct for sample selection bias. First, we utilize a probit regression to estimate the probability that firms' TFP is observed, and calculate the resulting "inverse Mills ratio." The computed "inverse Mills ratio" is then included in the regression as an explanatory variable. First-stage selection regression results are reported in Table A4.3 of Appendix A4.

4.4.5. Propensity Score Matching (PSM)

Technology spillovers are realistic possibilities if FIFs possess improved technologies and management techniques reflected by higher level of TFP. It is thus reasonable to ask whether the TFPs of FIFs is higher than that of their comparable domestic counterparts. We apply the propensity score matching (PSM) technique developed by Rosenbaum and Rubin (1983) to compare the productivity levels of FIFs and domestic firms that share the same characteristics. The parameter used in the matching technique is ATT (average treatment effect on the treated)—the average effect of the treatment for those subjects that actually received the treatment (foreign investment in this case). The ATT is defined as:

[63] This variable must be lagged because contemporaneous size is, to some degree, simultaneously determined with output and, therefore, productivity, making it endogenous.

$$ATT = E[Y(1) - Y(0)|T = 1, X] \quad (4.13)$$

where T is a treatment indicator that takes on a value 1 if a firm is treated (foreign-invested) and 0 if it is untreated (domestically-owned). Thus $Y(1)$ and $Y(0)$ are potential outcomes for foreign-invested (foreign ownership exceeding 10%) and wholly domestic firms (foreign investment of less than 10% including zero) respectively. The outcome is defined as firms' productivity level (TFP). $E[Y(0)|T = 1]$ is the counterfactual—expected unobserved outcome—which is to be estimated. X is a vector of pre-treatment characteristics of firms. Following Arnold and Javorcik (2009), the pre-treatment characteristics used in determining propensity scores are; lagged first-differenced TFP, lagged log of the number of employees and its square, lagged log of capital per employee, lagged share of materials imported in total materials used, and lagged share of output exported. The matching technique employed is nearest-neighbour matching with replacement.[64]

4.4.6. Data

The dataset used in this study is a plant-level panel drawn from the Annual National Industrial Survey (ENIA) carried out by the National Institute of Statistics of Chile (INE). The dataset covers the years 1995 through to 2007.[65] The database gives plant-level information for each year in separate files for (roughly) 5000 plants interviewed each year (see Table A4.1 in Appendix A4 for distribution of domestic firms and FIFs across years).[66] Each plant is given a unique identification

[64] Two common matching methods used in the matching technique are: the nearest neighbor matching; and optimal matching (Austin, 2011; Stuart, 2010). The first one (nearest neighbor matching) relies on an algorithm which randomly selects a treated participant and consecutively moves through the participants' list and matches the treated unit with the closest match from the comparison group. The second one (optimal matching) algorithm, on the other hand, minimizes the overall distance across matched groups (Benedetto et al., 2018).

[65] ENIA has been assigning random firm ID since 2008 which restricts dataset to be panel up to 2007. That is why data for period 1995-2007 is used in this study.

[66] Firms and plants are not necessarily the same since a firm may have several plants. However, Pavcnik (2002) pointed out that a significant percentage of Chilean manufacturing plants are single-plant firms.

number which is used to form the panel. The dataset is an unbalanced panel that allows for the identification of plants entering and exiting each year. There are a significant number of firms that survive for only a few years in the dataset. To avoid spurious results, we thus removed firms that survived for less than 5 years from the dataset. In other words, the dataset comprises of firms that survive for at least 5 years throughout the period 1995-2007.

From the numerous variables measured in the dataset, the ones employed in this study are: total revenue (sales), number of employees, value of capital, value of materials purchased, foreign equity share, exports of final product, value of imports of materials, industry code, region, and year. Employees refer to the sum of production and nonproduction workers. Capital refers to all fixed assets including land, vehicle, building, and machinery. Materials means sum of materials used in the production process. The nominal variables (revenue, capital, and materials) are deflated using the GDP deflator. The data on the GDP deflator is drawn from the World Bank's *World Development Indicators*. Input-output (IO) tables for each year are used to construct time-varying input-output coefficients. The data on input-output tables are extracted from the OECD database.

The dataset contains 4-digit international standard industry classification (ISIC) codes that are used to define the broad industries. Chile is a worthy location for FDI spillover analysis because of its sizable stock of FDI as discussed in Section 4.3. On the downside, however, the dataset, could not be extended beyond 2007 because of randomization of firm ID assignment after that year. Summary statistics of revenue, employees, capital, materials, and the log of TFP are presented in Table 4.1 (separately for domestic firms and FIFs). Two stylized facts from the dataset worthy of note are: (i) FIFs are, on average, larger than domestic firms in terms of output, capital, employment, and materials used; and (ii) FIFs are generally more productive than domestic firms.

Table 4.1: Summary statistics of the main size variables for domestic and foreign-invested firms

Variable	Domestic firms			FIFs		
	Obs	Mean	SD	Obs	Mean	SD
Sales (Revenue)	55,258	8,593,339	77,084,007	3,301	40,673,298	152,726,724
Employees	54,967	63	135	3,291	181	285
Assets	52,767	3,524,695	55,999,341	3,042	26,302,866	16,7310,123
Materials	54,897	4,723,736	51,034,972	3,284	20,911,359	57,606,038
LnTFP	52,301	2.65	0.62	3022	2.84	0.72

Figure 4.3 shows size distribution of domestic firms and FIFs in 1995 and 2007 (when size is measured in terms of the number of employees). The distribution of domestic firms did not change a great deal between 1995 and 2007 except at the lower end of the distribution, where it showed an increase in the proportion of small firms that were at the lowest end of the size spectrum (micro firms) in 2007. There was, however, a more significant shift in the distribution of FIFs. In 1995 the overwhelming majority of FIFs were small or medium in size but by 2007 the proportion of firms at the lower end of the spectrum had decreased significantly and the number of large firms had more than quadrupled in proportional terms. Though the proportion of firms in the middle of size spectrum remained roughly the same, the distribution of those firms across the range of employment sizes (50-249) was much more even and less concentrated at the lower end of that range.[67] A detail distribution of firms (both domestic and foreign-invested) across industries in 1995 and 2007 is shown in Table A4.2 of Appendix A4.

[67] In particular, the number of small, medium, and large domestic firms were 3649, 1310, and 260 respectively in 1995 and 3437, 1045, and 270 respectively in 2007. On the other hand, the number of small, medium, and large FIFs were 109, 136, and 38 respectively in 1995 and 71, 134, and 73 in 2007.

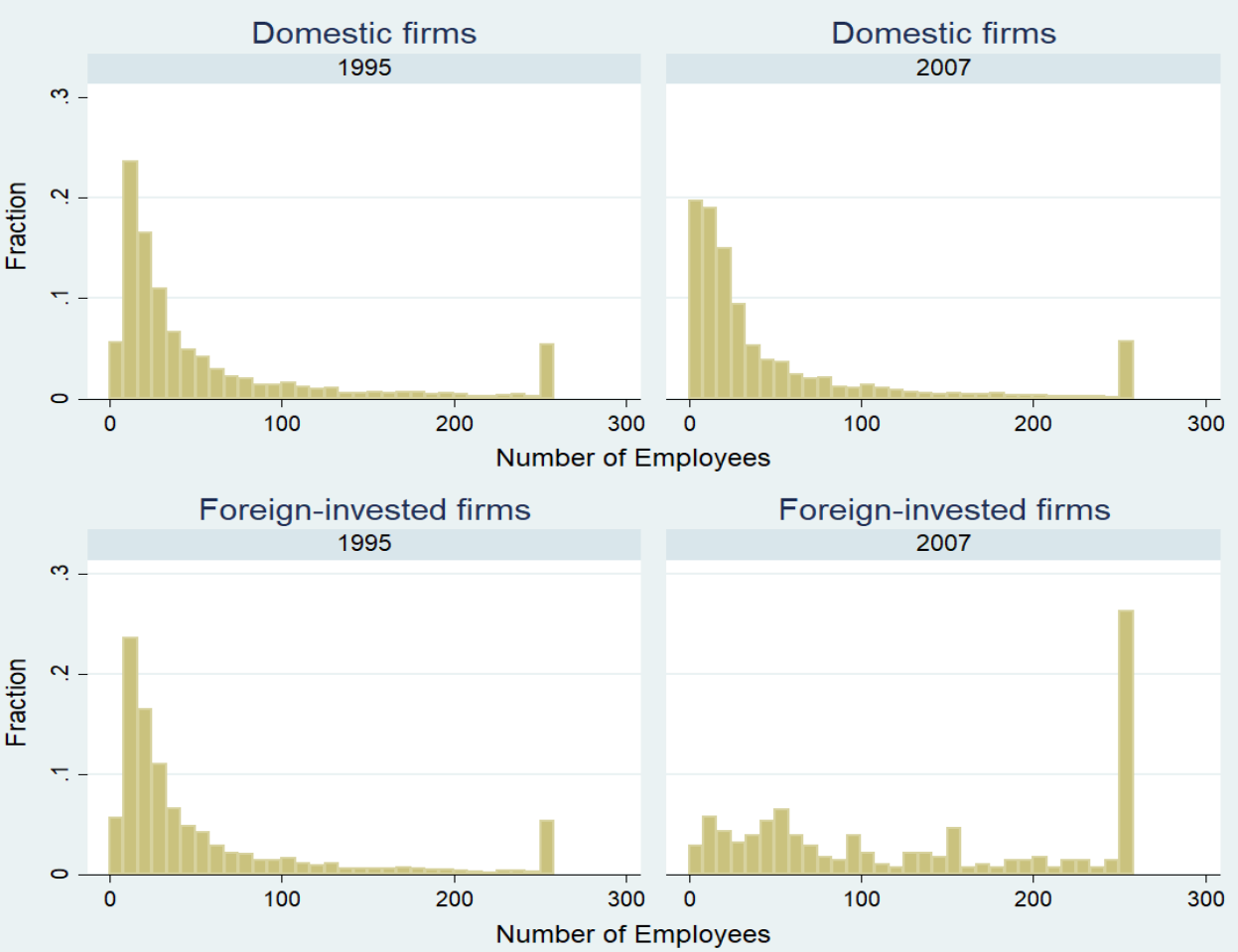


Figure 4.3: Distribution of domestic and foreign-invested firms in 1995 and 2007

Note: firms employing 250 or more employees are included in the 250-employee category
Source: (National Statistics Institute (Chile), 2008)

4.5. Results

4.5.1. Continuous size measure, productivity, and spillovers

Equation (4.11) is estimated for all domestic firms, incorporating size variables for both domestic firms and FIFs and interaction terms between size and spillover variables. Results are reported in Table 4.2, with columns 1, 2, and 3 indicating the spillover results when size is measured in terms of assets, sales, and employment respectively. Only fixed effects estimation results are reported

because the *Hausman* test selected the fixed effect model (see Table A4.4 in Appendix A4 for *Hausman* test result and Table A4.5 for random effect estimation results). With respect to the direct estimation of the productivity spillover effects, only the coefficient for the forward spillover variable is significant (and, in this case, negative) in all three columns—indicating that the presence of FIFs in upstream industries negatively affects productivity of domestic firms. None of the coefficients of the control variables (Herfindahl-Hirschman index, export intensity and import concentration) are significant.[68] The positive and significant inverse Mills ratio indicates that sample selection bias was indeed an issue that needed to be corrected.

Size of domestic firm (SDF), measured as a single continuous variable (i.e., assets, sales or employment divided by their corresponding industry-year median), is negatively related to productivity when measured in terms of assets but positively related to productivity when measured in terms of sales or employment. Moreover, when the spillover variables (*Horizontal*, *Backward*, and *Forward*) are interacted with SDF, we find that increasing firm size, when measured in terms of sales or employment, does not significantly increase the probability of any spillover effects. However, increasing SDF, when measured in terms of assets, is associated with negative backward spillover effects. In effect, when it comes to SDF, the use of sales and employment as indicators of size generate similar results while the use of assets (as size indicator) generate quite different results.

The average size of FIFs in the same industry and in other industries does not matter for productivity of domestic firms when size is measured in terms of assets. Size of FIFs in

[68] This result does not rule out the possibility that these variables may be important for specific sectors.

downstream industries (represented by the coefficient of SFF^{B}_{t-1}) does matter when size is measured in terms of sales, and the effect on productivity is positive.

Table 4.2: Domestic firm size and spillover effects (continuous size measure)

	Assets	Sales	Employment
	(1)	(2)	(3)
$Horizontal_{t-1}$	0.015	0.093	-0.011
	(0.076)	(0.091)	(0.088)
$Backward_{t-1}$	-0.280	-0.042	-0.408
	(0.260)	(0.238)	(0.252)
$Forward_{t-1}$	-1.138**	-1.373***	-0.793*
	(0.453)	(0.512)	(0.437)
HHI_{t-1}	0.183	0.177	0.148
	(0.128)	(0.113)	(0.106)
EX_{t-1}	-0.076	-0.040	-0.060
	(0.066)	(0.076)	(0.067)
IM_{t-1}	0.136	0.057	0.079
	(0.144)	(0.144)	(0.145)
Mills	4.477***	4.036***	3.807***
	(0.461)	(0.727)	(0.704)
SDF_{t-1}	-0.031***	0.133***	0.035***
	(0.004)	(0.012)	(0.008)
$(SDF^{*}Horizontal)_{t-1}$	0.020	0.007	-0.025
	(0.017)	(0.019)	(0.029)
$(SDF^{*}Backward)_{t-1}$	-0.218***	-0.095	-0.080
	(0.064)	(0.121)	(0.138)
$(SDF^{*}Forward)_{t-1}$	0.007	0.055	0.077
	(0.050)	(0.084)	(0.081)
SFF^{H}_{jt-1}	0.000	-0.006	0.039*
	(0.006)	(0.009)	(0.023)
SFF^{B}_{jt-1}	0.009	0.054**	0.028
	(0.015)	(0.026)	(0.029)
SFF^{F}_{jt-1}	0.022	-0.034	0.004
	(0.028)	(0.042)	(0.055)
$(SFF^{H} * Horizontal)_{t-1}$	0.080	0.098	0.014
	(0.059)	(0.068)	(0.035)
$(SFF^{B} * Backward)_{t-1}$	0.103	-0.563	0.684
	(0.411)	(0.575)	(0.913)
$(SFF^{F} * Forward)_{t-1}$	0.629**	0.746**	0.658
	(0.277)	(0.353)	(0.550)
Constant	2.602***	2.611***	2.616***
	(0.038)	(0.038)	(0.033)
Observations	46054	46800	46661
R-squared	0.034	0.044	0.023

Note: *** p<0.01, ** p<0.05, * p<0.1. SDF (from Equation 4.4) is defined in terms of assets in column 1, in terms of sales in column 2, and in terms of employment in column 3. Results are from fixed effect model. All samples are restricted to domestic firms. Standard errors in parentheses are clustered at industry-year level. The dependent variable is lnTFP. All regressions include industry, region, and year fixed effects.

When size is measured in terms of employment, size of FIFs in the same industry (represented by the coefficient of SFF^{H}_{t-1}) does matter and is associated with a positive effect. When the spillover variables are interacted with relevant FIFs' size variables, there is no evidence of increased likelihood of either horizontal or backward spillovers. However, a higher average size of FIFs in upstream industries is positively associated with higher productivity for domestic firms—implying stronger forward spillover effects (represented by the coefficient of $(SFF^{F} * For)_{t-1}$)—when size is measured in terms of assets and sales (but not employment). This result suggests that, when size is measured in terms of assets or sales, the negative forward spillover effect, indicated by the coefficient for the pre-interaction forward spillover variable, is moderated as size of FIFs increase. Put differently, this result suggests that smaller FIFs, in terms of assets and sales, in upstream industries are the ones most likely to create productivity challenges for their domestic customers (likely through changes in price, product quality or reductions in parallel services). However, when size is measured in terms of employment, that moderating effect of FIF size is not observed.

To summarize, the results from estimating Equation 4.11 suggest that:

1. With respect to productivity, the effect of size of domestic firms is similar when size is measured in terms of sales and employment (but quite opposite when size is measured in terms of assets), but the measured size effects of FIFs vary across the three ways of measuring size.

2. With respect to spillover effects, while all three ways of measuring firm size allow for the articulation of a negative forward spillover effect of FDI, that effect appears to be moderated with the increasing (average) size of FIFs when size is measured in terms of assets and sales, but not when size is measured in terms of employment.

3. Domestic firm size is shown to influence the extent of spillover effects only when size is measured in terms of assets and, in that case, increasing size is shown to be associated with a negative backward spillover effect.

It would appear then, that, while there is some overlap in the results across the three measures (because some productivity and spillover effects are picked up regardless of the measure of size used or picked up by more than one measure), in general, each measure will tell a different story about both the productivity and spillover effects of size (with respect to both foreign-invested and domestic firms).

4.5.2. Discrete size measure and spillovers

Given the heterogeneous results generated by the continuous measures of firm size, it is reasonable to ask whether discrete measures generate more uniform results. Discrete measures also offer the possibility of picking up nonlinearities in size effects, though the various measures of size may not be uniform in their ability to pick up these nonlinearities.[69] To address these concerns, we utilize discrete measures based on employment, assets and sales to estimate the effect of size on productivity and spillovers. For employment, we divide firms into three size categories (small, medium, and large) based on the criteria elucidated in section 4.4.3 and informed by a well-established literature. We use the same three categories for asset and sales measures but, in the absence of any strong guidance from the literature, we experiment with various cutoff points in defining these categories (see Section 4.4.3).

[69] Nonlinearities exist when size effects do not vary monotonically with size. Thus, there may be effects that are specific to medium firms but not to small or large firms or vice versa.

With respect to FIFs, a necessary corollary of the presumption that the discrete size measures matter for the generation of the productivity spillover effects is the presumption that the discrete size measures matter for productivity. We employ the propensity score matching (PSM) technique to determine whether the technological level (in terms of productivity) of FIFs is higher than that of their comparable domestic counterparts.

4.5.2.1. Discrete size and firm productivity

Table 4.3 (panels a, b, and c) shows PSM results when size is measured in terms of employment, assets and sales respectively. It shows that FIFs, as a group and also across size categories, regardless of the measure of size, are more productive than comparable domestic firms.[70] These are similar to the results found by Arnold and Javorcik (2009).

When size is measured in terms of employment, large FIFs have the highest productivity premium (relative to their domestic competitors) but the premium for small firms is only slightly smaller. When size is measured in terms of assets, it is always medium firms that exhibit the largest productivity gap, regardless of the cutoffs used to define the three size categories. When size is measured in terms of sales, medium firms display the largest productivity gap when the percentile ranges that define medium are 26-75 and 34-66. However, when the percentile ranges are 41-80, it is large firms (>80%) that display the largest productivity gap. Overall, these results indicate that FIFs are generally more productive than comparable domestic firms, but the productivity gap does

[70] FIFs are matched to domestic firms within the same size categories that share same characteristics with the former. To do so, the following variables are used in the propensity score matching model: lagged first-differenced TFP, lagged log of number of employees and its square, lagged log of capital per employee, lagged share of materials imported in total materials use, lagged share of output exported. This is done following Arnold and Javorcik (2009).

not necessarily increase or decrease with size. In effect, the relationship between the productivity gap and discrete size is both nonlinear and measure dependent.

Table 4.3: Effect of foreign ownership on total factor productivity (PSM)

	(a) Employment			
	All firms	Small firms	Medium firms	Large firms
ATT	0.1224***	0.1485***	0.0873***	0.1499***
	(0.0197)	(0.0401)	(0.0276)	(0.0458)
Observations	42,144	29,614	10,011	2,519
	(b) Assets			
		Disaggregation based on 1-25, 26-75, >75 percentile		
ATT		0.045**	0.1599***	0.0888***
		(0.019)	(0.0416)	(0.0243)
Observations		10,327	21,137	10,680
		Disaggregation based on 1-33, 34-66, >66 percentile		
ATT		0.0500*	0.1408**	0.1073***
		(0.0282)	(0.0581)	(0.0233)
Observations		13,737	13,835	14,572
		Disaggregation based on 1-40, 41-80, >80 percentile		
ATT		0.0411**	0.0901**	0.0761***
		(0.018)	(0.0431)	(0.0282)
Observations		16,633	16,995	8,516
	(c) Sales			
		Disaggregation based on 1-25, 26-75, >75 percentile		
ATT		0.0361**	0.0820***	0.0715***
		(0.0162)	(0.0353)	(0.0269)
Observations		10,633	21,065	10,446
		Disaggregation based on 1-33, 34-66, >66 percentile		
ATT		0.0902**	0.1471***	0.0758***
		(0.0404)	(0.0475)	(0.0253)
Observations		14,036	13,828	14,280
		Disaggregation based on 1-40, 41-80, >80 percentile		
ATT		0.0197**	0.0860***	0.1145***
		(0.0080)	(0.031)	(0.0264)
Observations		17,002	16,891	8,251

Notes: *** p<0.01, ** p<0.05, * p<0.1. The robust standard errors are in parentheses. Results are based on matched samples of foreign-invested and domestic firms. The ATT indicates the productivity impact of foreign ownership in terms of lnTFP.

To determine more specifically the relationship between discrete size and firm productivity, we regress firm productivity on the size variables (Equation (4.14) below). This relationship is estimated for domestic firms and FIFs separately and for each size measure.

$$lnTFP_i = \theta_0 + \delta_i Size_i + \alpha_r + \alpha_j + \varepsilon_i \quad (4.14)$$

In the equation above, TFP_i denotes firm *i*'s productivity and $Size_i$ represents three size categories (small, medium and large firms respectively).[71] In the regression, α_r and α_j represent regional and industry dummies respectively.

The estimation results, reported in Table 4.4, indicate that medium and large FIFs, when measured in terms of employment, are more productive than small firms with medium firms being the most productive. When size is measured in terms of sales (all disaggregations), both medium and large FIFs are more productive than small FIFs as well, but with the large FIFs being the most productive in this case. When size is measured in terms of assets, medium and large FIFs are found to be less productive than small FIFs. These productivity differentials largely duplicate the results for the continuous measures of size in terms of assets and sales but not employment. The significance of the *Wald* test for each of the equations indicates that the differences in the coefficients between medium and large firms are always significant.

[71] $Size_i$ is a categorical variable, but it is used as dummy variable in Equation (4.14) for three size categories. Small firms are used as the base and coefficients of medium and large firms compare productivity of these two size categories with that of small firms (see Table 4.4).

Table 4.4: Sizes of domestic firms and FIFs and productivity

	Employment	Assets 1	Assets 2	Assets 3	Sales 1	Sales 2	Sales 3
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Domestic firms						
Medium	0.091***	-0.139***	-0.119***	-0.111***	0.220***	0.205***	0.218***
	(0.007)	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Large	0.194***	-0.156***	-0.160***	-0.127***	0.448***	0.407***	0.445***
	(0.014)	(0.009)	(0.008)	(0.010)	(0.010)	(0.009)	(0.010)
Constant	2.510***	2.624***	2.606***	2.588***	2.354***	2.375***	2.396***
	(0.037)	(0.038)	(0.044)	(0.044)	(0.037)	(0.037)	(0.037)
Observations	61847	61847	52386	52386	61847	61847	61847
R-squared	0.094	0.067	0.082	0.084	0.121	0.119	0.118
Wald test	63.03***	5.26**	35.03***	3.52*	800.11***	795.83***	670.31***
	FIFs						
Medium	0.131***	-0.143***	-0.122**	-0.071	0.315***	0.248***	0.298***
	(0.029)	(0.053)	(0.054)	(0.046)	(0.063)	(0.059)	(0.051)
Large	0.109***	-0.209***	-0.221***	-0.169***	0.663***	0.551***	0.643***
	(0.041)	(0.056)	(0.055)	(0.050)	(0.066)	(0.061)	(0.055)
Constant	2.497***	2.736***	2.799***	2.726***	2.119***	2.178***	2.158***
	(0.133)	(0.141)	(0.156)	(0.153)	(0.140)	(0.137)	(0.135)
Observations	3586	3586	3034	3034	3586	3586	3586
R-squared	0.194	0.168	0.128	0.126	0.222	0.226	0.236
Wald test	7.04***	5.09**	7.40***	10.80***	111.85***	61.08**	130.44**

Notes: *** p<0.01, ** p<0.05, * p<0.1. The robust standard errors are in parentheses. Assets 1, 2, and 3 represent disaggregation based on 1-25, 26-75, >75, 1-33, 34-66, >66, and 1-40, 41-80, >80 percentile of assets respectively. Sales 1, 2, and 3 represent disaggregation based on 1-25, 26-75, >75, 1-33, 34-66, >66, and 1-40, 41-80, >80 percentile of sales respectively.

4.5.2.2. Spillovers and firm size based on employment

To investigate the effect of domestic firm size on spillover effects, when size is defined in discrete terms based on employment, we estimate Equation 4.12 for the full sample of domestic firms and then for the sub-samples of small, medium and large domestic firms respectively. The discrete size effect of FIFs on spillovers is accommodated by disaggregation of the spillover variables (see

Section 4.4.4 above). The fixed effects estimation results are reported in Table 4.5 (the random effect estimation results are reported in Table A4.6 of Appendix A4). Notably, firms' lagged sale (which we use as a control variable in place of asset size, more typical in the literature)[72] is positively associated with productivity in the aggregate data model but is shown to be relevant only to the small-firm group upon disaggregation. Since earlier results (Table 4.2) have already indicated that there is a strong relationship between sales volume and productivity, this is simply taken to imply that the relationship is not monotonic.

The results from Table 4.5 indicate that small FIFs generate negative backward spillovers for small domestic firms and positive forward spillovers for medium domestic firms. The implication is that small FIFs reduce the productivity of small domestic firms in upstream industries and increase the productivity of medium domestic firms in downstream industries. Medium FIFs generate only negative horizontal spillovers and they do so only for medium domestic firms—suggesting the displacement of domestic firms of similar size.

Large FIFs are associated with positive horizontal spillovers for small domestic firms, positive backward spillovers for small and medium domestic firms, and negative forward spillovers for small domestic firms. In effect, large FIFs are able to increase the productivity of small domestic firms in the same industry, and small and medium firms in upstream industries, but they reduce the productivity of small domestic firms in downstream industries. To summarize, large FIFs generate all three types of spillover effects, small FIFs generate two of the three and medium firms only one type while, on the receiving end, small and medium domestic firms experience all three

[72] We replaced the lagged value of total assets with the lagged value of total sales because the value of total assets was shown earlier to be negatively related to productivity. However, this change in choice of control variable did not affect the spillover effect results.

types of spillover effects (either positive or negative) but large domestic firms are not recipients of any spillover effects.

Table 4.5: FDI spillovers across FIFs and domestic firm size categories (based on employees)

	Domestic Firms			
	All	Small	Medium	Large
	(1)	(2)	(3)	(4)
$Horizontal_{t-1}$				
Small	-0.001	-0.045	0.122	0.399
	(0.062)	(0.069)	(0.090)	(0.256)
Medium	-0.036	0.016	-0.168***	-0.124
	(0.040)	(0.043)	(0.063)	(0.134)
Large	0.052**	0.065***	-0.016	0.125
	(0.021)	(0.023)	(0.034)	(0.104)
$Backward_{t-1}$				
Small	-0.894	-0.806	-0.725	-2.078
	(0.613)	(0.659)	(0.764)	(2.218)
Medium	-0.713*	-0.635	-0.511	-0.285
	(0.406)	(0.431)	(0.510)	(1.741)
Large	0.597***	0.618**	0.440	-0.098
	(0.226)	(0.241)	(0.308)	(1.156)
$Forward_{t-1}$				
Small	0.539**	0.247	0.705**	1.727
	(0.244)	(0.265)	(0.349)	(1.062)
Medium	-0.130	-0.059	-0.178	0.480
	(0.124)	(0.124)	(0.222)	(0.651)
Large	-0.182***	-0.198***	0.084	0.348
	(0.067)	(0.066)	(0.111)	(0.265)
Controls				
HHI_{t-1}	0.198*	0.267**	0.176	-0.720*
	(0.101)	(0.125)	(0.151)	(0.397)
EX_{t-1}	-0.054	-0.068	-0.165	-0.252
	(0.064)	(0.063)	(0.102)	(0.169)
IM_{t-1}	0.072	0.183	-0.086	-0.094
	(0.127)	(0.163)	(0.109)	(0.270)
$Sale_{t-1}$	0.031**	0.184**	-0.001	0.012
	(0.013)	(0.087)	(0.057)	(0.009)
Mills	3.732***	3.718***	11.251***	-7.667***
	(0.689)	(0.767)	(1.905)	(1.889)
Constant	2.573***	2.538***	2.703***	2.885***
	(0.096)	(0.134)	(0.118)	(0.085)
Observations	46800	34029	10423	2348
R-squared	0.024	0.031	0.026	0.054

Notes: *** p<0.01, ** p<0.05, * p<0.1. Results are from fixed effect model. All samples are restricted to domestic firms. Standard errors in parentheses are clustered at industry-year level. The dependent variable is lnTFP. All regressions include industry, region, and year fixed effects.

Comparing these results to those of the continuous case (third column of Table 4.2), we note that the equation results, when size is measured in terms of continuous employment levels, indicate only one type of spillover effect and firm size was not found to augment or diminish that effects. By comparison, using discrete measures, we are not only able to discern all three types of spillover effects but also able to identify which FIFs (in terms of size) were mostly responsible for generating them and which domestic firms (in terms of size) were most likely to experience them. Clearly, in the case of employment, the discrete approach yielded a great deal more information and nuance than the continuous approach.

Relating our results to the larger literature, our finding of no spillover impacts for large domestic firms is consistent with the previous literature. However, our finding that spillovers are generated by all three sizes of FIFs differs significantly from the findings of Lenaerts and Merlevede (2015) who found that, in the case of Romania, only medium FIFs generated spillovers while small and large ones did not. The findings of negative spillover effects found in this study are not particularly unusual.[73] Dogan et al. (2017), for example, found evidence of negative spillovers in Malaysia.

4.5.2.3. Spillovers and firm size based on assets

Unlike the employment size measure, there are no well-established criteria for discretely disaggregating firms in terms of assets or sales in the literature. We therefore applied three different disaggregation criteria based on the percentile distribution of assets and sales as enunciated in section 4.4.3. Table 4.6 presents the spillover results when size is measured in terms of assets. The

[73] There are evidences of negative spillovers through all three channels in previous FDI spillovers studies that did not consider firm size in the analysis. For example, Djankov and Hoekman (2000) for Czech Republic, Haddad and Harrison (1993) for Morocco, and Ni et al. (2017) for Vietnam found evidence of negative horizontal spillovers; Khalifah et al. (2015) for Malaysia, Kinuthia (2016) for Kenya, and Barge-Gil et al. (2019) for Spain found evidence of negative backward spillovers; Huynh et al. (2019) for Vietnam, and Sari et al. (2016) for Indonesia found evidence of negative forward spillovers.

terms small, medium, and large in the variable column correspond to the same (percentile) size disaggregations described in the first header row (see Table A4.7 in Appendix A4 for random effect estimation results).

Table 4.6: FDI spillovers across FIFs and domestic firm size categories (based on assets)

	Percentile of asset_1-25, 26-75, >75				Percentile of asset_1-33, 34-66, >66				Percentile of asset_1-40, 41-80, >80			
	All	Small	Medium	Large	All	Small	Medium	Large	All	Small	Medium	Large
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$Horizontal_{t-1}$												
Small	0.025**	0.013	0.028**	0.014	0.137**	0.004	0.087	0.179***	-0.044	0.073	-0.056	-0.084*
	(0.010)	(0.020)	(0.011)	(0.018)	(0.052)	(0.083)	(0.084)	(0.056)	(0.056)	(0.065)	(0.062)	(0.047)
Medium	-0.006	-0.007	-0.008	0.000	-0.054	-0.115	0.007	-0.054	-0.040	-0.092	-0.002	-0.009
	(0.007)	(0.013)	(0.008)	(0.012)	(0.040)	(0.076)	(0.055)	(0.049)	(0.034)	(0.066)	(0.038)	(0.059)
Large	0.030***	0.013	0.023**	0.018	0.046	-0.006	0.024	0.038	0.026	-0.010	0.011	-0.000
	(0.009)	(0.018)	(0.011)	(0.017)	(0.032)	(0.035)	(0.038)	(0.053)	(0.029)	(0.033)	(0.032)	(0.060)
$Backward_{t-1}$												
Small	-0.229	0.060	-0.291	-0.349*	-1.176	-1.247	-1.354	0.338	-0.085	-0.876	-0.380	1.392
	(0.163)	(0.108)	(0.187)	(0.186)	(0.859)	(0.830)	(1.054)	(1.330)	(0.505)	(0.632)	(0.657)	(1.263)
Medium	-0.026	-0.065	0.016	-0.234***	-0.630**	-0.291	-0.643**	-0.966***	-0.583**	-0.345	-0.907***	-0.803
	(0.041)	(0.069)	(0.052)	(0.082)	(0.265)	(0.349)	(0.309)	(0.370)	(0.280)	(0.389)	(0.344)	(0.704)
Large	0.045	0.173	-0.024	0.033	-0.037	0.351**	-0.246	-0.304	-0.038	0.225	-0.239	-0.225
	(0.074)	(0.136)	(0.090)	(0.202)	(0.121)	(0.144)	(0.164)	(0.212)	(0.111)	(0.155)	(0.156)	(0.348)
$Forward_{t-1}$												
Small	-0.121*	-0.308*	-0.044	-0.165*	0.318	0.073	0.276	-0.104	0.131	0.037	0.274**	-0.078
	(0.062)	(0.178)	(0.061)	(0.089)	(0.204)	(0.254)	(0.248)	(0.322)	(0.096)	(0.158)	(0.135)	(0.213)
Medium	-0.071**	0.021	-0.101***	0.036	-0.015	-0.082	-0.073	0.058	-0.046	-0.113	-0.077	0.107
	(0.035)	(0.056)	(0.032)	(0.087)	(0.045)	(0.057)	(0.048)	(0.075)	(0.064)	(0.075)	(0.068)	(0.219)
Large	-0.088*	0.027	-0.080	-0.237**	-0.117	-0.006	-0.011	-0.084	-0.121	-0.088	-0.071	0.134
	(0.051)	(0.062)	(0.049)	(0.100)	(0.073)	(0.101)	(0.096)	(0.130)	(0.075)	(0.110)	(0.118)	(0.191)
Controls												
HHI_{t-1}	0.165	0.314	0.325**	-0.440**	0.119	0.298*	0.300	-0.511***	0.125	0.268	0.069	-0.363
	(0.132)	(0.199)	(0.140)	(0.206)	(0.129)	(0.168)	(0.193)	(0.129)	(0.140)	(0.163)	(0.193)	(0.269)
EX_{t-1}	-0.057	-0.036	-0.045	-0.121	-0.026	0.001	0.041	-0.015	-0.020	0.000	0.069	-0.163
	(0.065)	(0.094)	(0.064)	(0.115)	(0.067)	(0.088)	(0.078)	(0.104)	(0.067)	(0.079)	(0.080)	(0.141)
IM_{t-1}	0.073	0.483***	0.104	-0.094	0.076	0.298*	0.167	-0.011	0.045	0.273	0.077	-0.275
	(0.143)	(0.154)	(0.178)	(0.155)	(0.147)	(0.160)	(0.168)	(0.161)	(0.147)	(0.172)	(0.135)	(0.230)
$Sale_{t-1}$	0.030**	13.292***	3.363***	0.027**	0.031**	12.243***	6.007***	0.030**	0.031**	10.138***	2.702***	0.027**
	(0.013)	(2.224)	(0.672)	(0.012)	(0.013)	(1.904)	(1.105)	(0.013)	(0.013)	(1.725)	(0.511)	(0.012)
Mills	3.716***	3.360***	23.577***	5.517**	3.729***	3.681***	18.872***	2.262	3.727***	3.942***	37.600***	5.640**
	(0.690)	(0.594)	(3.425)	(2.166)	(0.690)	(0.618)	(5.413)	(1.596)	(0.688)	(0.657)	(6.996)	(2.176)
Constant	2.571***	2.780***	2.258***	2.736***	2.584***	2.804***	2.288***	2.699***	2.589***	2.468***	2.317***	2.775***
	(0.097)	(0.085)	(0.119)	(0.096)	(0.097)	(0.087)	(0.130)	(0.092)	(0.097)	(0.204)	(0.119)	(0.116)
Observations	46777	12076	24151	10550	46777	15986	15946	14845	46777	19360	19207	8210
R-squared	0.024	0.065	0.022	0.021	0.023	0.063	0.026	0.012	0.023	0.057	0.021	0.023

Notes: *** p<0.01, ** p<0.05, * p<0.1. Results are from fixed effect model. All samples are restricted to domestic firms. Standard errors in parentheses are clustered at industry-year level. The dependent variable is lnTFP. All regressions include industry, region, and year fixed effects.

An immediately noticeable feature of the percentile disaggregations is that the choice of cutoffs matter. Changing the definitions of small, medium and large lead, inevitably, to a different set of

results. In the first percentile disaggregation (columns 1-4) when the cutoffs (between small and medium and medium and large) are the 25th and 75th percentiles of the firm population (in terms of assets), small FIFs generate positive horizontal spillovers for medium domestic firms, negative backward spillovers for large domestic firms, and negative forward spillovers for small and large domestic firms. Medium FIFs produce negative backward spillovers for large domestic firms and negative forward spillovers for medium domestic firms. Large FIFs generate positive horizontal spillovers for medium domestic firms and negative forward spillovers for large domestic firms. When the cutoffs are at the 33rd and 66th percentiles (columns 4-8) and the 40th and 80th percentiles (columns 9-12), the findings of spillover effects are much less common (in terms of the number of significant coefficients) and these findings do not match those derived from the first disaggregation (using 25th and 75th percentiles).

However, an interesting finding from the use of discrete categories based on assets (particularly the first disaggregation) is the receipt of spillovers by large domestic firms (as defined by assets). Clearly, the groups of firms that are considered large in terms of assets (regardless of the cutoff used) are not the same as those considered large in terms of employment.

4.5.2.4. Spillovers and firm size based on sales

To define discrete categories based on firm sales, we applied the same three disaggregations as we did for assets (and as described in section 4.4.3). The fixed effects estimation results are presented in Table 4.7 (see Table A4.8 in Appendix A4 for random effect estimation results). The first disaggregation (columns 1-4), based on cutoffs at the 25th and 75th percentiles, suggests that small FIFs generate positive backward spillovers for small domestic firms and negative forward spillovers for small domestic firms. Medium domestic firms generate negative backward spillovers

for medium and large domestic firms and positive forward spillovers for medium domestic firms. Large FIFs generate positive horizontal and backward spillovers for medium domestic firms, and negative forward spillovers for small domestic firms.

Table 4.7: FDI spillovers across FIFs and domestic firm size categories (based on sales)

	Percentile of sale_1-25, 26-75, >75				Percentile of sale_1-33, 34-66, >66				Percentile of sale_1-40, 41-80, >80			
	All	Small	Medium	Large	All	Small	Medium	Large	All	Small	Medium	Large
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$Horizontal_{t-1}$												
Small	-0.173	0.195	0.116	-0.203	0.035	0.206	0.229	0.257	0.571	0.947**	0.532	0.634
	(0.230)	(0.331)	(0.184)	(0.261)	(0.377)	(0.413)	(0.242)	(0.441)	(0.408)	(0.405)	(0.365)	(0.407)
Medium	0.195	0.077	0.016	0.039	0.014	-0.196	0.042	-0.197	0.063	0.056	-0.045	-0.144
	(0.188)	(0.255)	(0.152)	(0.265)	(0.189)	(0.200)	(0.154)	(0.269)	(0.129)	(0.179)	(0.127)	(0.228)
Large	0.041	-0.017	0.079**	-0.015	0.048	0.057	0.051	-0.013	0.033	0.055	0.029	-0.010
	(0.037)	(0.038)	(0.033)	(0.045)	(0.038)	(0.042)	(0.038)	(0.047)	(0.034)	(0.039)	(0.037)	(0.059)
$Backward_{t-1}$												
Small	-0.746	6.818*	1.530	0.097	-4.099	1.640	0.162	-2.663	-3.257	0.725	-8.284**	-2.015
	(3.161)	(4.044)	(2.518)	(4.303)	(3.583)	(3.632)	(2.271)	(4.841)	(4.483)	(4.855)	(4.068)	(5.370)
Medium	-6.634***	-3.685	-5.458***	-9.884***	-1.249	-3.709	-1.057	-2.116	-2.183**	-2.469*	-2.756**	-0.144
	(1.484)	(2.370)	(1.435)	(3.013)	(2.002)	(2.444)	(1.645)	(2.551)	(0.942)	(1.321)	(1.070)	(2.277)
Large	0.689***	0.130	0.540**	1.060	-0.015	-0.201	0.128	-0.064	0.292	0.188	0.557*	-0.175
	(0.262)	(0.541)	(0.264)	(0.708)	(0.203)	(0.329)	(0.208)	(0.365)	(0.249)	(0.403)	(0.324)	(0.795)
$Forward_{t-1}$												
Small	-0.438	-2.150***	-0.461	0.202	0.644	-2.202**	0.655	2.391*	-0.249	-2.260**	0.728	1.236
	(0.351)	(0.706)	(0.302)	(0.928)	(0.818)	(0.982)	(0.656)	(1.435)	(0.958)	(1.105)	(0.910)	(1.503)
Medium	0.727	-1.045	0.705*	1.256	-1.156	-1.150	-1.021*	-1.432	0.136	0.745	-0.072	-0.097
	(0.445)	(0.796)	(0.395)	(0.990)	(0.764)	(1.013)	(0.603)	(1.066)	(0.409)	(0.515)	(0.415)	(0.818)
Large	-0.357***	-0.572***	-0.091	-0.234	-0.291**	-0.358**	-0.122	-0.282	-0.285**	-0.348**	-0.156	-0.113
	(0.115)	(0.165)	(0.106)	(0.242)	(0.135)	(0.153)	(0.097)	(0.220)	(0.119)	(0.147)	(0.126)	(0.246)
Controls												
HHI_{t-1}	0.035	0.373**	0.003	-0.384*	0.115	0.231	0.251**	0.013	0.128	0.101	-0.059	-0.327
	(0.144)	(0.162)	(0.128)	(0.219)	(0.132)	(0.160)	(0.105)	(0.226)	(0.136)	(0.195)	(0.177)	(0.230)
X_{t-1}	-0.081	-0.207**	0.030	-0.111	-0.078	-0.247**	0.047	-0.047	-0.080	-0.221**	0.046	-0.159
	(0.070)	(0.090)	(0.070)	(0.112)	(0.073)	(0.120)	(0.069)	(0.098)	(0.073)	(0.111)	(0.076)	(0.132)
I_{t-1}	0.149	0.576***	0.012	0.143	0.113	0.396**	0.059	0.101	0.129	0.253	0.102	0.045
	(0.138)	(0.203)	(0.098)	(0.159)	(0.141)	(0.191)	(0.103)	(0.172)	(0.149)	(0.183)	(0.137)	(0.149)
$Assets_{t-1}$	-0.009***	-10.75***	-0.065***	-0.008***	-0.009***	-11.53***	-0.053***	-0.009***	-0.009***	-10.67***	-0.063***	-0.008***
	(0.003)	(3.233)	(0.014)	(0.003)	(0.003)	(3.012)	(0.018)	(0.003)	(0.003)	(2.162)	(0.018)	(0.003)
Mills	5.327***	4.659***	8.158***	6.446***	5.327***	4.775***	11.273***	7.030***	5.322***	4.984***	13.780***	5.937***
	(0.483)	(0.462)	(1.553)	(2.151)	(0.484)	(0.463)	(0.679)	(2.028)	(0.483)	(0.455)	(1.233)	(2.275)
Constant	2.566***	2.620***	2.272***	2.965***	2.579***	2.686***	2.455***	2.685***	2.551***	2.607***	2.125***	2.873***
	(0.095)	(0.144)	(0.162)	(0.065)	(0.095)	(0.176)	(0.111)	(0.114)	(0.095)	(0.166)	(0.134)	(0.056)
Observations	46032	12062	24019	9951	46032	15981	15882	14169	46032	19421	18942	7669
R-squared	0.029	0.060	0.041	0.036	0.028	0.059	0.058	0.032	0.029	0.054	0.043	0.039

Notes: *** p<0.01, ** p<0.05, * p<0.1. Results are from fixed effect model. All samples are restricted to domestic firms. Standard errors in parentheses are clustered at industry-year level. The dependent variable is lnTFP. All regressions include industry, region, and year fixed effects.

Similar to the asset-based disaggregations, when the cutoffs are the 33rd and 66th percentiles (columns 5-8) and the 40th and 80th percentiles (columns 9-12) the results indicate less instances

of spillover effects and only limited overlap in the types of spillover effects indicated. Importantly, though, when large domestic firms are defined as those with sales above the 80th percentile (column 12), they are not recipients of spillover effects in much the same way that large firms defined in terms of employees (>200) are also unaffected by spillover effects. While this may indicate significant overlap between those groups, they are far from identical because the latter group is much smaller.[74]

An important factor that might explain heterogeneity in spillovers is the number of FIFs in an industry in which domestic firms are located. Björk (2005) using Chilean manufacturing data revealed that spillovers exist only in industries that exhibit low foreign presence. In addition, since we used different size variables and disaggregations, same firms might be included in different size categories (small, medium, or large) across size variables, which may explain the non-unanimous spillover results across size variables and size measures.

4.6. Conclusions

This paper investigates the importance of firm size in determining productivity and FDI spillovers employing Chilean plant-level panel data for the period 1995-2007. In this pursuit, this paper considers both the continuous and discrete size measures in terms of firm-level employment, assets, and sales. Industry- and firm-level effects on firm productivity are controlled for by including variables accounting for industry competition, export intensity, and import

[74] The number of large domestic firms is 3070 when size is measured in terms of employment. However, the number of large domestic firms is significantly higher when size is measured in terms of firm sale: 13777, 19605, and 10661 for three percentile disaggregations considered (i.e., 25&75, 33&66, and 40&80 percentile cutoffs respectively).

concentration. The estimation technique is panel data fixed-effects with correction for sample selection bias (using the Heckman two-step approach).

With respect to the continuous size measures, for domestic firms, increasing size is associated with falling productivity when measured in terms of assets, and rising productivity when measured in terms of sales or employment. Increasing size, when measured in terms of assets, increases the likelihood of negative backward spillover effects, but there is no similar result when size is measured in terms of sales or employment. For FIFs, increasing size, when measured in terms of assets and sales is associated with a moderation of the negative forward spillover effects that is associated with FIFs more broadly, but there is no such moderating effect when size is measured in terms of employment.

Turning to the discrete size measures, we have been able to establish that FIFs are generally more productive than domestic firms of comparable size (and similar characteristics) regardless of the size measure used or size disaggregation chosen. However, that differential does not necessarily increase with size and, in fact, varies across size categories with changes in the measure of size. This lack of correlation between productivity differential and size is due, at least in part, to the fact that domestic firm productivity does not necessarily increase with discrete size. When size is measured in terms of sales, large firms are the most productive; when size is measured in terms of employment, medium firms are the most productive; and when size is measured in terms of assets, small firms are the most productive.

With respect to spillover effects, and remaining with the discrete size measures, when size is measured in terms of employment, all sizes of FIFs generate spillover effects (both positive and negative), but these effects are experienced exclusively by small and medium domestic firms.

Large domestic firms are unaffected. When firms are disaggregated into discrete sizes (small, medium and large) based on assets, we find evidence of both positive and negative spillovers generated by FIFs of all size categories and experienced by domestic firms of all size categories. However, the nature and frequency of observed spillover effects do not match those found for the employment-based categorization and also vary with the percentile cutoffs used for disaggregation. When discrete size is measured in terms of sales, for two of the three disaggregation criteria, we find that all sizes of FIFs generate spillover effects that are spread across all three sizes of domestic firms. But here, again, the particular set of spillover effects observed is unique to this measure and changes radically with the percentile cutoffs used for disaggregation.

These results allow us to conclude that, at least in the case of Chile, and possibly more broadly, both the choice of size measure (assets, sales or employment) and nature of the measure (continuous or discrete) matter for the estimation of both productivity effects and spillover effects. When size is measured in continuous terms, size effect, with respect to both FIFs and domestic firms, vary with the choice of measure. Moreover, findings of spillover effect are generally weaker with the continuous size measures, in part because they fail to capture non-linearities in spillover effects. The discrete size measures indicate that neither productivity nor spillover effects are linear in relation to size. Which domestic firm category (small medium or large) is most productive depends on the measure of size being used. The nature and frequency of spillover effects also vary with the choice of size measure, and even more so with the choice of disaggregation criteria for assets and sales-based measures. Thus, our results suggest, more broadly, that discrete measures of size offer richer and more nuance sets of results. However, in the absence of any consensus in the literature on what terms like “small”, “medium” and “large” mean for assets or sales-based

measures, our results also augur against the use of assets or sales as a basis for establishing distinct size groups (because the choice of measure, the nature of the measure, and the disaggregation criteria all have an effect on the estimation results). In this study, discrete size groups based on employment have the double advantage of offering: (1) the richest and most nuanced results; and (2) the use of boundary criteria that are well established in the literature. Thus, the current preference for the discrete size measures, based on employment, finds strong support here.

Since our research is specific to Chile, we do not have a firm basis for generalization beyond that country. However, it is quite clear from this research that, though size appears to matter for both productivity and spillover effects, the variable used to determine size, the choice of measure (continuous or discrete) and the nature of disaggregation (for discrete measures) matter for the estimation of both productivity and spillover effects. Therefore, at the very least, some thought must be given to the choice of size measure in empirical investigations. We look to future research on different countries to determine how generalizable these results are.

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Appendix A4

Table A4.1: Distribution of domestic and foreign-invested firms across years

Year	Domestic firms	FIFs	FIFs as % of domestic firms	Firms with 100% foreign ownership	Firms with 100% foreign ownership as % of all FIFs
	(1)	(2)	(3)	(4)	(5)
1995	5219	283	5.42	165	58.30
1996	5555	286	5.15	140	48.95
1997	5311	312	5.87	164	52.56
1998	5127	300	5.85	160	53.33
1999	5003	293	5.86	159	54.27
2000	4852	297	6.12	163	54.88
2001	4800	279	5.81	149	53.41
2002	5099	305	5.98	170	55.74
2003	5058	304	6.01	171	56.25
2004	5257	327	6.22	181	55.35
2005	5192	315	6.07	169	53.65
2006	4940	307	6.21	178	57.98
2007	4752	278	5.85	156	56.12
Total	66165	3886	5.87	2125	54.68

Table A4.2: Distribution of firms and spillover variables across industries in 1995 and 2007

	1995				2007			
	Domestic firms	FIFs	Total	% of FIFs	Domestic firms	FIFs	Total	% of FIFs
Food products and beverages	1479	97	1576	6.15	1433	87	1520	5.72
Textiles, textile products, leather and footwear	905	24	929	2.58	527	13	540	2.41
Wood and wood products	665	21	686	3.06	534	30	564	5.32
Paper, paper products, printing and publishing	342	17	359	4.74	406	14	420	3.33
Chemicals and chemical products	261	59	320	18.44	240	51	291	17.53
Rubber and plastics products	310	23	333	6.91	316	19	335	5.67
Other non-metallic mineral products	240	8	248	3.23	268	17	285	5.96
Basic metals	92	11	103	10.68	128	22	150	14.67
Fabricated metal products	387	8	395	2.03	384	8	392	2.04
Machinery and equipment	282	6	288	2.08	302	6	308	1.95
Electrical machinery and apparatus	86	3	89	3.37	62	4	66	6.06
Motor vehicles, trailers and semi-trailers	19	3	22	13.64	28	3	31	9.68
Other transport equipment	95	2	97	2.06	77	2	79	2.53
Other manufacturing	56	1	57	1.75	47	2	49	4.08
Total	5219	283	5502	5.14	4752	278	5030	5.53

Table A4.3: First-stage selection regression results

Variables	Coefficients
Log of capital	0.3572***
	(0.0309)
Log of (capital)^2	-0.0123***
	(0.0014)
Capital per worker	-0.0000**
	(0.0000)
Value addition per worker	-0.0000**
	(0.0000)
Labor productivity	0.0000*
	(0.0000)
Constant	0.3261*
	(0.1913)
Observations	65807
Pseudo R^2	0.0552

Note: *** p<.01, ** p<.05, * p<.1. Standard errors are in parentheses.

Table A4.4: Results of Hausman test for selection between random effect and fixed effect specifications in Tables 4.2, 4.5, 4.6, and 4.7 results

(a) Table 4.2

Model	χ^2-test	Probability
Assets	622.112	0.000
Sales	207.0716	0.000
Employment	307.4657	0.000

(b) Table 4.5

	χ^2-test	Probability
All	151.461	0.000
Small	166.079	0.000
Medium	68.518	0.000
Large	48.910	0.000

(c) Table 4.6

	1-25, 26-75, >75		1-33, 34-66, >66		1-40, 41-80, >80	
	χ^2-test	Probability	χ^2-test	Probability	χ^2-test	Probability
All	142.40	0.000	135.06	0.000	147.46	0.000
Small	76.78	0.000	87.88	0.000	126.04	0.000
Medium	105.42	0.000	72.67	0.001	64.59	0.006
Large	97.13	0.000	72.45	0.001	114.61	0.000

(d) Table 4.7

	1-25, 26-75, >75		1-33, 34-66, >66		1-40, 41-80, >80	
	χ^2-test	Probability	χ^2-test	Probability	χ^2-test	Probability
All	226.42	0.000	238.91	0.000	215.89	0.000
Small	108.97	0.000	68.73	0.006	75.97	0.001
Medium	132.44	0.000	120.97	0.000	112.66	0.000
Large	151.31	0.000	172.41	0.000	205.79	0.000

Note: '***' denotes significance at the 1% level. The underlying null hypothesis for χ^2 test is "difference in coefficients from random effect and fixed effect is not systematic".

In Table A4.4, the values of χ^2 statistic are significant at the 1% level for models characterizing all, small, medium, and large firms in all Tables results. These results imply that for all regression models, the fixed effect model is selected.

Table A4.5: Random effect results of Table 4.2

	Assets	Sales	Employment
	(1)	(2)	(3)
$Horizontal_{t-1}$	0.070	0.118	0.023
	(0.082)	(0.093)	(0.102)
$Backward_{t-1}$	-0.105	0.090	-0.181
	(0.290)	(0.255)	(0.280)
$Forward_{t-1}$	-1.203**	-1.377***	-0.898*
	(0.519)	(0.530)	(0.481)
HHI_{t-1}	0.135	0.154	0.140
	(0.121)	(0.106)	(0.118)
EX_{t-1}	-0.089	-0.055	-0.059
	(0.076)	(0.079)	(0.072)
IM_{t-1}	0.164	0.092	0.108
	(0.151)	(0.149)	(0.153)
Mills	4.848***	4.287***	3.931***
	(0.589)	(0.809)	(0.764)
$Size_{t-1}$	-0.009**	0.127***	0.065***
	(0.004)	(0.008)	(0.008)
$(Size*Hor)_{t-1}$	0.027	0.015	-0.021
	(0.020)	(0.025)	(0.031)
$(Size*Back)_{t-1}$	-0.282***	-0.176	-0.267**
	(0.067)	(0.115)	(0.105)
$(Size*For)_{t-1}$	-0.078*	-0.020	0.015
	(0.046)	(0.085)	(0.073)
SFF^{H}_{jt-1}	-0.001	-0.008	0.038
	(0.007)	(0.010)	(0.026)
SFF^{B}_{jt-1}	0.033*	0.065**	0.058*
	(0.020)	(0.027)	(0.034)
SFF^{F}_{jt-1}	0.012	-0.033	-0.024
	(0.033)	(0.046)	(0.060)
$(SFF^{H} * Hor)_{t-1}$	-0.005	-0.014	-0.012
	(0.021)	(0.019)	(0.040)
$(SFF^{B} * Back)_{t-1}$	-0.319	-0.753	-0.081
	(0.455)	(0.560)	(0.939)
$(SFF^{F} * For)_{t-1}$	0.645**	0.760**	0.779
	(0.312)	(0.366)	(0.593)
Constant	2.493***	2.503***	2.503***
	(0.063)	(0.062)	(0.060)
Observations	46054	46800	46661
R-squared	0.031	0.044	0.023

Note: *** p<0.01, ** p<0.05, * p<0.1. Size indicates firms' asset/(median of asset in industry-year) in column 1, sale/(median of sales in industry-year) in column 2, and employee/(median of employee in industry-year) in column 3. Results are from random effect model. All samples are restricted to domestic firms. Standard errors in parentheses are clustered at industry-year level. The dependent variable is lnTFP. All regressions include industry, region, and year fixed effects.

Table A4.6: Random effect results of Table 4.5

	Domestic Firms			
	All	Small	Medium	Large
	(1)	(2)	(3)	(4)
$Horizontal_{t-1}$				
Small	-0.008	-0.038	0.057	0.321
	(0.066)	(0.074)	(0.099)	(0.215)
Medium	-0.039	0.019	-0.174**	-0.167
	(0.044)	(0.048)	(0.070)	(0.145)
Large	0.054**	0.065**	-0.029	0.157
	(0.023)	(0.026)	(0.034)	(0.100)
$Backward_{t-1}$				
Small	-0.873	-0.678	-0.809	-2.429
	(0.617)	(0.668)	(0.862)	(2.181)
Medium	-0.650	-0.654	-0.474	0.114
	(0.407)	(0.422)	(0.576)	(1.811)
Large	0.561**	0.628***	0.342	-0.240
	(0.228)	(0.242)	(0.334)	(1.220)
$Forward_{t-1}$				
Small	0.487**	0.250	0.515	1.693
	(0.244)	(0.257)	(0.358)	(1.042)
Medium	-0.146	-0.047	-0.194	0.157
	(0.130)	(0.132)	(0.215)	(0.826)
Large	-0.194***	-0.215***	0.054	0.149
	(0.075)	(0.075)	(0.105)	(0.294)
Controls				
HHI_{t-1}	0.154*	0.212*	0.175	-0.744*
	(0.090)	(0.116)	(0.148)	(0.441)
EX_{t-1}	-0.043	-0.065	-0.157	-0.167
	(0.071)	(0.064)	(0.127)	(0.188)
IM_{t-1}	0.078	0.222	-0.169*	-0.203
	(0.129)	(0.183)	(0.102)	(0.277)
$Sale_{t-1}$	0.054***	0.100	0.148	0.027**
	(0.020)	(0.072)	(0.098)	(0.013)
Mills	3.727***	3.825***	11.629***	-4.627
	(0.725)	(0.797)	(2.506)	(3.320)
Constant	2.504***	2.417***	2.754***	3.096***
	(0.061)	(0.068)	(0.108)	(0.179)
Observations	46800	34029	10423	2348
R-squared	0.028	0.040	0.026	0.060

Notes: *** p<0.01, ** p<0.05, * p<0.1. Results are from random effect model. All samples are restricted to domestic firms. Standard errors in parentheses are clustered at industry-year level. The dependent variable is lnTFP. All regressions include industry, region, and year fixed effects.

Table A4.7: Random effect results of Table 4.6

	Percentile of asset_1-25, 26-75, >75				Percentile of asset_1-33, 34-66, >66				Percentile of asset_1-40, 41-80, >80			
	All	Small	Medium	Large	All	Small	Medium	Large	All	Small	Medium	Large
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$Horizontal_{t-1}$												
Small	0.027**	0.014	0.033***	0.011	0.138**	-0.010	0.101	0.171***	-0.038	0.069	-0.058	-0.072
	(0.011)	(0.021)	(0.012)	(0.021)	(0.055)	(0.084)	(0.096)	(0.051)	(0.061)	(0.060)	(0.074)	(0.072)
Medium	-0.005	-0.005	-0.007	-0.000	-0.050	-0.116	0.010	-0.045	-0.040	-0.087	0.016	-0.019
	(0.008)	(0.013)	(0.008)	(0.014)	(0.044)	(0.073)	(0.057)	(0.057)	(0.034)	(0.070)	(0.039)	(0.073)
Large	0.031***	0.021	0.020*	0.020	0.046	0.008	0.036	0.023	0.028	0.001	0.010	-0.014
	(0.010)	(0.021)	(0.011)	(0.019)	(0.036)	(0.044)	(0.041)	(0.069)	(0.033)	(0.043)	(0.034)	(0.077)
$Backward_{t-1}$												
Small	-0.234	0.038	-0.334	-0.329	-1.333	-1.385	-1.364	-0.057	-0.137	-0.912	-0.144	1.134
	(0.179)	(0.134)	(0.209)	(0.223)	(0.929)	(0.929)	(1.142)	(1.380)	(0.574)	(0.719)	(0.769)	(1.333)
Medium	-0.013	-0.057	0.010	-0.204**	-0.608**	-0.435	-0.700**	-0.965**	-0.522*	-0.416	-0.909***	-0.884
	(0.042)	(0.079)	(0.057)	(0.088)	(0.300)	(0.446)	(0.339)	(0.406)	(0.313)	(0.483)	(0.344)	(0.692)
Large	0.042	0.195	-0.005	0.010	-0.022	0.429**	-0.279	-0.273	-0.039	0.297	-0.254*	-0.250
	(0.075)	(0.140)	(0.096)	(0.199)	(0.132)	(0.168)	(0.189)	(0.224)	(0.122)	(0.182)	(0.151)	(0.348)
$Forward_{t-1}$												
Small	-0.111*	-0.226	-0.028	-0.196**	0.361*	0.202	0.353	-0.041	0.142	0.090	0.239*	-0.060
	(0.063)	(0.174)	(0.061)	(0.090)	(0.217)	(0.319)	(0.243)	(0.330)	(0.108)	(0.180)	(0.138)	(0.222)
Medium	-0.075**	0.019	-0.114***	0.012	-0.013	-0.054	-0.049	0.042	-0.047	-0.082	-0.072	0.071
	(0.036)	(0.059)	(0.033)	(0.090)	(0.046)	(0.066)	(0.054)	(0.078)	(0.066)	(0.082)	(0.070)	(0.257)
Large	-0.092*	0.040	-0.069	-0.259**	-0.128	-0.094	-0.033	-0.074	-0.131	-0.169	-0.075	0.110
	(0.049)	(0.062)	(0.055)	(0.107)	(0.078)	(0.103)	(0.106)	(0.144)	(0.082)	(0.110)	(0.119)	(0.206)
Controls												
HHI_{t-1}	0.129	0.228	0.201*	-0.310	0.077	0.214	0.114	-0.350**	0.089	0.178	0.046	-0.219
	(0.103)	(0.161)	(0.108)	(0.216)	(0.104)	(0.137)	(0.136)	(0.144)	(0.112)	(0.135)	(0.164)	(0.278)
EX_{t-1}	-0.049	-0.028	-0.069	-0.090	-0.015	-0.007	0.030	0.004	-0.009	-0.020	0.042	-0.100
	(0.071)	(0.097)	(0.061)	(0.161)	(0.073)	(0.084)	(0.073)	(0.135)	(0.074)	(0.081)	(0.072)	(0.214)
IM_{t-1}	0.080	0.435***	0.122	-0.074	0.086	0.251*	0.140	0.011	0.060	0.253	0.101	-0.230
	(0.143)	(0.154)	(0.173)	(0.173)	(0.149)	(0.143)	(0.169)	(0.190)	(0.148)	(0.166)	(0.139)	(0.269)
$Sale_{t-1}$	0.054***	2.464***	1.252***	0.041**	0.054***	2.826***	3.937***	0.047***	0.054***	3.084***	1.275***	0.040**
	(0.020)	(0.623)	(0.313)	(0.016)	(0.020)	(0.791)	(0.999)	(0.018)	(0.020)	(0.874)	(0.297)	(0.016)
Mills	3.711***	3.344***	17.477***	3.527	3.724***	3.641***	14.092**	2.203	3.721***	3.886***	32.244***	3.594
	(0.726)	(0.649)	(3.405)	(2.294)	(0.726)	(0.668)	(5.957)	(1.928)	(0.724)	(0.704)	(6.274)	(2.292)
Constant	2.493***	2.347***	2.385***	2.770***	2.492***	2.410***	2.341***	2.672***	2.497***	2.393***	2.301***	2.832***
	(0.059)	(0.089)	(0.063)	(0.141)	(0.059)	(0.082)	(0.074)	(0.101)	(0.059)	(0.079)	(0.070)	(0.156)
Obs	46777	12076	24151	10550	46777	15986	15946	14845	46777	19360	19207	8210
R-squared	0.022	0.057	0.012	0.019	0.022	0.055	0.010	0.011	0.022	0.050	0.011	0.020

Notes: *** p<0.01, ** p<0.05, * p<0.1. Results are from random effect model. All samples are restricted to domestic firms. Standard errors in parentheses are clustered at industry-year level. The dependent variable is lnTFP. All regressions include industry, region, and year fixed effects.

Table A4.8: Random effect results of Table 4.7

	Percentile of sale_1-25, 26-75, >75				Percentile of sale_1-33, 34-66, >66				Percentile of sale_1-40, 41-80, >80			
	All	Small	Medium	Large	All	Small	Medium	Large	All	Small	Medium	Large
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$Horizontal_{t-1}$												
Small	-0.161	0.255	0.093	-0.245	0.067	0.207	0.191	0.255	0.600	0.909**	0.475	0.725
	(0.265)	(0.329)	(0.182)	(0.347)	(0.410)	(0.408)	(0.254)	(0.497)	(0.429)	(0.407)	(0.372)	(0.463)
Medium	0.186	0.049	0.008	0.001	0.018	-0.202	0.030	-0.217	0.071	0.015	-0.072	-0.012
	(0.194)	(0.256)	(0.166)	(0.330)	(0.203)	(0.206)	(0.158)	(0.302)	(0.130)	(0.164)	(0.133)	(0.294)
Large	0.047	0.003	0.063*	-0.022	0.056	0.077*	0.031	-0.010	0.039	0.064	0.009	-0.014
	(0.041)	(0.043)	(0.034)	(0.048)	(0.043)	(0.046)	(0.037)	(0.048)	(0.038)	(0.041)	(0.036)	(0.062)
$Backward_{t-1}$												
Small	-1.096	6.878	1.417	-1.260	-4.427	1.325	-1.573	-3.552	-3.643	0.658	-9.100*	-1.897
	(3.284)	(4.443)	(2.514)	(5.244)	(3.866)	(4.078)	(3.460)	(5.245)	(4.816)	(4.866)	(4.673)	(6.576)
	-6.634***	-3.825	-5.145***	-	-1.145	-2.545	0.096	-3.239	-2.144**	-2.319*	-2.782**	-0.458
Medium				10.211***								
	(1.446)	(2.539)	(1.602)	(3.430)	(2.253)	(2.665)	(2.185)	(2.789)	(0.995)	(1.323)	(1.167)	(2.264)
Large	0.739***	0.240	0.546*	1.115	0.019	-0.124	0.057	0.026	0.319	0.230	0.590*	-0.139
	(0.268)	(0.584)	(0.301)	(0.750)	(0.221)	(0.335)	(0.226)	(0.388)	(0.254)	(0.389)	(0.337)	(0.761)
$Forward_{t-1}$												
Small	-0.437	-2.142***	-0.462	0.220	0.653	-2.448**	0.840	2.492	-0.233	-2.245*	0.863	1.291
	(0.410)	(0.770)	(0.290)	(1.106)	(0.903)	(1.183)	(0.765)	(1.541)	(1.052)	(1.148)	(0.915)	(2.061)
Medium	0.640	-0.299	0.536	0.856	-1.183	-0.701	-1.373**	-1.501	0.106	0.913*	-0.104	-0.471
	(0.452)	(0.747)	(0.419)	(1.127)	(0.783)	(0.997)	(0.695)	(1.174)	(0.452)	(0.533)	(0.470)	(0.885)
Large	-0.359***	-0.442**	-0.083	-0.281	-0.315**	-0.265	-0.160	-0.374	-0.291**	-0.303**	-0.141	-0.310
	(0.116)	(0.174)	(0.104)	(0.277)	(0.135)	(0.166)	(0.121)	(0.238)	(0.118)	(0.153)	(0.122)	(0.277)
Controls												
HHI_{t-1}	-0.000	0.388**	-0.042	-0.378*	0.080	0.227	0.127	0.029	0.096	0.144	-0.079	-0.161
	(0.120)	(0.188)	(0.118)	(0.230)	(0.111)	(0.185)	(0.088)	(0.236)	(0.112)	(0.169)	(0.141)	(0.245)
EX_{t-1}	-0.071	-0.232**	0.027	-0.092	-0.072	-0.262**	0.065	-0.055	-0.071	-0.227**	0.041	-0.145
	(0.080)	(0.092)	(0.078)	(0.155)	(0.083)	(0.112)	(0.080)	(0.119)	(0.085)	(0.101)	(0.080)	(0.189)
IM_{t-1}	0.169	0.577***	0.042	0.183	0.135	0.366**	0.049	0.149	0.148	0.227	0.096	0.079
	(0.143)	(0.186)	(0.108)	(0.174)	(0.143)	(0.159)	(0.104)	(0.186)	(0.152)	(0.150)	(0.153)	(0.178)
$Asset_{t-1}$	-0.006**	-3.710	-0.082***	-0.007***	-0.006**	-6.199	-0.072***	-0.007**	-0.006**	-5.771	-0.083***	-0.007***
	(0.003)	(5.539)	(0.021)	(0.003)	(0.003)	(5.996)	(0.017)	(0.003)	(0.003)	(4.712)	(0.024)	(0.003)
Mills	5.291***	4.969***	8.450***	7.086***	5.292***	4.954***	12.144***	7.924***	5.288***	5.134***	14.599***	6.502***
	(0.565)	(0.479)	(2.197)	(2.190)	(0.567)	(0.567)	(0.851)	(2.028)	(0.566)	(0.553)	(1.315)	(2.242)
Constant	2.490***	2.198***	2.554***	2.935***	2.500***	2.278***	2.507***	2.762***	2.478***	2.266***	2.548***	3.059***
	(0.062)	(0.084)	(0.057)	(0.116)	(0.063)	(0.089)	(0.059)	(0.088)	(0.064)	(0.084)	(0.052)	(0.142)
Obs	46032	12062	24019	9951	46032	15981	15882	14169	46032	19421	18942	7669
R-squared	0.028	0.060	0.041	0.036	0.027	0.057	0.058	0.032	0.029	0.054	0.043	0.037

Notes: *** p<0.01, ** p<0.05, * p<0.1. Results are from random effect model. All samples are restricted to domestic firms. Standard errors in parentheses are clustered at industry-year level. The dependent variable is lnTFP. All regressions include industry, region, and year fixed effects.

Chapter 5

Conclusion

This dissertation examines multilevel determinants of inward foreign direct investment (FDI) and firm-level attributes that explain the productivity spillovers from foreign-invested firms (FIFs) to domestic firms. The determination of the factors affecting cross-border investment decisions by multinational enterprises (MNEs) remains a vibrant, and still expanding, part of the empirical literature related to FDI. Within that literature, the level of inward FDI has been found to depend on both firm-level and country-level factors in host countries. However, in the current context, where global and regional supply chains make up a critical part of the structure of global production, regional factors are likely to matter as well. Regional factors (at the multi-country level), such as intra-regional trade, by affecting the movement of factors of production, and governance quality, by signaling a better investment climate, may also affect the flow of cross-border investment. Considering these facts, the empirical first essay (second chapter) answers two questions: first, what regional factors, along with firm- and country-level characteristics, significantly affect the presence of foreign equity participation; and second, do FDI determinants vary across global regions. In this pursuit, a dataset consisting of 197 surveys from 134 countries (i.e., for some countries, two surveys are used but excluding the repeated firms from the second survey using the panel ID) is utilized in a multilevel logit framework, and countries are clustered into eight distinct global regions. Results provide evidence in favor of the multilevel modelling

framework (as reflected by the non-negligible values of intra-class correlation coefficient (ICC) and the significant values of LR chi-square test in all specifications).

Among the firm-level determinants, challenges related to communication and the finance infrastructure were found to discourage the presence of foreign equity participation, while those related to physical infrastructure encouraged it (both in the aggregate data model and across regions). Infrastructural constraints more broadly defined (an index of communication, financial and physical infrastructure) was found to be detrimental to foreign equity participation. Overall results (those in the aggregated data model) showed that institutional constraints had negative impacts, administrative constraints had positive impacts, and those related to factor inputs had no impacts on foreign equity participation. The average wage was found to exert an overall positive effect, which alternatively might suggest that FIFs pay higher wages or that FDI is attracted to higher-wage firms. Across regions, these results were mostly reinforced but did deviate occasionally for specific variables and specific regions.

As for country-level variables, capital account openness, per capita GDP, inflation, and rate of taxation of profits were negatively related to the incidence of foreign ownership, while total trade relative to GDP and the country's governance score relative to the regional average positively affected the presence of foreign equity participation in the aggregate data model. However, some variables that did not have an overall impact were found to be important in some regions and vice-versa. Moreover, some of them had asymmetric effects across regions (i.e., they had positive and significant coefficients for some regions and negative and significant coefficients for some others). In short, though there was significant commonality in the effect of firm-level and country-level factors on the incidence of foreign equity participation there was, nevertheless, some evidence of regional idiosyncrasy.

The regional variables (intra-regional trade relative to regional GDP and the regional average governance quality) had an overall positive impact on foreign equity participation with asymmetric effects across regions. Overall, firm-level variables appeared to be more stable than country- and regional-level variables across regions, in terms of the sign and significance of their coefficients. Nevertheless, (as suggested by the non-negligible values of the ICC at the regional level) if regional-level variables are not taken into account, the analysis of determinants of the frequency of foreign equity participation would be incomplete in failing to consider the regional dimension and, with that, its potential implication for national and regional policies.

The second empirical essay (Chapter 3) answers two questions using multi-sector data from Brazilian manufacturing firms for the years 2003 and 2009. First, whether there is any evidence of FDI-induced horizontal and vertical (forward and backward) productivity spillovers in Brazil. Second, what attributes of FIFs (degree of foreign ownership, export orientation, and import dependence) and domestic firms (size, productivity level, and investment in employee training) might be important in terms of the facilitation or inhibition of spillover effects? The fixed effect panel data estimation method was employed, and sample selection bias was corrected by utilizing Heckman two-step approach.

Employing the full data set, with no differentiation by firm attributes, the results suggested that FIFs, as a group, were more productive than domestic firms and generated positive horizontal and backward spillover effects but no forward spillovers. After disaggregation, FIFs that were majority-foreign-owned, high export-concentrated or high import-concentrated were found to be significantly more likely to generate horizontal spillovers. Backward spillovers were similarly associated with majority-owned, high-exporting, and both low-importing and high-importing FIFs (suggesting that the import profile is broadly neutral with respect to backward spillovers—an

important result given that backward spillovers are generated by backward linkages). Given the absence of any evidence of forward spillovers in the undisaggregated data, the evidence of forward spillovers generated by low-importing FIFs (along with low-exporting FIFs) is an unexpected result, especially since there is no obvious (or theoretically articulated) relationship between low-importing profiles and forward linkages. Further, low-import profile was not found to be highly correlated with low-export orientation—the attribute most logically connected to forward linkages with domestic firms. Minority-foreign-owned firms were not found to be associated with the generation of any of spillover effects, which is not an unexpected outcome given the fact that these firms had been shown to be no more productive, on average, than domestic firms.

As for domestic firms, the analysis revealed that size (in terms of employees) is not an important determinant of spillover receipt of any kind. Domestic firms regardless of size and the level of investment in worker training received horizontal spillovers but the most productive firms were not found to receive them. Backward spillover effects were significantly enhanced by the level of investment in worker training but were unaffected by size or the productivity levels of domestic firms. Forward spillover effects were found to have been acquired only by domestic firms with higher productivity levels. The effect of improvements in absorptive capacity, defined in terms of improvement in productivity and human capital investment, can thus be described as nuanced in the Brazilian context. Increased productivity improved the capacity for absorbing forward spillovers but reduced the likelihood of horizontal spillovers. Investment in worker training by domestic firms was necessary for the absorption of backward spillover effects but did not change the potential for receiving horizontal or forward spillover effects.

The third empirical essay (fourth chapter) investigates whether measures of firm size matter for the occurrence of FDI-related productivity spillovers. In pursuit of this question, this essay

considers both the continuous and discrete size measures based on firm-level employment, assets, and sales. A firm-level panel dataset from the Chilean manufacturing sectors for the period of 1995-2007 is employed. Heckman two-step approach is utilized to correct for the sample selection bias, and firm- and industry-level effects on firm productivity are controlled for by including appropriate variables and utilizing a panel data fixed-effects model.

For the continuous size measures, size and the productivity of domestic firms are found to be inversely related when size is measured in terms of assets and positively related when measured in terms of sales or employment. With respect to spillover effects, the increasing size of domestic firms, in terms of assets, increases the likelihood of negative backward spillover effects, but there is no similar result when size is measured in terms of sales or employment. The increasing size of FIFs, when measured in terms of assets and sales, is associated with a moderation of negative forward spillover effects, but there is no such moderating effect when size is measured in terms of employment.

For the discrete size measures, when addressing domestic firms' productivity levels across size groups, the results for the continuous size measures are largely reproduced. In particular, the largest firms are the most productive when size is measured in terms of sales or employment, but the smallest are most productive when size is measured in terms of assets. FIFs are found to be generally more productive than similar domestic counterparts regardless of the size variable used or the size disaggregation chosen. The productivity differential profile (between FIFs and domestic firms) is similar across measures with the exception that it is medium FIFs that have the greatest productivity advantage when size is measured in terms of employment. With respect to spillover effects, when size is measured in terms of employment, all sizes of FIFs are found to generate spillover effects (both positive and negative), but only small and medium domestic firms receive

those spillover effects. The size disaggregation (small, medium and large) based on assets yield both positive and negative spillovers by FIFs of all size categories and receipt by domestic firms of all size categories. However, the nature and the frequency of observed spillover effects vary with the percentile cutoffs used for disaggregation and also do not match those found for the employment-based categorization. When size is measured in terms of sales, we again find that FIFs of all sizes generate spillover effects that are, in turn, received by all three sizes of domestic firms but, again, with a unique combination of spillover effects that changes radically with the chosen disaggregation criteria.

We can therefore conclude, based on these results, that both the choice of size-determining variable (assets, sales or employment) and the nature of the measure (continuous or discrete) matter, at least in the case of Chile, for the estimation of both the productivity effects and spillover effects. Moreover, findings of spillover effects are generally weaker with the continuous size measures because they fail to capture non-linearities in the effect of size on spillover effects. The results for the discrete size measures indicate that neither productivity nor spillover effects are linear in relation to size. Which domestic firm category (small, medium or large) is most productive depends on the choice of size variables being used. The nature, extent, and frequency of spillover effects also vary with the choice of size variable and the choice of continuous or discrete measures and, in the case of asset- and sales-based measures, the choice of disaggregation criteria as well.

Overall, the discrete size measures offer richer and more nuanced sets of spillover results compared to the continuous size measures. However, in the absence of any consensus in the literature on what terms like “small”, “medium” and “large” mean for assets or sales-based measures, our results also augur against the use of assets or sales as a basis for measuring distinct size groups. Employment-based the discrete size measures have the double advantage of offering the richest

and most nuanced results and the legitimacy that comes from generally agreed boundary criteria and decades of use in the academic and policy literature. Nonetheless, since this research is specific to a single country we must leave it to future research, conducted across different countries, to determine how generalizable these results are.

Previous research on FDI determinants has only taken into account firm characteristics and country-level factors in the analysis. The first essay expands the literature by highlighting the importance of regional dimensions and comparing FDI determinants across global regions for the first time. Results provide evidence of the non-negligible significance of regional factors in explaining the presence of foreign equity participation and significant dissimilarities among all levels of determinants across global regions. The implication is that FDI determinants cannot be generalized across global regions, rather, some caution should be exercised in attempting to generalize factors that affect foreign equity participation in a particular country or region.

This dissertation, in the second essay, enriches the FDI spillover literature by providing evidence of horizontal and vertical productivity spillovers from Brazil—a country which had not been studied extensively in terms of spillovers to this point—particularly in relation to different firm attributes (both foreign-invested and domestic). The results confirm the importance of both foreign-invested and domestic firm attributes in determining the magnitude of FDI-related productivity spillovers. However, both the nature and extent of the effects of firm attributes on spillovers are likely to vary across countries so we must leave it to future work, in the same vein and for different countries, to reveal the degree to which this is the case.

The third essay, for the first time, compares the results from employing two different measures of firm size (continuous and discrete) and three different variables (assets, sales, and employment) in

explaining productivity spillovers. The results revealed that type of size measure and the size variable used were important in determining the sign and magnitude of productivity spillovers from FIFs to domestic firms. This suggests that researchers should be careful in choosing measures of firm size in the analysis of FDI spillovers and in the interpretation and generalization of results.

The first essay (second chapter) uses Enterprise Survey data that incorporates firms from only developing countries and newly developed countries. Hence, this essay can be considered to be focused on the developing country experience in terms of the questions asked. Although some studies have already examined firm-level and country-level factors of FDI determinants in developed country contexts, it is also worth investigating whether the factors affecting the presence of foreign equity participation differs across developed regions as well. The second essay uses Brazilian firm-level data from Enterprise Surveys that is restricted to the manufacturing sector only. Hence, our results cannot be generalized to service, mining, forestry and fishing sectors without further study. In addition, many questions still remain unanswered as we have just scratched the surface with respect to the intricacies of the transmission mechanisms of spillover effects and how firm attributes fit into that picture, both in Brazilian context and beyond. Since, the third essay uses plant-level data from the Chilean manufacturing sectors, results from this essay cannot be extrapolated to other country contexts at this point. Further research on the size measure and its relation to productivity spillovers using data from several countries will be necessary in order to determine how generalizable our results are.