FDI and Localized Productivity Spillovers: Evidence from Developing and Transitional Countries[1]

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Abstract: This paper examines localized productivity spillovers from foreign multinational plants to domestic plants using detailed plant-level panel data from fifty-eight developing and transitional economies. The paper assesses the degree of productivity spillover at the city level and explores two potential channels, namely, intermediate input sharing and labor mobility, through which localized spillovers are realized. The paper constructs two new measures to capture, respectively, the likelihood of intermediate input sharing and the proximity of labor skill between foreign multinational and domestic plants. The analysis finds that foreign multinationals generate both competition and productivity spillovers effects on domestic plants. Specifically, results from fixed effect and instrumental variable estimations show that (i) local foreign presence alone is not a significant cause of spillovers; (ii) greater opportunities of sharing common local intermediate input suppliers with foreign multinationals increase domestic productivity; (iii) greater proximity in labor skill between foreign multinationals and domestic plants also leads to higher domestic productivity. However, productivity spillovers through intermediate input sharing are found to be conditional on domestic plants' own expenditure on local intermediate inputs. Moreover, labor skill proximity between foreign plants and domestic plants generates domestic productivity spillovers when there is a greater local presence of foreign multinational employees. In the absence of these conditions, negative foreign competition effects are found to outweigh productivity gains in domestic plants.

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Keywords: foreign direct investment, multinational corporations, horizontal spillovers, spillover channels, technology diffusion, knowledge transfers, local input suppliers, labor mobility

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1 Introduction

This paper offers evidence of horizontal and localized productivity spillovers from foreign multinational affiliates to domestic plants in developing and transitional economies for which conclusive evidence is lacking. Foreign direct investment (FDI) by multinational corporations has emerged as a leading source of cross-border capital flows in the last few decades. However, feasible gains from FDI continues to be an ardent topic of policy debate with a growing number of developing countries racing to draw international capital by liberalizing national policies and extending attractive policy incentives to foreign investors. Theory suggests that, increased competition from foreign multinationals can boost domestic productivity by efficiently reallocating resources to more productive firms, and increasing profitability of new and innovative investments by domestic enterprises. Potential gains from foreign multinational entry are also attributed to productivity inducing spillovers of advanced technology and knowledge. Foreign multinationals are characterized as owners of advanced technological and knowledge assets, at least part of which is expected to "spill over" to the local economy through non-market exchanges, and for which foreign firms cannot collect rent. Such information externalities may result from demonstration and imitation of foreign technology, as well as supply and distribution linkages, sharing of common intermediate input suppliers, and interaction and mobility of labor between foreign multinationals and domestic firms (Javorcik, 2004; Kee, 2014, Poole, 2013).

However, if foreign firms with lower marginal costs draw demand away from local firms and cause them to scale down production, then a large enough reduction in output could result in a net decline in domestic productivity (Aitken and Harrison, 1999). Furthermore, foreign competition in factor markets, that diverts capital, intermediate inputs, and labor from domestic firms to foreign multinationals, can lower indigenous firm productivity, or in the extreme case, lead to their complete exit from the market (Alfaro and Chen, 2013). There are also caveats to free flow of knowledge when foreign multinationals have strong incentives to prevent information flows to competing domestic firms, especially in less-developed countries with little or no implementation of intellectual property laws.

In this paper, I contribute to the existing empirical literature examining host country gains from foreign multinational production by providing evidence of localized intra-industry productivity spillovers as well as adverse foreign competition in factor markets. Furthermore, I highlight factor market conditions under which positive FDI spillovers can be observed. I assess the degree of productivity spillover at the city level and explore two potential channels, namely, intermediate input sharing and labor mobility, through which localized spillovers are realized. These relatively unexplored channels of spillovers are particularly important when there are opportunities of knowledge transfers through vertical linkages in common intermediate input markets or through labor interaction and movements between plants. Using detailed establishment level panel data from fifty-eight developing and transitional economies, I construct two new measures to capture, respectively, opportunities of intermediate input sharing, and opportunities of labor interaction and mobility between foreign multinationals and domestic plants.

To quantify domestic plants' opportunities of sharing common intermediate input suppliers with foreign multinationals, I first construct a new measure of *input-sharing proximity*, which captures presence foreign multinationals that source local intermediate inputs and are geographically clustered with domestic competitors. Second, I account for the own-plant share of local intermediate input expenditure of domestic plants as a key determinant of local supplier sharing opportunities with foreign competitors. By capturing foreign buyer presence in local input markets, the quantification of local intermediate input sharing opportunities also accounts for foreign factor market competition. More specifically, the estimated parameter on *input-sharing proximity* captures the net effect of foreign competition and knowledge spillovers from foreign multinationals to domestic plants. Subsequently I investigate whether greater opportunities of sharing common intermediate input suppliers lead to total factor productivity (TFP) gains within domestic plants. If foreign multinationals' demand for local intermediate inputs leads to improved quality, availability, and variety of local intermediate inputs, then access to better intermediate goods can positively impact productivity of competing domestic firms. Furthermore, common intermediate input suppliers can transmit advanced knowledge from foreign buyers to domestic clients which can ultimately lead to higher productivity among the latter (Rodriguez-Clare, 1996; Kee, 2011).

Next, I build a measure to capture opportunities of labor interaction and movement between foreign subsidiaries and domestic plants. I start by constructing the variable *labor-skill proximity*, which captures the degree of closeness in skill intensity of geographically clustered (at the city level) foreign and domestic competitors. Next, I interact *labor-skill proximity* with foreign multinational employee presence at the city level to quantify opportunities of labor interaction and movement between foreign multinationals and domestic plants. The measure of labor interaction and movement opportunities also accounts for foreign competition in the labor market for similar labor inputs, and therefore captures the net effect of competition and knowledge spillovers. Subsequently, I test whether greater opportunities of labor interaction and movement impacts domestic plant TFP.

Studies also show that, in general, foreign firms undertake more on-the-job training than domestic counterparts (Aitken and Harrison, 1999). Subsequently, domestic firms can benefit from spillovers of advanced technical and organizational knowledge through social interactions, networking opportunities, and labor movements between foreign multinationals and domestic plants (Gorg and Strobl, 2005; Poole, 2011). By considering geographical proximity of domestic plants with foreign multinationals I capture learning opportunities closer to local plants' operating boundaries. Moreover, accounting for *labor-skill proximity* captures how closely the type of knowledge transmitted by multinationals matches the existing knowledge base of the receiving domestic plant.

Empirical results of this analysis indicate that, (i) industry foreign presence of foreign plants in greater *numbers* leads to domestic productivity gains, especially in small and medium size enterprises; (ii) geographic proximity to foreign multinationals alone, is not a significant cause of spillovers; (iii) greater opportunities of sharing common local intermediate input suppliers with foreign multinationals increase domestic productivity; and (iv) greater opportunities of labor interaction and mobility between foreign multinationals and indigenous plants also leads to domestic productivity gains. The most interesting aspect of these results is that productivity spillovers through *input-sharing proximity* and *labor-skill proximity* are found to be conditional on sufficient degrees of interaction between foreign subsidiaries and domestic plants within local factor markets. Specifically, I find that *input-sharing proximity* between foreign and domestic plants leads to higher domestic plant productivity when both foreign multinationals and domestic plants source a sufficient degree of intermediate inputs locally. I also find that *labor-skill proximity* between foreign multinationals and domestic plants results in productivity spillovers when there is a greater localized presence of foreign multinational employees. In the absence of these conditions however, negative, foreign competition effects tend to dominate positive knowledge spillover effects, whereby foreign multinationals have a net negative impact on domestic plant TFP. These findings are consistent with the existing literature which offers mixed results in uncovering potential gains from foreign multinational entry.

The lack of consensus on intra-industry spillovers gains from foreign multinationals can be at large attributed to the endogenous determination of FDI. In the absence of panel data and valid instruments it becomes difficult to disentangle spillover channels and establish the causal direction between foreign presence and domestic productivity gains. Furthermore, endogeneity in domestic plants' production function input decisions can also lead to biased estimation of TFP. To address these identification concerns, I exploit plant level data from a set of unique cross-country survey panel datasets from the World Bank that cover key manufacturing and service industries across a large number of developing and emerging economies. The datasets contain detailed ownership, financial, operational, and geographical information that provide strategic advantages for the estimation of plant TFP and construction of the key explanatory variables.

The estimation strategy of this paper proceeds in two stages. In the first stage, I estimate plant level TFP. It is difficult to identify the exact type of productivity spillover due to various intermingled factors at play and because the exact mechanism of knowledge transfers is not observable in the data. Therefore, I focus on indirectly identifying FDI spillovers through the unexplained productivity gains of domestic plants. Employing detailed financial and operational data, I measure plant level TFP using the Levinsohn and Petrin's (2003) semi-parametric production function estimation technique to account for endogenously determined input choices due to plants' prior knowledge of future productivity. The Levinsohn and Petrin method employs plants' material input choices to proxy for unobserved productivity to control for correlations between production function inputs and unobserved shocks. The panel component of the surveys provides an important advantage by allowing me to observe plant productivity and performance over time.

In the second stage, I allow plant TFP to depend on various measures of foreign presence, and on new measures which capture opportunities of intermediate input sharing, and opportunities of labor interaction and mobility between foreign multinationals and domestic plants. To construct the key explanatory variables for the second stage, I first employ foreign shareholder information to explore activities of multinationals across countries, industries and time. Second, survey information on physical location of plants allows me to determine relative geographic proximity between foreign multinationals and domestic plants. Third, the surveys include information on the share of local and imported intermediate input expenditures which I exploit to quantify domestic plant's *input-sharing proximity* to foreign multinationals. Moreover, I utilize information on labor inputs disaggregated by production and non-production workers, and trained production workers to construct the measure of *labor-skill proximity*.

To address endogeneity of foreign multinational's industry and country location choice, I employ two techniques. First, I use the plant level panel data to control for industry-year and country-year specific fixed effects across time. Plant specific and time varying information from the datasets also allows me to account for unobserved heterogeneity and control for omitted variable bias. As the second identification strategy, I employ an instrumental variables technique using rare survey information on business climate characteristics of host countries to predict location and hiring choices of foreign multinationals. Furthermore, using business climate rankings of foreign multinational plants I construct an array of instruments for potentially endogenous regressors. The analysis also employs robustness tests to assess whether productivity gains are driven by aggregation bias due to variation in plant sizes and whether particular spillover channels are more conducive across various size groups.

In the presence of cross-country heterogeneity in domestic response to foreign competition and absorption of advanced knowledge from foreign multinationals it is not surprising that existing case study analyses provide mixed results in detecting spillovers. In this study I find evidence of both positive intra-industry spillovers as well negative competition effects by pooling data across countries in South and South East Asia, Eastern Europe and Central Asia, Latin America, North Africa, and Sub-Saharan Africa. The analysis of productivity spillovers across such a large set of developing and emerging economies is another contribution of this paper which to the best of my knowledge is yet to be added to the existing literature. The resilience of FDI flows to less-developed countries, despite drastic declines in overall foreign investment due to the recent financial crisis, highlights the importance of investigating productivity spillovers. Developing and transitional nations also present a particularly relevant economic setting with ample room to benefit from spillovers of advanced knowledge from foreign multinationals and yet where economic and infrastructural bottlenecks may prevent spillovers to be realized.

This study builds on several branches of the extensive literature assessing gains from foreign multinationals. Haddad and Harrison (1993) is one of the earlier influential studies to provide firm level evidence of FDI spillovers (or lack thereof), using panel data from the Moroccan manufacturing census between 1985 and 1989. The authors find no significant impact of horizontal foreign presence on productivity growth of Moroccan firms. Aitken and Harrison (1999) employ panel data from Venezuelan manufacturing establishments and find negative market stealing effects of foreign joint ventures on domestically owned plants. Djankov and Hoekman (2000) also reports negative productivity effects of FDI on domestically owned plants after correcting for endogeneity of foreign presence. Conversely, Haskel, Pereira, Slaughter (2007) use plant level manufacturing data from the UK between 1973 and 1992 and find robust evidence of FDI spillovers on domestic firm TFP. Keller and Yeaple's (2009) analysis of U.S manufacturing plant data between 1987 and 1996 also reveals significant domestic productivity gains from FDI. Spillovers are shown to be stronger in technology intensive industries, which is consistent with the theory of knowledge transfers from foreign multinationals to domestic plants.

While evidence of productivity spillovers from plant level panel studies are at large mixed, evidence of inter-industry spillovers which may arise through foreign multinational and domestic linkages in the production or value-chain are more conclusive. Chung, Mitchell, and Yeung (2003) examines the automotive industry data for Japanese auto investors operating in the U.S. between 1979 – 1991 and shows that U.S. firms which supplied to Japanese auto transplants benefited from direct productivity gains as result competitive pressures generated by foreign subsidiaries' demand for local inputs. Javorcik (2004) finds evidence of inter-industry FDI spillovers through backward linkages using firm level panel data from Lithuanian manufacturing firms between 1996 and 2000.

Among formal studies examining particular spillover channels, Kee (2014) is the first study to provide empirical evidence of spillovers occurring through suppliers of intermediate inputs from foreign firms to competing domestic firms. Using panel data from the Bangladeshi garment sector between 1999 and 2003, the study matches actual domestic and foreign firms which share suppliers of intermediate inputs to construct a firm specific measure of "sibling foreign presence". Kee finds that a quarter of product scope expansion and a third of productivity gains of domestic "siblings" can be attributed to foreign firm presence in the same industry. On the other hand, the theoretical model of Lin and Saggi (2007) predicts that when foreign firms' input demand leads to specialized local input suppliers, domestic firms which are unable to source from exclusive suppliers of foreign multinationals do not benefit from technology transfer. Carluccio and Fally's (2012) theoretical model further predicts that if incompatibilities exist between competing foreign and domestic firm technologies, a decrease a reduction of input costs by specialized suppliers of foreign firms can have heterogeneous effects on domestic productivity. On one hand, strengthening of the supply chain can lead to technology adoption by the most productive firms and lead to productivity spillovers. On the other firms utilizing inputs which are compatible with domestic technology do not benefit from upgrading of suppliers and are negatively affected by foreign presence.

Glass and Saggi (2002) and Fosfuri, Motta, and Ronde (2011) develop theoretical models to demonstrate technology transfer from foreign multinationals to domestic firms via labor mobility. Almeida and Kogut (1999) uses data on labor movements between patent holding firms and find that inter-firm mobility of engineers has a significant effect on regional knowledge transfers. Poole (2013) uses a matched establishment-worker database from Brazil and finds that relatively higher skilled, former multinational employees are better able to transfer knowledge to domestic counterparts and also that higher skilled incumbent domestic workers are able to absorb information better. While common intermediate input suppliers and inter-firm labor mobility have been previously analyzed as channels of productivity spillovers in a few country case studies, the new measures of *input-sharing proximity* and *labor-skill proximity* used in this analysis are constructed using data that is easily available for the large number of developing countries and are particularly useful in examining spillover channels in the absence of confidential information on the identities of individual plants.

Finally, the analysis emphasizes on detecting localized productivity spillovers because ignoring geographic dimensions may lead to misspecifications in which smaller localized and positive spillovers are offset by overall negative effects of FDI (Aitken and Harrison, 1999). Keller (2002) uses country and industry level data to find that technology diffusion is local to a substantial degree and that the benefits from spillovers fall with geographical distance. Girma and Wakelin (2002) provide positive evidence of regional FDI spillovers conditional on low technology gaps between foreign and domestic firms. Yet majority of the existing analyses of FDI spillovers ignore geographic aspects of knowledge transfers. Due to constraints with revealing exact identities of surveyed enterprises, it is seldom possible to determine the exact relative geo-location of foreign multinationals to domestic plants. This analysis employs geographical data at the city level where costs associated with knowledge transmission and worker mobility are considerably reduced if not negligible, offering greater opportunities of capturing knowledge transfers from foreign multinationals and observing any consequential gains in domestic plant productivity.

The remainder of this paper is organized as follows. In Section 2, I discuss productivity gains of multinationals in light of spillover channels that are determined by the proximity between foreign multinationals and domestic plants. In Section 3, I discuss details of the plant level data used in this analysis. Subsequently, I lay out the econometric framework and discuss the empirical findings in Sections 4 and 5 respectively. In Section 6, I conclude.

2 “Proximity” to Foreign Multinationals

In this section, I discuss the role of different “proximity” measures between foreign multinationals and local plants. The discussion highlights the theoretical foundation used to construct the new measures, *input-sharing proximity* and *labor-skill proximity*. Both these measures are expected to impact domestic plants’ response to foreign competition and knowledge spillovers from multinational production.

Foreign Competition: Firm specific ownership advantages of foreign multinationals often represent superior capital goods, advanced entrepreneurship and managerial practices, high-end technologies, and stronger global distribution networks (Blomström and Kokko, 2003). The threat of foreign entrants with these international comparative advantages can naturally boost competition in host country market (Caves, 1974; Blomström and Persson, 1983). Product market competition from foreign firms can remove existing monopolistic distortions by reducing excess profits by rival domestic firms, and thereby improve allocative efficiency in the host country. Moreover, foreign competition may have a selection effect by driving out the least efficient firms from the industry and raising the overall productivity level of domestic firms. Foreign competition can also affect profitability, and therefore incentives, of making new technological investments. By inducing local firms to invest in technology or make use of existing resources more efficiently, foreign multinationals can hence improve technical efficiency of domestic firms and industries (Caves, 1974; Lall, 1983; Chuang and Lin, 1999, Blomström and Kokko, 2003; Alfaro and Chen, 2012).

Knowledge spillovers: Foreign multinationals may also facilitate transfer of tangible capital, such as machinery and blueprints, as well as intangible capital, such as, entrepreneurial techniques and superior technological knowledge via demonstration effects, labor training, and vertical linkages to local suppliers and distributors, which consequently become available to the wider domestic economy (Djankov and Hoekman, 2000; Blomström and Kokko, 2003). As such, knowledge spillovers are simply positive information externalities which occur due to productive activities of foreign multinationals which they are not able to internalize fully. For such knowledge transfers to ultimately benefit the host economy, they must occur smoothly, cheaply or both (Caves, 1974). Ultimately, the rate or speed at which advanced knowledge disseminates, depends on the host country's competitive business environment and knowledge absorption capacity (Wang and Blomström; 1992).

In this paper, I focus on local intermediate input markets, and labor interaction and mobility as channels of knowledge transfer between foreign multinationals and domestic plants. Technology and knowledge diffusion from foreign multinationals to local plants is not inevitable. Degree of spillovers, if any, will depend on existing supply chains, established technological capabilities of domestic firms, level of human capital, as well as the "proximity" between the knowledge generating and knowledge receiving firm. In this paper, I investigate proximity measures which, respectively, represent closeness between two firms in terms of geographic distance, common intermediate input suppliers, and labor skill-intensity.

2.1 Geographical Proximity

This essay focuses on detecting localized productivity spillovers at the city level. Multinational firms contribute to geographical diffusion of technology and bridge gaps in knowledge between advanced and less advanced nations. If technology diffusion occurs globally then it is more likely to occur locally (Blomström and Wolff, 1989; Saggi, 2002). The cost of knowledge transmission is likely to increase with distance, and domestic firms in close geographic proximity to foreign firms are more likely to benefit first from advanced knowledge through demonstration effects, vertical linkages, and labor movements before they diffuse to other firms that are located further away (Aitken and Harrison, 1999; Keller, 2002; Haskel, Pereira, and Slaughter, 2002; Gorg and Greenaway, 2004). Knowledge with high innovative value or "tacit knowledge" may also be best transmitted via face-to-face interaction and frequent and repeated contact (Von Hipple; 1994). Notwithstanding great improvements in global communication channels, the importance of face to face interactions cannot be undermined as remote communication is only an imperfect replacement for face-to-face interactions (Keller, 2001). Furthermore, even when multinationals erect strong barriers to prevent knowledge and technology leakage to competing firms, advanced knowledge may still ultimately spillover anyway to firms nearby (Pack and Saggi, 1997). Locational proximity between firms also facilitates geographical mobility of workers. If labor networks vary by region then there should be variation in the localization of knowledge spillovers (Almeida and Kogut, 1999).

Existing studies show that geographical concentration of firms which actively interact with one another positively affects their efficiency and innovative activity (Audretsh and Feldman, 2004; Audretsch, 1998). The likelihood of geographically clustered innovative activity is also found to be higher for industries in which new knowledge plays an importance role (Audretsch and Feldman, 1996). Geographical proximity to foreign firms increases learning opportunities of domestic firms by bringing learning effects closer to their operating boundaries. Therefore, the higher the number of foreign firms that occupy a firm's operating periphery, the larger the opportunities for the firm to benefit from possible spillovers of knowledge. Furthermore, geographical proximity between domestic plants and MNCs also increase opportunities of spillovers through other channels discussed above, namely through the sharing of common intermediate input suppliers as well as labor turnover opportunities between foreign subsidiaries and domestic firms. These are discussed in more detail below.

However, while geographical proximity to foreign multinationals bring learning effects closer to domestic plant's operating boundaries, it also implies greater competition in both product and factor markets. The extent to which locational closeness to foreign enterprises help domestic firms to benefit ultimately depends on domestic firms capabilities in responding to foreign competition and absorbing potential gains from knowledge spillovers.

2.2 "Input-Sharing Proximity"

Existing evidence on vertical spillovers from foreign multinationals highlights the role of backward linkages between downstream multinational firms and their upstream intermediate input suppliers. These vertical linkages in turn can generate horizontal productivity gains to domestic firms but the empirical evidence of such gains is quite scarce. Greater foreign multinational demand for local intermediate inputs can lead to improvement in quality, availability, and variety of local intermediate inputs. Subsequently, access to better local intermediate input markets generate gains in product scope and productivity of local input sourcing, downstream domestic firms (Rodriguez-Clare, 1996; Kee, 2011). Moreover, if imposition on quality and standards by foreign clients leads to higher technological content in intermediate inputs, then downstream domestic firms which share common intermediate input suppliers can benefit from advanced knowledge spillovers (Kee, 2011).

However, alternative theory of vertical linkages suggest that upgrading of intermediate input markets may lead to heterogeneous effects on downstream domestic firms when suppliers specialize in solely producing for foreign multinationals. First, while downstream firms which share common suppliers with foreign multinationals are expected to benefit from technology and knowledge transfers, other competing firms that do not have access to superior intermediate input suppliers may be left worse off (Lin and Saggi, 2007). Second, incompatibilities between technologies employed by competing foreign and domestic firms may lead to a reduction in input costs only for specialized suppliers. Thus, stronger supply chains can lead to technology adoption by only the most productive domestic firms, while use of inputs that are not compatible with foreign technology by less efficient downstream firms leaves them at a competitive disadvantage (Carluccio and Fally, 2012).

For domestic plants, *input-sharing proximity* is characterized by factors that determine their likelihood of sharing common local intermediate input suppliers with foreign multinationals. In this paper, *Input-sharing proximity* is modeled to depend on the degree of locally (input) sourcing presence of foreign plants that are geographically clustered with competing and local input sourcing domestic plants. In other words, *input-sharing proximity* captures locally (input) sourcing foreign presence for local input sourcing domestic plants that are clustered by location and industry to foreign multinationals. Both competition and knowledge spillover effects are expected to increase with the likelihood of sharing common intermediate input suppliers.

In the presence of infrastructural bottlenecks and high transportation costs in developing countries, locational closeness of competing foreign and domestic firms can increase their likelihood of sharing common intermediate input suppliers. First, domestic and foreign firms producing in the same disaggregated industry use similar intermediate inputs. Second, profits maximizing domestic and foreign firms that buy local intermediate inputs will source from the most cost effective local suppliers in terms of product quality and procurement costs. Third, domestic and foreign firms that are located nearby are also expected to experience similar constraints in terms of infrastructural bottlenecks and transportation costs. Therefore, there is likely to be a common choice set of local intermediate input vendors that supply to competing domestic and foreign firms which source locally, are located close to each other, and face similar infrastructural constraints and transportation costs.

Furthermore, the higher the number of foreign multinationals in close proximity to domestic firms, the higher the likelihood of sharing common intermediate input suppliers. For example, if a few larger multinationals source from a limited number of suppliers or only source from specialized vendors then competing downstream firms may have less opportunities of sharing suppliers with foreign firms. Conversely, the existence of many local input sourcing foreign firms are expected to lead to diversity in the demand for quality and variety of intermediate inputs, and hence in intermediate input suppliers. In turn, domestic firms possessing a wide range of production technologies can have a higher opportunity of not only sharing common suppliers with foreign firms but also to choose the variety of inputs that match their own production technologies. Finally, the mere existence of foreign multinationals in the same location and industry may not lead to spillovers, especially if closely located foreign firms do not buy significant shares of local inputs to generate demand driven externalities, or if domestic firms do not source adequate shares of local intermediate inputs to benefit from existing spillovers. In other words, sharing common input vendors are likely to be an effective channel of spillovers when both foreign and domestic firms buy a significant share of local intermediate products.

However, the direction of the net impact of multinational production depends on the resilience of domestic plants to withstand foreign competition and their ability to absorb spillovers of knowledge. Greater *input-sharing proximity* to foreign multinationals however, also implies increased foreign competition for domestic firms in local intermediate input markets and may only benefit the most production domestic firms. If foreign input market competition leads to reallocation of productive resources away from the least efficient domestic firms then the likelihood of realizing spillover benefits may be diminished. The identification of positive spillovers in this paper rests on the assumption that greater foreign multinational presence in the same city and industry as domestic plants will increase likelihood of sharing input vendors and hence generate spillovers, if both domestic and foreign firms buy adequate shares of local intermediate inputs which increases opportunities of knowledge spillovers.

2.3 "Labor-Skill Proximity"

Interaction between foreign and local firm employees is another key channel of advanced knowledge spillovers that may result in domestic productivity gains. Foreign multinationals' advanced technical and managerial expertise help produce innovative ideas, technologies, and products. Advanced information can trickle down the organizational hierarchy when expert organizational members train and teach other employees of the firm. Training offered by MNCs to employees ranging from low level production employees to high level managers may include on-the-job practical training, seminars, formal courses, and overseas training (Blomström and Kokko, 2003). Subsequently, domestic firms can benefit from spillovers of advanced technical and organizational knowledge through social interactions and networking opportunities with MNC employees.

Labor turnover from foreign multinationals to domestic firms can also be a significant channel of FDI spillovers, when previous foreign firm employees subsequently move to domestic firms and the foreign firm is unable to fully lock the transfer of advanced knowledge from spilling over (Gorg and Strobl, 2005; Poole, 2009; Balsvik, 2011). When previous employees leave a foreign firm, they are not able to leave behind the advanced information they learn. With sufficient opportunities of inter-firm flow of labor, trained employees of MNC can be couriers of expert technical and organizational information to domestic firms which subsequently hire them (Boschma et al, 2009; Lenger and Taymaz, 2006). This channel may be especially important for the transfer of tacit knowledge that may be difficult to imitate or transfer by other channels (Gorg and Greenaway, 2004; Lenger and Taymaz, 2006) .

Labor-skill proximity between competing domestic and foreign plants is characterized by factors which influence the degree of knowledge transfers through the inter-plant interaction and mobility of labor. In this framework of analysis, *labor-skill proximity* depends on the degree of skill proximity between competing foreign and domestic plants that are geographically clustered at the city level. First, geographic closeness between organizations makes the process of meeting and greeting much simpler (Breschi and Lissoni, 2003; Boschma et al, 2009). Second, knowledge spillovers are likely to be higher when interactions happen between members employed in similar sectors where industry specific information may be easier to communicate. Third, the degree to which new technical and organizational knowledge increases productivity and innovation among domestic firms hinges on how well they are able to absorb and implement the advanced information in their production process or managerial practices. This is because domestic firms' learning or absorptive capacity depends on their ability to from the environment, imitate new product or process innovations, and exploit outside knowledge of an intermediate nature. It also depends on their ability to generate new knowledge (Cohen and Levinthal, 1989). Moreover, the quality of labor inputs of domestic firms determines their ability to identify, internalize, and exploit knowledge[3]. Thus, the effective transfer of knowledge through labor movements from MNCs to domestic firms depends on the type of knowledge that is brought and how well this knowledge matches the existing knowledge base of the receiving firm (Boschma *et al.*, 2009). As such knowledge transfers from MNCs to domestic firms are likely to be smoother and cheaper when the two have a compatible knowledge base as well as

[3]Haddad and Harrison (1993) also note that firms absorptive capacity is also dependent on the technological gap between foreign and domestic firms. If the technological gap is too high, domestic firms may not be able to capture spillovers of knowledge from foreign presence. The authors explain large technological gaps between leaders and followers may prevent spillovers from taking place. Also see Narula & Marin (2003)

labor inputs. In other words, a certain degree of 'labor-skill proximity' between domestic and foreign firms is required for effective inter-firm knowledge transfers.

For example the educational level and skill-type of workers in MNCs and the potentially receiving domestic firms are both important considerations in the transfer of knowledge as the educational level and skill-sets possessed by production workers and non-production workers are likely to be significantly different. While skilled non-production workers may embody a significant portion of the spillovers due to their greater technological and innovative knowledge, production workers may be more adept at specific production techniques which could also raise productivity (Haskel, Pareira, and Slaughter, 2007). Moreover, higher skilled MNC workers may be better able to transfer knowledge to domestic counterparts, just as higher skilled domestic workers are better able to absorb information (Poole, 2011). On the other hand, studies suggest that the relationship between knowledge transfers and skill base between firms may be U-shaped because opportunities of learning between firms may diminish if firms are too far or too close in relative skill levels (Nooteboom *et al.*; 2007, Boschma *et al.*, 2009).

Finally, innovative knowledge transfers through labor mobility also depends on the degree of foreign presence, and more importantly the number of available and geographically mobile foreign multinational employees who may interact with local plant employees or may potentially switch employment to domestic firms. A greater presence of foreign multinational employees (as opposed to a greater share of foreign multinational output) increases opportunities of knowledge transfer via face to face interactions and labor turnover.

On the other hand, greater "labor skill proximity" to foreign multinationals also implies that foreign and domestic firms are competing for similar labor inputs. Labor market competition effect is expected to be even stronger when contending foreign and domestic firms are in closer geographical proximity to one another. Foreign competition in labor markets may also lead to an increase in the price of labor, which in turn may result in the reallocation of labor inputs from domestic to foreign firms and ultimately dampens revenue distribution of domestic firms (Chen and Alfaro, 2013). Existing evidence also shows that inward FDI leads to increased relative wages of skilled workers (Berman et al, 1998; Olszewski, 2008). Moreover, MNCs pay higher wages to employees to prevent workers from moving to local competitors (Glass and Saggi, 2002; Fosfuri, Motta, and Ronde, 2011). If foreign competition leads to the reallocation of relatively skilled labor from domestic to foreign firms which are able to provide higher remunerations, then opportunities of benefiting from knowledge spillovers may be further diminished. In the end, the degree to which domestic firms are able to improve productive performance through absorption of knowledge spillovers via greater "labor skill proximity" to MNCs depends on domestic firm capabilities to withstand foreign competition in the labor market.

3 Cross-Country Survey Data

I use cross-country panel data from a unique set of establishment level survey datasets (referred to as the Enterprise Surveys henceforth) collected by the World Bank between 2002 and 2010.[4] I pool data from fifty-eight countries across Eastern Europe and Central Asia, Latin America, South and South East Asia,

[4] The enterprise surveys include the Business Environment Enterprise Surveys (BEEPS), World Bank Enterprise Surveys (WBES), and Productivity and Investment Climate Surveys (PICS/ICS).

and North and Sub-Saharan Africa.[5] Table A1 reports the region and year of survey information available for each country in the dataset. The surveys cover a representative sample of private sector firms (based on industry and location) across key manufacturing and service industries. The Enterprise Survey datasets offer significant advantages for analyzing productivity spillovers. First, they offer detailed and comparable information based on standardized questionnaires and methodology, from a large number of developing and emerging economies. Such a large cross-country coverage of plant level data is quite rare and allows exploration of regional and country heterogeneity of foreign multinational presence and productivity spillovers.

Second, and key to the estimation strategy, the Enterprise Survey datasets provide comprehensive plant level statistics on ownership structure, geographical location, financial statements, industry and main line of production, labor inputs, and rare information on plants' investment climate characteristics. Thus the datasets demonstrate strengths that are pivotal for addressing issues of identification in estimating productivity spillovers. For the first stage of the estimation framework, I make use of detailed financial and operation data to obtain plant TFP. Plant specific input demand is likely to be endogenous due to the producers' knowledge of future productivity shocks that are not observable in the data and can therefore lead to a simultaneity problem in the estimation of TFP if inputs are treated as exogenous by the econometrician (Griliches and Maireses, 1998). The datasets furnish detailed information on industry of operation, value of output (sales), and factors of production including value of physical capital, cost of material inputs, and total employment. Using this information, I am able to estimate an industry specific production function using the semiparametric estimation technique of Levinsohn and Petrin (2003) that employs material input choices of plants to address endogeneity in TFP due to unobserved heterogeneity.[6] The panel component of the surveys provides also allows me observe plant productivity over a longer period of time and avoid identification problems present in existing industry level and cross-sectional studies.

For the second stage, I use information on the percentage of foreign equity participation by to identify industry activities of multinational subsidiaries. I combine information on industry foreign presence with data on the city of operation for each plant to construct measures of geographical proximity to foreign multinationals at the city and city-industry level respectively. Besides data on geographical location, information on local intermediate input purchases and labor composition of each plant, allows me to construct the new variables *input-sharing proximity* and *labor-skill proximity*, respectively. Finally, I use *input-sharing proximity* and *labor-skill proximity* to quantify, respectively, opportunities of sharing common intermediate suppliers, and opportunities of labor interaction and movement between foreign multinationals and domestic plants.

Identification issues in the second stage of econometric framework include endogeneity of foreign subsidiaries location choice, omitted variable bias, data attrition, and potential measurement errors in survey data. The Enterprise Survey datasets provide rare information on business climate characteristics based on interviews with managers and owners of each plant. I exploit information on foreign subsidiaries'

[5] The Enterprise surveys were implemented in more than one hundred developing countries in Eastern Europe and Central Asia, Latin America and the Caribbean, South and South East Asia, Middle East and North Africa, and Sub-Saharan Africa. I use data from fifty-eight countries, for which panel data and information on the key variables of interest were available. Enterprise Survey respondents include business owners, top managers, accountants and human resource managers of the firm. Further information on the enterprise survey data and methodology can be found at http://www.enterprisesurveys.org/.

[6] The estimation technique of Levinsohn and Petrin is discussed further in the empirical section (Section 4) below.

responses to construct investment climate indicators which can be used as instrumental variables (IVs) for predicting foreign firm location and labor choice without affecting domestic plant TFP. Moreover, detailed information on individual plant characteristics and city-industry characteristics allows me to control for unobserved heterogeneity to minimize the number of omitted variables and avoid correlations between explanatory variables and the error term.

The extensive information on geographical location and geo-characteristics, including the region and the size of the city in which plants operate serve a particularly useful purpose in avoiding issues of attrition in survey data. I start by addressing attrition concerns in the data due to missing observations on the plants' city of operation. I address this data attrition by exploiting other extensive information on geographical location and geo-characteristics of plants. By matching information on region name and the size (population) of the city in which individual plants operate in a particular year, with global city population statistics from external sources, I am able to exclusively identify missing data on the city of operation for a large number of plants.[7] This matching exercise allows me to augment key information required for construction of the main explanatory variables of interest.

Reconciling cross country data from country-specific surveys or national accounts may also pose complexity due to different methods of sampling, collecting, and aggregating information. Here, the Enterprise Surveys provide a fifth advantage of minimizing measurement errors by using standardized survey techniques and uniform stratified sampling methodologies to collect data and maintain comparability across all different countries and regions.[8] Finally, the sensitive and confidential nature of data collection methods ensures a greater degree of survey participation and accuracy. The survey respondents include business owners and top managers, as well as other organization members such as accountants and human resource managers who are best suited to provide accurate plant specific information.

The pooled dataset consists of a unique sample of 32,875 manufacturing plants, 10,113 service sector plants, and 12,267 retail and wholesale plants across the fifty-eight countries in our dataset.[9] Table A2 of the Appendix reports the number of unique plants by country and ownership. Countries in Eastern Europe and Central Asia, Latin America, and Sub-Saharan Africa represent a large proportion of the survey sample. While enterprise survey data is only available for one year for most developing countries in Asia and the Middle East and North Africa, I am able represent these regions in my analysis using panel data from Pakistan, Vietnam, and Egypt respectively. Figure A1 of the Appendix reports the average share of foreign subsidiaries in the total number of unique plants in the sample for each country. For the entire sample, the top three countries with the largest average representation of foreign plants are location in Sub-Saharan Africa, including Botswana (47 percent), Madagascar (40 percent), and Zambia (31 percent) respectively. The lowest average share of total foreign plant presence in the sample is reported in Egypt (3 percent) and Pakistan (1 percent) respectively. In the data sample from Eastern Europe and Central Asia, countries with the highest percentage of total foreign plants include Hungary (18 percent), Estonia (18

[7] Demographic statistics on city population sizes are collected from *Demographic Statistics*, United Nations Statistics Division; *World Urbanization Prospects: The 2011 Revision*, Population Division, United Nations Department of Economic and Social Affairs; and *Thomas Brinkhoff: City Population* (http://www.citypopulation.de).

[8] The World Bank Enterprise Surveys use stratified random sampling methodology and selects random samples after grouping population units within homogenous groups. Sampling weights facilitated by the survey methodology allows accounting for selection bias across different strata. For more information regarding weighted sampling methodology of the surveys see http://www.enterprisesurveys.org/methodology.

[9] While I analyze productivity spillovers for domestic manufacturing plants, information on foreign plants in other industries are retained for quantifying geographical proximity to foreign presence.

percent), and Latvia (16 percent). Finally, the data collected from Latin America shows that the largest share of foreign plant presence appear to be in Panama (15 percent), Ecuador (15 percent) and Honduras (14 percent). Overall, Figure A1 shows considerable heterogeneity of foreign subsidiary presence across countries.

Table A3 and Table A4 in the Appendix report the average sectoral and ISIC 2 digit industry distribution of unique plants by ownership respectively. In Table A3 we can see that foreign and domestic plants exhibit similar sectoral distribution shares within their respective ownership groups. 61 percent of all unique domestic plants belong to the manufacturing sector compared to 62 percent of distinct foreign plants. Domestic and foreign plants in the service sector make up, respectively, about 18 percent and 17 percent of the total number of plants within each ownership group. Finally, within each group, both domestic and foreign plants represent about 21 percent of wholesale and retail plants. Table A4 shows that among all manufacturing plants, the highest average representation of foreign plants appears to be among producers of transport & transport equipment (21 percent), electrical equipment (18 percent), and chemical products (16 percent) respectively. Among service industries the information technology industry holds the highest average share of foreign plants at 20 percent.

The datasets also provide information on the variation in plants sizes including small plants (5-19 employees); medium plants (20-99 employees), and large plants (100 or more employees). Figure A2 of the Appendix depicts the share of domestic and foreign manufacturing plants by plant size from the pooled sample. Large plants constitute about a quarter of the total manufacturing sample, while medium and small plants make up about 36 percent and 37 percent respectively. Among domestic plants, about 23 percent are large, 37 percent are medium, and 40 percent are small. On the other hand, over half of the foreign plants are large, while approximately 32 percent and 15 percent are, respectively, medium and small foreign plants.

The city location data of domestic and foreign plants plays a key role in the analysis of localized FDI spillovers. The sample represents 3,323 distinct cities in 483 regions across countries. Table A5 and Figure A3 in Appendix 1, report ownership distributions of plants by city size. Approximately 60 percent of all plants in the sample are located in capital cities or in cities with population over 1 million. Half of the foreign plants are situated in large cities, while the other half are distributed among cities of medium and small population sizes. Not surprisingly, the primary locations for foreign plants are capital cities or major metropolitan areas.

Figure A4 of the Appendix shows the share of exporting and non-exporting plants by ownership, respectively, in the total sample as well as the manufacturing sample only. Over 50 percent of all foreign plants relative to only a quarter of the domestic plants operate in the export market. These comparative figures are particularly relevant to the measure of *input-sharing proximity.* Generally, intermediate input requirements of exporting and non-exporting plants are likely to be considerably different in terms of quality and technological content, albeit depending on the destination of exports. A greater share of exporting foreign plants relative to domestic plants may imply that foreign multinationals are more likely to buy from specialized intermediate input suppliers. Majority of the domestic plants do not appear to be exporters and may have significantly different intermediate input requirements, on average, than foreign multinationals. This information points to potential negative competition effects from foreign multinationals to competing domestic plants in the factor market for intermediate inputs. The exporting trend of plants within each ownership group in the manufacturing sample, are similar to the overall sample of plants but with an even greater of share of exporting foreign plants. About 66 percent of foreign manufacturing plants are exporters relative to only 36 percent domestic plants. Moreover, information on the quality certification status of foreign and domestic plants in Table A6 shows that 41 percent of all foreign plants report producing goods with international quality certifications, relative to only 21 percent of domestic producers. Table A7 reports the manufacturing plant share of domestic intermediate input purchase by plant ownership. Over half of all plants in the manufacturing sector purchase over 75 percent of domestic intermediate inputs. Disaggregating by ownership, we see that 70 percent of domestic manufacturing plants relative to 46 percent of foreign manufacturing plants buy 50 percent or more of local intermediate inputs. The numbers show a strong variation in the data for intermediate input purchases which is a key part of the information I exploit in constructing the *input-sharing proximity* variable.

Finally, Table A8 reports the average share of non-production workers and the average share of trained production workers by ownership. Foreign plants have a higher mean share of non-production workers at 44 percent, relative to domestic plants at 25 percent. Foreign plants also report a higher average share of trained production workers than domestic plants, at 48 percent and 26 percent respectively. I use this variation in data to construct our measure of *labor-skill proximity* that is instrumental in quantifying opportunities of labor interaction and movement between foreign multinationals and domestic plants.

4 Estimation Strategy

In the first stage of the empirical framework I obtain plant level TFP by estimating an industry specific production function. In the second stage, I first construct measures of industry and geographical foreign presence, and the new measures of *input-sharing proximity* and *labor sharing proximity*. Subsequently, I allow plant level TFP to depend on foreign presence and the quantified measures capturing opportunities of intermediate input sharing, and labor interaction and mobility between foreign multinationals and domestic plants.

4.1 Total Factor Productivity Estimation

Since plant TFP is not readily observable from the data, I construct it as the estimated residual of an industry specific production function akin to standard productivity estimation literature. I start by assuming a simple Cobb-Douglas function, given by equation (1), where the value of output depends on the interaction of labor, capital, and material inputs. $Y, K, L,$ and $M,$ represent output value, capital stock, labor inputs, and material inputs, plant i, within each sector j, located in city c, in country k, at time t.[10]

$$Y_{ijckt} = A_{ijckt} L_{ijckt}^{\beta_L} K_{ijckt}^{\beta_K} M_{ijckt}^{\beta_M} \quad (1)$$

A is referred to as the total factor productivity of the individual plant because it is expected to concurrently increase the marginal product of all factors of production. In other words, A_{it} represents the plants efficiency in converting production inputs into output at time t. Applying log-linear transformation to Equation (1) (and dropping the industry, city, and country subscripts for ease of notation), gives us the

[10] The Cobb-Douglas production function is the most common functional form used in the standard literature examining productivity spillovers due to its simplicity in analyzing the estimated coefficients and in providing a reasonable description of actual production technologies. While a trans-log production function may lend more flexibility relative to the Cobb-Douglas form, it does not make too much of a numerical difference (Arnold, 2005).

baseline specification in the form of Equation (2) where, the residual ϑ_{it}, represents the natural log of plant-specific TFP, A_{it}.

$$\ln Y_{it} = \beta_L \ln L_{it} + \beta_K \ln K_{it} + \beta_M \ln M_{it} + \vartheta_{it}, \qquad (2)$$

The error term, ϑ_{it}, in Equation (3.2) can be separated into two components such that,

$$\vartheta_{it} = \omega_{it} + \varepsilon_{it} \qquad (3)$$

In Equation (3), ω_i is the systematic component of the error term, which is observed by the plant and thus influences input choices endogenously, and ε_{it} is the true error that may contain unobserved shocks as well as measurement errors.[11] Incorporating equation (3) into equation (2) yields equation (4) below.

$$\ln Y_{it} = \beta_L \ln L_{it} + \beta_K \ln K_{it} + \beta_M \ln M_{it} + \omega_{it} + \varepsilon_{it} \qquad (4)$$

Levinsohn and Petrin (2003) proposes using intermediate inputs as a proxy for unobserved shocks to productivity as opposed to other proxies such as investment suggested by Olley and Pakes (1996).[12] Plants' adjustment costs of changing intermediate inputs are likely to be lesser than changing investment decisions, and therefore plants can respond more smoothly to productivity shocks by adjusting intermediate inputs. Levinsohn and Petrin note that if plants' using investment decisions to proxy for unobserved productivity may be problematic if investment adjustment costs lead to kinked points in its investment demand function and plants cannot fully adjust to productivity shocks by changing investment. Furthermore, since intermediate inputs, M, is not state variable its use as a proxy for unobserved productivity shocks is justified as a suitable estimation strategy. Intermediate inputs also serve as a relatively better proxy because information on intermediate inputs is likely to be available even when plants report zero investment. Finally, employing the Levinsohn and Petrin (L-P) method lends another advantage when one is not certain whether investment is monotonously increasing in productivity, conditional on the values of all state variables which is a identifying condition of the Olley-Pakes methodology.

Using the Levinsohn and Petrin technique (Levinsohn-Petrin henceforth), I obtain plant TFP estimates for 22,603 manufacturing plants between 2002 and 2010.[13] To proxy for production function inputs, I use

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[11] Estimation of Equation (2) using least squares would yield consistent and unbiased estimates only given that input choices are exogenously determined. In all practicality however, at least a portion of ϑ_{it} may be observed by the plant and consequently affect its input decision leading to a simultaneity problem. For example, number of employees and materials purchased may depend on unobserved managerial ability, which is the part of TFP observed by individual plants, but not by the researcher (Fernandes, 2008). If unobserved components in the residual affect input choices of the plant then these input choices would be correlated with the error term, and would no longer be exogenously determined. In such cases, productivity estimations based on an OLS framework are suspect as the estimation will yield inconsistent and biased estimates of $(\beta_L, \beta_K, \beta_M)$.

[12] Several alternative methodologies have been proposed to tackle the issue of simultaneity in productivity estimation. A methodology commonly used in the literature is the semiparametric production function estimation technique proposed by G. Steven Olley and Ariel Pakes (1996) (the Olley-Pakes approach henceforth), which employs plants' investment decisions to proxy for unobserved productivity shocks to control for correlations between production function inputs and unobserved shocks. The rational is that if plants expect a higher future realization of TFP they will increase investment today, allowing one to model the plant's optimal investment decision as a function of unobserved productivity shocks and capital, given that output is monotonously increasing in investment. Since capital is expected to respond to shocks in a lagged manner through contemporaneous investment, the return to other inputs can be obtained by non- parametrically inverting investment and capital to proxy for unobserved shocks (Olley and Pakes, 1996).

[13] Due to international comparative advantages, foreign multinational plants are expected to exhibit higher productive than domestic plants. Failing to exclude foreign plants from the left hand side of the second stage regressions will push upwards the

information on sales (value of output), number of full time employees (labor inputs), value of fixed assets (capital), and cost of material inputs (material inputs). All nominal local currency units are converted to real and 2005 constant US dollars using published gross domestic product deflators and period average exchange rates from the Balance of Payment Statistics (BOPS) and International Financial Statistics (IFS) provided by the International Monetary Fund. All variables enter the production function in logarithmic form.

Table 1 reports the industry distribution of the number of domestic plants by plant size. The average size distribution of domestic plants is relatively similar within each industry. The top three industries in terms of the number of manufacturing plants include food and beverage (21 percent), garments (14 percent), and metal (11 percent) industries, which are all intensive in the use of labor and material inputs. The smallest share of domestic manufacturing plants belong to the transport manufacturing industry (2 percent) which is highly capital intensive. Considering the industrial share distribution of plants, I expect the coefficients on material inputs and labor to be relatively more significant, on average, than capital inputs.

Table 1: Industry Distribution Share of the Number of Domestic Plants by Size

Industry (ISIC 2 Digit)	Small	Medium	Large	Total
Chemicals & Chemical Products	9.74	10.32	8.1	9.4
Electrical Machinery & Electronics	3.23	2.72	1.98	2.62
Food & Beverages	22.67	20.01	21.06	21.13
Furniture	4.26	5.92	7.11	5.85
Garments	12.73	14.43	15.23	14.21
Leather & Leather Products	2.75	3.38	2.82	3.01
Machinery and Equipment	6.53	6.73	5.78	6.35
Metals & Metal products	9.8	11.17	12.87	11.36
Non-metallic Mineral Products	5.28	4.35	6.2	5.24
Other Manufacturing	3.45	3.21	2.24	2.95
Rubber & Plastic	4.96	4.99	4.1	4.68
Textiles	10.02	8.11	7.65	8.5
Transport & Transport Equipment	2.97	1.98	0.91	1.9
Wood & Wood Products	1.57	2.66	3.93	2.78
Total	100	100	100	100

Table 2: Production Function Estimation Results

	Dependent Variable: Natural Log of Sales		
	(1) Least Squares	(2) Fixed Effects	(3) Levinsohn-Petrin
Natural Log of Labor	0.378***	0.775***	0.143***
	(0.009)	(0.007)	(0.010)
Natural Log of Capital	0.206***	0.061***	0.077*
	(0.003)	(0.003)	(0.042)
Natural Log of Material	0.502***	0.299***	0.734***
	(0.004)	(0.003)	(0.065)
# Obs.	22603	22603	22603

Notes: Robust standard errors are presented in parentheses. Significance at the 10%, 5%, and 1% confidence levels are denoted by *, **, and *** respectively.

observed effects of FDI by introducing aggregation bias. Therefore all second stage estimations are conducted on the sample of domestic manufacturing plants.

Table 2, columns (1), (2), and (3) report the coefficients and standard errors from the production function estimation using OLS, fixed effects, and Levinsohn-Petrin methods respectively. Coefficient estimates obtained by the Levinsohn-Petrin method shows a greater importance of material inputs (in magnitude) relative to both labor and capital. As expected given the industrial distribution of domestic plants in the pooled sample, labor and material appear to be highly significant, while capital is the least significant factor input. The elasticity of capital is still significant according to the Levinsohn-Petrin estimation, although its magnitude is significantly smaller relative to OLS and fixed effects estimations.

In Table 3, I report average TFP values (in natural logs) by industry and ownership. In all industries foreign plants report higher average TFP than domestic plants. These results are consistent with the assumption that more productive foreign plants are expected to generate productivity spillovers to less productive indigenous plants. The sectors reporting the highest dispersion in average productivity between domestic and foreign plants include leather, machinery and equipment, and textiles. Food and beverages and other manufacturing sectors report the least dispersion in average productivity between foreign and domestic plants.

Table 3: Average Productivity of Foreign and Domestic Plants by Ownership

ISIC 2 Digit Industry	Domestic Plant lnTFP	Foreign Plant lnTFP	Dispersion of Average lnTFP between Foreign and Domestic Plants
Chemical & Chemical Products	3.04	3.46	0.42
Electrical Machinery & Electronics	3.30	3.75	0.45
Metals & Metal Products	2.94	3.34	0.40
Food & Beverages	2.96	3.10	0.14
Furniture	2.96	3.45	0.49
Garments	3.03	3.66	0.64
Leather	2.86	3.55	0.70
Machinery & Equipment	3.07	3.71	0.64
Metals & Metal Products	3.04	3.42	0.38
Non-metallic Mineral Products	2.95	3.34	0.40
Rubber & Plastic	2.83	3.22	0.39
Textiles	2.91	3.47	0.55
Transport & Transport Equipment	3.16	3.47	0.31
Wood & Wood Products	2.95	3.42	0.47
Other Manufacturing	2.83	2.93	0.09

4.2 Construction of Key Explanatory Variables

Now that I have plant level TFP estimates, I proceed to the second stage econometric analysis. I first construct measures of industry and geographic foreign presence. I then create two new measures, namely, *input-sharing* proximity and *labor-skill proximity*, which aid in quantifying opportunities of common intermediate input suppliers and opportunities of labor interactions and movements between foreign multinationals and domestic plants.

(1) Industry Foreign Presence - An Alternative Measure: I use two alternative measures of industry foreign presence. The first, denoted as FSI_{jkt}, is the standard measure of industry foreign presence, constructed as the natural log of total foreign equity participation share in industry j, in country k, at time t, averaged over all plants in the industry at time t, and weighted by each plant's share of sectoral output. It is given by Equation (5), where FDI_{it} is the natural log of plant level foreign equity participation at time t.

$$FSI_{jkt} = \ln \frac{\sum_{i\, for\, all\, i\epsilon j\epsilon k} FDI_{it} * Y_{it}}{\sum_{i\, for\, all\, i\epsilon j\epsilon k} Y_{it}} \quad (5)$$

The alternative and key indicator of industry foreign presence in this analysis is based on the number of foreign multinational subsidiaries. This alternative measure denoted by FPI_{jkt}, can potentially capture additional spillover channels not fully captured by the conventional measure. FPI_{jkt}, as shown in Equation (6), represents the total number of foreign plants in domestic plant's i's industry j, in country k, at time t.

$$FPI_{jkt} = \ln(Total\ number\ of\ foreign\ plants_{jkt}) \quad (6)$$

I expect the mechanisms of capturing foreign competition and knowledge transfers to be intrinsically different for the two measures of industry foreign presence. While FSI captures effects of the cumulative share of foreign plants' industry output, FPI accounts for the degree and frequency with which foreign plants' activities and interactions permeate the domestic industry. The prevalence of foreign plants and interpersonal contacts between foreign plant employees and domestic workers are important factors in determining spillovers (Haskel, Pereira, and Slaughter, 2007). Moreover, productivity increases in domestic plants may act through their interaction with foreign plants rather than cumulative production for market demand (Keller, 2001). A greater physical presence of foreign subsidiaries and foreign employees in a domestic plant's operating environment is expected to create greater opportunities of knowledge transfers through interaction effects. First, the domestic plant's opportunities of knowledge transfers through business or employee interactions are expected to increase, simply because there are more foreign plants to interact with. Second, the domestic plant may also have more opportunities of learning from competing foreign plants that are heterogeneous in innovative activities. For example, foreign plants may be heterogeneous in terms of product verses process innovations, which can increase opportunities for domestic plants to absorb both types of technological knowledge. The presence of a larger number of competing foreign plants with a range of technological capabilities also implies that domestic enterprises across a range of technological capacity have opportunities of learning from foreign subsidiaries.

A greater number of foreign plants can boost allocative efficiency of competing domestic plants if productivity is driven by competitive pressures. However, a larger number of foreign plants also implies the existence of potential "market stealing" effects on the productive performance of indigenous plants if competition lowers productivity of local plants or drives the least efficient plants out of the market. Furthermore, a greater number of foreign plants can generate aggressive competition in factor markets which can possibly lead to reallocation of productive inputs from domestic to foreign plants.

A larger number of foreign multinationals can also affect the demand, and consequently the variety and quality of local intermediate inputs. If foreign plants' demand for intermediate inputs are heterogeneous in variety, quality, or technological content, domestic plants across a wide range of production technologies can gain access to better inputs. At the same time, a greater number of foreign plants sourcing inputs locally can lead to adverse competition effects in the market for intermediate inputs and consequently lower productivity of downstream domestic competitors.

Finally, the actual number of foreign plants also matters for the opportunities of labor turnover. First, a higher number of foreign plants implies greater number of managerial positions that need filling. If domestic workers are hired in these positions then the host country can gain from a pool of managerial level employees with foreign multinational firm experience. Conversely, a greater number of foreign subsidiaries also implies greater labor market competition effects for domestic plants especially if plants under the two ownership categories hire similar labor inputs. For all these reasons discussed above, the alternative measure of foreign presence, FPI_{jkt}, is likely to capture spillovers and competition effects from foreign multinationals differently than the conventional measure, FSI_{jkt}. I also apply these same underlying principles in constructing the various measures of *proximity* below.

(2) Geographical Proximity of Foreign Presence: In the empirical framework, geographical proximity of foreign presence is captured by the variables FPC_{ckt} and $FPCI_{jckt}$, and are given by equations (7) and (8) respectively[14].

$$FPC_{ckt} = \ln(Total\ number\ of\ foreign\ plants_{ckt}) \quad (7)$$

$$FPCI_{jckt} = \ln(Total\ number\ of\ foreign\ plants_{jckt}) \quad (8)$$

FPC_{ckt}, measured by the total number of foreign plants in same city c, as plant i, in country k, at time t, is expected to capture the net effect of competition and knowledge spillovers from all foreign multinationals to neighboring domestic plants. A key attribute of FPC_{ct} is that it captures horizontal as well as vertical effects of competition and knowledge spillovers from foreign plants. This is because the count of foreign multinationals is not restricted to the same industry as domestic plant i, but rather includes all foreign plants in any industry j, located in the same city as the domestic plant. In other words, the effect of FPC_{ckt} may represent both intra-industry as well as inter-industry spillovers from foreign plants.

On the other hand, $FPCI_{jct}$ captures the net productivity impact of localized competition and knowledge spillovers from neighboring foreign competitors. As such, $FPCI_{jct}$ is given by the total number of foreign plants in the same industry j and same city c, as plant i, in country k, at time t. $FPCI_{jct}$ is expected to capture productivity gains to domestic plants via competitive pressures, demonstration effects, sharing of common intermediate input suppliers, as well as labor movements between foreign and domestic plants. This measure intends to correct for misspecification in the empirical framework which can arise if the overall negative effect of industry foreign presence conceals the identification of smaller positive spillovers that occur locally. If estimations reveal a net negative effect of FPI_{jkt} but a positive net impact of $FPCI_{jckt}$, then it is indicative of FDI spillovers occurring locally.

[14] For the specification using the conventional measure of industry foreign presence, FSI_{jkt}, I also use alternative measures of city and city-industry foreign presence, using total foreign equity participation (at the city and city-industry level) averaged across all plants and weighted by each plant's share of sectoral output. Proxies for city and city-industry level foreign presence are denoted as FSC_{ckt} and $FSCI_{jckt}$ respectively.

(3) "Input-Sharing Proximity": In the absence of information on identifying input vendors, I construct an alternative measure to help capture domestic plants' likelihood of sharing common local intermediate inputs suppliers with foreign multinationals. I do so under a set of practical assumptions and based on key factors that are expected to influence domestic plants' opportunities of sharing common intermediate input suppliers with foreign multinationals. For each domestic plant, I expect the likelihood of sharing common intermediate input suppliers with foreign plants to depend on, (i) the domestic plant's own share of local intermediate input purchases; (ii) the concentration of competing and local intermediate input sourcing foreign multinationals; (iii) the share of local intermediate input purchases of competing foreign multinationals; (iv) geographical closeness between the domestic plant and competing foreign multinationals. The underlying principle is that competing foreign subsidiaries and domestic plants that source intermediate inputs locally and are geographically clustered, have a higher likelihood of sharing common local input intermediate input suppliers. Several developing country characteristics and infrastructural conditions provide further context to this particular assumption.

First, in developing countries, competing foreign subsidiaries and domestic plants that are geographically clustered together are likely to face similar constraints with respect to high transportation costs and infrastructural deficiencies. Second, profit maximizing producers (both domestic and foreign) are expected to choose intermediate input suppliers based on the lowest available transportation and procurement costs (cost of transporting intermediate inputs to the production facility). Moreover, location choice of local intermediate input suppliers is also likely to be limited to areas with sufficient infrastructure to support specific production activities. In the presence of high transportation costs and infrastructural bottlenecks, competing and geographically clustered plants that source intermediate inputs locally, are more than likely to source from a common set of local suppliers that provide cost effective procurement options. As a result, greater geographical proximity between competing foreign multinationals and domestic plants is expected to increase opportunities of sharing common local intermediate input suppliers. Moreover, for each domestic plant, this opportunity is expected to be increasing in the number of closely situated competing foreign nationals, and the share of intermediate inputs purchased locally by the domestic plant and competing foreign plants.

Component (i) is simply captured by the variable LIS_{ijckt} for each domestic plant, and is constructed as its local intermediate input expenditure share in its total expenditure for intermediate goods. Next, components (ii), (iii), and (iv) are nested together in the variable that captures domestic plants' *input-sharing proximity* to foreign multinationals and denoted by $IS\ Proximity_{jckt}$. For each domestic plant *i*, $IS\ Proximity_{jckt}$ is formally defined as the natural log of the total number of foreign plants that purchases X percent of local intermediate inputs, in domestic plant *i*'s city *c* and industry *j*, at time *t*, where, $0 < X \leq 100$), and is given in Equation (9) below. By gradually increasing values of X, where $0 < X \leq 100$, I am able to explore a general upper and lower bound for foreign subsidiaries' local input expenditure share at which domestic spillover gains can be observed.

$$IS\ Proximity_{jckt} \mid X =$$

$$\ln \left[\begin{array}{c} Total\ number\ of\ foreign\ plants\ that\ purchase\ X\ percent\ of\ local \\ intermediate\ inputs\ in\ domestic\ plant\ i's\ city\ c \\ and\ industry\ j, in\ country\ k, at\ time\ t \end{array} \right] \text{where, } 0 < X < 100 \qquad (9)$$

$IS\ Proximity$ captures the net effect of knowledge spillovers and foreign competition in the market for intermediate inputs.[15] Finally, I quantify opportunities of sharing local intermediate input suppliers by interacting *input-sharing proximity* with domestic plants' local input expenditure share. The sign of the coefficient estimates for $IS\ Proximity_{jckt}$ and for the interaction term $(LIS_{ijckt}) * (IS\ Proximity_{jckt})$ indicates whether greater opportunities of sharing common local intermediate input suppliers with foreign multinationals alone lead to domestic productivity gains (or losses), or whether spillovers (if any) are also conditional on a greater sourcing of local intermediate inputs by domestic plants.

(4) "Labor-Skill Proximity": Finally, due to unavailability of employee level information in the survey datasets, I quantify opportunities of labor interaction and movement between foreign multinationals and domestic plants by using data on labor skill composition of plants. I expect its opportunities of worker interaction and movements between domestic plant *i* and foreign multinationals to increase with, (i) Presence of foreign multinational employees in domestic plant *i*'s city of operation *c* (ii) the relative skill proximity between foreign multinationals and domestic plant i; (iii) geographical closeness between foreign plants and domestic plant i. I first compute the absolute deviation between the labor-skill intensity of domestic plant i and the mean labor-skill intensity across all foreign plants in domestic plant i's city of location *c*, and industry *j*. I then define $LS\ Proximity_{ijckt}$ as the natural log of the inverse of this deviation in skill intensity as shown in Equation (10).

$$LS\ Proximity_{ijckt} = \ln \left|(LS\ Intensity_{ijckt} - LS\ Intensity\ MNC_{jckt})\right|^{(-1)} \quad (10)$$

In Equation (10) $Labor\_Skill\_Int_{ijckt}$ is domestic plant *i*'s labor skill intensity and $LS\ Intensity\ MNC_{jckt}$ is the value of labor-skill intensity averaged across all foreign plants in domestic plant i's city of location *c*, and industry *j*. I use the share of non-production workers in the total number of workers and the share of trained production workers over the total number of workers to include alternative specifications of skill intensity for domestic and foreign plants.[16] The variable $LS\ Intensity_{ijckt}$ incorporates components (ii) and (iii) in determining opportunities of labor interaction and movement between foreign multinationals and domestic plants. Component (i), is simply computed as the total number of foreign plant workers across all foreign subsidiaries in domestic plant *i*'s city of operation *c* and ISIC 2 digit industry *j* and is denoted as FPW_{jckt}.

The variable $LS\ Proximity$ is designed to capture the net effect of knowledge spillovers through employee interactions and labor mobility and foreign competition in the labor market. Lastly, opportunities of labor interaction and movement between foreign multinationals and domestic plants is quantified as the interaction of $LS\ Proximity_{ijckt}$ and FPW_{jckt}. Parameter estimates for $LS\ Proximity_{ijckt}$ and for the

[15] I expect $Input\_Sharing\_Prox$ to influence domestic productivity in three (and potentially opposing) ways. First, *input-sharing proximity* to foreign multinationals can boost domestic productivity by improving access to better and cheaper local intermediate inputs. Second, it can generate knowledge spillovers from foreign producers to domestic plants by creating opportunities of sharing common intermediate input suppliers. Finally, it can lower domestic productivity for the least efficient domestic plants by diverting the best intermediate inputs to more productive producers or giving rise to specialized suppliers of foreign subsidiaries due to disparities in foreign and domestic production technologies.

[16] The use of non-production worker share versus trained production worker share allows me to explore if productivity effects of greater *labor-skill proximity* to foreign multinationals are driven by the *type* of skill. The distinction is skill type may be important if one type of skill is more conducive to domestic plant productivity gains than another. As a result, relative skill proximity to foreign plants which possess the type of skill that matches the skill base of the domestic plants more likely to lead to productivity gains.

interaction term ($LS\ Proximity_{ijckt}$)*(FPW_{jckt}) allows me to gauge whether domestic productivity gains (or losses) are observed due to *labor-skill-proximity* to foreign multinationals alone or if productivity spillovers (if any) are conditional on a greater city-presence of foreign employees as vehicles of knowledge transfers.

Table 4 and 5 presents definitions and summary statistics of the key variables respectively. It is difficult to assess an expected direction of effect for the key explanatory variables as the estimated parameters represent a net effect of competition and potential knowledge spillovers from foreign multinationals. In Table 5, the size of the standard deviations suggest that foreign presence at the industry, city, and city-industry levels is distributed quite unevenly at the ISIC 2 digit level. Table 5 shows that, on average (across all countries and industries), production of foreign subsidiaries represent about 26 percent of industry output. We also see than domestic plants, on average, source a much greater share of local intermediate inputs (71 percent) relative to foreign multinationals (49 percent). This is consistent with the decreasing standard deviation of $IS\ Proximity$ with increasing values of X.

5 Estimation Results

5.1 Productivity Effects of Industry Foreign Presence and Geographic Proximity to Foreign Multinationals

In this section, I examine domestic productivity spillovers due to greater geographic proximity to foreign multinational subsidiaries. In the specification given by Equation (11) and (12), plant TFP is regressed on variables capturing industry foreign presence, geographical proximity foreign presence, and localized horizontal foreign presence respectively. Equation (11) employs measures of foreign presence represented by the cumulative production of foreign multinationals. Equation (12) on the other hand, uses indicators of foreign plant concentration in terms of total counts of foreign subsidiaries. To account for unobserved heterogeneity, the specification in Equation (11) and (12) also control for domestic plant and city characteristics including firm size, export status (exporter or non-exporter), and city size. Furthermore, γ_{jt} and γ_{kt} represent industry-year and country-year fixed effects to control for, respectively, fixed differences across industries and countries across time. For example, γ_{jt} and γ_{kt} controls for the location choice of all foreign multinationals and other unobserved aggregate-level factors that may influence domestic productivity, including industry or country specific trade policies, institutional quality, political environment, financial stability, and other productivity shocks. Both equations are estimated using foreign presence measures at various levels of industry disaggregation, i.e., at the ISIC 2, 3, and 4 digit levels.

$$\ln TFP_{ijckt} = \beta_0 + \beta_{FSI} FSI_{jkt} + \beta_{FSC} FSC_{ckt} + \beta_{FSCI} FSCI_{jckt} + \varphi_F(plant\ controls) + \gamma_{jt} + \gamma_{kt} + \varepsilon_{ijckt} \quad (11)$$ [17]

$$\ln TFP_{ijckt} = \beta_0 + \beta_{FPI} FPI_{jkt} + \beta_{FPC} FPC_{ckt} + \beta_{FPCI} FPCI_{jckt} + \varphi_F(plant\ controls) + \gamma_{jt} + \gamma_{kt} + \varepsilon_{ijckt} \quad (12)$$

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Table 4: Definitions for Key Variables

Dependent variable		**Definitions**	
Natural log of Plant TFP	*lnTFP*	Residual of industry specific production function estimated using the Levinsohn-Petrin (2003) semi-parametric estimation technique	
Explanatory variables			Expected Effect on Plant TFP
Industry foreign (share) presence	FSI_{jkt}	Total foreign equity participation share in industry j, in country k, at time t, weighted by each plant's share of sectoral output and averaged over all plants in the industry at time t.	(+/-)
Industry foreign (plant) presence:	FPI_{jkt}	Total number of foreign plants in domestic plant *i*'s industry *j*.	(+/-)
Geographical (city) foreign	FPC_{ckt}	Total number of foreign plants in domestic plant *i*'s city *c*.	(+/-)
Localized industry (city-industry)	$FPCI_{jckt}$	Total number of foreign plants in domestic plant *i*'s city *c* and industry *j*.	(+/-)
Local input share	LIS_{ijckt}	Total share of local intermediate inputs expenditure in total expenditure on intermediate inputs of plant *i*.	(+/-)
Input-sharing Proximity	$IS\ Proximity_{jckt} \mid X$	The total number of foreign plants that purchases X percent of local intermediate inputs, in domestic plant *i*'s city *c* and industry *j*, where, $0 < X \leq 100$).	(+/-)
Foreign plant workers	FPW_{jckt}	Total employment of foreign plants in domestic plant *i*'s city *c* and industry j.	(+/-)
Labor-skill proximity	$LS\ Proximity_{ijckt}$	The inverse of the absolute deviation between the labor skill intensity of domestic plant *i* and the mean labor skill intensity of all foreign plants in domestic plant i's city of location *c*, and industry *j*.[18]	(+/-)

Note: All key explanatory variables enter estimations in natural logs.

[18] The deviation between the labor skill intensity of domestic plant *i* and the mean labor skill intensity of all foreign plants in domestic plant i's city of location *c*, and industry *j*, at time *t* is given by the expression ($LS\ Intensity_{ijckt} - LS\ Intensity\ MNC_{jckt}$), where $LS\ Intensity_{ijckt}$ is domestic plant i's labor skill intensity and $LS\ Intensity\ MNC_{jckt}$ is the value of labor-skill intensity averaged across all foreign plants.

Table 5: Summary Statistics for Key Explanatory Variables

Measures of Industry & Geographical Foreign Presence	Obs.	Mean	Standard deviation	Minimum	Maximum
Industry foreign (share) presence(FSI_{ikt})	67252	26.215	27.487	0	100
Industry foreign (plant) presence (FPI_{ikt})	55354	21.241	29.485	0	128
Industry foreign (plant) presence - ISIC 2 digit (FPI_{ikt})	67326	6.406	7.300	0	57
Industry foreign (plant) presence - ISIC 3 digit	60145	2.986	4.691	0	40
Industry foreign (plant) presence - ISIC 4 digit	60147	1.584	3.180	0	38
Localized Industry foreign (plant) presence - ISIC 2 digit ($FPCI_{ikt}$)	54698	2.434	5.264	0	43
Localized Industry foreign (plant) presence - ISIC 3 digit	47954	1.057	3.001	0	39
Localized Industry foreign (plant) presence - ISIC 4 digit	47956	0.541	1.817	0	30
LSI (domestic plants)	42758	71.872	35.491	0	100
LSI of (foreign plants)	5623	49.237	38.349	0	100
$IS\ Proximity$, where, $0 < X \leq 100$					
$X \geq 20$	48128	1.494	3.037	0	24
$X \geq 40$	48128	1.193	2.539	0	22
$X \geq 60$	48128	0.973	2.148	0	18
$X \geq 80$	48128	0.719	1.658	0	13
$X = 100$	48128	0.336	0.940	0	10
FPW	54698	640.606	2161.383	0	37772
$LS\ Proxmity$ (with respect to non-production workers)	14543	2.379	1.253	4.60	33.271
$LS\ Proximity$ (with respect to trained production workers)	13247	3.029	1.173	4.60	31.884

Results from estimating Equation (11) indicate no significant presence of intra-industry or localized spillovers from foreign presence on domestic plant TFP and are reported Table A9 of the Appendix. To account for productivity effects on larger and older (relatively more established) domestic plants, Columns (1) – (6) of Table A9 includes plant age (in years) and size dummies for small and large plants. Furthermore, since more productive plants tend to be exporters I also include a dummy variable to indicate whether or not the plant engages in the export market. Finally, Columns (3) – (6) include an additional dummy variable indicating whether or not the plant is located in the capital or in a city with a population of over 1 million to account for the choice of more productive plants to locate in larger industrial cities. Table A9 shows that the variable FSC, which captures geographical proximity to both horizontal and vertical foreign presence, is positive and but insignificant in all specifications and at all levels of industry disaggregation. The coefficient estimates for the industry foreign presence variable, *FSI* is negative, indicating a potential "market stealing" effect of foreign presence, albeit insignificant under all specifications.

Finally, I also find that localized industry foreign presence, *FSCI,* has a negative and insignificant effect on domestic plant TFP at the ISIC 2 digit level, but a positive and insignificant effect at the ISIC 3 and 4 digit levels respectively. Despite the insignificance of the results, the signs of the coefficients on the respective foreign presence variables indicate that the effect of FDI spillovers on domestic plants' TFP may increase with greater industry as well as locational proximity to foreign plants. In terms of plant control variables, the results indicate that age is not a significant determinant of plant TFP. Conversely, productivity of domestic plants is strongly explained by size and export status under all specifications. Furthermore, parameter estimates on the dummy variable for city size in Columns (4) – (6) indicates that larger cities are destinations for more productive plants.

Now I turn to estimation Equation (12), in which the total count of foreign multinationals is employed in quantifying geographical and industry foreign presence. As before, columns (1) – (3) report results from estimating equation (12) at the 2, 3, and 4 digit industry and city-industry levels respectively, after controlling for the age, size, and export status of domestic plants. Columns (4) – (6) reports evidence from repeating this estimation after controlling for export status and city size. With respect to the influence of geographical proximity to foreign presence at the city level (*FPC)*, the results from estimating the alternative specification given by Equation (13) remain qualitatively unchanged from the results in the earlier specification. Estimation results are reported in Table A10 of the Appendix. Interestingly, although insignificant, the coefficients on *FPI* and *FPCI* are now positive under all specifications in Columns (1) – (6). These results are consistent with the expectation that measures of foreign presence represented by the total count of foreign multinationals capture additional effects of competition and knowledge spillovers that may not be captured by proxies for foreign presence represented by the cumulative production of foreign subsidiaries.

Results from this section show mere geographical proximity to foreign multinationals may not be a sufficient condition for generating domestic productivity gains through knowledge spillovers, especially if foreign plants can successfully protect technology and knowledge spillovers to competing plants. Furthermore, the over results indicate potential effects of industry and localized product market competition that may cancel out any influence of knowledge spillovers.

5.2 Productivity Gains from "*Input-Sharing Proximity*" and "*Labor-Skill Proximity*" to Foreign Multinationals

In this sub-section I turn to examining the influence of *input-sharing proximity* and *labor-skill proximity* to foreign multinationals respectively on domestic plant productivity. I estimate the specification given by Equation (13), where domestic plant TFP is regressed on variables capturing industry foreign presence, geographical proximity to foreign plants, *input-sharing proximity*, and *labor-skill proximity*. Moreover, the specification includes interaction terms that are used to quantify, respectively, opportunities of sharing common local intermediate input suppliers and opportunities of labor interaction and mobility between foreign subsidiaries and domestic plants respectively.

$$\begin{aligned}\ln TFP_{ijckt} = {} & \beta_0 + \beta_{FPI} FPI + \beta_{FPC} FPC_{ckt} + \beta_{FPCI} FPCI_{jckt} + \\ & \beta_{ISP} IS\ Proximity_{jckt} \,\big|\, X + \beta_{LIS} LIS_{ijckt} + \beta_{OIS}\big(LIS_{ijckt} * IS\ Proximity_{jckt} \,\big|\, X\big) + \\ & \beta_{LsP} LS\ Proximity_{ijckt} + \beta_{FPW} FPW_{jckt} + \beta_{OLIM}(LS\ Proximity_{ijckt} * FPW_{jckt}) + \\ & \varphi_F(plant\ controls) + \gamma_{jt} + \gamma_{kt} + \varepsilon_{ijckt}\end{aligned} \tag{13}$$

Once again, I include industry-year and country-year dummies, γ_{jt} and γ_{kt}, to account for effects on productivity driven by industry and country specific fixed differences across time respectively. Furthermore, if the error terms from the estimated model are not independently and identically distributed, (*i.i.d*.) but are assumed to be so, then standard errors from estimating the model will be biased downward, indicating significance of variable coefficients even when they are not. To account for possible correlations of standard errors in plant level regressions I estimate the model using robust standard errors clustered around the city and industry level. Given that some of the key explanatory variables are constructed at the city-industry level, the clustering of standard errors around the city and industry allows accounting for correlations between repeated observations through time, especially for plants which appear in the panel subsample. Finally, I control for plant age, size, and exporter status and city size to control for omitted variable bias due to unobserved plant heterogeneity.

Recall that $Input\_Sharing\_Prox$ takes on different values depending on foreign plants' minimum share of local intermediate input expenditure X, where values of X can range between 0 and 100 percent. I therefore estimate Equation (13) across a range of values for *X*. I start with *X*= 10, which gives, (for each domestic plant *i*) the number of foreign plants that source at least 10 percent of intermediate inputs from local suppliers in domestic plant *i*'s city c and industry j, at time *t*,.[19] Then, *ceteris Paribus*, I re-estimate Equation (13) by changing X in increments of 10 percent, up to 100 percent. *X*= 100 represents the count of foreign plants that source their entire intermediate input requirements from domestic suppliers. Hence, by increasing X in increments of 10 percent, I obtain ten estimations of Equation (13) which are presented in Columns 1 – 10 of Table 6 respectively.[20] In Table 10, the measure for domestic plants' *labor-skill proximity* to foreign multinationals, $LS\ Proximity$, is computed using the share of non-production workers in the total number of workers.

(1) Industry foreign presence *(FPI)*: Among interesting findings reported in Table 10, the coefficients on the proxy for industry foreign presence, FPI are positive and significant at the 5 percent level across all estimations of Equation (13) reported in Columns (1) - Column (10) respectively. These results are indicative of positive domestic productivity gains associated with the horizontal foreign multinational presence. Given that FPI represents the count of foreign plants (in natural logs), it is difficult to decipher magnitudes of β_{FPI} in terms of a 1 percent increase in the number of foreign multinationals. For the purpose of providing a meaningful interpretation of the parameter estimates in Columns (1) – Columns (10), we can say that a 10 to 12 percent increase in domestic plant TFP is associated with 100 percent (intra-industry) increase in the number of foreign multinationals. However, the more interesting result is the direction and significance of β_{FPI}, which implies positive and significant horizontal spillovers to domestic firms from the presence of foreign multinational.

This result is particularly interesting against the ample existing evidence of market stealing effects from foreign multinationals, and implies that while cumulative production of foreign multinationals may be a key determinant of domestic productivity, an increase in the actual number of foreign industry competitors may facilitate spillovers through additional channels of foreign and domestic plant interaction. These channels may not fully captured by proxy measures of foreign presence that rely on weighted share of foreign plants' industry output. For example, a greater number of foreign multinationals simply increase opportunities of interactions with domestic plants and thus create learning opportunities. Moreover, foreign subsidiaries in larger numbers may embody a greater variety of foreign technologies, providing scope for domestic plants to comfortably absorb technological knowledge that complements their own production process and absorptive capacity.

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[19] I choose 10 percent at the starting value for *X*, as I expect foreign plants to generate spillovers when they have sufficient linkages to domestic intermediate input markets. Furthermore, starting at *X* = 10 percent allows me to change values of *X* in 10 percent increments for ease of presenting results.

[20] The estimation of equation (13) is restricted to the ISIC 2 digit industry level to avoid decreasing variation in the count of foreign plants at the ISIC 3 and 4 digit level as I move across increasing values of *X*.

Table 6: Effect of *Input-Sharing Proximity* and *Labor-Skill-Proximity* on Plant TFP
Dependent variable is Natural log of TFP
Foreign Presence represented by the Number of Foreign Plants (MNCs)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Geographical foreign presence (*FPC*)	-0.028	-0.027	-0.025	-0.026	-0.027	-0.023	-0.021	-0.023	-0.027	-0.033
	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)	(0.031)	(0.031)	(0.030)	(0.030)
Intra-industry foreign presence (*FPI*)	0.106**	0.109**	0.114**	0.114**	0.116**	0.118**	0.117**	0.113**	0.113**	0.103**
	(0.049)	(0.049)	(0.050)	(0.049)	(0.049)	(0.049)	(0.050)	(0.049)	(0.049)	(0.049)
Localized industry foreign presence (*FPCI*)	0.001	0.017	0.025	0.026	0.010	0.025	0.017	0.010	0.006	0.001
	(0.078)	(0.069)	(0.064)	(0.061)	(0.059)	(0.059)	(0.059)	(0.059)	(0.056)	(0.052)
Local intermediate input share (*LIS*)	-0.035**	-0.036**	-0.035**	-0.034**	-0.035**	-0.035**	-0.032**	-0.033**	-0.034**	-0.031**
	(0.016)	(0.016)	(0.015)	(0.015)	(0.015)	(0.015)	(0.014)	(0.014)	(0.014)	(0.015)
	$X \geq 10$	$X \geq 20$	$X \geq 30$	$X \geq 40$	$X \geq 50$	$X \geq 60$	$X \geq 70$	$X \geq 80$	$X \geq 90$	$X = 100$
"Input-sharing proximity" (*IS_Proximity*)	-0.064	-0.100*	-0.111**	-0.112**	-0.109**	-0.141***	-0.103**	-0.111**	-0.107**	-0.048
	(0.069)	(0.053)	(0.048)	(0.045)	(0.047)	(0.051)	(0.048)	(0.049)	(0.051)	(0.064)
Opportunities of sharing common input suppliers	0.002	0.003*	0.003*	0.003*	0.004**	0.005***	0.003**	0.005**	0.007**	0.004
(*LIS * IS Proximity*)	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.005)
Localized presence of competing foreign plant workers	0.015**	0.016**	0.015**	0.014**	0.014**	0.012**	0.012**	0.012**	0.011**	0.012**
(*FPW*)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
"Labor-skill-proximity" (*LS Proximity*)	-0.257**	-0.255**	-0.253**	-0.254**	-0.259**	-0.257**	-0.258**	-0.252**	-0.256**	-0.255**
	(0.127)	(0.127)	(0.126)	(0.127)	(0.127)	(0.128)	(0.128)	(0.126)	(0.127)	(0.127)
Opportunities of labor interaction and mobility	0.039*	0.038*	0.038*	0.038*	0.039*	0.039*	0.039*	0.038*	0.038*	0.038*
(*FPW * LS Proximity*)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
Plant controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
City level controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Country-Year dummies	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Industry-Year dummies	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R-sq	0.349	0.349	0.349	0.349	0.349	0.349	0.349	0.349	0.349	0.349
# Observations	7110	7110	7110	7110	7110	7110	7110	7110	7110	7110

Notes: Robust standard errors clustered at the joint city-industry (ISIC 2 digit) level respectively are presented in parentheses.

Significance at the 10%, 5%, and 1% confidence levels are denoted by *, **, and *** respectively. Unless otherwise specified, all nominal variables are represented in natural logs.

The variable *LS Proximity* employs the share of trained production workers in the total number of workers of the plant.

Other independent variables (not reported in the table) include (at time *t*): natural log of plant age; two dummy variables representing plant size (small plants with less than 20 workers and large plants with 100 or more workers); two dummy variables indicating, respectively, whether the plant is located in the capital city and city with population over 1 million; and dummy variable indicator if the plant is an exporter.

Even under mild but positive spillover gains, the cumulative impact of openness to foreign investors on domestic productivity may be quite substantial. Notwithstanding, β_{FPI} represents the net effect of competition and knowledge spillovers from industry foreign presence, negative competition effects evident from point estimates on other key variables (as I will demonstrate below) suggest that domestic productivity gains due to greater industry foreign presence may be driven by knowledge spillovers rather than competitive forces.

This result is particularly interesting against the ample existing evidence of market stealing effects from foreign multinationals, and implies that while cumulative production of foreign multinationals may be a key determinant of domestic productivity, an increase in the actual number of foreign industry competitors may facilitate spillovers through additional channels of foreign and domestic plant interaction. These channels may not be fully captured by proxy measures of foreign presence that rely on weighted share of foreign plants' industry output.

(2) Local input expenditure share of domestic plants *(LIS)*: Next, results reported in Table 10 show that domestic productivity is negatively and significantly associated with own-plant share of locally sourced inputs. Specifically, the point estimates suggest that a 10 percent increase in the share of local intermediate input expenditure leads to a 0.3 to 0.4 percent fall in domestic plant productivity. First, while modest, losses in domestic plant productivity can be attributed to an increase in usage of inferior local intermediate inputs *ceteris paribus*. Second, it could potentially indicate re-allocation of productive resources from domestic plants to foreign multinationals due to greater foreign competition in the market for local intermediate goods. To assess further, let us consider the effect of the variable that captures *input sharing proximity* of domestic plants to foreign multinationals.

(3) Input-sharing proximity (*IS Proximity*): The coefficient estimates on *IS Proximity* are negative and significant between $20 < X \leq 90$. These results indicate that, *ceteris paribus*, an increase in the number of foreign competitors that purchase at least some share above 10 percent and below 100 percent of intermediate inputs locally, leads to a decline in domestic plant productivity. This is strongly suggestive of aggressive foreign competition in the market for local intermediate inputs, especially given the overall impact of industry foreign presence (FPI) was found to be positive and significant. The effect of *IS Proximity* below the values of *X = 10* is still negative but insignificant. This fall in significance may be accounted for by weaker competition in the market for local intermediate inputs from foreign multinationals that source mostly imported inputs. Since, Moreover, *IS Proximity* at X = 100 percent is also negative but insignificant, indicating that an increase if foreign competition from multinationals that source their entire input requirements locally do not substantially affect productivity of domestic competitors. The summary statistics for *IS Proximity* reported in Table 5, may shed further light on this particular result. At X = 100, the maximum number of local input sourcing and neighboring foreign competitors observed in the data is only 10, suggesting, insufficient variation in foreign presence to coax out significant influence on domestic plant productivity in the data.

(4) Opportunities of sharing common intermediate input suppliers ($IS\ Proximity * LIS$): Spillovers though *input-sharing proximity* may not be observed if domestic plants choose not to locate in industries with aggressive foreign competition in the market for intermediate inputs. When neighboring, foreign and domestic competitors both source a greater share of local intermediate inputs, the opportunities of sharing common intermediate input suppliers are increased.[21] It is therefore important to account for domestic own-plant share of intermediate inputs purchased locally in determining domestic plants' opportunities of sharing common intermediate input suppliers with foreign multinationals. These sharing opportunities are captured by the interaction term ($IS\ Proximity\ * LIS$) which takes into consideration that the effect of *input-sharing proximity* on domestic TFP is different for different values domestic plants' own share of local intermediate input expenditure, LIS. In Table 6, Columns (2) – (9), the point estimates on ($IS\ Proximity\ * LIS$) is positive and significant when we account for foreign multinationals that locally source intermediate inputs at some share above 10 percent and below 100 percent. This is a key finding of this analysis which suggests that domestic productivity gains are driven by *input-sharing proximity* to foreign multinationals conditional on a greater share of domestic firms' own-plant expenditure on local intermediate inputs. In other words, greater *input-sharing* proximity to foreign multinationals positively influences productivity of competing domestic plants which source a sufficient share of local intermediate inputs. Without this condition however, the negative factor market competition offsets any positive gains from *input-sharing* proximity to foreign multinationals. Moreover, given the evidence of negative factor market competition, we can further speculate that the positive gains are likely to be driven by better and/or cheaper local intermediate inputs (through input-demand effects of foreign plants) and knowledge spillovers as a result of foreign multinational presence.

Due to several unrelated factors at play, it is difficult to express the magnitudes of ($IS\ Proximity\ * LIS$) in terms of partial elasticity. However, note that the level of significance of β_{OIS} declines once I consider foreign multinationals that purchase at least 60 percent to 70 percent of local intermediate inputs, and disappears completely when we only consider foreign multinationals that satisfy 100 percent of their input demand locally. The reduction is significance may be attributed to insufficient variation in the number of foreign plants that source a majority of inputs from local vendors. On the other hand, foreign multinationals' full reliance on domestic intermediate goods may give rise to specialized intermediate inputs which are not accessible to competing domestic plants at large. In such cases, domestic plants' opportunities of sharing common intermediate input suppliers with foreign plants are expected to be significantly diminished, thereby reducing potential spillovers effects through common intermediate input markets.

(5) Localized presence of foreign plant workers *(FPW):* In Table 6, the parameter estimates on localized presence of competing foreign plant workers (*FPW*) are found to be positive and significant at the 5 percent level across all specification results reported in Columns (1) – (10) respectively. This is finding is consistent with the evidence found for positive of intra-industry spillovers and further suggests that the actual number of foreign plant employees may generate spillovers gains to domestic plants through foreign-domestic plant employee interactions and knowledge transfers. A greater number of foreign multinational employees also present greater opportunities for domestic plants to benefit from knowledge transfers through labor mobility if domestic plants subsequently hire previous workers of foreign multinationals. While the point estimates suggest a modest productivity effect of *FWP*, the collective impact of knowledge transfers could be sizeable in the long run.

[21] For a detailed discussion, see Section 2.2: "Input-Sharing Proximity" and Opportunities of Sharing Common Intermediate Input Suppliers with Foreign Multinationals.

(6) Labor-skill proximity *(LS Proximity)*: Next, Table 6 shows that the signs on the coefficients on $LS\ Proximity$ remain negative and significant at the 5 percent level in all specifications, suggesting substantial labor market competition from foreign multinationals which adversely impacts domestic plant performance (once again, due to the interaction of several factors, the point estimates cannot be interpreted in simple elasticity terms). Given that I employed the share of non-production workers in building the proxy for *labor skill proximity*, the evidence of overall labor market competition suggests that entry of foreign multinationals leads to a diversion of productive non-production labor inputs from domestic plants to competing foreign plants at the city level where the cost of geographical mobility in negligible.

(7) Opportunities of labor interaction and mobility ($\boldsymbol{LS\ Proximity * FPW}$): To assess whether the effect of *labor-skill proximity* changes under other conditions I consider the interaction term ($LS\ Proximity\ * FPW$) which captures greater opportunities of labor interaction and movement between foreign multinationals and domestic plants. The point estimates corresponding to this interaction terms are positive and significant at the 10 percent level across all specifications reported in Columns (1) – (10). The results indicate that the impact of domestic plants' *labor-skill proximity* to foreign multinationals changes with different realizations of FPW. Specifically, I find that greater *labor-skill proximity* between competing foreign multinationals and domestic plants leads to higher domestic productivity conditional on a larger localized presence of foreign multinational employees at the city level. Both, proximity in labor skill and the presence of foreign plant employees can be attributed with increasing domestic plants' likelihood of advanced knowledge absorption through labor interactions and mobility. Without a sufficient presence of foreign plant employees locally, there is a net negative impact of *labor-skill proximity* on domestic plant TFP.

As for the other variables, including geographical foreign presence and localized industry foreign presence, I do not find any significant impacts of these variables on domestic plant TFP. Geographical presence of foreign plants exhibit a negative but insignificant impact on domestic plant TFP, while localized industry presence of foreign multinationals generates a positive but insignificant impact on domestic plant performance. To explore whether opportunities of labor interaction and movement are driven by *skill-type*, I employ the share of trained production workers of foreign multinationals and domestic plants to construct an alternative measure of the variable *LS Proximity* and re-estimate Equation (13) for all previous values of X. Replacing the share of plant non-production workers with trained production workers in quantifying *labor-skill proximity* does not change the qualitative nature of the results. In terms of the direction of effect, there is no change observed in any of the explanatory variables. However, in Table 7 the parameter estimates on the *LS Proximity* variable and on the term capturing opportunities of labor interaction and mobility, ($LS\ Proximity\ * FPW$) are now highly significant at the 1 percent level.

Table 7: Effect of *Input-Sharing Proximity* and *Labor-Skill-Proximity* on Plant TFP
Dependent variable is Natural log of TFP
Foreign Presence represented by the Number of Foreign Plants (MNCs)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Geographical foreign presence (*FPC*)	-0.012	-0.011	-0.010	-0.012	-0.012	-0.009	-0.006	-0.006	-0.012	-0.018
	(0.030)	(0.029)	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)
Intra-industry foreign presence (*FPI*)	0.135***	0.137***	0.140***	0.140***	0.142***	0.145***	0.146***	0.143***	0.142***	0.130**
	(0.052)	(0.052)	(0.052)	(0.052)	(0.052)	(0.051)	(0.052)	(0.051)	(0.052)	(0.052)
Localized industry foreign presence (*FPCI*)	0.023	0.031	0.031	0.028	0.011	0.027	0.022	0.014	0.004	0.002
	(0.077)	(0.066)	(0.059)	(0.055)	(0.054)	(0.053)	(0.053)	(0.051)	(0.048)	(0.044)
Local intermediate input share (*LIS*)	-0.034**	-0.034**	-0.033**	-0.032**	-0.033**	-0.033**	-0.030**	-0.032**	-0.032**	-0.029*
	(0.017)	(0.016)	(0.016)	(0.016)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
	$X \geq 10$	$X \geq 20$	$X \geq 30$	$X \geq 40$	$X \geq 50$	$X \geq 60$	$X \geq 70$	$X \geq 80$	$X \geq 90$	$X = 100$
"Input-sharing proximity" (*IS_Proximity*)	-0.094	-0.115**	-0.114**	-0.112**	-0.106**	-0.140***	-0.109**	-0.128***	-0.118**	-0.071
	(0.071)	(0.054)	(0.047)	(0.045)	(0.047)	(0.052)	(0.049)	(0.049)	(0.051)	(0.064)
Opportunities of sharing common input suppliers	0.002	0.003*	0.003*	0.003*	0.004**	0.005***	0.003*	0.005**	0.007**	0.005
(*LIS * IS Proximity*)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.005)
Localized presence of competing foreign plant workers	0.017**	0.018**	0.016**	0.016**	0.016**	0.013**	0.013**	0.012**	0.012**	0.012**
(*FPW*)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.014)	(0.015)	(0.015)	(0.015)	(0.015)
"Labor-skill-proximity" (*LS Proximity*)	-0.487***	-0.486**	-0.485**	-0.488***	-0.484**	-0.494***	-0.492***	-0.501***	-0.502***	-0.505***
	(0.188)	(0.188)	(0.189)	(0.187)	(0.187)	(0.186)	(0.186)	(0.188)	(0.189)	(0.190)
Opportunities of labor interaction and mobility	0.067***	0.066***	0.066***	0.067***	0.066***	0.067***	0.067***	0.069***	0.069***	0.069***
(*FPW * LS Proximity*)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.027)
Plant controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
City level controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Country-Year dummies	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Industry-Year dummies	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R-sq	0.355	0.355	0.355	0.355	0.355	0.356	0.355	0.355	0.355	0.355
# Observations	6778	6778	6778	6778	6778	6778	6778	6778	6778	6778

Notes: Robust standard errors clustered at the joint city-industry (ISIC 2 digit) level respectively are presented in parentheses.
Significance at the 10%, 5%, and 1% confidence levels are denoted by *, **, and *** respectively. Unless otherwise specified, all nominal variables are represented in natural logs. *FDI_Plants_City*,
The variable *LS Proximity* employs the share of trained production workers in the total number of workers of the plant.
Other independent variables (not reported in the table) include (at time *t*): natural log of plant age; two dummy variables representing plant size (small plants with less than 20 workers and large plants with 100 or more workers); two dummy variables indicating, respectively, whether the plant is located in the capital city and city with population over 1 million; and dummy variable indicator if the plant is an exporter.

The increase in significance may perhaps be explained by production cost advantages (in labor inputs) which drive location choice of foreign multinationals in developing countries. If foreign subsidiaries are by large engaged in labor intensive industries then foreign competition in the labor market for non-production workers are expected to be higher and can be explained by the highly significant and negative impact of the *LS Proximity* variable. On the other hands, opportunities of spillovers throughinteractions and mobility of trained production workers may also be relatively more important in generating spillover benefits to domestic plants.

Ultimately, the parameter estimates of the key explanatory variables capture the net effect of competition and knowledge spillovers from foreign multinationals which are difficult to disentangle fully in the absence of supplier information and employee level data. However, at large, results from the estimations of Equation (13) suggest that productivity gains in domestic plants may be explained by greater overall industry foreign presence, and greater *input sharing proximity* as well as greater *labor skill proximity* to foreign subsidiaries. However, productivity spillovers through greater *input-sharing proximity* and *labor-skill proximity* with foreign multinationals are conditional on the degree of interaction between domestic and foreign plants within local factor markets. This is because a greater degree of interaction between foreign subsidiaries and domestic plants ultimately determines the opportunities of spillovers, respectively, through common local intermediate input suppliers, and labor interaction and mobility of domestic and foreign plant employees.

In the following section I test the validity of these results by addressing some key econometric concerns which may lead to biased estimates of Equation (13).

5.3 Addressing Key Econometric Issues

One of the key advantages of using plant level data is that it allows the econometrician to control for firm specific and time dependent fixed effects that may drive productivity spillovers. While the plant level data allows me to control for omitted variable bias to the extent possible, the estimation results may be driven by other effects related to aggregation bias and endogeneity of foreign multinational presence. In this section I discuss and address some key econometric issues related to the estimation of productivity spillovers from foreign multinationals.

5.3.1 Aggregation Bias: Do Productivity Effects Associated with Specific Spillover Channels Vary by Plant Size?

If larger plants simply tend to be more productive, FDI spillover effects may vary systematically across plant sizes leading to aggregation bias and consequently inconsistent parameter estimates (Aitken and Harisson, 1999). In other words, productivity gains observed for the whole sample of plants may not be true for a smaller subset of plants. Since a key part of this analysis is to explore different channels of productivity spillovers, it would be even more interesting and policy relevant if productivity effects associated with specific spillover channels vary across plant sizes. To investigate further, I divide the domestic plant sample by large manufacturing plants (100 or more workers) and small and medium plant (5-99 workers), and subsequently re-estimate Equation (13) on the two sub-sample of plants. The results are reported in Table 8.[22] (I limit reporting the results for specifications for which the value of X is 20 percent. I choose this lower bound for X as spillovers were previously observed for specifications that accounted for foreign plants that sourced at least 20 percent of local intermediate inputs and because re-estimation of Equation (13) across plant sizes produces qualitatively similar results across the range of values of X). In Columns (1) and (2) of Table A11, I report results for the sample of large domestic manufacturing plants, while in Columns (3) and (4) I include results for the sample of small and medium manufacturing enterprises. Furthermore, Column (1) and (3) represents estimation results for specifications that use non-production worker (skill) intensity to construct the proxy for *labor-skill proximity* (*LS Proximity*). Similarly, in Columns (2) and (4) I report estimation results for specifications that employ the trained production worker (skill) intensity to construct *LS Proximity*. Results reported in Table A11 show some interesting differences for the sub-sample of large and, small and medium manufacturing plants relative to the pooled sample.

First I find that productivity gains driven by industry presence of foreign multinational plants (*FPI*) are associated with small and medium size enterprises (SMEs) as shown in Columns (3) and (4). Second, Columns (1) and (2) show that, the negative effect of *input-sharing proximity* which suggests foreign competition in the market for intermediate inputs for domestic plants appears to be significant for only large domestic enterprises. Therefore, as expected, greater opportunities of sharing common local intermediate input suppliers with foreign nationals also appear to be conducive to productivity gains only in large domestic plants. A plausible explanation for this result may be that larger plants benefit more from greater opportunities of sharing common local intermediate input suppliers with foreign multinationals because they have the resources to invest in production technologies to complement advanced intermediate inputs. Conversely, another explanation may be selection effect. If larger more productive domestic plants self-select themselves into upstream linkages with suppliers of foreign multinationals, then the estimation results may be driven by selection bias. However, given the very small number of observations for the large plant sample, the results may be driven by data attenuation due to lack of observations on the key variables of interest and should not be relied upon as representative of the entire sample of domestic plants.

Third, negative impacts of foreign competition in the labor market seem to be significant only for SMEs. As expected, productivity gains in SMEs also seem to driven by *labor-skill proximity* to foreign multinationals when there is a greater localized (city level) presence of foreign plant workers to facilitate labor interactions and mobility between plants. The results for the small plant sample however have important implications on industrial and FDI policy. First they suggest that labor interaction and mobility between foreign plants, and small and medium domestic plants may be key channels of knowledge transfer and domestic productivity spillovers. Furthermore, they indicate that SMEs may be more vulnerable to increased foreign competition in the labor market and consequently to diversion of productive labor inputs to foreign plants. In a developing country context, in which the location choice of foreign multinationals

[22] Since small and medium plants represent a significant share of the entire domestic plant sample, the number of observations for the large plant sub-sample is much smaller than the small and medium plant sub-sample. In estimations employing the share of non-production workers in total workers to construct *LS Proximity*, the large plant sample size is only 1,730 while the small and medium plant sub-sample size is 5,626. On the other hand, in estimations employing the share of trained production workers in total workers in the *LS Proximity* variable, the large plant sample size is only 1,630 while the small and medium plant sub-sample size is 5,329.

may be largely based on production cost advantages in labor inputs and in labor intensive industries, these results seem quite intuitive. [23]

5.3.2 Endogeneity of Foreign Multinationals' Location Choice: Instrumental Variable Estimations

Endogeneity of FDI poses a significant econometric concern when estimating spillover effects from foreign multinationals. If foreign multinationals are attracted to more productive industries and cities then the evidence of positive spillovers may be simply driven by foreign firms' location choice and bias parameter estimates on foreign presence measures upward. In such instances it is difficult to identify whether foreign presence drives domestic productivity gains, or whether productive industries simply attract more foreign investors. Possible corrections for endogeneity include estimating the model using plant specific fixed effects and introducing lagged foreign presence measures to avoid contemporaneous specification of FDI and domestic plant productivity. However, given the limited span of the panel data, plant fixed effects is not an ideal solution, whereas lagged values of FDI would reduce the sample size significantly.

Another alternative identification strategy is to employ suitable instrumental variables (IVs) to predict city and industry foreign presence. Although it is quite difficult to obtain IVs that demonstrate high predictive power for the endogenous variable without affecting unobserved components in the error term, the Enterprise Survey datasets provide unique information on business climate characteristics which I exploit to construct plausible IVs for endogenous foreign presence. Business climate characteristics can be ideal instrumental variables in identifying impediments experienced by foreign investors in the host country and therefore in predicting the location choice of foreign multinationals. The information on plant business climate characteristics are obtained through face-to-face interviews with owners, managers, and other key personnel regarding the business climate of the country in which they function and how it affects their operations and productivity.

The full specification given by Equation (13) potentially contains multiple endogenous variables capturing foreign presence. To avoid over-identification in the IV specification, I only instrument for the key variables of interest to provide a comparison of parameter estimates with previous results. The key variables chosen are the ones that help in investigating *localized* productivity gains to domestic plants.

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[23] Differences in competitiveness or knowledge absorption capacity across regions may also be a source of aggregation bias in the analysis of the pooled sample. To account for such potential differences across regions I also estimate the full model given by equation (13) by separating the sample for Eastern Europe and Central Asia (ECA), Latin America (LAC), Sub-Saharan Africa (SSA), and finally for Egypt, Pakistan, and Vietnam together, due to a small representation of countries in North Africa and Asia.

Results (not reported here) show that in the ECA region, greater opportunities of sharing intermediate input suppliers between foreign multinationals and local plants still has a positive effect on domestic plant TFP but only when there is a greater number of foreign plants which buy between 30 percent and 60 percent of local intermediate inputs (as opposed to 20 – 90 percent for the full sample). Furthermore, in the ECA region there is significant evidence of input-market competition effects given by the negative and significant coefficient estimates of *IS Proximity*. Although effects of industry foreign presence and effects of greater skill-proximity between MNCS and domestic plants appear insignificant for this region, the results may be affected by a very small sample size (759 observations).

Conversely, I find that for the LAC region (with 4558 observations), knowledge spillovers seem to be driven by greater *labor-skill proximity* between foreign subsidiaries and local plants when there is a greater number of MNC workers present in domestic plants' city and industry. Competition effects in the labor market are also found to be significant in the LAC region indicated by the negative and significant coefficient estimates on *FPW*. Once again, analysis of a very small sample size for countries in SSA (1270 observations), and Egypt, Pakistan, and Vietnam (523 observations) yield no significant results from the re-estimation.

Namely, I instrument for localized industry foreign presence $FPCI_{jckt}$ and the interaction terms $(LIS * IS\ Proximity)$ and $(FPW * LS\ Proximity)$ which serve as proxies for domestic plants' opportunities of sharing of common intermediate input suppliers with foreign subsidiaries, and the domestic plants' chances of interacting with and absorbing foreign plant employees respectively. The validity of IVs also depends on their capability of predicting the endogenous regressor without influencing domestic plant TFP. Therefore, I avoid using information on indicators of investment climate for which the average values for domestic and foreign plants are highly correlated.

The business climate information which I exploit pertain to the degree of obstacles in terms access to finance, customs and regulations, business licenses and permits, and labor regulations as perceived by the interviewee. Survey respondents are asked to rank the business climate in which their plant operates by the (perceived) degree of obstacles experienced with respect to finance, policies, and regulations. Specifically, for each category of the business or regulatory environment, the respondent is asked whether it poses no obstacle; a minor obstacle; a moderate obstacle; a major obstacle, or a very severe obstacle to the current operations of the establishment. To construct IVs, I exploit the variation in foreign multinationals' obstacle ranking on: (i) Access to finance (which includes availability and cost, interest rates, fees and collateral requirements); (ii) Customs and trade regulations (iii) Business licensing and permits; (iv) Labor regulations. Since the foreign presence variables to be instrumented for are constructed at the joint city and industry level, I employ city-industry average values of investment climate indicators for only foreign multinational plants.

Given that the plant level data pertains to developing countries, business climate obstacles experienced by foreign subsidiaries are likely to be significantly different and tougher than those experienced by domestic plants. This is because foreign firms are expected to face greater challenges in tackling business climate impediments than domestic counterparts. Domestic producers are likely to be relatively more familiar with the economic, legal, and political factors specific to the host country and are therefore likely to respond to obstacles with greater ease than foreign multinationals that operate in another country.

For example, communication between plant personnel and regulatory authorities are expected to be smoother in a domestic environment than in a foreign environment. Furthermore, foreign investors may be subject to stricter regulatory policies due to host country protective practices. Since dealing with regulatory bottlenecks in developing countries may involve substantial time and effort, domestic producers are expected to have an advantage in tackling obstacles in the business environment over foreign investors.
The obstacles and costs associated with access to finance in the host country is expected to be considerably different for foreign subsidiaries relative to domestic competitors that are likely to have local and established connections to financial intermediaries. Foreign plants are also likely to be subject to stricter customs and trade regulations in the host country relative to domestic plants. Moreover, I expect acquisition of licensing and permits and labor regulations to be significantly more complex for foreign producers than their domestic counterparts.

5.3.2.1 Construction of IVs and Estimation Results

In this section I discuss the method of construction of the chosen IV for the selected set of endogenous variables. I start by addressing the endogenous component of each of the selected explanatory variables.

(1) Instrument for localized industry foreign presence: As we did not see any evidence of *localized* productivity spillovers, I reexamine the variable, *FPCI* with an instrument. First, to instrument for the potentially endogenous proxy for localized industry foreign presence ($FPCI_{jckt}$), I employ the city-industry average value of foreign plant rankings pertaining to obstacles in access to finance in the host business environment. The degree of obstacles involving access to finance in the host country is likely to be a key determinant of foreign multinationals' location choice. I express this IV as $IV\ Finance_{jckt}$. The degree of obstacles involving access to finance in the host country is likely to be a key determinant of foreign multinationals' location choice.

(2) Instrument for local intermediate input sourcing foreign presence: Second, to construct an IV for the interaction term $(LIS * IS\ Proximity)$ I first address the endogenous component, represented by $IS\ Proximity$. The city-industry average value of foreign plant responses to the degree of obstacle faced in dealing with customs and trade regulations represents the IV used to predict the variable *IS Proximity*. The city-industry average value of foreign plant responses to the degree of obstacle faced in dealing with customs and trade regulations therefore represents the IV used to predict the variable *IS Proximity*,. I call this IV, $IV\ Customs_{jckt}$. The choice of this IV seems particularly suitable as I expect customs and trade regulations to be important in determining location choice of foreign multinationals as these regulatory factors determine their ability to import intermediate inputs of production and export final goods. The IV for $IS\ Proximity$ is subsequently employed to re-construct the interaction term $(LIS * IS\ Proximity)$.

(3) Instrument for foreign plant average skill intensity: Third, I construct an IV for the component of the *labor-skill proximity* measure $(LS\ Proximity)$ that is likely to suffer from endogeneity, that is, foreign plants choice of labor inputs. The potentially endogenous component of $LS\ Proximity$is the city-industry average skill intensity of foreign multinational plants $(LS\ Intensity\ MNC_{jckt})$ given that foreign subsidiaries location choice is expected to depend on the industry and location specific productivity of labor inputs. To instrument for foreign plants' (city-industry) average skill intensity $(LS\ Intensity\ MNC_{jckt})$ of non-production workers and trained production workers, I use, respectively, the city-industry average values for foreign plants' obstacle rankings with respect to acquiring business and licensing permits and labor regulations. Acquisition of licenses and permits (such as work permits and employments visas), and labor regulations are expected to affect the ease of hiring and firing of employees. Consequently, business licenses and permits as well as labor regulations in the host country are likely to affect foreign subsidiaries' choice of employing production and non-production workers. I call these IVs which represent IVs foreign plants skill intensity (on average) in terms of non-production worker $IV\ Permits$ and $IV\ Labor\ Regulations$ s and trained production worker respectively.

I start by regressing each of the alternative measures for foreign plants' (city-industry) average skill intensity on the respective IV and city level covariates to obtain two sets of predicted values for $LS\ Intensity\ MNC_{jckt}$. In other words I allow the proxy foreign plants' (city-industry) average skill intensity with respect to non-production workers to depend on $IV\ Permits$. Similarly, I also regress the proxy foreign plants' (city-industry) average skill intensity with respect to trained production workers on $IV\ Labor\ Regulations$. From these estimations, the respective predicted values obtained for the two measures of $LS\ Intensity\ MNC_{jckt}$ are subsequently used to reconstruct the variable $LS\ Proximity_{ijckt}$ (with respect to non-production workers and trained production workers) and the interaction term $(FPW) * (LS\ Proximity)$.for IV estimations of Equation (13).

5.3.2.2 Instrumental Variable Estimation

The information collected on business climate characteristics are based on perceptions of the survey respondents, and are therefore subjective by nature. As a result, they are prone to a number of biases. However, in the absence of other information in the datasets that would qualify as suitable instruments I expect that, taken as averages, foreign plants' perceptions of business climate obstacles should provide reasonable representation of the true business climate of the host country. I exploit variation in the city-industry average values for foreign plants' obstacle rankings to identify Equation (13) to the degree allowed by the data.

While finding instruments may be problematic, weakly chosen instruments that are poor predictors of the endogenous variables may lead to severe loss of precision in the estimated coefficients. Hence, I proceed by checking the validity and strength of the instruments described above. First, to qualify as valid instruments, the city-industry average values of obstacle rankings of foreign multinationals and domestic plants cannot be highly correlated, to ensure that the instruments do not suffer from the same problem as the endogenous variable in influencing domestic TFP. Table 8 reports the correlations between the city-industry average values of the chosen business climate obstacle rankings of foreign and domestic industry competitors within the same city.

Table 8: Correlation between City-Industry Average Values of Obstacle Rankings of Foreign Multinationals and Domestic Plants

Business Climate Obstacle	Correlation coefficient
Access to finance	0.233
Customs and regulations	0.320
Business licenses and permits	0.257
Labor regulations	0.408

The coefficients in Table 8 shows relatively low correlation between the average values of obstacle rankings with respect to access to finance, customs and trade regulations, and business licensing and permits. The size of the correlation coefficient with respect to labor regulations is only moderate. These figures are consistent with the notion that competing foreign subsidiaries and domestic plants (on average) are likely to experience and respond to business climate obstacles present in the host country quite differently.

Table 9: Correlation of Obstacle Variables with Endogenous Variables of Interest

	(1)	(2)[24]	(3)	(4)
Business Climate Obstacles	Localized industry foreign presence ($FPCI_{jckt}$)	*Input-sharing proximity* ($IS\ Proximity_{jckt}$)	City-industry average skill intensity of foreign plants (non-production workers) ($LS\ Intensity\ MNC_{jckt}$)	City-industry average skill intensity of foreign plants (trained production workers) ($LS\ Intensity\ MNC_{jckt}$)
Access to finance	-0.305***			
Customs and regulations		-0.164***		
Business Licenses and Permits			0.0342***	-0.0247
Labor regulations			-0.00685	-0.116***

[24] Correlation between the interaction term *LIS*IS Proximity* and *IV Customs* is --0.182***.

Second, I assess the strength of the relationship between the selected endogenous regressors and the respective instruments. Table 9 reports the correlation between the endogenous variables of interest and the proxies chosen to instrument for them. Column (1) of Table 9 shows that localized industry foreign presence is negatively associated with the degree obstacles to accessing finance for foreign multinationals (on average). Similarly, in Column (2) we observe that presence of local input sourcing foreign plants is negatively correlated with the degree of obstacles faced by foreign subsidiaries with respect to customs and regulations in the host country. Figures from Columns (3) and (4) also indicate that the degree of difficulties experienced by foreign multinationals in terms of stringent labor regulations has a negative relationship with, respectively, the share of non-production workers as well as trained production workers in the total number of employees. Moreover, higher obstacles in terms of acquiring various business permits reduces MNCs' share of trained production workers. These observed relationships appear consistent with the expected impact of business climate obstacles on foreign multinational presence and foreign subsidiaries choice of labor inputs.

Conversely, Column (3) reports that the extent of impediments faced by foreign plants in acquiring business licenses and permits is positively correlated with foreign plants' (city-industry) average share of non-production workers in the total number of workers. A possible explanation for this positive relationship could be that non-production employees of foreign subsidiaries represent skilled foreign workers in managerial roles, for whom the hiring process may not be affected negatively by business and licensing permits for hiring local employees. Another potential explanation is that greater obstacles in conducting business in a foreign country, including difficulties in acquiring work permits, may affect skill acquisition of workers. For example, obstacles pertaining to labor market institutions, including protective labor market laws, may raise employee expectations of long terms relationships with employers and consequently raise incentives to acquire plant specific skills (Tang, 2012). Given that foreign multinationals in my sample are attributed with a much larger share of non-production workers relative to domestic plants, and also considering that non-production workers are attributed with greater business specific skills, it is quite plausible that business climate obstacles may be positively correlated with foreign plants' non-production worker intensity. In other words, if general business and licensing obstacles capture labor market obstacles such as worker permits, then an increase in these obstacles may render it less likely to hire and fire employees, and positively affect foreign plants' share of non-production workers with industry-specific skills on average. Furthermore, the correlation between obstacles in acquiring business licenses and permits and *labor-skill proximity* between domestic and foreign plants is – 0111, implying that the greater these obstacles the larger the deviation in skill intensity between domestic and foreign plants which is consistent with the second explanation.

While the magnitude of the correlations between the endogenous regressors and choice of respective IVs appear relatively low, I test whether the IVs may still have sufficient predictive power by regressing each one of the endogenous variables on the respective IVs and city, industry-year, and country-year dummies. Subsequently, based on the asymptotic normal approximation of the *t-statistics* reported in Table 10, where the squared *t-statistic* values are all greater than 10, I reject the null hypothesis that the parameter estimates on the respective IVs are zero. These *t-statistics* reported in Table 10 therefore indicate that the chosen IVs have sufficient explanatory power to be used in the IV estimations of Equation (13).

(1) First Stage IV Estimations: In this section I report the first stage results from estimating Equation (13) using instruments for the selected endogenous variables that capture localized industry foreign presence, domestic plants' opportunities of sharing common intermediate inputs suppliers with foreign multinationals, and opportunities of labor interaction and mobility between foreign multinationals and domestic plants. I start by regressing each individual endogenous variable on the corresponding IV and other exogenous regressors. As there are more than one endogenous regressor and therefore multiple IVs, I also regress each endogenous variable on the entire set of instruments to ensure that the relationship between the endogenous variable and the IV chosen to instrument for it does not change due to the inclusion of the other instruments.

Table 10: Absolute value of *t-statistics* for Obstacle Variables of Interest

	(1)	(2)	(3)	(4)
	Localized industry foreign presence ($FPCI_{jckt}$)	*Input-sharing proximity* ($IS\ Proximity_{jckt}$)	City-industry average skill intensity of foreign plants (non-production workers) ($LS\ Intensity\ MNC_{jckt}$)	City-industry average skill intensity of foreign plants (trained production workers) ($LS\ Intensity\ MNC_{jckt}$)
Access to finance	11.42			
Customs and regulations		4.55[25]		
Business Licenses and Permits			3.32	
Labor regulations				3.65
City size controls	Y	Y	Y	Y
Country-year dummies	Y	Y	Y	Y
Industry-year dummies	Y	Y	Y	Y
# Observations	2098	1853	2290	1532

Notes: Robust standard errors are presented in parentheses. Significance at the 10 percent, 5 percent, and 1 percent confidence levels are denoted by *, **, and *** respectively. All specifications include Country-Year and Industry-Year dummies and city size as an exogenous control variable. Regressions are conducted at the city-industry level to avoid inflation of t-statistics.

In the first column of Table 11, I present results from the single-IV regressions, while in Columns (2) and (3) I present estimation results post inclusion of all the IVs (for the alternate specifications employing two different measures of labor skill intensity with respect to non-production workers and trained production workers respectively). Panel A of Table 11 reports results from the first stage IV analysis with respect to localized industry foreign presence ($FPCI_{jckt}$) as the endogenous variable. As expected, the analysis in Panel A shows that city-industry specific obstacles in the regulatory environment pertaining to access to finance, customs and trade regulations, acquisition of business and licensing permits, as well as labor regulations have a significant and negative influence on the localized industry presence of foreign multinationals. Among the instrumental variables, access to finance appears to have the largest impact on foreign plant location choice. Furthermore, the results from the single-IV and multiple-IV estimations appear qualitatively similar.

In Panel B of Table 11, I regress the endogenous variable $IS\ Proximity$ on the chosen IVs and find that the number of locally sourcing foreign buyers is negatively and significantly affected by higher customs and trade regulation obstacles faced by foreign multinationals on average. Qualitatively, the results do not change across specifications and are intuitive. Foreign manufacturers of technologically advanced products may have imported input requirements.

[25] The *t-statistic* from regressing $IS\ Proximity$ separately on $IV\ Customs$ is 6.39. If *IV Customs* is computed for only local input sourcing foreign subsidiaries that satisfy at least 20 percent of their intermediate input demand domestically, then (given identical control variables) the *t-statistic* from regressing $IS\ Proximity$ on *IV Customs* is 7.08, while the *t-statistic* from regressing $(LIS) * (IS\ Proximity)$ on $IV\ Customs$ is 4.58, respectively.

Table 11: First Stage IV Regressions

Panel A	(1) Localized industry foreign presence ($FPCI_{jckt}$)	(2) Localized industry foreign presence ($FPCI_{jckt}$)	(3) Localized industry foreign presence ($FPCI_{jckt}$)
IV Finance	-0.240***	-0.174***	-0.204***
	(0.021)	(0.029)	(0.025)
IV Customs		-0.132***	-0.175***
		(0.032)	(0.026)
IV Permits		-0.172***	
		(0.030)	
IV Labor Regulations			-0.007
			(0.034)
City size controls	Y	Y	Y
Country-Year dummies	Y	Y	Y
Industry-Year dummies	Y	Y	Y
R-sq	0.555	0.630	0.599
# Obs.	2098	1408	1667

Panel B	(1) *Input-sharing proximity* ($IS\ Proximity$)	(2) *Input-sharing proximity* ($IS\ Proximity$)	(3) *Input-sharing proximity* ($IS\ Proximity$)
IV Finance		-0.039**	-0.149***
		(0.480)	(0.385)
IV Customs	-0.886***	-0.948**	-0.687***
	(0.415)	(0.443)	(0.380)
IV Permits		-0.390***	
		(0.481)	
IV Labor Regulations			0.526
			(0.365)
Country-Year dummies	Y	Y	Y
Industry-Year dummies	Y	Y	Y
R-sq	0.394	0.524	0.502
# Obs.	1853	1077	1285

Panel C	(1) Average city-industry skill intensity of foreign plants $LS\ Intensity\ MNC$ (Non-production workers)	(2) Average city-industry skill intensity of foreign plants $LS\ Intensity\ MNC$ (Non-production workers)
IV Finance		0.083*
		(0.047)
IV Permits		-0.007
		(0.047)
IV Labor Regulations	0.076**	-0.161***
	(0.033)	(0.046)
Country-Year dummies	Y	Y
Industry-Year dummies	Y	Y
R-sq	0.444	0.028
# Obs.	2290	1162

Panel D	(1) Average city-industry skill intensity of foreign plants (Trained production workers) ($LS\ Intensity\ MNC$)	(2) Average city-industry skill intensity of foreign plants (Trained production workers) ($LS\ Intensity\ MNC$)
IV Finance		-0.114***
		(0.034)
IV Permits		0.060*
		(0.034)
IV Labor Regulations	-0.086***	-0.150***
	(0.033)	(0.047)
Country-Year dummies	Y	Y
Industry-Year dummies	Y	Y
R-sq	0.261	0.028
# Obs.	1532	1002

Notes: Robust standard errors are presented in parentheses. Significance at the 10 percent, 5 percent, and 1 percent confidence levels are denoted by *, **, and *** respectively. All specifications include Country-Year and Industry-Year dummies and city size as an exogenous control variable. All regressions employ city size controls.

Moreover, foreign multinationals are also likely to be operating in the export market while off-shoring production locally due to production cost advances. In such cases, the degree of customs and trade barriers are likely to strongly determine foreign plants' city-industry location choice. Moreover, foreign subsidiaries that buy local intermediate goods are also likely to require local financing options and contracts with domestic intermediate input suppliers. It is not surprising therefore, that higher obstacles in financing options and acquisition of business permits and licensing negatively affect foreign plant location and input sourcing choice at the city-industry level. Once again, higher labor regulations seem to have a positive and significant effect on local input sourcing foreign plants' location choice. which can be attributed to the same reasons discussed above.

Finally, in Panels C and D of Table 11, one can see that obstacles to financing and customs and trade regulations have a negative effect foreign multinationals' share of both non-production workers as well as trained production workers. Barriers to accessing finance and stringent customs and trade regulations are likely to affect foreign multinationals' choice of industry location by affecting access to local intermediate inputs and foreign trade options. In turn, foreign multinationals' industry location choice is expected to affect the skill intensity of labor inputs. If higher impediments with respect to finance and customs and regulations deter foreign plant' from locating in relatively high technology industries, one can expect the share of non-production workers as well as trained production workers to be negatively affected.

Note once again that the relationship between obstacles in acquiring business licenses and permits and the city-industry average share of non-production workers of MNCs is positive and significant. As discussed above, one explanation is that stringent regulations in terms of overall business licensing and permits may lead multinationals to substitute local workers with imported foreign workers especially highly skilled workers in managerial roles. I also offered an alternative explanation that higher obstacles in business and licensing permits which make it harder to hire and fire employees increases workers' incentives to acquire job-specific skills, which may in turn affect foreign multinationals' non-production skill intensity. Finally, from results reported in Panel D of Table 11, on can see that higher obstacles faced by foreign plants due to labor regulations negatively affects their share of trained production workers on average. Overall, Table 11 shows that beside reduction in observations, the results of specifications in columns (2), and (3) appear qualitatively similar to those in column (1) where I use single instrumental variables for each endogenous variable. This approach also allows the selection of the most economically relevant instrument for the each endogenous variable[26].

(2) Second Stage IV Estimations: I now proceed to the second stage of the IV analysis by obtaining two stage least squares (2SLS) estimations of the endogenous variables of interest. Table 12 reports results from 2SLS IV regressions using the instruments chosen. For the estimator for *IS Proximity*, I limit X, that is, foreign plants' expenditure share of local intermediate inputs in total inputs, to 20 percent. I do this to avoid biasing the effect of the IVs which represent foreign subsidiaries mean (city-industry) rankings of business climate obstacles and would have to be averaged over lesser and lesser number of foreign plants as X increases. I choose 20 percent as the threshold since the baseline results showed productivity positive spillovers starting at approximately $X = 20$ percent.

[26] Since I am instrumenting for three endogenous variables (*FDI_Plants_Citind, Input_Sharing_Prox2, and Labor_Skill_Prox1,2*), and therefore require the same number of IVs, I also test whether the over-identifying restrictions are valid using the plant level data.

In Columns (1) and (3) of Table 12, I report results from the specification in which the proxy for *labor-skill proximity* is computed using the share of non-production workers in the total number of workers. In Columns (2) and (4) I report results from the specification which includes the proxy for *labor-skill proximity* constructed using the percentage of trained production workers in the total number of workers. Moreover, results reported in Columns (1) and (2) pertain to specifications which exclude the interaction terms (*LIS*)*(*IS Proximity*) and (*FPW*)*(*LS Proximity*).

While all proxy variables capturing foreign presence have the risk of being endogenous, I only instrument for the main variables of interest to avoid the risk of over-identification of the model. Since I instrument for three endogenous variables and therefore require the same number of IVs, I also test whether the over-identifying restrictions are valid using the plant level data.

The results in all columns provide qualitatively similar results to our previous specifications using fixed effects estimation for our main endogenous variables of interest. In all four specifications I find that plant TFP is positively and significantly affected by domestic plants' likelihood of sharing common domestic intermediate input suppliers with foreign multinational plants when domestic plants also buy a higher share of domestic intermediate inputs. As expected, the standard errors of the parameter estimates from IV estimations appear to be much larger than fixed effects estimations. Furthermore, the IV results in Column (1) shows no significant effect of *labor skill proximity* with respect to non-production workers on domestic plants' TFP, although the variable maintains the expected direction of impact. On the contrary, greater proximity in labor skill between MNCs and domestic plants with respect to trained production workers appears to significantly affect domestic plant TFP but only at a 10 percent level of confidence

I refrain from commenting on the effects of non-instrumented endogenous variables in the IV specification, especially for the industry foreign presence variable FDI_Plants_Ind, which remains positive and significant. Also, as a result of using IVs, the number of observations are reduced considerably which may affect the precision of the IV analysis. However, combined results from the fixed effects and IV analysis lend support to the following conclusions:

(i) Geographic proximity to the presence of foreign multinationals alone is not a significant cause of productivity spillovers;

(ii) Industry foreign presence generates productivity gains to domestic plants, and particularly to small and medium size enterprises

(iii) *Input-sharing proximity* to foreign multinationals increase domestic plant productivity conditional on domestic plants' own expenditure share on local intermediate inputs;

(iv) *Labor-skill proximity* to foreign multinationals also leads to productivity of domestic plants conditional on a sufficient degree of city-industry presence of foreign multinational employees.

Table 12: Effect of $Inp\_Sharing\_Prox2$ and $Labor\_Skill\_Prox1,2$ on Plant TFP

Dependent variable is Natural log of TFP

IV Regressions

Estimator	(1)	(2)	(3)	(4)
Geographical foreign presence (*FPC*)	-0.081	-0.071	-0.081	-0.043
	(0.117)	(0.088)	(0.064)	(0.048)
Intra-industry foreign presence (*FPI*)	0.143**	0.149**	0.153**	0.154**
	(0.069)	(0.075)	(0.072)	(0.072)
Localized industry foreign presence (*FPCI*)	0.551	0.513	0.279	0.522
	(0.651)	(0.515)	(0.319)	(0.574)
Local intermediate input share (*LIS*)	-0.129*	-0.104**	-0.094**	-0.095**
	(0.071)	(0.052)	(0.045)	(0.045)
	$X \geq 20$	$X \geq 20$	$X \geq 20$	$X \geq 20$
"Input-sharing proximity" (*IS_Proximity*)	-2.568	-2.089	-0.124	-0.115
	(1.203)	(1.611)	(0.170)	(0.245)
Opportunities of sharing common input suppliers (*LIS * IS Proximity*)			1.664**	1.786**
			(0.823)	(0.740)
Localized presence of competing foreign plant workers (*FPW*)	0.146*	0.144**	0.168***	0.148***
	(0.080)	(0.065)	(0.047)	(0.045)
"Labor-skill-proximity" (*LS Proximity*) (non-production workers)	-3.997		-0.199	
	(1.135)		(0.257)	
Opportunities of labor interaction and mobility (non-production workers) (*FPW * LS Proximity*)			0.522	
			(0.574)	
"Labor-skill-proximity" (*LS Proximity*) (trained production workers)		-3.234		-0.204
		(1.775)		(0.198)
Opportunities of labor interaction and mobility (trained production workers) (*FPW * LS Proximity*)				1.880*
				(1.093)
Plant controls	Y	Y	Y	Y
City level controls	Y	Y	Y	Y
Country-Year dummies	Y	Y	Y	Y
Industry-Year dummies	Y	Y	Y	Y
Sargan P-Val.	0.2796	0.8482	0.9260	0.0505
# Observations	5070	4929	4951	4702

Robust standard errors are presented in parentheses. Significance at the 10 percent, 5 percent, and 1 percent confidence levels are denoted by *, **, and *** respectively. The test for the exclusion restrictions, each of the excluded instruments was removed from the excluded instruments list and showed no direct significant explanatory power on the plant TFP.

6 Conclusion

An extensive body of literature provides important insight into the effects of FDI on the productive performance of domestic plants. Notwithstanding significant developments in data availability and methodology for examining FDI spillovers, firm level studies exploring intra-industry gains from foreign multinationals show conflicting evidence. Specific channels of FDI spillovers also remain under-examined beyond country case studies. Furthermore, spatial aspects of spillovers have received relatively less attention from empiricists. In this study, I examine whether spillovers gains from foreign multinationals to domestic plants are evident from plant level panel data across a large number of developing and transitional economies using.

I infer that existing evidence on intra-industry spillovers may find a spurious relationship between foreign presence and domestic productivity if proxies for foreign presence do not quite capture *all* channels of knowledge transfer from foreign multinationals to domestic plants. For example, if the conventional measure of industry foreign presence, typically represented by the weighted share of foreign plants' output in total industry output, does not fully capture spillover channels (such as the degree of interaction between foreign multinationals and domestic plants), then uncovering spillovers that do indeed take place through such channels is unlikely. Furthermore, I note that geographic determinants are likely to be extremely important in determining spillover effects as I expect the flow of knowledge and technology transfers to be inversely related to the distance between knowledge generating multinationals and knowledge absorbing domestic plants. To account for these factors, I construct alternative measures of foreign presence and spillover channels to uncover domestic productivity gains.

Fixed effects estimation results reveal that geographic proximity to the presence of foreign multinationals alone is not a significant cause of spillovers. However I do find that industry foreign presence generates productivity gains to domestic plants, and particularly to small and medium size enterprises. I also find that *input-sharing proximity* to foreign multinationals increase domestic plant productivity conditional on domestic plants' own expenditure share on local intermediate inputs, and that *labor-skill proximity* to foreign multinationals also leads to productivity of domestic plants conditional on a sufficient degree of city-industry presence of foreign multinational employees. Finally, since foreign presence is likely to be endogenously determined I use an IV approach to lend credence to the observed relationship between FDI and domestic productivity from the baseline results. IV estimations produce similar findings for selected endogenous variables of interest with the exception of labor proximity between foreign and domestic plants in terms of non-production worker intensity.

The findings of this paper provide important insight into implications of FDI policy incentives which are increasing in number as countries liberalize their trade regimes. First, results of intra-industry spillovers suggest that policies to attract larger foreign multinationals as opposed to a greater number of multinationals may result in different spillover effects to domestic plants. Second, the results also imply that policies to promote local intermediate input sourcing and sharing by geographically clustered foreign subsidiaries and domestic plants may prove favorable in extracting spillovers from FDI. Finally, the results of this analysis also suggest that investment in human capital and skill training of domestic employees that creates greater *labor-skill proximity* between foreign and domestic plant employees may lead to substantial spillover benefits.

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Appendix: Tables and Figures

Table A1: Cross-Country Data Availability

Region	**Country**	**Available Years of Survey Data**
Eastern Europe and Central Asia	Albania	2002, 2005, 2007, 2009
Eastern Europe and Central Asia	Armenia	2002, 2005, 2009
Eastern Europe and Central Asia	Azerbaijan	2002, 2005, 2009
Eastern Europe and Central Asia	Belarus	2002, 2005, 2009
Eastern Europe and Central Asia	Bosnia & Herzegovina	2002, 2005, 2009
Eastern Europe and Central Asia	Bulgaria	2002, 2005, 2007, 2009
Eastern Europe and Central Asia	Croatia	2003, 2009
Eastern Europe and Central Asia	Czech Republic	2002, 2005, 2009
Eastern Europe and Central Asia	Estonia	2002, 2005, 2009
Eastern Europe and Central Asia	Georgia	2002, 2005, 2009
Eastern Europe and Central Asia	Hungary	2002, 2005, 2009
Eastern Europe and Central Asia	Kazakhstan	2002, 2005, 2009
Eastern Europe and Central Asia	Kyrgyz Republic	2002, 2003, 2005, 2009
Eastern Europe and Central Asia	Latvia	2002, 2005, 2009
Eastern Europe and Central Asia	Lithuania	2002, 2005, 2009
Eastern Europe and Central Asia	Macedonia FYR	2002, 2005, 2009
Eastern Europe and Central Asia	Moldova	2002, 2005, 2009
Eastern Europe and Central Asia	Montenegro	2002, 2003, 2005, 2009
Eastern Europe and Central Asia	Poland	2002, 2003, 2005, 2009
Eastern Europe and Central Asia	Romania	2002, 2005, 2009
Eastern Europe and Central Asia	Russian Federation	2002, 2005, 2009
Eastern Europe and Central Asia	Serbia	2002, 2003, 2005, 2009
Eastern Europe and Central Asia	Slovak Republic	2002, 2005, 2009
Eastern Europe and Central Asia	Slovenia	2002, 2005, 2009
Eastern Europe and Central Asia	Tajikistan	2002, 2003, 2005, 2009
Eastern Europe and Central Asia	Turkey	2005, 2008
Eastern Europe and Central Asia	Ukraine	2002, 2005, 2009
Eastern Europe and Central Asia	Uzbekistan	2002, 2003, 2005, 2009
Latin America	Argentina	2006, 2010
Latin America	Bolivia	2006, 2010
Latin America	Brazil	2003, 2009
Latin America	Chile	2006, 2010
Latin America	Colombia	2006, 2010
Latin America	Costa Rica	2005, 2010
Latin America	Ecuador	2003, 2006, 2010
Latin America	El Salvador	2003, 2006, 2010
Latin America	Guatemala	2003, 2006, 2010
Latin America	Honduras	2003, 2006, 2010
Latin America	Mexico	2006, 2010
Latin America	Nicaragua	2003, 2006, 2010
Latin America	Panama	2006, 2010
Latin America	Paraguay	2006, 2010
Latin America	Peru	2006, 2010
Latin America	Uruguay	2006, 2010
Latin America	Venezuela	2006, 2010
East Asia Pacific	Vietnam	2005, 2009
South Asia	Pakistan	2002, 2007
North Africa	Egypt	2004, 2006, 2007, 2008
Sub-Saharan Africa	Angola	2006, 2010
Sub-Saharan Africa	Botswana	2006, 2010
Sub-Saharan Africa	Burkina Faso	2006, 2009
Sub-Saharan Africa	Cameroon	2006, 2009
Sub-Saharan Africa	Madagascar	2005, 2009
Sub-Saharan Africa	Mali	2003, 2007, 2010
Sub-Saharan Africa	Mauritius	2005, 2009
Sub-Saharan Africa	Senegal	2003, 2007
Sub-Saharan Africa	South Africa	2003, 2007
Sub-Saharan Africa	Zambia	2002, 2007

Table A2: Number of Unique Plants by Country and Ownership

Country	Region	Domestic	Foreign	Total
Albania	Eastern Europe and Central Asia	627	105	732
Armenia	Eastern Europe and Central Asia	796	96	892
Azerbaijan	Eastern Europe and Central Asia	782	118	900
Belarus	Eastern Europe and Central Asia	713	116	829
Bosnia & Herzegovina	Eastern Europe and Central Asia	659	83	742
Bulgaria	Eastern Europe and Central Asia	1620	233	1853
Croatia	Eastern Europe and Central Asia	1030	130	1160
Czech Republic	Eastern Europe and Central Asia	735	116	851
Estonia	Eastern Europe and Central Asia	542	119	661
Georgia	Eastern Europe and Central Asia	662	81	743
Hungary	Eastern Europe and Central Asia	940	210	1150
Kazakhstan	Eastern Europe and Central Asia	1256	122	1378
Kyrgyz Republic	Eastern Europe and Central Asia	510	99	609
Latvia	Eastern Europe and Central Asia	542	110	652
Lithuania	Eastern Europe and Central Asia	597	83	680
Macedonia FYR	Eastern Europe and Central Asia	635	100	735
Moldova	Eastern Europe and Central Asia	775	112	887
Montenegro	Eastern Europe and Central Asia	147	7	154
Poland	Eastern Europe and Central Asia	1713	196	1909
Romania	Eastern Europe and Central Asia	1185	185	1370
Russian Federation	Eastern Europe and Central Asia	1907	196	2103
Serbia	Eastern Europe and Central Asia	774	126	900
Slovak Republic	Eastern Europe and Central Asia	569	92	661
Slovenia	Eastern Europe and Central Asia	605	82	687
Tajikistan	Eastern Europe and Central Asia	672	59	731
Turkey	Eastern Europe and Central Asia	1841	70	1911
Ukraine	Eastern Europe and Central Asia	1302	209	1511
Uzbekistan	Eastern Europe and Central Asia	785	141	926
Argentina	Latin America	1820	283	2103
Bolivia	Latin America	836	128	964
Brazil	Latin America	2694	155	2849
Chile	Latin America	1837	206	2043
Colombia	Latin America	1826	115	1941
Costa Rica	Latin America	763	116	879
Ecuador	Latin America	1258	214	1472
El Salvador	Latin America	1324	192	1516
Guatemala	Latin America	1384	181	1565
Honduras	Latin America	1070	172	1242
Mexico	Latin America	2694	264	2958
Nicaragua	Latin America	1135	127	1262
Panama	Latin America	810	139	949
Paraguay	Latin America	852	112	964
Peru	Latin America	1436	194	1630
Uruguay	Latin America	1074	144	1218
Venezuela	Latin America	268	37	305
Egypt	North Africa	3033	96	3129
Pakistan	South Asia	770	11	781
Vietnam	East Asia Pacific	1919	276	2195
Angola	Sub-Saharan Africa	604	171	775
Botswana	Sub-Saharan Africa	324	283	607
Burkina Faso	Sub-Saharan Africa	462	67	529
Cameroon	Sub-Saharan Africa	426	107	533
Madagascar	Sub-Saharan Africa	439	298	737
Mali	Sub-Saharan Africa	1023	94	1117
Mauritius	Sub-Saharan Africa	534	66	600
Senegal	Sub-Saharan Africa	783	103	886
South Africa	Sub-Saharan Africa	1409	250	1659
Zambia	Sub-Saharan Africa	198	91	289

Table A3: Average Share of Domestic and Foreign Plants by Sector

Sector	Domestic	Foreign	Total
Manufacturing	61.24	61.56	61.28
Services	17.56	17.13	17.51
Wholesale & Retail	21.20	21.31	21.21
Total	100	100	100

Note: The share of plants is based on the number of domestic and foreign plants in the total number of plants.

Table A4: Average Share of Domestic and Foreign Plants by ISIC 2 Digit Industries

ISIC 2 digit Industry	Domestic	Foreign	Total
Manufacturing			
Chemical and chemical	83.77	16.23	100
Electrical equipment	82.25	17.75	100
Food and beverages	88.29	11.71	100
Furniture	92.75	7.25	100
Garments	90.97	9.03	100
Leather	92.4	7.6	100
Machinery and equipment	88.29	11.71	100
Metals & metal products	89.26	10.74	100
Non-metallic mineral	89.88	10.12	100
Publishing and printing	90.4	9.6	100
Rubber and plastic	86.69	13.31	100
Textiles	90.85	9.15	100
Transport and transport	79.03	20.97	100
Transport services	86.94	13.06	100
Wood and wood product	90.85	9.15	100
Other manufacturing	82.3	17.7	100
Services			
Construction services	92.71	7.29	100
Hotels and restaurant	86.29	13.71	100
Information technology	83.35	16.65	100
Other services	87.34	12.66	100
Wholesale and Retail			
Wholesale trade	84.41	15.59	100
Retail trade	90.11	9.89	100
Total	88.15	11.85	100

Note: The average share of plants is based on the number of domestic and foreign plants in the total number of plants.

Table A5: Average Share of Domestic and Foreign Plants by City Size

City Size by Population	Domestic	Foreign	Total
Capital city	33.37	47.18	34.99
City with population over 1 million (other than the capital)	26.7	20.32	25.96
Over 250,000 to 1 mil	12.37	9.02	11.97
50,000 to 250,000	14.41	12.97	14.24
Less than 50,000	13.15	10.51	12.84
Total	100	100	100

Note: The share of plants is based on the number of domestic and foreign plants in the total number of plants.

Table A6: Average Share of Domestic and Foreign Plants with Internationally Recognized Quality Certifications

	All sectors			Manufacturing sector		
Quality certification status	Domestic	Foreign	Total	Domestic	Foreign	Total
Has quality certification	20.78	40.62	23.13	23.7	46.23	26.38
Does not have quality certification	79.22	59.38	76.87	76.3	53.77	73.62
Total	100	100	100	100	100	100

Note: The share of plants is based on the number of domestic and foreign plants in the total number of plants.

Table A7: Average Share of Domestic and Foreign Plants that Buy Local Intermediate Inputs

Share of Domestic Intermediate Input Purchase	Domestic	Foreign	Total
Less than 25 %	16.79	36.13	18.99
25 % - 50 %	12.41	17.91	13.04
50 % - 75 %	9.78	12.15	10.05
Over 75 %	61.02	33.81	57.92
Total	100	100	100

Note: The share of plants is based on the number of domestic and foreign plants in the total number of plants by ownership.

Table A8: Average Share of Non-production Workers and Trained Production Workers by Ownership

Skill Type	Domestic	Foreign
Mean Share of Non-production Workers	24.69	44.45
Mean Share of Trained Production Workers	26.78	48.04

Table A9: Effect of Geographic and Industry Foreign Presence on Plant TFP
Dependent variable is Natural log of TFP
Foreign Presence represents Foreign Plants' Share of Output at the City, Industry, and City-Industry Levels

	(1) lnTFP	(2) lnTFP	(3) lnTFP	(4) lnTFP	(5) lnTFP	(6) lnTFP
Geographical foreign presence (*FSC)*	0.104	0.088	0.084	0.085	0.076	0.077
	(0.083)	(0.078)	(0.073)	(0.089)	(0.084)	(0.077)
	ISIC 2 digit	ISIC 3 digit	ISIC 4 digit	ISIC 2 digit	ISIC 3 digit	ISIC 4 digit
Industry foreign presence (*FSI)*	-0.016	-0.040	-0.024	-0.017	-0.063	-0.034
	(0.107)	(0.082)	(0.075)	(0.113)	(0.086)	(0.077)
Localized Industry foreign presence (*FSCI)*	-0.016	0.025	0.076	-0.011	0.055	0.094
	(0.089)	(0.087)	(0.094)	(0.093)	(0.090)	(0.098)
Age	0.010	0.006	0.006	0.020	0.016	0.016
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
Large plant (*L* >= 100)	0.104***	0.106***	0.107***	0.106***	0.112***	0.112***
	(0.028)	(0.028)	(0.028)	(0.029)	(0.030)	(0.029)
Small plant (*L* < 20)	-0.109***	-0.116***	-0.115***	-0.108***	-0.114***	-0.114***
	(0.024)	(0.024)	(0.023)	(0.025)	(0.025)	(0.025)
Export status	0.102***	0.107***	0.106***	0.096***	0.098***	0.097***
	(0.025)	(0.025)	(0.024)	(0.026)	(0.026)	(0.025)
Large city				0.068**	0.049*	0.049*
				(0.029)	(0.029)	(0.029)
Country-Year dummies	Y	Y	Y	Y	Y	Y
Industry-Year dummies	Y	Y	Y	Y	Y	Y
R-sq	0.238	0.238	0.238	0.248	0.248	0.248
# Observations	18370	17265	17266	16804	15709	15710

Notes: Robust standard errors clustered at the joint city and corresponding ISIC 2, 3, and 4 digit industry level respectively are presented in parentheses. Significance at the 10%, 5%, and 1% confidence levels are denoted by *, **, and *** respectively. Unless otherwise specified, all variables are represented in natural logs. *Large plant* are *Small plant* represent indicator variables for small plants (less than 20 workers) and large plants (100 or more workers) respectively. Indicator variables *Large city* and *Export status* represent, respectively, whether or not the plant is located in a large city (capital city or city with population over 1 million) and whether or not the plant engages in exporting.

Table A10: Effect of Geographic and Industry Foreign Presence on Plant TFP
Dependent variable is Natural log of TFP
Foreign Presence represented by the Number of Foreign Plants at the City, Industry, and City-Industry Levels

	(1)	(2)	(3)	(4)	(5)	(6)
Geographical foreign presence (*FPC)*	0.003	0.001	0.002	0.001	0.005	0.001
	(0.013)	(0.011)	(0.010)	(0.015)	(0.013)	(0.011)
	ISIC 2 digit	ISIC 3 digit	ISIC 4 digit	ISIC 2 digit	ISIC 3 digit	ISIC 4 digit
Industry foreign presence (*FPI)*	0.041	0.018	0.002	0.041	0.022	0.003
	(0.025)	(0.020)	(0.021)	(0.027)	(0.021)	(0.022)
Localized Industry foreign presence (*FPCI)*	0.013	0.024	0.019	0.015	0.030	0.015
	(0.024)	(0.026)	(0.029)	(0.026)	(0.027)	(0.029)
Age	0.011	0.006	0.006	0.022	0.016	0.016
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
Large plant (*L* >= 100)	0.104***	0.109***	0.110***	0.107***	0.112***	0.112***
	(0.028)	(0.028)	(0.028)	(0.029)	(0.029)	(0.029)
Small plant (*L* < 20)	-0.110***	-0.115***	-0.115***	-0.109***	-0.116***	-0.116***
	(0.024)	(0.024)	(0.024)	(0.025)	(0.025)	(0.025)
Export status	0.100***	0.105***	0.105***	0.094***	0.097***	0.097***
	(0.025)	(0.025)	(0.024)	(0.026)	(0.026)	(0.025)
Large city				0.072**	0.057*	0.055*
				(0.031)	(0.032)	(0.031)
Country-Year dummies	Y	Y	Y	Y	Y	Y
Industry-Year dummies	Y	Y	Y	Y	Y	Y
R-sq	0.238	0.237	0.237	0.248	0.248	0.248
# Observations	18371	17267	17268	16805	15710	15711

Notes: Robust standard errors clustered at the joint city and corresponding ISIC 2, 3, and 4 digit industry level respectively are presented in parentheses. Significance at the 10%, 5%, and 1% confidence levels are denoted by *, **, and *** respectively. Unless otherwise specified, all variables are represented in natural logs. *Large plant* are *Small plant* represent indicator variables for small plants (less than 20 workers) and large plants (100 or more workers) respectively. Indicator variables *Large city* and *Export status* represent, respectively, whether or not the plant is located in a large city (capital city or city with population over 1 million) and whether or not the plant engages in exporting.

Table A11: Effect of Input Sharing Proximity and Labor Skill Proximity of Foreign Presence on Plant TFP

Dependent variable is Natural log of TFP

	(1)	(2)	(3)	(4)
	Large Plants	Large Plants	Small and Medium Plants	Small and Medium Plants
Geogriphical foreign presence (*FPC*)	0.001	0.004	-0.017	0.002
	(0.055)	(0.058)	(0.035)	(0.034)
Industry foreign presence (*FPI*)	0.144	0.071	0.109***	0.142**
	(0.146)	(0.158)	(0.041)	(0.063)
Localized Industry foreign presence (*FPCI*)	-0.051	-0.095	-0.051	-0.004
	(0.126)	(0.125)	(0.126)	(0.083)
Local input share (*LIS*)	-0.060*	-0.065*	-0.030*	-0.026*
	(0.038)	(0.038)	(0.016)	(0.016)
	$X \geq 20$	$X \geq 20$	$X \geq 20$	$X \geq 20$
Input-sharing proximity (*IS Proximity*)	-0.169*	-0.158*	-0.045	-0.067
	(0.095)	(0.092)	(0.065)	(0.066)
Opportunities of sharing common local suppliers (*LIS * IS Proximity*)	0.006**	0.007**	0.001	0.001
	(0.003)	(0.003)	(0.002)	(0.002)
Foreign employee presence (*FPW*)	0.037*	0.052*	0.037	0.003
	(0.031)	(0.029)	(0.031)	(0.017)
Labor-skill proximity (*LS Proximity*)	-0.196	-0.001	-0.281*	-0.608***
	(0.174)	(0.384)	(0.147)	(0.185)
Opportunities of labor interaction and mobility (*LS Proximity*FPW*)	0.029	0.002	0.044*	0.083***
	(0.030)	(0.061)	(0.025)	(0.026)
Plant controls	Y	Y	Y	Y
City level controls	Y	Y	Y	Y
Country-Year dummies	Y	Y	Y	Y
Industry-Year dummies	Y	Y	Y	Y
R-sq	0.429	0.436	0.346	0.354
# Observations	1730	1684	5626	5329

Notes: Robust standard errors clustered at the joint city and corresponding ISIC 2, 3, and 4 digit industry level respectively are presented in parentheses. Significance at the 10 percent, 5 percent, and 1 percent confidence levels are denoted by *, **, and *** respectively. Unless otherwise specified, all variables are represented in natural logs. Other independent variables (not reported here) include natural log of plant age and dummy variables indicating whether or not the plant is located in a large city (capital city or city with population over 1 million) and whether or not the plant engages in exporting respectively.

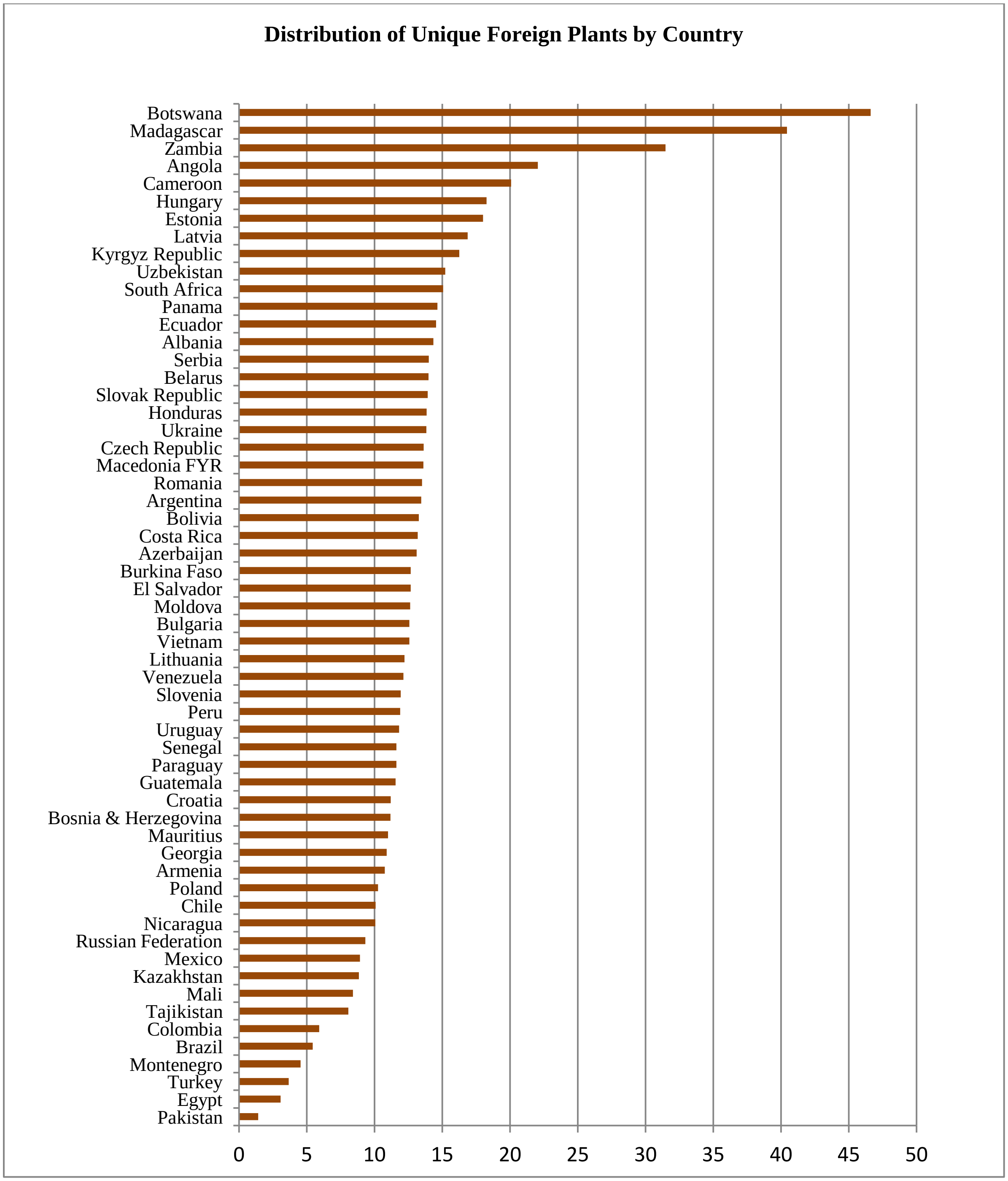

Figure A1: Percentage of foreign subsidiaries in the total number of unique plants by country

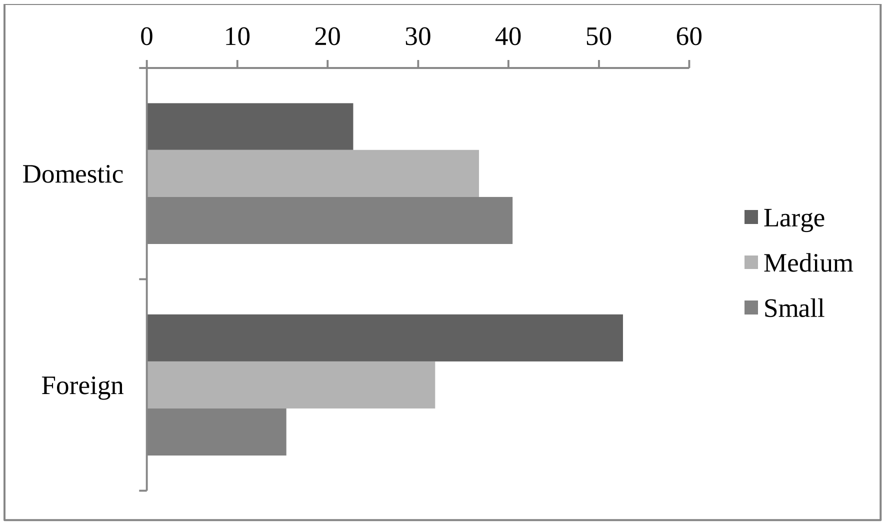

Figure A2: Average Share of Domestic and Foreign Manufacturing Plants in the Total Number of Manufacturing Plants by Size[27]

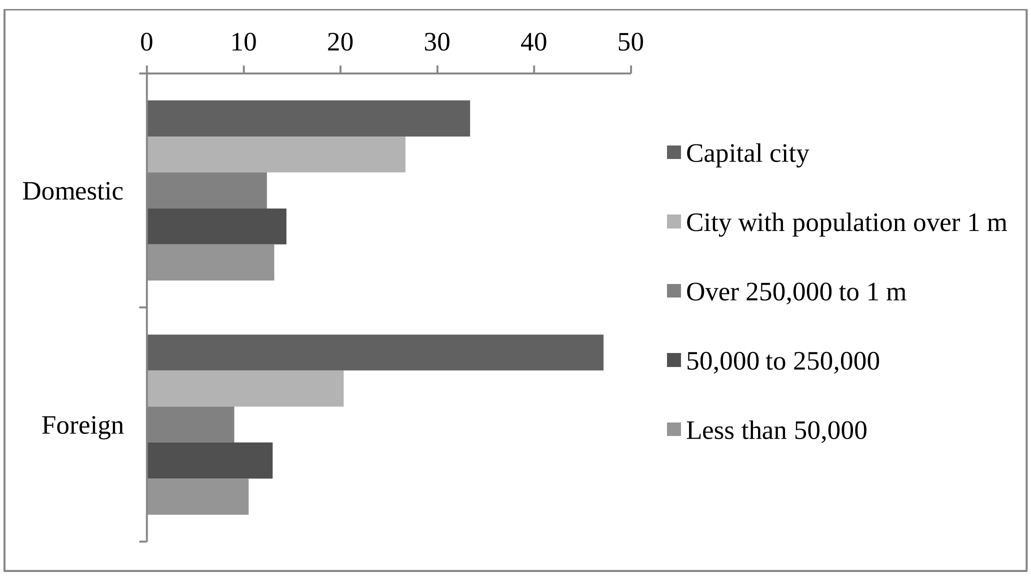

Figure A3: Average Share of Domestic and Foreign Manufacturing Plants in the Total Number of Manufacturing Plants by City Size

[27] Plant size measures are based on the annual number of full time permanent employees.

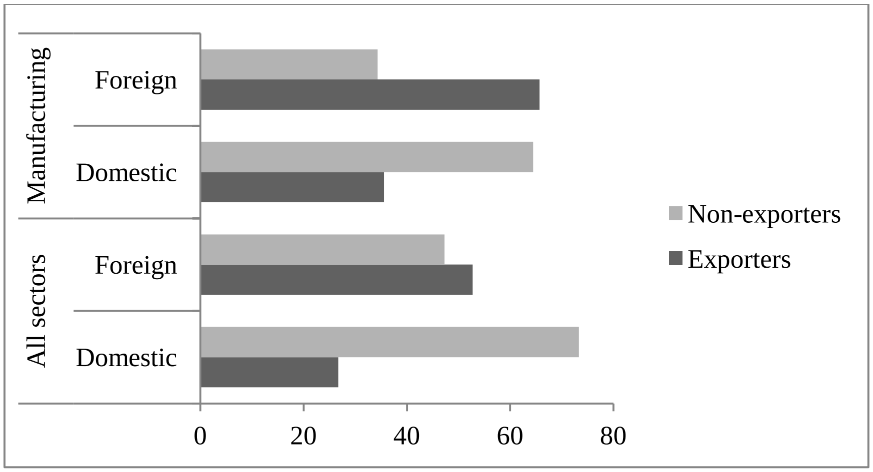

Figure A4: Average Share of Domestic and Foreign Exporters and Non-exporters