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Foreign Direct Investment and Technology Transfers to Local Suppliers: Identifying the effects of type of ownership and the technology gap

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**Regional FDI Spillovers and Local Suppliers:
Disentangling the effects of Foreign Ownership, Technology Gap and Absorptive
Capacity**

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Abstract

FDI firms can generate important positive dynamic impacts via sourcing linkages with local suppliers. In this paper, I present novel evidence on the scale, nature and spillover impact of FDI firms in Nuevo Leon, Mexico. The main findings are three-fold. First, I find no differences between FDI and domestic producer firms regarding their level of use of local suppliers. In strong contrast to this, FDI firms are significantly more involved in a variety of knowledge transfer activities. In particular, FDI firms provide more technological support, support with a direct positive impact on production processes of suppliers. In extension of this, I find that suppliers of FDI firms are significantly more likely to experience large positive technological and organizational impacts. Second, the technology gap between producer firms and suppliers plays a varied role. In general, a large technology gap lowers the supportiveness of producer firms. However, FDI firms offer more technological support when the technology gap with their local suppliers of material inputs is large. A large technology gap also enhances the probability that a suppliers experiences large positive effects from its dealings with the producer firms. Third, the level of absorptive capacity of suppliers is also important, as several indicators of absorptive capacity are significantly associated with local suppliers experiencing large technological and organizational impacts.

Key Words: FDI, input-output linkages, knowledge transfer activities, spillovers, technology gap, absorptive capacity, Mexico

JEL Classification: C21, F23, O18, O33

1. Introduction

Foreign direct investment (FDI) is increasingly seen as an important mechanism via which multinational enterprises (MNEs) disseminate new technologies to a large number of developed and developing host economies (Venables and Barba Navaretti, 2005). The entrance of FDI firms benefits a host economy, as it enhances the overall level of technology, fostering economic growth (Caves, 1996). Furthermore, via channels including labor turnover, demonstration effects and input-output linkages, domestic firms may learn about and adopt new technologies that are incorporated into FDI firms. As the domestic firms do not have to compensate the FDI firms for these extra-market transfers of technology, any resulting efficiency or productivity effects represent positive externalities or spillovers (Blomström and Kokko, 1998).

A growing part of recent applied research on these FDI effects focuses on externalities that materialize via input-output linkages between FDI firms and local suppliers. One approach focuses on the detailed empirical identification of these input-output linkages. Consisting of case studies and small scale surveys in regions within individual host economies, the original focus of this approach was placed on obtaining indicators of the static impact of FDI firms, representing the level of use of local suppliers (UNCTAD, 2001; Dunning and Lundan, 2008). More recent studies are trying to identify the dynamic impact of FDI firms, where these firms are seen source of new knowledge and technologies to their local suppliers (Potter et al., 2002, 2003). For instance, suppliers may learn about new technologies when FDI firms provide training programs to employees of their suppliers (Javorcik and Spatareanu, 2005; Javorcik, 2008). Also, personnel of FDI firms may offer assistance with quality control systems and other aspects of production processes of their suppliers (see e.g. Potter et al., 2002). As a result of such support, suppliers may experience technological development and upgrading.

The second approach towards the analysis of spillovers between FDI firms and local suppliers attempts to identify these effects econometrically. An initial wave of empirical studies produced evidence of positive FDI spillovers materializing in industries in which the FDI firms operate themselves, indicated by positive associations between the industry level of FDI participation and productivity of domestic firms (e.g. Blomström and Persson, 1983; Kokko, 1994; Sjöholm, 1999). However, subsequent studies have produced findings that challenge the original notion that such positive intra-industry FDI spillovers are prevalent (Aitken and Harrison, 1999; Djankov and Hoekman, 2000). In response to the heterogeneous nature of the evidence on these intra-industry spillovers, recent studies have started to distinguish between intra- and inter-industry externalities (Jordaan, 2009). Regarding inter-industry spillovers, the focus lies in particular on identifying externality effects among suppliers. Furthermore, the distinction between intra- and inter-industry FDI effects is accompanied by a focus on identifying these spillover effects at regional levels within host economies. A good example of this is Blalock and Gertler (2008), who estimate FDI spillovers in Indonesia. They distinguish between intra- and inter-industry FDI participation in the region of a given domestic firm. Their findings indicate that positive FDI spillovers only occur between industries, from FDI firms to local suppliers (see Blalock and Gertler, 2008). Similar evidence of positive spillover effects between FDI and local suppliers for other host economies is presented by Girma and Wakelin (2007) and Driffield (2004) for the UK, Smarzynska and Spatareanu (2011) for Romania and Jordaan (2008a) for Mexico.

The purpose of the present paper is to build on these recent developments in applied research on FDI spillover effects among local suppliers, whereby I attempt to combine the two approaches as described above. Using unique data that I obtained from several purpose-built firm level surveys in the manufacturing sector of Nuevo Leon in Mexico, my study

makes the following contributions to the literature. First, I address the central question that underlies all research on FDI effects, whether and how foreign-owned firms differ in their impact from comparable domestic firms. By design, standard econometric FDI spillover studies do not address this question, by estimating exclusively for associations between the industry presence of FDI and productivity of domestic firms. Case studies and surveys often present detailed indicators of the scale and nature of FDI backward linkages, but the vast majority rely on information obtained only from FDI firms. Comparable domestic firms and local suppliers are usually not included in the sample (for an exception, see Potter, 2002, 2003). In contrast to this, in the present study I compare the scale and nature of local linkages that FDI firms and domestic firms establish with local suppliers. Furthermore, using a random sample of actual local suppliers, I investigate the impact of these linkages on the local suppliers and assess whether there are differences between the impacts of FDI and domestic firms.

Second, the analysis focuses in detail on the roles that the technology gap and absorptive capacity of local suppliers play in externality-transmitting and –creating processes. Several econometric studies have attempted to identify the effect of absorptive capacity of domestic firms on FDI spillovers. This is done mainly by estimating for a relation between the technology gap between FDI and domestic firms and FDI spillovers, whereby the technology gap is interpreted as direct inverse indicator of the level of absorptive capacity of the domestic firms (e.g. Kokko, 1994; Girma, 2005). However, this interpretation of the technology gap can be challenged (Jordaan, 2009, 2011a). There is substantial evidence that a large instead of a small technology gap promotes positive FDI spillovers (e.g. Haskel et al., 2007; Jordaan, 2008b). Furthermore, the common interpretation of the technology gap is linked imperfectly to the underlying concept of catch up, originally developed to understand how international technology flows facilitate processes of convergence between advanced and lagging countries (Gershenkron, 1962; Nelson, 1968). An additional reason to investigate the role of the technology gap in externality-transmitting processes is that the majority of studies have looked at the effect of this gap on intra-industry FDI spillovers, leaving it unclear whether and how externalities to local suppliers are influenced by the level of technological differences between FDI firms and these suppliers.

To obtain new evidence on this, I separate the concepts of the technology gap and absorptive capacity. I do this in two different settings. First, I look at whether the technology gap between producer firms and local suppliers influences the level of supportive linkages and knowledge transfer activities that producer firms engage in. For instance, it may be that a producer firm lowers its support to a supplier that is technologically substantially backward. If so, a large technology gap can result in lower positive spillovers. Alternatively, a large technology gap may foster support, when the gap reflects the magnitude of the scope for improvement of the supplier, in which case a large gap may result in larger externalities (Jordaan, 2009). Second, I conduct multivariate analysis to see whether and how the technology gap matters for the dynamic impact that local suppliers experience. In particular, by estimating for separate effects of the technology gap and absorptive capacity, the analysis sheds new light on whether and how these two concepts can have independent effects on positive spillovers. For both settings, I also investigate whether there are differences between FDI and domestic producer firms, in particular to assess whether the technology gap plays a similar role for both types of firm.

The third contribution is that I conduct my analysis in a developing country setting. As mentioned earlier, FDI firms can play a key role in the international dissemination of new technologies. Mexico is a good example of this. Not only is the Mexican economy characterized by a substantial and growing share of foreign participation, the operations and effects of FDI firms are expected to play a key role in current and future processes of

economic and technological development in this host economy (OECD, 2009a, 2009b). In fact, the role of FDI firms is of central importance when considering that the Mexican economy is trying to move away from low skilled, labor intensive industries towards specializing in more technology and skilled-labor intensive manufacturing activities. Detailed evidence on the existence and nature of linkages between FDI firms and Mexican firm is sparse, however. In this context, the findings of this study will generate importance policy implications that can assist national and regional governments in Mexico and other developing host economies in designing and applying effective policies to stimulate positive local technology impacts of FDI firms.

The paper is constructed as follows. In section two I discuss the concept of FDI spillovers and present a selective review of empirical findings on the relation between spillovers and FDI input-output linkages. I also use this section to challenge the common interpretation of what the technology gap represents and I present an alternative interpretation that supports the expectation that a large technology gap fosters positive spillovers. Section three discusses the main findings on FDI spillovers and their regional dimensions in the Mexican economy. This section also explains the regional set up of the presents study and presents the findings from dichotomous comparisons between FDI firms and domestic producer firms. Regarding their static impact, I find no differences between FDI and Mexican producer firms. As for the dynamic impact, I find that producer firms are involved in a variety of knowledge transfer activities. In contrast to the static impact, the comparisons show substantial and significant differences, as FDI firms offer several types of support more frequently. This difference is most pronounced when it comes to support of a technological nature, support that has a direct positive impact on actual production processes of local suppliers.

Section four presents the findings from multivariate analysis on determinants of knowledge transfer activities and the impact of inter-firm linkages between producer and supplier firms. The analysis of determinants of the provision of support confirm that FDI firms are significantly more likely to offer support. Next, producer firms are less likely to offer support when the technology gap with their suppliers is large. However, FDI firms offer more support under a large technology gap. This suggests that whereas FDI firms interpret a large gap as indicating that the scope for improvement among their suppliers is large, domestic firms lower their support to technologically lagging suppliers. FDI firms only offer more support under a large technology gap when it concerns technological support, support with a direct impact on production processes of the suppliers. The findings from the multivariate analysis of determinants of a local supplier experiencing positive spillovers indicate that suppliers of FDI firms are significantly more likely to experience these effects. This finding is robust to controlling for the feature that FDI firms offer more support and that FDI firms offer more support when the technology gap is large. The positive effect of having FDI client firms is also robust to the possibility that suppliers with a high level of absorptive capacity self-select into becoming suppliers of FDI firms. If suppliers prefer to operate as supplier to FDI firms, (part of) the estimated positive effect of having FDI client firms would reflect this self-selection tendency. However, I find no evidence of such a bias. As for the independent effect of the technology gap, a local supplier is more likely to experience large positive technological impacts when the gap is large. At the same time, absorptive capacity is also important, as I find that several indicators of the level of absorptive capacity of a supplier influence the probability that the supplier experiences large technological and organizational impacts.

Finally, section five summarizes the main findings and discusses policy implications.

2. FDI Spillovers: Local Linkages, Technology Gap and Absorptive Capacity

FDI firms can generate important technology impacts in host economies. Not only does their entrance enhance the overall level of technology in these countries, domestic firms may benefit from indirect effects in the form of externalities or spillovers. For instance, the entrance of a new FDI firm may expose domestic firms to a new piece of technology. If the domestic firms absorb the new technology, any resulting efficiency or productivity effects constitute externalities, as there is no market capturing this technology dissemination (Blomström and Kokko, 1998; Jordaan, 2009). Next to these demonstration effects, processes of labor turnover between FDI and domestic firms can also generate non-market technology transfers, when domestic firms benefit from irreversible skills that workers gained while working for the FDI firms (Lipsey, 2004). Finally, input-output linkages between FDI firms and local suppliers or client firm represent the third channel that can foster the dissemination of technologies¹.

Despite the growing acceptance of the notion that FDI spillovers represent an important component of the positive economic impact that FDI firms can generate, the body of empirical evidence is far less clear on the prevalence of these effects (Hanson, 2001; Rodrik, 1999; Jordaan, 2009). Partly as a response to the heterogeneous nature of the evidence on intra-industry FDI spillovers, recent research is trying to improve identification strategies to obtain more robust evidence. In particular, several studies distinguish between intra- and inter-industry FDI externalities. It may be the case that positive intra-industry FDI spillovers are limited. In particular, FDI firms have an active interest in protecting their technology-based ownership specific advantages from their competitors. This gives them an incentive to try to prevent or lower positive spillover effects to these domestic firms that operate in the same industries as the FDI firms. In contrast, FDI firms may be less concerned about positive technological spillovers that are disseminated to other industries, in particular to input-supplying industries (Kugler, 2006; Moran, 2005). Blalock and Gertler (2008) present evidence that support these ideas. They find evidence of strong intra-regional positive FDI spillovers among domestic firms in input-supplying industries in Indonesia, whereas there is no evidence of intra-industry effects. Other studies that present similar evidence of positive intra-regional inter-industry spillovers include Girma and Wakelin (2007) and Driffield (2004) for the UK, Javorcik and Spatareanu (2011) for Romania and Jordaan (2008b, 2008c) for Mexico.

Having said this, it is important to consider that findings of a positive association between the industry presence of FDI firms and productivity of domestic firms in input-supplying industries represents only indirect evidence that input-output linkages are the main technology disseminating channel. Also, such evidence does not clarify how and why these spillover effects occur. To understand better how such spillover effects can occur, evidence from case studies and small scale surveys is more useful. Originally, the emphasis of this research approach rested on identifying the level of use of local suppliers by FDI firms. Harking back to Hirschman (1958), this interest relates to identifying the degree of the FDI firms' static impact, or multiplier effects, via the purchase of inputs in a host economy². More recently, the interest has shifted towards identifying the nature and types of linkages between FDI firms and their suppliers, in an attempt to obtain a better understanding of the dynamic

¹ The entrance of new FDI firms may also create a competition effect, where domestic firms are forced to become more efficient in response to the increased level of competition. In this case, FDI firms do not act as source of new technologies, but affect the conduct of domestic firms, representing a form of pecuniary externalities. Another aspect of this competition effect is that it may generate positive or negative externalities (see Aitken and Harrison, 1999).

² For surveys of research on the static impact of FDI firms, see UNCTAD (2001) and Dunning and Lundan (2008).

impact of FDI firms. Dynamic effects arise when input-output linkages generate flows of knowledge and technologies from FDI firms to their suppliers.

One reason why input-output linkages are particularly conducive to the creation of flows of technologies is that markets for inputs are usually characterized by limited numbers of buyers and sellers, firms that are in frequent contact (Lall, 1980; UNCTAD, 2001). As such, input markets are often not characterized by “at arm’s length” market transactions between anonymous and homogenous economic agents. Instead, markets for inputs are often characterized by close relationships between buying and selling firms, which fosters the transmission of ideas and information (Potter et al., 2002). Furthermore, FDI firms are often engaged in a variety of knowledge transfer activities, trying to improve the performance of their suppliers (Javorcik, 2008). Although FDI firms receive benefits in return for the support that they provide in the form of e.g. more cost effective or better quality inputs, the assumption is that in practice FDI firms will be unable to obtain complete compensation for the support that they provide. Therefore, supportive linkages are likely to result in the materialization of positive externalities of some degree (Blomström and Kokko, 1998). This is especially the case when a supplier can use the support it receives from one client firm to improve its performance for other client firms (Potter et al., 2003; Jordaan, 2011b),

Potter et al. (2002, 2003) provide detailed findings on the scale and nature of supportive linkages that FDI firms can establish. In their survey among domestic and FDI firms in the UK, they find that the informal sharing of views and ideas, personal contacts between personnel of FDI firms and domestic firms and visits by FDI staff to inspect production processes of their suppliers all constitute important ways via which knowledge and technologies are disseminated and shared. Their findings indicate that assistance with quality control systems, production development and cost control processes occur most frequently. Javorcik and Spatareanu (2005) present evidence from the Czech Republic that FDI firms are engaged in particular in financial support and the provision of training programs for employees of their suppliers (see also Javorcik, 2008). Crone and Roper (2001) find in their survey among FDI firms in Northern Ireland that ongoing audits of suppliers’ products and direct assistance with improving production processes are important types of knowledge transfer activity. Overall, these findings indicate that FDI firms can be an important source of new knowledge and technologies to their suppliers. The actual types and degrees of support and knowledge transfer activities may vary between different host economies and contexts, but it is clear that supportive linkages between FDI firms and suppliers offer an important explanation for the occurrence of positive spillovers among domestic firms in input-supplying industries.

2.2. Technology Gap and Absorptive Capacity

Another response to the heterogeneous nature of the evidence on intra-industry FDI spillovers has been the development of research that tries to identify endogenous factors that influence the level of these FDI effects (Blomström and Kokko, 2003; Venables and Barba Navaretti, 2005). Although there is a variety of factors that may be important, the majority of econometric research focuses on identifying the importance of absorptive capacity of domestic firms for the materialization of FDI spillovers (Jordaan, 2009)³. This is problematic, as there is no direct measure of the level of absorptive capacity. Most studies use the level of technological differences between FDI and domestic firms as proxy for absorptive capacity, equating a large technology gap with a low level of absorptive capacity of domestic firms. For

³ Other factors that may be important include the motivation of a FDI firm to invest in a host economy (Driffield and Love, 2007), its nationality (Haskel et al., 2007) and the level of foreign participation in the firm (Sjoholm and Blomstrom, 1999).

instance, Girma (2005) finds in his study on FDI spillovers among UK manufacturing firms that positive spillovers only occur when the technology gap is small, interpreting this as evidence that FDI spillovers only materialize among those domestic firms that have a sufficient level of absorptive capacity. Taki (2005) presents similar evidence for Indonesia. Kokko (1994) finds for Mexico that a positive association between industry wide FDI and productivity of domestic firms does not apply to industries that are characterized by a large FDI presence and a large technology gap.

However, a closer examination of the interpretation of the technology gap as direct inverse indicator of absorptive capacity suggests that this interpretation can be challenged (Jordaan, 2009). The concept of absorptive capacity is linked to the underlying concept of catch up, originally devised to understand how flows of technology between advanced and lagging countries can foster processes of convergence (Gershenkron, 1962, Nelson and Phelps, 1966; Nelson, 1968; Cohen and Levinthal, 1989, 1990; Keller, 1996). Lagging countries need a sufficient level of absorptive capacity to be able to absorb technology flows from advanced countries. However, the second key component of the idea of catch up is that the level of technological differences between the two groups of countries needs to be sufficiently large for meaningful effects to occur. When the technology gap is large, there is sufficient scope for lagging countries to learn and advance, suggesting a positive relation between the size of the technology gap and technological spillovers. Applying this notion to the occurrence of FDI spillovers suggests that, all else equal, positive FDI spillovers may be stimulated rather than hindered by a large technology gap (see Findlay, 1979, Blomström and Wang, 1992). Furthermore, as Rodrik (1992) argues, it is important to consider that the materialization of externality effects partly depends on active participation by externality receiving agents (see also Goh, 2005). This suggests that domestic firms will increase their efforts to absorb technologies when the technology gap is large, as the large gap indicates that there are large benefits to be obtained from doing so. In other words, domestic firms may try to enhance their level of absorptive capacity when the technology gap is sufficiently large. All else equal, this would result in an estimated positive relation between the technology gap and positive FDI spillovers.

There is substantial evidence that such a positive relation exists (Jordaan, 2009). For a variety of host economies, Haskel et al. (2007), Castellani and Zanfei (2003), Zukowska-Gagelmann (2000) and Jordaan (2005, 2008b) all find a positive productivity effect of an interaction variable between the industry presence of FDI and the industry level of technological differences between FDI and domestic firms. Also, Jordaan (2005) presents evidence indicating that positive intra-industry spillovers only occur in high tech industries. Furthermore, Blomström and Wolff (1994), Sjöholm (1999) and Jordaan (2008b, 2008b) all find a direct positive effect of the technology gap on positive intra-industry FDI spillovers. Evidence on the effect of the technology gap on inter-industry spillovers is more limited, but the few studies that do look at this relation find a positive effect of the technology gap. Nicolina and Resmini (2010) estimate FDI spillovers for Bulgaria, Romania and Poland and find that positive spillovers among suppliers are most pronounced in high tech industries, industries with a presumably large technology gap between FDI and domestic firms. Bekes et al. (2009) and Jordaan (2008b) find a direct positive effect of a large technology gap on positive inter-industry FDI spillovers for Hungary and Mexico respectively.

2.3. Hypotheses

It is clear that FDI firms can generate important technology impacts when they act as source of new knowledge and technologies to domestic firms in host economies. Although the large body of evidence is very heterogeneous of nature, it appears that positive FDI spillovers are

more likely to be of an inter- than an intra-industry nature. In particular, FDI firms may generate positive spillovers effects among their local suppliers. Having said this, there are certain aspects of the research approaches and the evidence that require more investigation. The purpose of the present paper is to conduct a study on FDI linkages with local suppliers that tries to address these aspects. To do so, I address the following hypotheses:

(a) Foreign-owned producer firms generate a larger dynamic impact among local suppliers than domestic producer firm

Econometric research on FDI spillovers as well as case and survey based studies on FDI backward linkages focus on the impact that FDI firms create. This means that they do not address the central question that underlies all research on FDI effects, whether the impact of FDI firms differs from the impact that domestic firms create. Especially from the point of view of host economy governments that often offer substantial financial incentives to attract more FDI firms, questions whether and how FDI firms are actually different from domestic firms are very relevant. I address this hypothesis in two ways. First, I look at the level and nature of knowledge transfer activities that producer firms are engaged in and I assess whether and how FDI firms may differ from domestic producer firms. Second, I assess whether type of ownership of a producer firm matters for the positive impact that actual local suppliers may experience from their business dealings with the producer firm.

(b) The technology gap between producer firms and local suppliers promotes rather than hinders the dynamic impact among local suppliers

Empirical evidence on the effect of the technology gap is conflicting. Also, the standard interpretation of what the technology gap captures can be challenged. Especially given the fact that findings that a small or a large technology gap promotes positive spillovers lead to completely opposing policy implications, more detailed evidence on what the effect of the technology gap is and what the explanations of this effects may be is called for. Following the discussion in the previous section, the hypothesis reflects that large technological differences between FDI firms and local suppliers can promote positive spillovers. Rather than representing the inverse level of absorptive capacity of domestic firms, I interpret the technology gap as capturing the scope for improvement of suppliers, offering incentives to the suppliers to try to absorb new technologies. I address the hypothesis as follows. First, I look at whether the technology gap is related to the degree to which a producer firm offers support to its suppliers. Second, I analyze the relationship between the technology gap between the producer firms and the suppliers and the dynamic impact that suppliers experience from their business dealings with the producer firms.

(c) The level of absorptive capacity of a supplier influences the dynamic impact that local suppliers experience

The common interpretation of the technology gap as inverse indicator of absorptive capacity of domestic firms is inaccurate. Of course, this does not mean that absorptive capacity is unimportant for spillover effects to occur. Instead, the main implication of rejection the standard interpretation of the technology gap is that alternative indicators of absorptive capacity need to be explored. I address this hypothesis on the importance of absorptive capacity by investigating whether supplier characteristics that capture aspects of the level of absorptive capacity are important for allowing dynamic impacts from producer firms to local suppliers to materialize.

3. Research Setting and the Static and Dynamic Impact of FDI and Mexican Producer Firms

3.1. Introduction

Mexico represents a suitable developing host economy to study the effects of FDI firms. The country belongs to a select group of developing countries that have received substantial inflows of inward FDI for several decades (UNCTAD, 2005). The introduction of trade liberalization in the late 1980s, followed by the creation of the North American Free Trade Agreement (NAFTA) in 1994 have further increased levels of inward FDI markedly (Cuevas et al., 2005; Jordaan, 2008a). To indicate the growing level of foreign participation in the Mexican economy, the share of the stock of inward FDI in Mexico's total GDP has increased from a little over 8% in 1990 to more than 27% in 2006 (Jordaan, 2008c). As a result, FDI firms will play a central role in current and future processes of economic and technological development in this host economy (OECD, 2009a, 2009b).

There is considerable econometric evidence that FDI firms generate spillover effects among Mexican firms. Well-known evidence on intra-industry spillovers, based on unpublished manufacturing data for the 1970s, shows positive associations between the industry presence of FDI and productivity of Mexican firms (Blomström and Persson, 1983; Kokko, 1994; Blomström and Wolff, 1994). More recent evidence, based on unpublished national and regional manufacturing census for the 1990s also identifies positive FDI spillovers. Jordaan (2005, 2010) presents evidence of a positive association between industry FDI and productivity of Mexican firms at the national level. Similar evidence for a selection of Mexican regions is presented by Jordaan (2008b).

Next, there are indications that FDI spillovers are more pronounced at the regional level within Mexico. For instance, Aitken et al. (1997) find that market access spillovers are confined at the state level. Jordaan (2005) finds that positive FDI spillovers are most pronounced in industries with a high level of agglomeration within Mexico. Regarding FDI spillovers among local suppliers, Jordaan (2008a) finds a positive association between productive of Mexican firms and intra-regional inter-industry FDI participation. Related evidence of a positive growth effect of regional FDI participation is presented by Jordaan and Rodriguez-Oreggia (2010). Finally, Jordaan (2008b) uses detailed manufacturing industry data to estimate FDI spillovers in Mexico City and states that share a border with the US, representing the regions within Mexico containing the vast majority of FDI investment. The findings indicate that positive associations between productivity of Mexican firms and FDI participation occur mainly among Mexican firms operating in regional input-supplying industries, suggesting that local suppliers of FDI firms are benefitting from positive FDI spillovers.

In addition to these findings from econometric studies on FDI spillovers, some more qualitative studies present evidence that FDI firms may be involved in knowledge transfer activities with their local suppliers. Overall, the impression exists that technology transfers from FDI firms to domestic firms are limited, however (see OECD, 2009a, 2009b). Survey findings from the early 1990s indicate that FDI firms are mainly involved in helping local suppliers with quality control procedures (UNCTAD, 1992). Padilla-Perez (2008) presents survey findings of a similar nature, although the number of affected Mexican suppliers is limited. Ivarsson and Alvstam (2005) present detailed findings from their case study of the Swedish multinational Volvo in Puebla. They follow UNCTAD (2001) in distinguishing between assistance with product technology, production technology and training of suppliers. Overall, their findings indicate that assistance with product technology occurs most frequently.

3.2 Research Setting and Design

The regional economy where the study is conducted is Nuevo Leon in Mexico. This state, also known as the manufacturing belt of Mexico, is located in the north-east of Mexico and contains the second or third largest agglomeration of economic activity (Vellinga, 2000; Jordaan, 2009). Importantly, Nuevo Leon has grown in importance following the introduction of trade liberalization in the late 1980s and has actively and successfully pursued policies of trade promotion and economic liberalization. Also, its manufacturing sector is characterized by a considerable level of foreign participation, offering good opportunities to identify and analyze the effects of FDI firms (Jordaan, 2009; Vellinga, 2000; Jordaan and Harteveld, 1997). With respect to the analysis of spillover effects between FDI firms and local suppliers, the earlier-referred to study by Jordaan (2008b) finds a positive association between the industry presence of FDI and productivity of Mexican firms in input-supplying industries in this regional economy.

In cooperation with the ITESM University, I carried out extensive fieldwork during the years 2000-2001. In particular, I applied several purpose-built firm level surveys among FDI and Mexican firms in key sectors of the manufacturing sector of Nuevo Leon. Using information from the local branch of INEGI, the local affiliate of the American Chamber of Commerce in Mexico and local industry associations, I compiled a list of 180 Mexican and foreign-owned producer firms with more than 150 employees operating in the car, electronics or chemical industries. Following a pilot study among 30 of these firms, all firms were contacted to participate in the producer firm survey. 82 firms participated, representing a response rate of 46%⁴.

Next, I conducted a survey among local firms that operate as supplier to the producer firms. Here I faced the important problem that asking the producer firms for contact details of their suppliers would result in a biased sample (see Potter et al., 2003). Therefore, I constructed a second list of firms, containing all manufacturing firms in the regional economy that employed less than 150 workers and were registered with a regional industry association. I treated this list of 1,100 firms as the pool of potential local suppliers. I carried out a telephone survey to identify actual local suppliers of the large producer firms. After a three month period, 356 firms had participated in the telephone survey⁵. Of these participating firms, 300 indicated having large producer firms in the regional economy as client firms⁶. Finally, following a pilot study, we approached all the 300 suppliers to participate in the supplier survey. 100 firms participated, representing a response rate of 33%⁷.

3.3. Static and Dynamic Impact: Comparing FDI and Domestic Producer Firms

The first component of the local impact of FDI firms concerns their static impact, related to their level of use of local suppliers. Figure one presents several key indicators related to this static impact, of both FDI and domestic producer firms. The main impression that emerges is

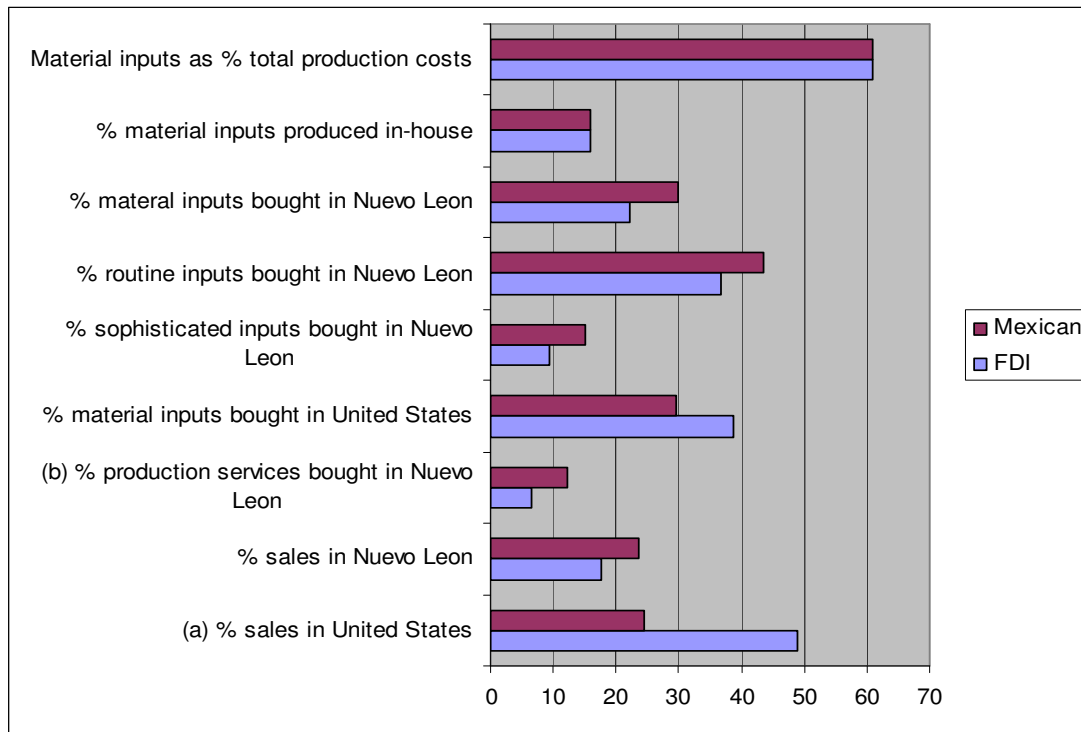
⁴ See the appendix for information on the characteristics of the producer firms.

⁵ We tried to contact all the firms on the list. The most important reason for non-response was that the telephone number of a firm was no longer in operations or that a firm did not answer the phone. In the case that a firm did not answer the phone, the company was called back the next day, with a maximum number of 5 tries. Looking at the non-respondents, the vast majority consist of micro firms, employing 1 to 5 employees.

⁶ A firm's decision not to participate with the telephone survey is not related with a firm not being a supplier to producer firms. Firms were told at the start of the telephone interview that the short interview was conducted to obtain information on their firm characteristics and the overall functioning of the regional economy, after which the firms indicated whether or not they wanted to participate in the survey.

⁷ See the appendix for characteristics of the supplier firms.

Figure 1 Static Impact FDI and Domestic Producer Firms



Source: Producer Survey. a and b indicate significance levels of 1 and 5%, based on Equality of Means test. Material input variables measured as % of total material input costs. Production services measured as % of total production costs. Sales variables measured as % of total sales.

that FDI firms and Mexican producer firms are remarkably similar. Both types of firm report a similar importance of material inputs in overall production costs. They also produce a comparable level of inputs themselves in-house. Mexican firms do source a higher percentage of their material inputs from local suppliers, but a comparison of the mean values of both types of firm indicates that the difference with FDI firms is insignificant. The sample average use of local suppliers is 26% of total material inputs is, which is substantial and in line with findings by e.g. UNCTC (1992) and Martinez-Solano and Phelps (2003). The marked similarity in local sourcing applies to both routine and sophisticated inputs. As for the level of international sourcing, FDI firms do purchase more of their inputs from suppliers in the US, but again the difference with Mexican producer firms is not significant. The only significant differences appear to exist in the use of local providers of production services and the level of international sales⁸. However, in related research I conduct multivariate analysis to identify determinants of the level of use of local suppliers by the producer firms and find that, once I control for the effects of firm size, use of parts and components and type of production process, there is no significant difference in the level of use of local providers of production

⁸ Local production services are usually not included in surveys on the static impact of FDI firms, which tend to focus on material inputs. Production services capture situations where intermediate inputs leave the factory of a producer firm to receive some form of treatment by a local firm. After the treatment, the input is returned to the producer firm to be re-integrated into the production process. Production services include activities such as metal plating and stamping, plastic molding, surface conversion and coating and product finishing activities. The sample average of locally purchased production services is about 10% of total production costs, indicating the importance of including local providers of this type of input in the survey.

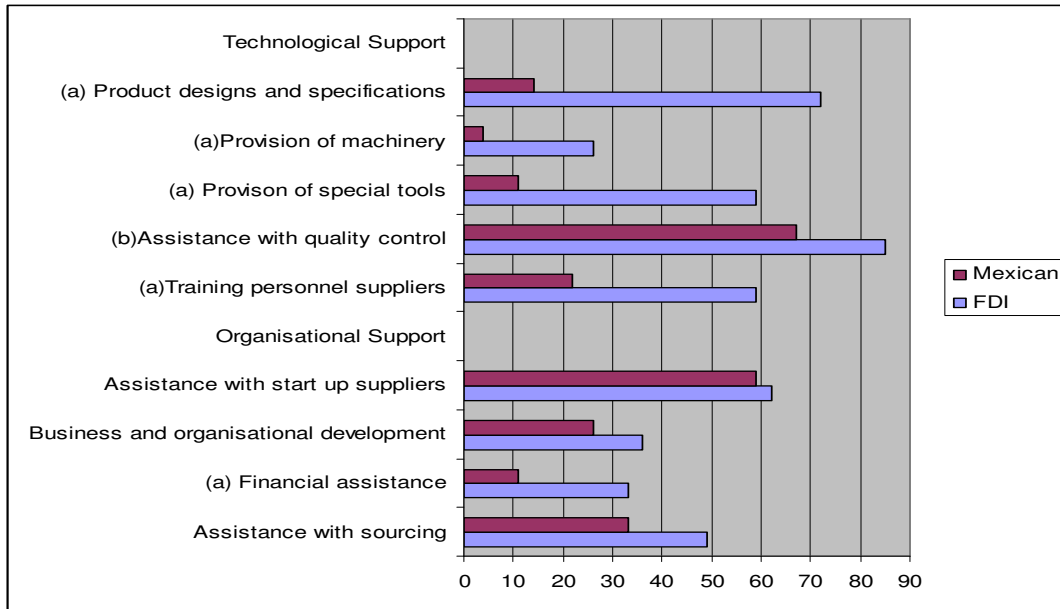
services between FDI and Mexican firms (see Jordaan, 2011b). Therefore, the only difference between FDI and domestic producer firms is that FDI firms sell a larger share of their products on international markets.

The second component of the local impact of producer firms concerns their dynamic impact. Figures two and three present findings from the producer survey on the nature and degree of knowledge transfer activities that the producer firms engage in. I distinguish between FDI and domestic producer firms and between support offered to suppliers of material inputs and providers of production services. In the survey, I distinguished between two main types of support, following UNCTAD (2001). Technological support concerns support with a direct impact on production processes of suppliers. This category includes the provision of product designs, specifications and blue prints, the provision of machinery or special tools, assistance with quality control systems and the provision of training programs for employees of suppliers. The other type of support is organizational support, support that is aimed at improving the overall business performance of suppliers. This includes general business support, assistance during the start-up phase of a new supplier, financial support and assistance with the sourcing of inputs.

The findings on the supportive linkages that producer firms engage in are interesting in several respects. Overall, FDI firms are involved in the provision of a variety of both technological and organizational support. Setting aside for the moment any differences with domestic producer firms, FDI firms are most engaged in helping local suppliers with quality control systems and procedures. Almost 85% of the FDI firms offer this type of support frequently. Second most important is the provision of product designs, specifications and blue prints, followed by the provision or lending of special tools and the provision of training programs for suppliers. Overall, it does seem to be the case that FDI firms are more supportive to their suppliers of material inputs than to local providers of production services. Also, it appears that the FDI firms are more engaged in the provision of support of a technological nature, support with a direct impact on production processes of the suppliers. Having said this, especially given that I only consider those FDI firms that offer frequent support to offer any support at all, the scores for several types of organizational support indicate that many FDI firms are involved in this type of support. For instance, one out of every three FDI firms offers frequent financial support, and half of the foreign-owned firms frequently provide help to suppliers with their input sourcing practices.

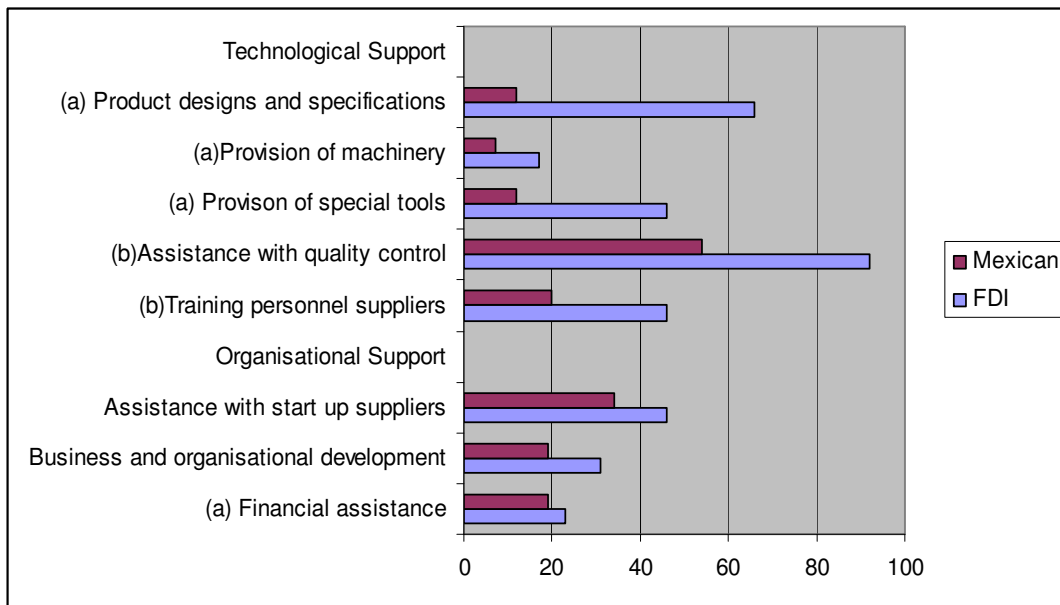
Next, a comparison of the responses given by the FDI firms and domestic producer firms indicates that there are significant differences between the two types of firm regarding their involvement in knowledge transfer activities. There are several types of support where FDI firms are significantly more active. This finding is very suggestive, in particular given the findings presented in figure 1 that show that FDI and domestic producer firms are markedly similar in terms of the static impact that they create. In strong contrast to this high degree of similarity, FDI firms are very different when it comes to the provision of support that is linked to the creation of a positive dynamic impact. Another distinctive feature of the differences between FDI firms and domestic producer firms is that FDI firms are more supportive in particular when it comes to providing support of a technological nature, including help with quality control systems, the training of employees of suppliers and the provision and lending of special machinery. This applies to both support offered to suppliers of material inputs and providers of production services. In other words, FDI firms are more involved in those types of support with a direct positive impact of production processes of their suppliers. This indicates that FDI firms are a particular good source of new knowledge and technologies to their suppliers, suggesting that the foreign-owned firms are a better source of positive local technological spillovers than the domestic producer firms.

Figure 2 Knowledge transfer activities to suppliers of material inputs



Source: Producer Survey. The table shows % of producer firms that indicate that they provide a particular type of support frequently. a and b indicate significance levels of 1 and 5 %, based on Kruskal-Wallis test.

Figure 3 Knowledge transfer activities to suppliers of production services



Source: Producer Survey. The table shows % of producer firms that indicate that they provide a particular type of support frequently. a and b indicate significance levels of 1 and 5 %, based on Kruskal-Wallis test.

4. Foreign Ownership, Technology Gap and Absorptive Capacity

The previous section has identified important differences in the local dynamic impact between FDI firms and domestic producer firms. In particular, FDI firms are more supportive when it comes to offering support with a direct positive impact on production processes of local suppliers. Of course, this finding needs to be interpreted with caution, as it is based on dichotomous comparisons between the two types of producer firm, unconditional on other factors that may explain levels of supportiveness. Also, although it is a plausible assumption that supportive linkages will generate positive externalities among the suppliers, differences in supportiveness may not translate directly into differences in the impact of the two types of producer firms. For instance, it may be the case that although domestic firms offer less support, they are more effective in the provision of support, which could result in a larger dynamic local impact. Alternatively, it may be that suppliers of FDI firms are less capable of using the support that they receive to improve their performance, which would necessitate higher levels of support to create a similar impact compared to domestic producer firms. In this section, I conduct multivariate analysis to identify factors that influence the level of supportiveness of the producer firms and the positive impact that suppliers experience from their business dealings with their client firms. In this analysis, I focus in particular on identifying the effects of type of ownership of the producer firms, the technology gap between producer firms and their suppliers and the level of absorptive capacity of the suppliers.

4.1. Provision of Support by Producer Firms

To identify the effects of type of ownership and the technology gap on knowledge transfer activities, I estimate regression models of the following specification:

$$(1) \text{Support}(i) = \beta_0 + \beta \text{FDI}(i) + \beta \text{TECHGAP}(i) + \beta \text{TECHGAP} * \text{FDI}(i) + \beta X(i) + \beta \text{INDUSTRY}(i) + \varepsilon(i)$$

The dependent variable is a binary variable taking the value of 1 when producer firm (i) offers support frequently and 0 when a producer firm offers support sometimes, occasionally or offers no support. The dichotomous nature of the variable makes the use of the logit regression model appropriate, relating to the odds that a producer firm offers support. These odds are defined as the ratio of the probability that a producer firm offers frequent support (π) over the probability that a producer firm does not offer frequent support ($1-\pi$). Taking the log of this ratio gives the logit, which is used as dependent variable of a logit regression model that can be estimated with maximum likelihood techniques. The estimation of this type of logit model is very appropriate for the present analysis. It has been used frequently in similar research (see e.g. McCann and Fingleton, 1996) and is in line with approaches and interpretations of the OECD Oslo Manual and the European Community Innovation Surveys. The logit model becomes:

$$(2) \ln(\pi/1-\pi) = \beta_0 + \beta \text{FDI}(i) + \beta \text{TECHGAP}(i) + \beta \text{TECHGAP} * \text{FDI}(i) + \beta X(i) + \beta \text{INDUSTRY}(i) + \varepsilon(i)$$

The variable FDI takes the value of 1 when a producer firm is foreign-owned and 0 otherwise⁹. Given the findings in the previous section, I expect a positive effect of this

⁹ See the appendix for a list with all the variables with definitions.

variable on the level of supportiveness. The variable TECHGAP captures the level of technological differences between a producer firm and its suppliers. Previous research has only considered the direct impact of the technology gap on spillovers. However, the technology gap may also affect the level of supportiveness of a producer firm, which subsequently can affect the resulting level of spillovers among domestic firms. I interpret the technology gap as indicating the scope of the potential improvements that local suppliers can experience. The variable is measured as follows. It takes the value of 1 when a producer firm indicates that large technological differences with its local suppliers are among the two most important reasons preventing the firm from increasing its level of local sourcing¹⁰. I also include an interaction variable between the variables FDI and TECHGAP to test whether foreign-owned firms differ in their level of supportiveness from domestic producer firms when facing a large technology gap with local suppliers.

Striving towards the specification of a parsimonious regression model, X contains five control variables. I control for the age of a producer firm (AGE), given findings from research on determinants of the static impact of producer firms that show that older firms generate a larger static impact (UNCTAD, 2001). Next, I control for the size of a producer firm (SIZE) under the assumption that larger firms have more resources to devote to the provision of support (Jordaan, 2011b). I also include a variable labeled MAT, capturing the relative importance of material inputs in total input costs. I expect a positive effect of this variable when a larger reliance on material inputs (as opposed to raw materials and intermediate inputs) fosters a producer firm's supportiveness to local suppliers (see Jordaan, 2011b).

Next, I need to control for the feature that producer firms may participate in the Maquiladora program. It is well documented that many Maquiladora firms are poorly integrated into their local economy (CEPAL, 199; Buitelaar and Padilla-Perez, 2000; Ramirez, 2003). However, there is a recent development where younger generation Maquiladora firms may be advancing linkages into their local economies (Carrillo and Hualde, 1998; Sargent and Matthews, 2004; Jordaan, 2011b). These Maquiladora firms are more engaged in actual production rather than assembly operations and are more autonomous regarding decisions on their level and nature of local sourcing (Sargent and Matthews, 2008). To capture the effect of participation in the Maquiladora program and the possibility that younger generation Maquiladora firms have a different local impact, I include two variables to the regression model. I include a dummy variable labeled MAQUILA to capture those Maquiladora firms that have been operating in Nuevo Leon for more than 15 years. I expect a negative effect of this variable, as it captures first generation Maquiladora firms. The second variable is a dummy variable labeled NEWMAQUILA, which takes the value of 1 when a producer firm operates in the Maquiladora program. If younger generation Maquiladora firms are more integrated into the local economy, this variable will be positively associated with the probability that a producer firm offers support.

Finally, I need to address two econometric issues. First, I need to control for the possible presence of structural differences in supportiveness between industries and municipalities. To capture the industry effects, I include dummy variables for the car, electronics and chemical industries (INDUSTRY). As for the municipality effect, it may be that certain municipalities are characterized by higher levels of support. This may be the case when suppliers locate in proximity of producer firms that they know or expect to be more supportive. Also, municipalities may have a high level of agglomeration of economic activity in general. This may facilitate formal and informal inter-firm contacts, promoting the

¹⁰ The variable TECHGAP is measured in this way because producer firms indicated that the most important reason for not increasing their level of local sourcing is the absence of suitable suppliers. All the other reasons that the producer firms provided, including a large technology gap with local suppliers, apply to existing local suppliers.

occurrence of knowledge spillovers (See Storper and Venables, 2004). To control for this spatial effect, I estimate the regression model allowing for clustered standard errors at the municipality level.

Second, I need to consider the issue of how to interpret the estimated coefficient of the interaction variable between FDI and TECHGAP. In a standard OLS regression, the estimated β coefficient of an interaction variable capture the direct and full effect on the dependent variable. This is not the case for logit or probit regression models (Greene, 2003; Ai and Norton, 2003). The reason for this is that in such regression models the estimated effect of an interaction variable also depends on the values of the other control variables. This means that the directly estimated β coefficient only represents the marginal effect on the interaction variable. In fact, it may be the case that whereas the directly estimated effect is not significantly different from zero, the actual interaction effect does exist (Norton et al., 2004). Also, the sign of the estimated β coefficient is unreliable. Therefore, in addition to reporting the directly estimated coefficient of the interaction variable FDI*TECHGAP I also report an adjusted β coefficient with corresponding z statistic that I obtain from applying the procedure as discussed by Ai and Norton (2003) and Norton et al. (2004). This procedure uses the cross-partial derivative of the expected value of the dependent variable with respect to the interaction variable and gives the average (full) effect of the interaction variable.

Empirical Findings on Determinants of Knowledge Transfer Activities

The main findings from estimating regression model (2) for the various types of technological and organizational support are presented in table 1. The first column with findings presents the results from estimating the model with the frequent provision of aggregate technological support to suppliers of material inputs as dependent variable. The estimated positive effect of firm size indicates that firms with more resources are more likely to offer support, as expected. Producer firms with a relative large share of material inputs in total inputs costs also provide more support. The estimated effect of the two Maquiladora variables confirms the presence of a structural difference between Maquiladora firms of different generations: whereas first generation Maquiladora firms are less likely to offer support, younger generation Maquiladora firms offer more support.

Next, the estimated effect of type of ownership is positive, indicating that FDI firms are significantly more likely to offer support. This finding constitutes important support for the findings in the previous section that indicate the marked supportiveness of FDI firms. The importance of the finding here is that the supportiveness of FDI firms is confirmed, even when controlling for a range of other factors that are associated with supportiveness.

The estimated effect of the technology gap between producer firms and local suppliers is negative. This indicates that a producer firm offers less support to a local supplier when the supplier is technologically substantially backward. This provides an alternative explanation for findings from econometric studies that find a negative effect of a large technology gap on FDI spillovers (e.g. Girma, 2005; Taki, 2005). Rather than capturing the effect of a low level of absorptive capacity of domestic firms, the negative effect of the large technology gap can be explained by the decrease in support that producer firms offer. As this lower the amount of technologies that are transferred to domestic firms, the resulting spillover effects will be smaller.

However, the estimated effect of the interaction variable between the technology gap and type of ownership is significant and positive. According to this finding, FDI firms are more likely to offer support when facing a large technology gap with its suppliers. This suggests that whereas domestic firms see a large technology gap as an obstruction to offer support, FDI firms perceive the gap as representing a large potential scope for their suppliers

to improve. This finding offers an explanation for econometric evidence of a positive relation between FDI spillovers and an interaction variable between industry FDI and the technology gap (e.g. Haskel et al., 2007; Jordaan, 2005). FDI firms offer more support when the technology gap is large, enlarging the amount of technologies that is transmitted to their suppliers. As a result, the suppliers experience more positive externalities.

The next set of columns presents the findings from estimating the regression model for the various individual types of technological and organizational support. Most variables show a considerable consistency in their estimated effect. For several types of support, the positive effect of firm size and reliance on material inputs is confirmed. Also, in almost all cases the effect of the variable of mature Maquiladora firms is negative, indicating their poor level of integration into the local economy. In contrast, younger generation Maquiladora firms are more likely to offer more support, confirming the notion that there are structural differences in local connectedness between Maquiladora firms of different generations.

As for the effect of type of ownership, FDI firms are more supportive when it concerns types of technological support. Except for financial support, type of ownership does not matter for the provision of organizational support. Again, this is in line with the findings from the dichotomous comparisons between FDI and domestic producer firms of the previous section. The negative effect of the technology gap applies to all but one type of technological support.

Importantly, the estimated positive effect of the interaction variable between FDI and TECHGAP also applies mainly to types of technological support. Looking at the adjusted β coefficient of the interaction variable, the positive effect materializes for technological support in the form of lending of machinery, the provision of special tools, assistance with quality control systems and the provision of training programs for employees of the suppliers. When it comes to organizational support, the estimated effect of the interaction variable is insignificant. An explanation for this importance difference may be that FDI firms are better able to assess potential improvements of their suppliers when it comes to evaluating the scope to improve actual production processes of these firms. This may be much more difficult when it comes to assessing whether and to what extent suppliers can achieve substantial improvements from receiving organizational support, support that does not have a direct link with suppliers' production processes. In other words, the positive effect of the technology gap on the supportiveness of FDI firms materializes only in those cases where FDI firms are in a position that they can assess the potential of their suppliers to experience improvements of a technological nature.

Finally, the last set of findings presents the effects of the control variables on the provision of types of technological support to local providers of production services. The estimated effects of the main variables of interest are more varied compared to the previous regressions. For instance, in two of five cases, the estimated effect of the Maquiladora variables is in line with the existence of differences between Maquiladora firms of different generations. This variability does not apply to the effect of type of ownership, as the findings indicate that FDI firms are significantly more supportive to local providers of production services. The negative effect of the technology gap on the provision of support applies to the provision of product designs and specifications, the provision of special machinery and the lending of special tools. Importantly, the z statistic of the adjusted β coefficient of the interaction variable between FDI and TECHGAP indicates that FDI firms do not offer more support to providers of local production services when the technology gap with these providers is relatively large. This can be explained by the feature that FDI firms are much less familiar with production services. When FDI firms have knowledge and experience in the production of material inputs, they are in a good position to assess and predict potential

Table 1 FDI and the Technology Gap as Determinants of Knowledge Transfer Activities

	Support offered to Suppliers Material Inputs										Support offered to Providers Production Services				
	Techn Support	Designs	Mach	Tools	Control	Training	New Supp	Business	Finance	Inputs	Designs	Mach	Tools	Control	Training
AGE	0.23 (0.50)	-0.23 (1.05)	-0.31 (0.92)	0.65 (1.78)c	-0.85 (2.80)a	-0.14 (0.60)	-0.55 (1.60)	-0.22 (0.27)	-0.14 (0.60)	-0.08 (0.30)	-0.37 (1.09)	0.41 (0.73)	0.23 (0.56)	-0.82 (3.32)a	0.35 (1.43)
SIZE	0.33 (2.98)a	0.85 (2.63)a	0.09 (0.50)	0.19 (0.64)	0.10 (0.61)	0.21 (3.53)a	0.85 (3.55)a	0.31 (1.72)c	0.25 (0.77)	0.14 (0.45)	0.27 (0.77)	-0.28 (0.82)	-0.19 (0.80)	0.15 (0.74)	0.18 (0.40)
MAT	1.94 (3.62)a	1.89 (2.80)a	0.79 (1.71)c	0.92 (1.70)c	0.90 (1.78)c	0.60 (1.06)	0.67 (1.36)	0.68 (1.78)c	0.60 (1.42)	-0.24 (0.45)	3.39 (5.86)a	1.26 (0.78)	0.91 (2.49)a	0.84 (2.53)a	0.26 (0.48)
MAQUILA	-2.67 (3.02)a	-2.66 (3.44)a	-2.51 (2.21)b	-1.67 (2.58)a	-0.83 (2.11)b	-1.29 (3.18)a	-1.41 (2.19)b	-0.83 (2.11)b	-0.31 (0.76)	-0.33 (0.95)	-9.80 (12.54)a	-7.12 (3.78)a	-0.41 (0.71)	-1.08 (1.47)	0.38 (0.66)
NEWMAQUILA	4.52 (3.10)a	4.70 (3.01)a	4.68 (3.06)a	3.24 (3.53)a	1.39 (1.96)b	2.71 (3.00)a	2.24 (1.92)b	1.39 (1.96)b	1.54 (2.24)b	1.81 (1.73)c	18.56 (12.22)a	9.52 (3.17)a	0.93 (1.13)	1.65 (2.84)a	1.22 (1.36)
FDI	1.38 (3.42)a	2.31 (3.43)a	0.37 (0.66)	1.34 (2.28)b	-0.06 (0.34)	0.81 (2.08)b	0.14 (0.36)	-0.15 (0.26)	0.78 (2.39)b	-0.04 (0.55)	9.14 (5.43)a	1.67 (3.14)a	0.81 (1.71)c	1.42 (2.33)a	0.80 (2.38)a
TECHGAP	-6.85 (7.18)a	-6.67 (8.11)a	-6.45 (7.29)a	-5.89 (9.62)a	-2.02 (0.13)	-5.87 (5.90)a	0.04 (0.11)	0.07 (0.13)	-5.20 (8.79)a	-6.42 (6.79)a	-7.07 (4.63)a	-5.56 (3.08)a	-4.45 (5.21)a	0.65 (1.38)	1.24 (1.49)
FDI*TECHGAP	6.52 (5.45)a	5.09 (6.12)a	6.89 (7.95)a	6.36 (5.30)a	2.34 (1.71)c	5.91 (6.64)a	-0.52 (0.72)	0.53 (1.28)	5.21 (7.41)a	6.77 (5.05)a	6.22 (3.49)a	5.01 (4.54)a	4.96 (5.35)a	-0.48 (0.58)	-1.03 (1.02)
Adjusted FDI*TECHGAP	0.37 (1.90)b	-0.012 (0.06)	0.35 (2.06)b	0.44 (1.83)b	0.67 (2.74)a	0.33 (1.90)b	-0.19 (0.85)	0.11 (0.46)	0.15 (0.73)	0.56 (1.92)b	0.06 (0.13)	-0.01 (0.27)	0.30 (1.33)	-0.16 (0.91)	-0.07 (0.21)
Industry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Log Likelihood	-25.52	-20.54	-18.11	-24.09	-26.22	-28.51	-28.36	-32.28	-32.04	-39.34	-12.79	-23.41	-25.26	-21.53	-20.68
LR Chi square	28.76	39.10	15.50	28.84	10.41	22.28	21.28	8.60	12.40	20.53	44.42	12.34	11.34	14.41	20.74
Significance model	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	(0.00)	0.00	0.00	0.00
R square	0.36	0.49	0.30	0.37	0.17	0.28	0.27	0.12	0.19	0.26	0.63	0.18	0.26		0.33
Observations	82	82	82	82	82	82	82	82	82	82	64	64	64	64	64

Absolute value of t statistic in parentheses. a, b and c indicate significance levels of 1, 5 and 10%. Adjusted FDI*TECHGAP presents adjusted β coefficient and absolute value z statistic based on Norton et al. (2004). R square is McFadden. In all regressions, F test rejects that industry dummies have coefficients equal to 0.

Techsupport = overall technological support, Designs = provision of product designs and specifications, Mach = provision of machinery, tools = provision of special machinery, Control = support with quality control measures and procedures, Training = training personnel suppliers, Newsup = assistance for new suppliers, Business = business and organizational support, Finance = financial support, Inputs = support with sourcing practices and procedures.

improvements of local suppliers of material inputs, resulting in more support when the technology gap with these suppliers is large. Production services are much more specialized activities however, activities that producer firms have less experience with. If this is the case, it will be much more difficult for FDI firms to assess whether local providers of production services possess the potential to make large improvement. This would explain the estimated insignificant effect of the interaction variable between FDI and TECHGAP for the provision of support to these local providers.

4.2. Determinants of the Impact on Local Suppliers

So far, the analysis has established that FDI firms are significantly more likely to offer support. Furthermore, the technology gap appears to play a dual role. In general, the technology gap lowers the supportiveness of the producer firms, which may result in smaller spillovers. At the same time, FDI firms offer more technological support to suppliers of material inputs when the technology gap is large, suggesting that FDI firms see large technological differences as an indicator of a large scope for technological improvement of this type of supplier. To assess whether these factors also play a role when it comes to the materialization of positive impacts among the local suppliers, in this section I estimate regression models to identify factors that are associated with the likelihood that suppliers experience positive spillovers. To do so, I use information from the supplier survey to estimate regression models of the following specification:

$$(3) \text{ Impact}(i) = \beta_0 + \beta \text{ FDISUPPLIER}(i) + \beta \text{ TECHSUPPORT}(i) + \beta \text{ ORGSUPPORT}(i) + \beta \text{ CONTRACT}(i) + \beta \text{ TECHGAP}(i) + \beta \text{ ABSCAP}(i) + \beta \text{ FDI*TECHGAP}(i) + \varepsilon(i)$$

The dependent variable IMPACT takes the value of 1 when supplier (i) indicates to have experienced a large positive impact on its operations from its business dealings with the producer firms. It takes the value of 0 when the positive impact is moderate, small or non-existent¹¹. Similar to the regression model on determinants of the provision of support, the nature of the dependent variable on the impact makes the logit regression model appropriate. The dependent variable is the logit of the ratio that a supplier experiences a large positive impact (μ) over the probability that a supplier does not experience this large impact ($1-\mu$):

$$(4) \text{ Ln}(\mu/1-\mu) = \beta_0 + \beta \text{ FDISUPPLIER}(i) + \beta \text{ TECHSUPPORT}(i) + \beta \text{ ORGSUPPORT}(i) + \beta \text{ CONTRACT}(i) + \beta \text{ TECHGAP}(i) + \beta \text{ ABSCAP}(i) + \beta \text{ FDI*TECHGAP}(i) + \varepsilon(i)$$

The variable FDISUPPLIER takes the value of 1 when a supplier's client firms in the region consist only or mainly of FDI firms¹². I expect to find a positive effect of this variable. The variables TECHSUPPORT and ORGSUPPORT control for the level of technological and

¹¹ In this sense I exercise restrictiveness by only considering those suppliers that have experienced a large positive impact to have experienced any positive impact at all.

¹² See the appendix for a full description of the variables.

organizational support that a supplier's client firms engage in. I expect a positive effect of both variables, under the assumption that suppliers that receive more support are more likely to experience positive impacts. I also include a dummy variable CONTRACT which captures the nature of the contacts between a supplier and its client firms. This variable takes the value of 1 when suppliers operate with standard purchasing orders, representing "at arm's length" market transactions. I expect a negative effect of this variable, as frequent contacts and mutual coordination between buying and supplying firms are more conducive to the creation of flows of knowledge and technologies than pure market transactions (UNCTAD, 2001).

As discussed earlier, there are important problems in empirical research of FDI effects that interpret the technology gap as direct inverse indicator of the level of absorptive capacity of domestic firms. Therefore, I include separate control variables to capture the effects of the technology gap and absorptive capacity. The variable TECHGAP captures the level of technological differences between suppliers and their client firms. In the supplier survey, firms were asked to indicate on a Likert scale the size of the technology gap with the producer firms, with a high score indicating a large technology gap. Given my interpretation that the technology gap captures the potential of a supplier firm to improve, I expect a positive effect of this variable.

To capture the effect of absorptive capacity of the suppliers, I include three proxy variables of this capacity. I control for the size of a supplier (SIZE), as a large firm is likely to have more resources to devote to knowledge transfer activities (Aitken and Harrison, 1999; Blyde et al., 2004). I also include a variable that measures the level of experience that a supplier has with producing inputs for producer firms in the region (EXPERIENCE). I expect a positive effect of this variable, under the assumption that suppliers that have been operating in the region for some time will have more experience with absorbing new technologies. Third, I include a variable that captures the overall level of experience and skills of a supplier with modern production technologies. This variable is labeled QUALITY and reflects the degree to which a supplier experiences problems with quality control systems and technical production issues. This variable is measured on a Likert scale, whereby a high score indicates a high frequency of problems¹³.

Finally, I estimate the regression model allowing for clustered standard errors at the level of the nature of the product that a supplier provides. Most suppliers indicated to be active in more than one industry, making it difficult to use standard industry dummies. Instead, I estimate the regression model allowing for clustered standard errors for suppliers supplying raw materials, material inputs, production services and (replacement) machinery parts.

Empirical Findings on Determinants of Positive Impacts among Suppliers

The main findings from estimating regression model (4) are presented in table 2. The first part of the table shows the estimated effects of the control variables on the probability that a supplier has experienced a large overall positive impact on its performance. The estimated positive effect of the firm size variable indicates that large suppliers are better able to absorb new technologies. The estimated positive effect of the experience variable further confirms the positive effect of absorptive capacity. The third indicator of absorptive capacity, the degree to which a supplier experiences problems with quality control systems and technical production issues lowers the chance that a supplier has experienced a large positive impact. Overall therefore, these findings

¹³ I also experimented with level of exports as an indicator of absorptive capacity of a supplier (see Abraham et al., 2007), but this variable had no significant effect in preliminary regressions.

confirm the notion that the level of absorptive capacity of a supplier is important for the materialization of positive spillovers.

Next, the level of supportiveness of client firms is also important. For the overall impact, it seems that the level of organizational support is more important. However, the findings for the subsamples of suppliers indicate that technological support fosters the materialization of a large impact among suppliers of material inputs, whereas organizational support facilitates such an impact among providers of production services. This is in line with the earlier analysis on the determinants of the provision of support that also identifies differences between the two types of supplier. Importantly, the estimated effect of type of ownership of client firms is significant and positive. Earlier on, the analysis found that FDI firms are more supportive. The findings in table 2 indicate that suppliers of FDI firms are more likely to experience large positive impacts, even when I control for the feature that FDI firms are more supportive, by including the variables TECHSUPPORT and ORGSUPPORT. Clearly, this finding represents strong support for the notion that type of ownership matters for the creation of positive spillovers.

In line with the hypothesis, the estimated effect of the technology gap is positive. This indicates that suppliers with a large scope to improve are more likely to experience large positive impacts. One implication of this finding is that, in line with the finding that the indicators of the level of absorptive capacity are positively associated with large impacts, the positive effect of the technology gap cannot be interpreted as being directly linked to absorptive capacity. Instead, the positive effect of the technology gap reflects that a large impact is more likely to arise when there is a large scope for suppliers to improve. The second implication is that, as the regression model controls for both the level of support that suppliers receive and type of ownership of their client firms, the positive effect of the technology gap is likely to be capturing efforts made by the suppliers to absorb new technologies, resulting in positive impacts. Regarding the overall positive impact, there is no additional effect of the interaction variable between the technology gap and having FDI firms as client firms.

Finally, table 2 presents the findings of a Wald test on the possibility that supplier status is endogenous to the estimated regression model. It could be that a local supplier self-selects into becoming a supplier of FDI firms, if it expects that it will benefit more from linkages with these firms than from linkages with domestic producer firms. In particular, this may be the case for those suppliers that have a relative high level of absorptive capacity. If so, (part of) the estimated positive effect of the FDISUPPLIER variable will capture this self-selection process. To assess whether this is the case, I regress the FDISUPPLIER variable on the absorptive capacity variables. The Wald test subsequently estimates whether there is a correlation between the errors of this regression and the errors of the structural regression model. As reported in table 2, the Wald test rejects any correlation between the two sets of errors, suggesting that the estimated positive effect of supplier status is not caused by suppliers self-selecting into being suppliers of FDI firms in the region¹⁴.

The second part of table 2 presents the findings from estimating the regression model using a large technological impact as dependent variable. There are some important differences with the findings from the first regression model. One difference is that the level of technological support matters for a large technological impact, irrespective of the type of local supplier. As for

¹⁴ I also conducted the test using all control variables in the first regression, after which I regress the impact dependent variable on supplier status and a constant term. This also produces an insignificant Wald test statistic. As table 2 indicates, the Wald test rejects a significant correlation between the two sets of errors in all but case.

Table 2 FDI, Technology Gap, Absorptive Capacity and the Impact on Local Suppliers

	Large overall impact			Large technological impact			Large organizational impact		
	Full sample	No production services	No material inputs	Full sample	No production services	No material inputs	Full sample	No production services	No material inputs
SIZE	0.20 (2.91)a	0.24 (0.69)	0.45 (4.13)a	0.28 (1.90)b	-0.15 (0.55)	0.42 (2.45)a	0.27 (1.90)b	0.01 (0.10)	0.29 (1.72)c
EXPERIENCE	0.60 (2.08)b	0.71 (2.34)a	1.24 (3.20)a	0.32 (1.32)	0.50 (1.24)	1.24 (3.83)a	1.88 (3.76)a	2.74 (4.83)a	0.40 (1.20)
QUALITY	-1.37 (2.75)a	-1.20 (1.90)a	-1.80 (1.52)	-0.12 (0.40)	-0.22 (0.55)	-0.26 (1.50)	-1.07 (2.95)a	-1.26 (2.64)a	0.57 (0.93)
CONTRACT	-1.23 (1.59)	-1.06 (1.40)	-1.44 (0.95)	-0.37 (6.41)a	-0.32 (2.18)b	-0.18 (1.45)	0.52 (2.77)a	0.67 (6.62)a	0.72 (2.34)a
TECHSUPPORT	-0.06 (0.62)	0.27 (2.45)a	0.42 (1.27)	0.38 (10.19)a	0.30 (10.28)a	0.42 (5.80)a	0.01 (0.18)	0.09 (1.10)	-0.19 (1.54)
ORGSUPPORT	0.19 (3.14)a	0.07 (1.60)	0.39 (7.95)a	0.05 (0.41)	0.04 (0.35)	0.25 (0.56)	0.15 (1.39)	0.25 (2.35)a	0.18 (0.67)
FDI	2.24 (4.77)a	2.08 (7.03)a	2.33 (2.79)a	0.65 (5.52)a	0.57 (2.08)b	1.01 (2.01)b	0.69 (3.67)a	0.65 (2.01)b	1.51 (5.78)a
TECHGAP	1.42 (3.76)a	1.79 (4.35)a	0.87 (1.61)	1.25 (4.57)a	1.18 (1.74)c	1.37 (3.42)a	-0.16 (0.20)	-0.21 (0.18)	-0.09 (0.14)
FDI*TECHGAP	-1.10 (1.39)	-0.58 (0.60)	-1.42 (1.23)	4.71 (5.53)a	5.27 (8.39)a	4.43 (4.24)a	0.12 (0.46)	-0.09 (0.68)	0.07 (0.08)
Adjusted FDI*TECHGAP	-0.19 (0.75)	-0.10 (0.29)	-0.27 (0.76)	0.34 (3.38)a	0.44 (5.77)a	0.15 (0.67)	0.03 (0.17)	-0.08 (0.04)	-0.07 (0.04)
Wald test exogeneity supplier status	0.52 (0.47)	1.67 (0.20)	2.96 (0.09)	0.26 (0.61)	2.43 (0.14)	2.25 (0.17)	0.41 (0.52)	1.11 (0.30)	1.17 (0.32)
Log Likelihood	-42.89	-29.95	-33.22	-56.81	-40.66	-40.86	-51.57	036.20	-36.22
Chi square	37.24 (0.00)	30.84 (0.00)	26.10 (0.00)	21.17 (0.00)	11.60 (0.00)	25.09 (0.00)	14.04 (0.00)	15.39 (0.00)	15.72 (0.00)
R-square	0.32	0.36	0.29	0.16	0.13	0.24	0.12	ty0.18	0.19
Observations	100	67	70	100	67	70	100	67	70

Absolute value of t statistic in parentheses. a, b and c indicate significance levels of 1, 5 and 10%. Adjusted FDI*TECHGAP presents adjusted β coefficient and absolute value z statistic based on Norton et al. (2004). R square is McFadden. Large overall impact is summation of large technological and large organizational impact. Large technological impact is summation of large impact in areas of use of product designs and specifications, use of machinery, use of special tools, increase in human capital. Large organizational impact is summation of positive impact in areas of business and organizational improvement, finance and sourcing of inputs.

absorptive capacity, all variables have the correct sign, but the size of a supplier is the main factor influencing the chance that a large technological impact occurs. The estimated negative effect of the CONTRACT variable indicates that suppliers that deal with their client firms via “arms length” linkages are less likely to experience a large technological impact, suggesting that some level of formal and informal contacts between input buying and -selling parties facilitates the transmission of technologies.

Looking at the estimated effect of supplier status, the findings confirm that suppliers of FDI firms are more likely to experience a large technological impact. The technology gap also carries a significant positive coefficient, indicating that suppliers with a large potential to improve are more likely to experience a large impact. Importantly, the findings also indicate that there is an additional positive effect of the interaction variable between FDI and TECHGAP. This further supports the impression that FDI firms are more likely to generate positive effects. In particular, the regressions show an estimated positive effect of the FDISUPPLIER variable, even when controlling for the feature that FDI firms are more supportive and that FDI firms offer more support when the technology gap with their suppliers is large.

Finally, the last part of table 2 presents the findings on factors that influence local suppliers experiencing a large positive organizational impact. All three absorptive capacity variables carry significant coefficients with the correct sign. The estimated effect of the variable CONTRACT is positive. This is contrary to expectations, as it suggests that “arms length” market transactions favor the materialization of a positive organizational impact. This finding may be explained by producer firms preferring to offer organizational support to those suppliers with which they deal via pure market linkages, resulting in an estimated positive effect of the contract variable. The estimated effect of the support variables indicates that in most cases this support is not significantly associated with suppliers experiencing a large organizational impact. The estimated effect of the FDISUPPLIER variable is positive, confirming that FDI firms are more likely to generate positive spillovers. Finally, the technology gap and the interaction variable between FDISUPPLIER and the technology gap carry insignificant coefficients, indicating that the technology gap mainly plays a role in processes that generate positive technological impacts.

5. Summary and Policy Implications

FDI firms can generate important positive spillovers when they act as source of new technologies to domestic firms in host economies. Having said this, the evidence on these externality effects is heterogeneous, especially concerning intra-industry effects. In response to this, several recent studies distinguish between intra- and inter-industry FDI participation and find that positive spillovers are more likely to occur between industries, especially among local suppliers of foreign-owned firms. Additional evidence from case studies and small scale surveys shows that input-output linkages can act as knowledge transfer activities between FDI and local suppliers. Another development is that several econometric studies look at the effect of the technology gap, trying to identify the effect of absorptive capacity of domestic firms on FDI spillovers. In these studies, the technology gap is interpreted as direct inverse indicator of the level of absorptive capacity of domestic firms.

The purpose of the present study is to obtain novel evidence on how spillovers can arise between FDI firms and local suppliers and to investigate whether and how the technology gap influences these effects. The study incorporates several aspects that have remained

underexplored in applied research on FDI spillovers. In particular, I consistently compare the operations and effects of FDI and domestic producer firms, to assess whether FDI firms actually differ from domestic firms. Also, I separate the concepts of absorptive capacity and the technology gap, based on an alternative interpretation of what the technology gap captures. Using this new interpretation, I conduct multivariate analysis to identify the individual effects of the technology gap and absorptive capacity on FDI spillovers among local suppliers.

The findings of the study can be summarized as follows. First, I find that FDI firms are involved in a variety of knowledge transfer activities of a technological and organizational nature. Furthermore, in contrast to the marked similarity between FDI and domestic producer firms regarding their static impact, I find that FDI firms are significantly more involved in the provision of several types of support. In particular, FDI firms are more engaged in the provision of technological support, support with a direct positive impact on production processes of local suppliers. The feature that FDI firms are more supportive is confirmed by means of multivariate analysis. Furthermore, I also find that suppliers of FDI firms are more likely to enjoy large positive impacts from their business dealings with their client firms, even when I control for the fact that FDI firms are more supportive and that FDI firms offer more technological support when the technology gap with local suppliers of material inputs is large. Importantly, I find no evidence that the estimated positive effect of having foreign-owned client firms is (partly) caused by suppliers self-selecting into becoming suppliers to the FDI firms.

Second, the findings indicate that the technology gap between producer firms and local suppliers plays a varied role, subject to the nature of the support that is provided and the impact that producer firms generate. In general, producer firms are less likely to offer support when the technology gap with their suppliers is large. However, FDI firms offer more support under a large technology gap with their suppliers. This suggests that whereas domestic producer firms perceive a large technology gap as an obstruction to offer support, FDI firms interpret a large gap as indicating a large scope for their suppliers to improve. The restriction to this is that this applies only to the provision of technological support to local suppliers of material inputs, support with a direct impact on the production processes of these suppliers. This suggests that FDI firms are able to assess the potential improvements of suppliers of inputs with which the foreign-owned firms have experience themselves, resulting in specific support to improve production processes of the suppliers. As for the effect of the technology gap on the impact that suppliers experience, I find that suppliers that are technologically backward have a higher chance to experience large positive impacts, in line with the interpretation that a large gap reflects a large scope to improve. Similar to the findings on the determinants of the provision of support, I find that the positive effect of the technology gap on the impact of FDI firms only applies to impacts of a technological nature. Also, given that the estimations control for the level of support of producer firms as well as type of ownership of client firms, the estimated positive effect of the large technology gap suggests that local suppliers are making efforts to absorb new technologies when the potential to obtain benefits from doing so is large.

Third, the multivariate analysis of determinants of suppliers experiencing large positive impacts indicates that the level of absorptive capacity of these suppliers is important. The alternative interpretation of the technology gap rejects any direct link between the technology gap and absorptive capacity. In the analysis, I use three alternative indicators of the level of absorptive capacity of the suppliers. The findings confirm the importance of absorptive capacity, as these indicators are significantly associated with the change that a local supplier experiences a large technological or organizational impact. This confirms that it is important to separate the

technology gap from absorptive capacity, as the findings indicate that both these concepts can have independent effects on the occurrence of positive spillovers between FDI firms and their local suppliers.

Finally, the findings carry several important policy implications. First, at a general level, the findings indicate that produce firms are involved in a variety of support and knowledge transfer activities, resulting in positive technological and organizational impacts among local suppliers. This confirms the notion that FDI firms generate positive local suppliers via input-output linkages with domestic firms. As such, this is in support of government policies of host economies that try to promote economic and technological development via the facilitation and attraction of FDI firms. Furthermore, the feature that the findings clearly identify inter-firm linkages between FDI firms and domestic firm as channel via which technologies are shared and transmitted suggests that there is scope for policy making to facilitate positive spillovers. For instance, by developing programs that foster inter-firm linkages between foreign-owned and domestic firms, host economy governments can try to enhance the degree and nature of technologies that domestic firms may benefit from. Of course, the findings of the present study apply to only one region in a developing host economy; the exact nature and the level of the local technology impact of FDI firms is likely to vary between different settings. However, the findings of the present study constitute support of the general policy of FDI-driven economic and technological development that is pursued by many host economies.

Second, the study presents strong evidence that FDI firms are more supportive than domestic firms and that the FDI firms are more likely to generate positive impacts. Host economy governments that try to promote economic development often face difficult decisions whether to attract new FDI or focus on the further development of indigenous economic activity. Especially for developing host economies, the findings of the present study suggest that the attraction of FDI firms can lead to larger flows of knowledge and technologies to suppliers. Having said this, I also find that domestic producer firms are also involved in several types of knowledge transfer activities. As such, although policies that try to promote economic and technological development can certainly be successful, there is also scope for promoting the activities of those domestic firms that also act as source of new technologies to other domestic firms. In any case, host economy governments will benefit greatly from obtaining detailed information on whether and how technology flows occur between FDI, domestic producer firms and local suppliers and to determine whether and how the two types of producer firm differ in the scale and nature of their impact.

Third, and most crucially, the findings on the technology gap relate to one of the most strategic decisions that host economy governments face when attracting FDI. The original interpretation of the technology gap as direct inverse indicator of the level of absorptive capacity of domestic firms suggests that, to facilitate the technology impact of FDI firms, host economy governments should try to attract FDI firms that are technologically not too different from domestic firms. In strong contrast, the findings from the present study indicate that FDI firms need to be technologically substantially more advanced to foster meaningful spillover effects. This finding is especially relevant for developing countries such as Mexico that try to move away from low skilled low tech activities towards technology and skilled-labor intensive activities. This process is more likely to succeed when technologically advanced foreign-owned firms are attracted. In relation to this, the findings of the study confirm that the level of absorptive capacity is important for positive spillovers to materialize. This means that domestic firms need a sufficient level of absorptive capacity to benefit from technologically advanced FDI

firms. By investing in enhancing the level of absorptive capacity of technologically backward domestic firms, host economy governments may create real opportunities for substantial positive spillover effects to materialize between FDI firms and local suppliers.

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Appendix

Table A. Characteristics Producer Firms and Local Suppliers

Characteristics producer firms	No. of firms	Characteristics local suppliers	No. of firms
Ownership		Type of product	
Mexican	32	Raw materials	10
FDI	50	Parts and components	23
Foreign-owned		Production services	35
US	37	Machinery and parts	32
Japan	6	Age (years)	
Other	7	0-9	24
Sector		10-15	21
Chemical	20	> 15	55
Electronics	19	Size (employees)	
Cars/Car engines	43	0-10	30
Size (employees)		11-49	44
150-250	40	50-150	23
251-500	21	Client firms	
> 500	21	Mexican	43
Age (years)		FDI firms	19
0-9	24	Both types	38
10-15	14	Exports	
> 15	44	No	73
Exports (% sales)		Yes	27
0-10	27	Sales in regional economy	
11-30	18	0-20	12
> 30	37	21-75	61
		> 75	27

Table B. Variables used in multivariate analysis section 4

Variables used in section 4.1		
Name	Description	Measurement
AGE	Age of producer firm	Ln (nr years in operation)
SIZE	Size of producer firm	Ln (nr employees)
MAT	Use of material inputs	Material inputs as % total input costs
MAQUILA	First generation Maquiladora firms	Dummy variable taking value of 1 when a Maquiladora firms has been in operation in the region for 15 years or more
NEWMAQUILA	Younger generation Maquiladora firms	Dummy variable taking value of 1 when a firm is participating in the Maquiladora program
FDI	Foreign-owned producer firm	Dummy variable taking value of 1 when a firm has 10% or more foreign participation
TECHGAP	Indicator of size technology gap between producer firm and suppliers	Dummy variable taking value of 1 when producer firm indicates that large technology gap is one of the 2 most important reasons not to increase use of local suppliers
INDUSTRY	Chemical, electronics and car industries	Dummy variables for the three industries
Variables used in section 4.2		
Name	Description	Measurement
SIZE	Size of supplier	Ln (number of employees)
EXPERIENCE	Experience as supplier in regional economy	Ln (number of years in operation)
QUALITY	Frequency of problems with quality control systems and other technical production issues	Scale of 1-4; 1 = no problems, 4 = frequent problems
CONTRACT	Type of contract between supplier and client firms	Dummy variable taking value of 1 when supplier uses standard purchasing orders (*)
TECHSUPPORT	Level of technological support that a supplier receives from client firms	Summation of frequent support received in form of product design, use of machinery, use of advanced tools, quality control systems and development of human capital
ORGSUPPORT	Level of organizational support that a supplier receives from client firms	Summation of frequent support received in form of business organization, finances, sourcing of inputs, exporting and diversification of products
FDI	Type of ownership of a supplier's client firms	Dummy variable taking the value of 1 when a supplier's client firms are only or mainly foreign-owned
TECHGAP	Indicator of level technological differences between a supplier and its client firms	Scale of 1-4; 1 = no technology gap, 4 = large technology gap

(*) Suppliers were asked to indicate on a scale of 1 to 4, with one being standard purchasing orders and 4 representing monthly contacts between supplier and client firms, to indicate the degree to which their business relations with their client firms involve frequent contacts and coordination. Given the preference of the suppliers for either 1 or 4, this variable is transformed into a dummy variable.