Local Intermediate Inputs and the Shared Supplier Spillovers of Foreign Direct Investment

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Abstract

Trade liberalizations have been shown to improve domestic firms' performance through the new varieties of imported intermediate inputs. This paper uses a unique, representative sample of Bangladeshi garment firms to highlight that local intermediate inputs may also enhance domestic firms' performance, through the shared supplier spillovers of foreign direct investment (FDI) firms. An exogenous EU trade policy shock is shown to cause some FDI firms in Bangladesh to expand, which led to better performance of the domestic firms that shared their suppliers. Overall, the shared supplier spillovers of FDI explain 1/4 of the product scope expansion and 1/3 of the productivity gains within domestic firms.
Local Intermediate Inputs and the Shared Supplier Spillovers of Foreign Direct Investment

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“We make cutter knives in Malaysia. We used to source a special plastic resin from a local supplier to make the handles for our cutter knives. The local supplier also sold the same material to a fax machine plant in Malaysia owned by the Japanese firm, Panasonic. When Panasonic closed down the fax machine plant, the local supplier also stopped selling the plastic resin, due to insufficient demand. As a result, our cutter knife production suffered. Now we are looking to import the material from Taiwan at a higher cost and have to face exchange rate and shipping uncertainties.” – General Manager of SJD Industries (M) Sdn. Bhd., Malaysia, November 2011.

“LSI manufactures garment accessories in Bangladesh since 1999. Among other factors, serving FDI garment firms was an important reason for us to set up our plant in Dhaka, EPZ. At the beginning, the share of FDI garment firms in our total sales was about 20%. Now it is 35-40%. Many Bangladeshi garment firms benefitted from LSI working with FDI garments firms, and to comply to the standard of FDI garment firms which requires LSI to upgrade and expand product range, capacity, efficiency, and to reduce our costs and lead time. Moreover, LSI always shares the market intelligence we learned from our FDI garment clients regarding the latest product requirements and fashion trend with our other clients. Thus, the domestic garment firms that buy from us can further improve themselves based on the information.” – Managing Director of LSI Industries Ltd., Bangladesh, November 2010.

1 Introduction

While new intermediate inputs play a critical role in explaining productivity gains and growth in many theoretical models of endogenous growth, empirical evidence in support of this channel has been scant. At the macro level, Feenstra (1994) is the first to estimate substantial gains from trade derived from using new import varieties as a measure of new intermediate inputs. Broda and Weinstein (2006) further find significant gains in US GDP through increased import variety that pushes down the import price index. Nevertheless, it is not until recently that one begins to see some micro-level evidence linking new imported intermediate inputs to the gains in product scope and productivity of domestic firms. In the context of input tariff reduction due to trade
liberalization, Amiti and Konings (2007) show how Indonesian firms gain in terms of total factor productivity (TFP) due to input tariff cuts, which allow the firms to import more intermediate inputs. Furthermore, Goldberg, Khandelwal, Pavcnik and Topalova (2010) find Indian firms expand their output variety in response to increased access to new imported intermediate input variety. Most recently, Halpern, Koren and Szeidl (2011) find that importing foreign varieties of inputs increases Hungarian firm productivity by 12 percent. However, new varieties of intermediate inputs can also be produced locally, as opposed to being acquired through imports. In fact, there is seldom any distinction made between imported and local intermediate inputs in explaining productivity gains in most models (Ethier, 1982; Romer 1990). For many developing countries with problematic trading infrastructure, promoting viable local intermediate input industries that offer high quality and more varieties of intermediate inputs may have significant benefits to domestic final goods producers.¹ To date, there is no empirical evidence on this important issue which has significant policy implications. Besides lowering tariffs on imported intermediate inputs, what else can governments do to enhance the product scope and productivity of domestic firms?

This paper shows that local intermediate inputs may also enhance the performance of domestic firms, through the shared supplier spillovers (SSS) of foreign direct investment (FDI) firms.² Plainly stated, SSS of FDI firms capture the positive, non-pecuniary externalities a FDI firm may exert on a domestic firm when they share an intermediate input supplier. In this paper, I focus only on local intermediate input suppliers and, for the ease of discussion, when two firms share a local intermediate input supplier, they are considered as siblings. FDI firms may have SSS on their domestic siblings because FDI firms improve the quality and variety of local intermediate inputs. To identify SSS of FDI firms, I relate the within-firm, over time gains in product scope and productivity of each domestic firm to the exogenous increase of the market shares of their FDI siblings. The exogenous change in market share is the result of a natural experiment due to a one-time trade policy change in a foreign market. At the sample mean, SSS is shown to explain about a quarter of the product scope expansion and a third of the productivity gains within firms, over the 5 year

¹Unlike imported intermediate inputs, local intermediate inputs are not subjected to tariff and exchange rate risks, and could avoid problems due to unreliable customs clearing and shipping delays, which significantly cut down lead time for the downstream firms. Moreover, firms may have better control over the quality and specification of these intermediate inputs as they may inspect or supervise the production process of their local suppliers.

²I am very grateful to John Sutton for suggesting the term “shared supplier spillovers” to me at an IGC conference in spring 2011.
sample period, a result that is significant both statistically and economically. I further derive and estimate a simple multiproduct firm model which shows that, through the use of IV regressions, (i) the increase in FDI presence causes the number of local input suppliers to increase which leads to greater variety of local inputs; and (ii) a larger variety of local inputs promotes product scope and productivity of domestic firms.

Firm level data of the Bangladeshi garment sector is specifically collected to study this issue. The data set consists of a stratified random sample of 10 percent of the domestic firms and 100 percent of the FDI firms in the apparel sector of Bangladesh. Each of these firms is asked to identify its top three local input suppliers. Given that I have all the FDI firms in the sample, I have the complete list of the top three local suppliers that work with FDI firms in Bangladesh. For each domestic firm it is, therefore, possible to construct the market share of their FDI siblings. The data set also has information on the product scope of each firm. To measure the unobservable firm productivity, this paper considers multiple firm productivity measures, which include sales per worker, output per worker, and estimated TFP (OLS and augmented Olley-Pakes due to Ackerberg, Benkard, Berry and Pakes (2007), which takes into account the FDI status of the firms). Furthermore, firm specific prices on output and materials are used to deflate sales and material costs of firms for the productivity estimations to avoid bias due to the use of industry price deflators. By looking at a wide range of performance indicators, the results of the paper are not specific to the way firm productivity is measured. Nevertheless, these different performance indicators yield very similar and consistent results. Several robustness checks of the paper further confirm that these results are not driven by selection bias, omitted variable bias, endogeneity bias, reversed causality, and the alternative spillovers from FDI firms to domestic firms when they have

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3In 2004, this data set was jointly collected by Ana Fernandes and me, as part of a World Bank project requested by the government of Bangladesh. I focused on the garment sector while Ana studied the rest of the manufacturing sector. The ultimate purpose of my project is to inform the Government on whether or not it is worthwhile to liberalize the garment sector for more FDI, in anticipation of the end of the Multi-Fiber Agreement in 2005. Many FDI restrictions have been removed since then, given the findings of positive spillovers in the previous draft of this paper in the Bank’s report.

4Demidova, Kee and Krishna (2012) and Cherkashin, Demidova, Kee and Krishna (2010) also use the same data set to study the sorting behavior of firms when they face very different demand shocks and trade policy regimes in different markets. Both these papers do not look at local intermediate inputs and other factors that would affect product scope and productivity of firms.

5There were only about 49 FDI garment firms in Bangladesh at the time the survey was collected and I made sure that we visited all of them. However, not all firms provided all the information necessary for the regression analysis. After dropping firms that have incomplete data, I am left with 41 FDI firms.
common markets or common products. Robustness checks also rule out SSS from other domestic firms, or from large firms regardless of FDI status. In a placebo exercise, random matching of domestic firms with FDI suppliers yields no significant or meaningful results, further lend credits to the findings of this paper when it only relies on information of the top three local suppliers at the end of sample period. When the fraction of a firm’s top three local suppliers that also sell to FDI firms is used as an alternative measure of the influence of FDI siblings, the results are very similar and consistent with SSS. This paper also confirms that in the garment sector of Bangladesh, FDI firms use local intermediate inputs more intensively relative to domestic firms, which satisfy the necessary condition for FDI spillovers to materialize, according to Rodriguez-Clare (1996). To further supplement the econometric results of this paper, the local suppliers listed in the firm survey were interviewed. These suppliers indicate that not only does working with FDI clients help them improve their efficiency, product quality and variety, they also sell to their domestic firm clients these better quality and new variety products. These results are consistent with the finding of shared-supplier spillovers from FDI firms.

It is important to highlight that my analysis is not about comparing the performance of domestic firms with more FDI siblings with those that have less or no FDI siblings, as that could be driven by selection bias due to firm size, and productivity. All the analyses are done with firm fixed effects and firm specific time trends, so the estimations only rely on variations within a firm across time that is over and beyond firm specific time trend. In addition, the within estimations also control for firm-supplier relationship which is fixed at the end of the sample period, and the identification of SSS only depends on the detrend market share movement of the FDI siblings, not the choice and/or the numbers of local suppliers. Finally, while firms within the same industry often share intermediate input suppliers, some intermediate input suppliers may also serve firms in different industries. Thus, while related, SSS is not equivalent to horizontal spillovers. The quote from the general manager of a cutter knife firm in Malaysia, presented at the beginning of this paper, nicely provides such an example.6 Horizonal spillovers of FDI typically were identified by relating the performance of domestic firms to the overall industry presence or market shares of all FDI firms in the same industry, an identification strategy that has been made standard due to an influential

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6 Another simple example of intermediate inputs that could be used in different industries are zippers, which are used by the apparel firms to make jackets, or shoes firms to make boots, or luggage firms to make bags.
paper by Aitken and Harrison (1999). Instead, to study SSS of FDI, I focus on the firm specific sibling relationship between domestic and FDI firms, and I control for the overall presence of all FDI firms using industry-location-year fixed effects. Industry-location-year fixed effects also control for any macro-level influences on firm performance, such as trade policies, market competition, demand and productivity shocks.  

Thus, this paper concludes that the governments should attract FDI firms with significant backward linkages that can help promote the local intermediate input industries, which may then indirectly enhance the performance of domestic firms that use these local intermediate inputs. Such FDI firms not only can benefit those local suppliers by improving their productivity and quality (Javorcik, 2004; Blalock and Gertler, 2008; and Javorcik and Spatareanu, 2009), they will also improve the product scope and productivity of those domestic firms that use these local intermediate inputs (Rodriguez-Clare, 1996; Carluccio and Fally, 2011).

The rest of this paper is organized as follows: Section 2 discusses the intuitions behind SSS, shows that there is a conducive environment for SSS to happen in Bangladesh and the related literature on FDI spillovers. Section 3 provides some definitions for the main variables used in the empirical analysis. Section 4 describes the data set and the policy environment during the sample period. Reduced form regression results are presented in Section 5, followed by some robustness checks in Section 6. Section 7 concludes. The Appendix of this paper provides some details on the related literature on horizontal spillovers, survey evidence on FDI promoting quality upgrading and variety expansion of local input suppliers, the construction of the firm specific price indexes and the estimation of firm productivity.

Nevertheless, given that, in this paper, domestic and FDI firms are within the same industries, I can further relate the finding of SSS to horizontal spillovers. The results show that if an industry consists of mostly domestic firms that do not have FDI siblings, which could be due to the limited backward linkages among these FDI firms, the scope of positive horizontal spillovers will be very limited, which could explain the existing findings of the literature. Conversely, if an industry consists of mostly domestic firms that have FDI siblings, the scope of positive horizontal spillovers will likely be big. Please refer to Section 6.4 for the results and the Appendix for the related literature.

It should be noted that there are other industries in other countries that where we may expect to find similar results. Kee and Tang (2013) looks at the processing exports in China and find that the presence of FDI in a downstream industry may promote the output variety in the upstream variety, which leads to an increase in domestic value added in the downstream industry as firms actively substituting imported materials with domestic materials. Such a result would be consistent with SSS.
2 Shared Supplier Spillovers and the Related Literature

The intuitions of SSS can be traced back to Marshall (1920) in the classic *Principles of Economics*. In the book, Marshall detailed possible benefits of industry agglomerations, one of which is through backward linkages that the clustering of firms increases the industry demand for specialized inputs, which may lead to “the growth of subsidiary trades,” proliferation and improvement of local input varieties and create positive externalities on all firms that use these specialized inputs.

Thus, one possible reason for FDI firms to generate SSS on domestic firms is by promoting the expansion of the variety of local intermediate inputs. The presence of FDI firms, through their size and consistent orders, may increase industry demand for specialized intermediate inputs. That will attract entry of firms into the intermediate input industries, which expands the variety of local intermediate inputs. With a love of variety for inputs technology, those domestic firms that use these new inputs will experience a productivity boost. This mechanism is modeled in Rodriguez-Clare (1996) where all domestic firms employ all new varieties of local inputs and, thus, share the local input suppliers with FDI firms, which leads to spillovers that could be interpreted as SSS. My paper provides the empirical support for Rodriguez-Clare’s theory.\(^9\)

To illustrate that FDI firms promote new local intermediate input varieties, Figure 1 plots the number of FDI firms in the garment industry alongside the number of local input suppliers in the upstream industries in Bangladesh, from 1984 to 2003.\(^10\) The two series are closely correlated, even after controlling for the number of domestic garment firms and a time trend.\(^11\) Thus, at an

\(^9\) A recent paper by Carluccio and Fally (2011) also provides a theoretical model showing that those domestic firms that adopt the technology through the use of specialized local inputs demanded by the FDI firms may benefit from the presence of FDI firms in the industry.

\(^10\) Data on the number of local input suppliers is constructed by searching for, on-line, the year of establishment of each of the local input suppliers provided by all the firms in the current survey.

\(^11\) Granger causality tests also suggest that, at this aggregate level, FDI firms Granger-cause the number of local input suppliers to increase and not the reverse. I did the following two versions of Granger Causality tests (one in level and one is detrend):

\[
\begin{align*}
FDI_t &= \beta_0 + \beta_1 FDI_{t-1} + \beta_2 Suppliers_{t-1} + \varepsilon_{1t} \\
Suppliers_t &= \gamma_0 + \gamma_1 FDI_{t-1} + \gamma_2 Suppliers_{t-1} + \varepsilon_{2t}
\end{align*}
\]  

\(1\)

\[
\begin{align*}
FDI_t &= \beta_0 + \beta_1 FDI_{t-1} + \beta_2 Suppliers_{t-1} + \beta_3 trend + \varepsilon_{1t} \\
Suppliers_t &= \gamma_0 + \gamma_1 FDI_{t-1} + \gamma_2 Suppliers_{t-1} + \gamma_3 trend + \varepsilon_{2t}
\end{align*}
\]  

\(2\)

In both versions, F-tests reject the null hypothesis that \(\beta_2 = 0\), with a 95% confidence level, while failing to reject the null hypothesis that \(\gamma_1 = 0\).
aggregate level, the data seems to suggest that the presence of FDI firms helps to promote a vibrant local input industry in Bangladesh that is conducive for domestic firms to expand their product scope and productivity.

Another reason for FDI firms to cause SSS on domestic firms is by affecting the quality and productivity of their local suppliers. The positive impacts of FDI firms on their local supplying industries have been identified in Javorcik (2004), Blalock and Gertler (2008) and Javorcik and Spatareanu (2009), based on firm level data from Lithuania, Indonesia and Czech Republic.\(^{12,13}\) These authors found that the overall presence of FDI in a downstream industry affects the productivity of the domestic firms in the upstream industry, a finding that has been widely referred to as the “vertical spillovers” of FDI, or the spillovers of FDI due to backward linkages. I am taking the analysis one step forward by suggesting that these better local suppliers will further improve the productivity and product scope of those downstream domestic firms that also buy from them. Survey evidence, based on some follow up interviews with the local garment input suppliers in Bangladesh, also supports this point.\(^{14}\) In these interviews, FDI garment firms are often described as being “pickier” as they demand higher quality inputs. Thus, in order to meet the higher standards of the FDI firms, these local intermediate input suppliers need to improve their quality and consistency, and to decrease the product reject rates which, inevitably, benefit their other clients.

\(^{12}\) These papers find that the productivity of upstream domestic firms improves with the increased presence of downstream FDI firms, which suggests that downstream FDI firms transfer technology to their local suppliers. National industry input-output tables are used to relate upstream domestic firms to FDI firms in the downstream industry. Thus, all FDI firms in the downstream industry are considered as homogenous, regardless of whether or not these FDI firms indeed use local suppliers. Unlike these papers, the current paper has firm level information on each FDI firm, their specific local suppliers, and the domestic firms that are also using the same local suppliers. Thus, while some FDI firms that do not share local suppliers with domestic firms may not generate any spillovers to domestic firms, those FDI firms that share local suppliers are shown to improve productivity and product scope of domestic firms. Results of this paper could shed light as to why Javorcik (2004) finds strong evidence of vertical spillovers with low horizontal spillovers – it could be that these FDI firms do not share local suppliers with domestic firms in the same industry.

\(^{13}\) Note that, in addition to validating vertical spillovers, Blalock and Gertler (2008) also find significant pecuniary externalities, in terms of profitability of downstream domestic firms buying from an upstream industry that supply to FDI firms in Indonesia. In their paper, foreign firms transfer technology to their local suppliers, which, through entry of local suppliers, leads to more competition in the supplier industry and an overall reduction in the price of local intermediate inputs. As a result, domestic firms downstream of that supply market enjoy lower intermediate input prices which improve their profits, but not necessarily their product scope and productivity. Such pecuniary externalities, while important, are not the focus of this paper and will not affect the results, given that I use firm level price indices on output and input of each firm to deflate their sales and material costs. If prices of domestic inputs are lower, due to pecuniary externalities, material costs of firms will also be lower. Deflating the low material costs with the low firm material price will not bias the quantity of intermediate inputs and, therefore, will not affect firm productivity.

\(^{14}\) More detailed discussion on the follow up interviews with the suppliers can be found in the Appendix.
3 Definitions

In this section, I will define the main variable of interest in this paper, which is Foreign Sibling Presence or FDI Sibling Presence. Given that this paper is closely related to the FDI spillovers literature, which has a long history of using Industry Foreign Presence to measure the effect of FDI firms on domestic firms performance (see e.g. Aitken and Harrison, 1999; Javorcik, 2004), I would like to construct Foreign Sibling Presence in a similar way as Industry Foreign Presence, to allow for easy comparisons. In a nutshell, Industry Foreign Presence captures the collective influence of all the FDI firms within an industry, while Foreign Sibling Presence only focuses on the influence of those FDI firms that are related to each domestic firms through the common local input suppliers. As a result, Industry Foreign Presence is common among all domestic firms within the same industry while Foreign Sibling Presence varies across domestic firms. An increase in Industry Foreign Presence could be due to increases in capital investment of some FDI firms, while such increases will affect Foreign Sibling Presence of a domestic firm only if these FDI firms share local input suppliers with this particular domestic firm. Please refer to Figure 3 for an illustration of how Industry Foreign Presence and Foreign Sibling Presence are calculated in an industry with two domestic firms, four FDI firms, and four local suppliers. Note that, in the econometrics exercise below I will focus on relating the within firm variation of Foreign Sibling Presence (due to the expansion or contraction of the FDI firms) to the performance of domestic firms over time, and not looking at cross firm comparison of Foreign Sibling Presence which could be driven by selection bias, since if a domestic firm a higher value of Foreign Sibling Presence than another domestic firm, it could be because the first domestic firm self-select to share local input suppliers with more FDI firms.

I will start by defining the Foreign presence of a firm, which is the share of foreign equity of a firm. Next, I sum up the foreign presence of all firms in an industry to obtain Industry Foreign Presence. Both these variables follow the standard definitions in the literature. For firm i in year

\[\text{Foreign Sibling Presence}\]

15The SSS of FDI firms to domestic firms, while not equivalent, is related to the horizontal spillovers of FDI firms to domestic firms, if the FDI and domestic firms are all in the same industries (Aitken and Harrison, 1999). For readers interested to know more about the literature on horizontal spillovers, please refer to the Appendix.
its Foreign Presence ($FP_{it}$) is the product of firm’s foreign ownership share ($FS_i$) and its capital share in industry $j$ in year $t$,

$$FP_{it} = \sum_{i \in j} K_{it} FS_i.$$

($3$)

$FP_{it}$ captures how much influence the foreign capital of each firm has in the industry, with influence being measured by the share of each firm in industry capital stock. The reason capital share is used to measure the influence of a firm in an industry is because, by construction, capital is predetermined by the investment in period $t - 1$, unlike employment or output, which is highly endogenous to contemporary changes in firm productivity.\footnote{See Appendix on construction of capital and productivity estimation.} When we sum up the $FP_{it}$ of all firms in an industry, we have the Industry foreign presence ($IFP_{jt}$) of the industry ($j$) in year $t$,

$$IFP_{jt} \equiv \sum_{i \in j} FP_{it} = \frac{\sum_{i \in j} K_{it} FS_i}{\sum_{i \in j} K_{it}}.$$

($4$)

Mathematically, $IFP_{jt}$ is also equivalent to averaging the foreign ownership share of each firm in the industry, with weights equal to each firm’s capital share in the industry.

To define Foreign Sibling Presence, I first define Sibling firms, which are firms that share common local input suppliers. Then Foreign Sibling Presence of each firm is simply obtained by summing the Foreign Presence of all the sibling firms of the firms, similar to how Industry Foreign Presence is defined. Note that Foreign Sibling Presence will be proportionate to Industry Foreign Presence if all firms share the same local input suppliers in an industry. However, if firms each have a different set of local input suppliers and therefore different sibling firms, their Foreign Sibling Presence will be different from Industry Foreign Presence.

For each firm $i$ in year $t$, Let $S_{it}$ be its set of local suppliers. Then two firms $i$ and $k$ are considered Siblings in $t$ if they share common local suppliers, i.e. $S_{it} \cap S_{kt} \neq \emptyset$. Consequently, for every local supplier $s$ in $S_{it}, \forall s \in S_{it}$, I define a dummy variable, $S^s_{ikt}$, equals one, if the local
supplier is also serving firm $k$, i.e. $s \in \mathbf{S}_{kt}$, or

$$S^s_{ikt} = \begin{cases} 1, & \text{if } s \in \mathbf{S}_{it} \cap \mathbf{S}_{kt} \\ 0, & \text{if } s \notin \mathbf{S}_{it} \cap \mathbf{S}_{kt} \end{cases}. \quad (5)$$

In other words, $S^s_{ikt}$ is a supplier specific sibling dummy that indicates whether supplier $s$ is a common supplier of $i$ and $k$ in year $t$. Alternatively, let $NS_{ikt}$ be the total number of common suppliers between $i$ and $k$ in $t$,

$$NS_{ikt} \equiv \sum_{s \in \mathbf{S}_{it}} S^s_{ikt}. \quad (6)$$

Then firms $i$ and $k$ are siblings in $t$ if $NS_{ikt} \geq 1$. Note that sibling firms, in the context of this paper, have nothing to do with their ownership structure, and certainly do not imply that they share same parent firms or are part of the same conglomerate group. Moreover, even though I only have information on the set of local suppliers for each firm in 2003, there are two local suppliers that are only set up in the latter part of the sample period. For firms that use these newer suppliers, their sets of local suppliers exhibit year to year variations. This is why $\mathbf{S}_{it}$ and $S^s_{ikt}$ are indexed by $t$.

**Foreign Sibling Presence or FDI Sibling Presence** ($FSP_{it}$) of firm $i$ in year $t$, is constructed by summing the *Foreign Presence* of all its siblings from all its local suppliers,

$$FSP_{it} \equiv \sum_{s \in \mathbf{S}_{it}} \sum_{k \in j} F_{kt} S_k S^s_{ikt} = \frac{\sum_{k \in j} K_{kt} F_{kt} S_k \sum_{s \in \mathbf{S}_{it}} S^s_{ikt}}{\sum_{k \in j} K_{kt}} \quad = \frac{\sum_{k \in j} K_{kt} F_{kt} S_k \sum_{s \in \mathbf{S}_{it}} S^s_{ikt}}{\sum_{k \in j} K_{kt}} \quad (7)$$

$$= \frac{\sum_{k \in j} K_{kt} NS_{ikt} F_{kt} S_k}{\sum_{k \in j} K_{kt}} \quad = \frac{\sum_{k \in j} K_{kt} NS_{ikt} F_{kt} S_k}{\sum_{k \in j} K_{kt}} \quad = \frac{\sum_{k \in j} K_{kt} F_{kt} S_k}{\sum_{k \in j} K_{kt}} \quad (8)$$

It is also equivalent to averaging the foreign ownership share of $i$’s siblings in $j$, weighted by each sibling’s capital share in the industry and the number of common input suppliers with the sibling in year $t$. Comparing (4) with (7) it is easy to see that $FSP_{it}$ is very similar to $IFP_{jt}$, except that it only focuses on the foreign presence of the sibling firms rather than all firms in the industry. If a domestic firm $i$ does not share any local input suppliers with FDI firms, (i.e. $NS_{ikt} F_{kt} S_k = 0, \forall k$),
then $FSP_{it} = 0$. This is the lower bound for $FSP_{it}$. On the other extreme, if a domestic firm $i$ shares all its local input suppliers with all FDI firms, and there are a total of $N$ local suppliers, then $FSP_{it} = N \times IFP_{jt}$. This is the upper bound for $FSP_{it}$. In general, $FSP_{it}$ increases with the number of local suppliers $i$ shares with FDI firms, as well as the presence of these FDI firms in the industry. In short, a domestic firm $i$ will have a higher $FSP_{it}$, if it shares more local suppliers with FDI firms that have larger presence in the industry. Please refer to Figure 3 for an illustration of how Industry Foreign Presence and Foreign Sibling Presence are calculated in an industry with two domestic firms, four FDI firms, and four local suppliers.

Those domestic firms that have at least one FDI sibling is identified by a dummy variable $FDI Sibling_{it}$:

$$FDIS_{it} = \begin{cases} 
1, & \text{if } FSP_{it} > 0 \\
0, & \text{if } FSP_{it} = 0
\end{cases}.$$  

(9)

In other words, $FDIS_{it}$ indicates whether or not firm $i$'s foreign sibling presence is positive.

Note that, unlike $IFP_{jt}$, which by construction is common across all firms in an industry in a given year, $FSP_{it}$ varies by firm and time. It depends on the foreign presence of each sibling of each firm as well as the number of common local suppliers with each sibling in each year. Moreover, while $FSP_{it}$ is typically less than $IFP_{jt}$, mathematically it is possible for $FSP_{it}$ to be greater than $IFP_{jt}$, if some siblings have multiple common suppliers with the firm. Moreover, by construction, given the set of suppliers is fixed at 2003 level for the whole sample period (with the exception of 2 suppliers which only set up after 1999), the year to year within firm fluctuation of $FSP_{it}$ is mainly due to changes in the foreign presence of the sibling firms, and not the selection of suppliers. Hence the selection bias due to firms switching and selecting suppliers will be controlled for by firm fixed effects in within firm panel estimations.

4 Data

Firm level survey was conducted from the period of November 2004 to April 2005, which covers a stratified random sample of 350 firms, which is about 10 percent of the total population of the domestic firms and 100 percent of FDI firms currently operating in the Bangladeshi garment sector. The sample is stratified to reflect the population distribution of firms by size, by industry (woven
garments versus non-woven garments), and by location (Chittagong, Chittagong-EPZ, Dhaka, and Dhaka-EPZ). After cleaning up the data to exclude outliers and firms with incomplete information, there are a total of 297 firms in the five year unbalanced panel data set of 1213 observations, from 1999 to 2003.\textsuperscript{17} In this unbalanced panel data set, the composition is 68 percent in woven industry and 32 percent in non-woven industry, roughly reflecting the population of firms in the garment sector. Among the sampled firms, 14 percent have positive foreign equity, while the remaining 86 percent are purely domestic owned.

Table 1 presents the sample means of the key variables by woven and non-woven industries and by equity ownership. It is clear that in both industries FDI firms are, in general, larger in sales and exports, purchase more material inputs, including imported materials, hire more employees, and have more capital. All these presumably suggest that foreign firms are more productive.

Note that, to promote the improvement and expansion of locally available inputs, it is necessary for FDI firms to increase the industry demand for these inputs through greater local input intensity, a point emphasized greatly in Rodriguez-Clare (1996), but not necessarily more productive. Given that FDI firms are much larger on average in the current data set, this is likely to be the case. In fact, given its size, a typical FDI firm in the current sample source 83 percent more local inputs than domestic firms, even though only 20 percent of their inputs are locally supplied, while the comparable figure for a domestic firm is 32 percent. More evidence on FDI firms increase the industry demand of local intermediate inputs in Bangladesh is presented in Section 6.4, where we examine the local intermediate input intensity of FDI firms. This is essential to support SSS, whereby, the presence of foreign firms significantly increases the industry demand for local inputs, which may then lead to quality upgrading and variety expansion in the intermediate input industry.

Table 2 presents the sample means of industry foreign presence and FDI sibling and foreign sibling presence of domestic firms in the sample, by industries. On average, there is more foreign presence in the woven industry than in the non-woven industry, judging by their industry foreign presence, although the difference is only about 8 percentage points. The contrast is larger between two industries when focussing on the siblings. On average, 52 percent of domestic firms in the woven industry have FDI siblings, while only 16 percent of domestic firms in the non-woven industry

\textsuperscript{17}In the survey, the accounting managers of the firms were asked to provide financial information from 1999 to 2003, which is what I used to conduct the analysis. Some of these firms stopped production and exited the industry during the sample period but have resumed production in 2004. These firms are the exiters in the sample.
have FDI siblings. Furthermore, the average foreign sibling presence in the woven industry is 6.1 percent, nearly 10 times higher than that of the non-woven industry. This is true even if I restrict the comparison to only those domestic firms with FDI siblings. The foreign sibling presence for domestic firms with FDI siblings in the woven industry is 11.3 percent, while the same variable for the non-woven industry is only 3.3 percent. Differences between the two industries may be driven by other industry level variables, such as trade policies and demand shocks. I will, instead, rely only on the within firm variations in foreign sibling presence in the regressions.

5 Reduced Form Regression Results

The two industries in the garment sector of Bangladesh, namely, woven and non-woven have very different production structures and techniques. The Appendix discusses how two separate industry specific production functions are estimated using Ackerberg et al (2007) in a three step procedure that takes into account endogeneity of labor and material inputs, and how input and investment decisions may depend on the FDI status of firms. This technique is similar to that of De Loecker (2007), to allow production function to depend on exporter status. Here, I focus on relating foreign sibling presence to product scope and sales per worker, output per worker and the estimated firm productivity. The Appendix also contains a discussion on the construction of the very crucial firm specific price indexes. Output and material inputs of firms used in the production function estimation are constructed by deflating total revenue and cost of materials using these firm specific output and material price indexes. This significantly improves what Haskel, Pereira and Slaughter (2007) describe as a “pervasive problem in the literature on micro panels” that uses industry prices in place of the often missing firm level prices.

5.1 Shared supplier spillovers: Do FDI firms improve the performance of their domestic siblings?

To identify SSS, I relate the performance of domestic firms to their foreign sibling presence, as defined in equation (7), in a domestic firm only panel data set:

$$\ln y_{it} = \alpha_i + \alpha_{jkt} + \alpha_{FPS} FPS_{it} + X_{it} \beta + \beta_i Trend_{it} + u_{it},$$

(10)
where the dependent variable $y_{it}$ includes the product scope, sales per worker, output per worker, TFP estimated via OLS and TFP estimated via augmented Olley-Pakes procedures of domestic firms in our sample. A positive estimate of $\alpha_{FSP}$ suggests the performance of domestic garment firms is enhanced, due to the increased presence of their FDI siblings. I control for firm fixed effects, $\alpha_i$, in the panel regressions, (10), and only rely on the within firm variations of performance and foreign sibling presence to identify the coefficient. In other words, between-firm productivity changes, such as the exiting of inefficient firms as the market toughens due to the increased presence of FDI firms, whilst important, should not affect or explain the within coefficient on foreign sibling presence. In addition, it is important to highlight that, since I only rely on the within firm variations of performance and foreign sibling presence to identify the coefficient, factors and characteristics of firms, such as firm size (large vs small firms) and firm productivity (more productive vs less productive firms) will be controlled for and will not affect the estimation of $\alpha_{FSP}$.

As previously mentioned, firm fixed effects also controlled for the set of suppliers which is kept constant at 2003, and the within firm movement of $FSP_{it}$ only reflects the changes in foreign presence of the sibling firms of each domestic firms. Selection of suppliers, as well as the number of local suppliers, while important, will not affect the within estimations, since by construction, within firm movement of $FSP_{it}$ is not affected by the selection of suppliers. In addition, firm specific time trend, $Trend_{it}$, is also included to soak up any firm trend on $\ln y_{it}$ and $FSP_{it}$ that is specific to each firm. This would include some firm specific exogenous shocks, such as a shock to the common suppliers, that move $\ln y_{it}$ and $FSP_{it}$ up a time trend, simultaneously. In other words, $\beta_i$ will pick up the effect of $FSP_{it}$ on $\ln y_{it}$ if for whatever reason firms that perform better over time (rising $\ln y_{it}$) happen to have $FSP_{it}$ that is either rising or falling over time. For example, a domestic firm may receive a positive productivity shock by hiring a better manager, and the manager sources from a better local supplier that also serves FDI firms with expanding market shares, $Trend_{it}$ will be able to pick this up and will not contaminated the estimation of $\alpha_{FSP}$. In short, with $Trend_{it}$ and firm fixed effects, only the non-trending within firm co-movement of $FSP_{it}$ and $\ln y_{it}$ is used to identify $\alpha_{FSP}$.
5.1.1 Omitted variable bias

Equation (10) controls for industry-location-year specific effects, $\alpha_{jkt}$, to wipe out any macro omitted variables which are common among all firms within the same industry, location, and year and which may affect the performance of domestic firms and foreign sibling presence. Such variables may include industry specific demand and productivity shocks, government policies that favor domestic firms, investment climate change in the export processing zones, or trade policy changes of the main markets such as the EU and the US. Equation (10) also controls for industry foreign presence and the resulting market competition specific to an industry in a given year. In addition, firm level control variables, $X_{it}$, are also included, which are age, the share of imported materials in total material cost, and the share of materials in total sales. This is because overseas buyers may request Bangladeshi firms to use imported fabrics to ensure quality of the final products. Such business practices are typical among firms that export to the US and these firms could be more productive as the US market is more competitive. Using imported fabrics decreases the demand for domestic materials, which may decrease the number of FDI siblings and cause the within firm year to year change in foreign sibling presence to be smaller and, in turn, inducing a downward bias on the coefficient for foreign sibling presence. To control for this, the share of imported materials in the total materials of firms is included. Another possible omitted variable pertains to production techniques. Inefficient firms tend to waste material, which leads to a high material-to-sales ratio. The more materials a firm uses, the more likely it is that this firm has more FDI, as they may demand more domestic materials. This leads to larger within-firm year to year change in foreign sibling presence among unproductive firms that have high materials-to-sales ratio, which in turn leads to a downward bias on the coefficient on foreign sibling presence. Equation (10) also controls for materials-to-sales ratio in the regression. Finally, the age of a firm may also bias the estimate. Specifically older firms tend to be more productive, and older firms tend to work with the more established local suppliers, which could be also preferred by FDI firms. This causes an upward bias on the coefficient of foreign sibling presence.

5.1.2 Selection bias, endogeneity and reverse causality

While the beauty of using foreign sibling presence is that $FSP_{it}$ is firm specific and time varying, which allows us to control for industry-location-year fixed effects to wipe out the influence of the
macro variables, the short coming of using $FSP_{it}$ is, also that, it is a firm level variable that is subjected to selection bias, endogeneity, reverse causality and measurement errors.

One may worry that, as a domestic firm performs better over time, it may choose to buy from local suppliers that also work with FDI firms. Such self-selection will cause an upward bias in the least squares estimate of $\alpha_{FSP}$. However, given that I only use local supplier information in 2003 to construct $FSP_{it}$, within firm variation of $FSP_{it}$ is driven by changes in the market presence of FDI siblings, rather than through adding or dropping of local suppliers. Thus, while potentially large or more productive domestic firms may self-select to buy from local suppliers that also serve FDI firms, given the nature of within firm estimation and the fixed set of local suppliers for each firm, selection bias may not be too relevant.\(^{18}\) In other words, within estimations limit the comparison of firm performance to be within firm over time, so the issue of cross firm comparison of performance driven by firm size while could be important is not relevant in this context.

There is also a concern that if a local supplier becomes exogenously better (which could be because it is a FDI firm), it improves the performance of all its clients, and some FDI client firms may expand their market presence, as a result. Such simultaneity problems will also cause an upward bias in the least squares estimate of $\alpha_{FSP}$.

On the other hand, as a domestic firm becomes better over time, it may expand its own market share, causing the market share of FDI firms to decrease and lead to a smaller $FSP_{it}$. In other words, within firm performance changes may cause $FSP_{it}$ to change. This reverse causality will result in a downward bias in the least squares estimate of $\alpha_{FSP}$. Another source of downward bias in the least squares estimate of $\alpha_{FSP}$ is measurement error in $FSP_{it}$. Given that I only use local supplier information for 2003 to construct $FSP_{it}$, local suppliers are assumed to stay the same through our the sample period. While this limits the size of select bias once firm fixed effects are used, may nonetheless introduce measurement errors in $FSP_{it}$ that potentially may bias the least squares estimate of $\alpha_{FSP}$ towards zero.

The overall bias in least squares estimate of $\alpha_{FSP}$ is not clear, it depends on whether or not

\(^{18}\)Note that, it is in fact not that case that large or more productive domestic firms self select to buy from local suppliers that also serve FDI firms. The reader may be reassuring to know that when we regress the productivity of domestic firms on their foreign sibling status, it shows that firms that have foreign siblings are significantly less productive than firms that do not have foreign siblings, controlling for industry-location-year fixed effects and other firm characteristics such as the share of the US and the EU market in total export, and the share of imported material in total material. These domestic firms that have FDI siblings are also not significantly larger than other domestic firms that do not have FDI siblings. These results are available upon request due to space constraints.
reverse causality and measurement errors dominate selection and endogeneity biases, while omitted variable bias will have ambiguous effects on the least squares estimate of $\alpha_{FSP}$. One way to address all these issues is to introduce more control variables, and by using lag $FSP_{it}$ to limit the contemporaneous spurious relationship between within firm performance and $FSP_{it}$. Here I exploit an unanticipated change in the EU trade policy and use it to build an instrumental variable (IV) that has within firm non-trending exogenous changes for $FSP_{it}$. Note that the results based on more control variables and lag $FSP_{it}$ are very similar to the IV estimation and are not reported here due to space constraint but is available upon request.

### 5.1.3 Instrumental variable estimations

In 2000, the EU announced that it will implement the “Everything-But-Arms” (EBA) initiative in 2001, which provides duty-free, quota-free access to imports from all 48 Least Developed Countries, Bangladesh being one of them. However, to enjoy such trade preference, rules of origin (ROOs) requirements of the products must be met. There are two sub-industries within the garment sector of Bangladesh, one consisting of firms producing woven apparels and the other consisting of firms producing non-woven apparels, such as knitwear and sweaters. These two industries have very distinct production techniques and, while any of the nonwoven apparel producing firms can easily satisfy ROOs, only the larger woven firms, many of which are FDI firms, find it profitable to meet ROOs by using local inputs that are, typically, more expensive.\(^{19}\) Thus, the announcement of EBA in 2000 prompted differential impacts on the investment and capital share of the firms, depending on the sub-industry they are in and whether or not they export to the EU. In other words, the announcement of EBA in 2000 prompted the woven FDI firms that export to the EU to investment and expand their market share, and at the same time increase their demand for local inputs to meet ROOs. Figure 2 presents the share of FDI firms in the industry capital. While FDI firms that export to the EU, generally, have a larger presence in the industries relative to FDI firms that do not export to the EU, the presence increases only in the woven sub-industry. The news of EBA caused the market share of FDI firms that export to the EU to increase from 38 percent in 1999 to 43 percent in 2000 and stabilized to 42 percent in 2003. Conversely, the share of those

\(^{19}\)Please refer to Demidova, Kee and Krishna (2012) for a discussion of how ROOs of the EU add an additional layer of fixed and marginal costs for firms exporting to the EU.
FDI firms in the woven sub-industry that do not export to the EU dropped from 6 percent in 1999 to 0.7 percent in 2000, and barely increased to 1.6 percent in 2003. On the other hand, market presence of FDI firms in the non-woven sub-industry did not follow this pattern. Such distinct movements of market shares among different FDI firms in different sub-industries were a result of an unanticipated exogenous policy change in the EU that may have affected foreign sibling presence of some domestic firms. I will use the impact of the EBA announcement on the market presence of those FDI firms in the woven industry as an instrument for the exogenous increase in the foreign sibling presence. The exclusion restriction here is that the announcement and implementation of EBA has no direct impact on the productivity of domestic firms. This exclusion restriction is motivated by the findings in the literature that, while the more productive firms may self select into exporting, further exporting may not have feedback effects on the productivity of exporters (Clerides, Lach and Tybout, 1998; Bernard and Jensen, 1999). However, some recent papers find that exporting may further promote productivity gains (Van Biesebroeck, 2006; De Loecker, 2007; Fernandes, 2007). As a robustness check, I run both the first stage and second stage IV regressions on a subset of domestic firms that do not export to the EU, given that in this case, trade policy of the EU should not directly affect the productivity and performance of these firms. In addition, given that EBA affects all firms that export to the EU, thus the expansion of market shares may not limit to the FDI firms. In the next section on robustness check, I also examine how domestic firms may be benefitted from their domestic siblings that expand their market shares as a result of EBA. Please refer to the next section, and particularly footnote 18 for this discussion.

Table 3 presents the first stage estimations, where I regress $FSP_{it}$ on a dummy variable which equals one if domestic firm $i$ has a FDI sibling that exports to the EU in year $t$, $FDIS\_EU_{it}$, and the triple interaction term between $FDIS\_EU_{it}$, an EBA dummy that equals to one for 2000 onwards and a woven industry dummy variable:

$$FSP_{it} = \gamma_1 FDIS\_EU_{it} + \gamma_2 FDIS\_EU_{it} \times \text{woven}_i \times EBA_t + Z_{it} \gamma + \zeta_{it},$$  \hspace{1cm} (11)$$

where $Z_{it}$ has all the right-hand side variables of (10), which includes firm fixed effects, firm specific time trend, firm level control variables, and industry-location-year fixed effects. I expect $\gamma_1$ and $\gamma_2$ to be positive, which would suggest that, conditional on domestic firm $i$ having a FDI sibling that
is exporting to EU in year $t$, foreign sibling presence of firm $i$ is higher if firm $i$ is in the woven industry, in the years following the announcement of EBA. Column (1) of Table 3 presents the results based on a subset of domestic firms that do not export to the EU, and Column (2) shows the first stage regression based on the full sample of domestic firms who may or may not export to the EU. Given that the instrumental variables only vary by industry and year, I cluster the standard errors by industry-year in all the columns. The estimated $\gamma_1$ and $\gamma_2$ are positive and statistically significant, with F-statistics that are greater than 10, suggesting that these instrumental variables have explanatory power on $FSP_{it}$.

Tables 4 and 5 present the second stage regressions according to (10), for the restricted sample of domestic firms that do not export to the EU and for the full sample of domestic firms that may or may not export to the EU. These tables also present the least squares estimations and compare them to the IV estimates. In both the tables, the IV estimates for $\alpha_{FSP}$ are larger than the LS estimates, suggesting that the downward biases, due to reverse causality between the performance of domestic firms and their foreign sibling presence, as well as measurement errors in $FSP_{it}$, dominate the upward biases due to selection and endogeneity. For the restricted sample of domestic firms that do not export to the EU, an exogenous increase in foreign sibling presence due to EBA causes these domestic firms to have better performance in terms of a higher product scope, sales per worker, output per worker, and TFP (estimated with OLS and the augmented Olley Pakes procedure). This is the sample of firms, upon whose performance EBA should not have had a direct impact, other than through their FDI siblings that export to the EU, thus satisfying the exclusion restriction. These results are very similar in the full sample of domestic firms.

In summary, by exploiting exogenous changes in foreign sibling presence due to EBA, I show that domestic firms benefitted from the increased presence of their FDI siblings, a result that is driven by the improved access to better and new local input variety as the FDI garment firms push up their demand for local inputs. Based on the estimates in Columns (2) and (10) of Table 5, a one percent increase in foreign sibling presence is associated with a 1 percent gain in product scope and 3 percent gain in productivity for domestic firms on average. From 1999 to 2003, the average within firm gain in product scope and productivity among domestic firms is about 4 and 8 percent, respectively, while the average change in foreign sibling presence is 1 percent. A back-of-an-envelope calculation would then suggest that the increase in foreign sibling presence throughout the sample
period could explain about a quarter of the within firm product scope expansion and a third of the within firm productivity gains. These results are important, statistically and economically.

6 Robustness Checks

6.1 Alternative Interpretations

Could the above results be driven by the linkage between FDI and domestic firms when they produce the same products or export to the same market, and not necessarily due to SSS? To study these other channels, I construct two variables to capture the market presence of those FDI firms that share common products or common market with each domestic firm. Specifically, *product foreign presence* (*PFP*_it) of each domestic firm _i_ in industry _j_ and year _t_ is defined as the following:

\[
PFP_{it} = \sum_{p \in P_i} \sum_{k \in j} K_{kt} F S_k R_{ik} = \sum_{k \in j} K_{kt} F S_k \sum_{p \in P_i} R_{ik}.
\]  

(12)

where \( P_i \) is the set of products (HS 6 digit goods) for _i_ in _t_, and \( R_{ik} \) is a dummy variable which equals one if _i_ and _k_ both produce product _p_. Note that there is no time index for \( R_{ik} \) since I only have information of the product mix of firms in 2003. So _PFP*_it for each firm _i_ is the weighted average of the market presence of all the FDI firms that have common products with _i_ in industry _j_, with weights reflecting their shares of capital in _j_ and the number of common products with _i_.

Similarly, *market foreign presence* (*MFP*_it) of each domestic firm _i_ in industry _j_ and year _t_ is constructed as the following:

\[
MFP_{it} = \sum_{m \in M_i} \sum_{k \in j} E_{kt}^{m} E_{jt}^{m} F S_k R_{ikt}.
\]  

(13)

where \( M_i \) is the set of export markets for _i_ in _t_, \( E_{kt}^{m} \) is the value of export of firm _k_ to market _m_ in year _t_, \( E_{jt}^{m} \) is the total value of export of industry _j_ of Bangladesh to market _m_ in year _t_, and \( R_{ikt} \) is a dummy variable which equals one if _i_ and _k_ both export to market _m_ in year _t_. Table 2 presents the sample average of _PFP*_it, _MFP*_it, _R_{ik}^p_ and _R_{ikt}^m_ by industry. There are about 90 percent of domestic firms that have at least one common product with a FDI firm and more than 97 percent of domestic firms that have common output markets with FDI firms. This is not too surprising
since most firms export to the EU, the US or both, and produce similar products. Relative to foreign sibling presence, product and market foreign presence are also significantly higher, which potentially may explain more of the within firm productivity gains over the sample period.

Alternatively, could domestic firms benefit from their domestic siblings? To understand this, I construct the following domestic sibling presence variable \( DSP_{it} \) for each domestic firm \( i \) in year \( t \):

\[
DSP_{it} = \sum_{s \in S_{it}} \sum_{k \in j} (1 - FP_{kt})S_{ikt}^s.
\] 

(14)

Finally, could SSS merely capture the large firm impact on suppliers and not necessarily because these firms are FDI firms? Given that FDI firms are on average much larger than domestic firms within an industry, it is plausible that our empirical results are driven by firm size and not the FDI linkages. Please note that some domestic firms are just as large as the FDI firms within an industry. If firm size is the driving reason behind the finding of SSS, we would expect domestic sibling presence variable to have some explanatory power on domestic firms’ performance. However, to properly address this, I construct the following firm size sibling presence variable \( FSSP_{it} \) for each domestic firm \( i \) in year \( t \), which capture the market shares of all firms (both domestic and foreign sibling firms) that each domestic firm share a local input suppliers:

\[
FSSP_{it} = \sum_{s \in S_{it}} \sum_{k \in j} \frac{K_{kt}}{K_{kt}} \sum_{k \in j} \frac{Sales_{kt}}{Sales_{kt}} S_{ikt}^s.
\] 

(15)

\( FSSP_{it} \) is similar to \( FSP_{it} \), but rather than focusing on the foreign ownership share, \( FSSP_{it} \) uses the market shares of each sibling firms as weights. Thus, if firm \( i \) has a large sibling firm, FDI or domestic, its market share \( \sum_{k \in j} \frac{Sales_{kt}}{Sales_{kt}} \) will be large and have a large influence on \( FSSP_{it} \).

Columns (1) to (4) and (6) to (9) of Table 6 present the regression results when I relate product foreign presence, market foreign presence, domestic sibling presence and firm size sibling presence to product scope and TFP of domestic firms. In all cases, these other possible channels are not statistically significant, suggesting that the performance of domestic firms does not improve simply because they share a common product or market with FDI firms, or when they share common
local suppliers with other domestic firms, or any large firms. In particular, the fact that both domestic sibling presence and firm size sibling presence are not statistically significant suggest that our finding of SSS is not driven by large firms. It should also be noted that when $FS_{it}$ is included in these columns, the coefficients on $FS_{it}$ remain positive and significant, similarly to the estimates listed in Columns (1) and (9) of Table 5. So including these other possible channels do not affect the findings of SSS. Due to space constraints, this set of results are not reported but is available upon request.

6.2 Placebo experiment – random siblings

Another concern could be that the sibling relationship is, somehow, random and the previous result is just coincidental. There is also a concern that using the top supplier list of 2003 to estimate foreign sibling presence for the previous years, I may introduce large and systematic measurement errors that may affect the regression results. Finally, for each firm, I only have information on their top three local suppliers, which may leave out other local suppliers if the firms have more. To address these concerns, I use an artificial foreign sibling presence variable, constructed when domestic firms are randomly assigned FDI siblings. I repeated this placebo experiment 50 times and report the mean and standard deviation of the estimated coefficients from these 50 regressions in Columns (5) and (10) of Table 6. The randomized foreign sibling presence does not have any explanatory

\footnote{In addition, we also use EBA as an IV for domestic sibling presence, given that when EBA was announced in 2000, both FDI and domestic firms may affect their investment decision which affects the foreign sibling presence and domestic sibling presence of the same domestic firms. In other words, we have two “treated groups,” and it is important to show that sibling foreign presence did not pick up the influence of domestic sibling presence. In both the restricted sample of non-EU exporters and the full sample, domestic sibling presence is not statistically significant in the second stage across all dependent variables. In the first stage, while the interaction term is positive and significant, domestic sibling that export to the EU is not statistically significant. When I also include FDI siblings that export to the EU in the first stage, together with its interaction term with EBA and woven dummies, only the FDI siblings variables are positive and significant and the domestic sibling variables have wrong sign and insignificant. Overall, this result shows that domestic siblings do not have a positive impact on the performance of other domestic firms and only FDI siblings are important.}

\footnote{It should also be noted that in the survey data, each firm also reports whether their top manager has worked in a FDI firm prior to joining the firm. I tried to explore whether there is any spillover from FDI firms to domestic firms through such movement of workers. I failed to find any statistically meaningful results. Across firms, those that have top manager with FDI experience do not out perform firms that do not have top manager with FDI experience. Within firm, there is no robust evidence indicating those FDI trained managers make their firms grow faster. Due to space constraint, these results are not reported but are available upon request.}

\footnote{Note that another alternative hypothesis could be that foreign sibling presence captures the effect of “exporter sibling presence,” – may be by sharing local suppliers with an exporter, domestic firms may perform better. However, given that all firms in our sample are exporters, there will be no meaningful variation in the exporter sibling presence variable to explain the performance of domestic firms.}

22
power in affecting firm’s product scope and productivity. This is in sharp contrast to the previous finding where foreign sibling presence is consistently important in explaining firm performance. This suggests that the previous finding may not have been a fluke, and the measurement errors based on supplier information of 2003 may not have been empirically important, and the list of top three suppliers may just be enough to relate the firms.

### 6.3 Alternative Measure of FDI Influence

In this section, we explore using another variable to capture the influence of FDI siblings on domestic firm performance, which is the fraction of a firm’s top 3 local suppliers that also sell to FDI firms (\(\text{FDisuppliers}_{it}\)).\(^{23}\) If a domestic firm has more local suppliers that also sell to FDI firms, it is likely that this domestic firm will benefit more from the presence of these FDI siblings. Similar to \(FSP_{it}\), this variable is endogenous, which we will instrument with the EBA variables the same way as we have instrumented for \(FSP_{it}\), (see Section 5.1.3). Table 7 presents the empirical results for the full sample of domestic firms, including the highly significant first-stage F-statistics at the bottom of the table. Results based on the restricted sample of domestic firms who do not export to the EU are very similar and are available upon request. All regressions control for firm fixed effects, firm-specific time trend, industry-location-year fixed effects, age, the share of intermediate inputs in total sales and the share of imported intermediate input in total materials, similar to Table 5, with standard errors clustered by industry-year. The results are qualitatively very similar to the previous results using \(FSP_{it}\), which is not surprising, since \(\text{FDisuppliers}_{it}\) and \(FSP_{it}\) are highly correlated in the sample, both within firms as well as across firms.\(^{24}\) Overall, a within firm increase in \(\text{FDisuppliers}_{it}\) is positively associated with better firm’s performance, in terms of product scope and productivity. In particular, according to the IV estimate in Column (8), a one standard deviation increase \(\text{FDisuppliers}_{it}\) causes firm’s productivity to improve by nearly 30 percent, which is significant statistically as well as economically. These results are consistent with the previous findings based on \(FSP_{it}\), which support the hypothesis of shared supplier spillovers of FDI firms.

\(^{23}\)I thank the editor, Nathan Nunn, for this suggestion.

\(^{24}\)Results available upon request.
6.4 Horizontal Spillovers

What can the finding of shared supplier spillovers of FDI firms within the same industries, while not equivalent, inform us about the overall horizontal spillovers of FDI firms? Here I follow the standard approach in identifying horizontal spillovers, by relating the productivity of domestic firms to the industry foreign presence of all FDI firms in the same industry:25

\[
\ln \text{TFP}_{it} = \alpha_i + \alpha_t + \alpha_{IFP} \text{IFP}_{jt} + X_{it}\beta,
\]

where the log of TFP of domestic firms, \( \ln \text{TFP}_{it} \), is regressed on the industry foreign presence, \( \text{IFP}_{jt} \), controlling for firm and year fixed effects, \( \alpha_i \) and \( \alpha_t \), as well as industry controls for demand shocks (tariffs set by the EU and US on the garment imports from Bangladesh), and productivity shocks (the average industry level TFP). Given that \( \text{IFP}_{jt} \) is time varying industry specific, I no longer can control for industry-location-year fixed effects, and it is necessary to cluster the standard errors by industry-year to avoid the classic macro-variable-in-micro-unit problems (Moulton, 1990).

Table 8 presents the results based on industry foreign presence. These results are more compatible with the existing literature in terms of methodology. Column (1) shows that, controlling for productivity and demand shocks, an increase in industry foreign presence tends to depress the productivity of domestic firms. This strong negative result echoes the existing findings of Aitken and Harrison (1999). Columns (2) and (3) split the sample of domestic firms into those that share local suppliers with FDI firms and those that do not. Here, one can see some contrasting picture. While the effect of industry foreign presence on the productivity of domestic firms that have foreign siblings is ambiguous - it has a positive sign but is statistically insignificant, those domestic firms that do not share local suppliers with the FDI firms clearly suffer from the increased presence of FDI firms in the industries. In other words, productivity spillovers depend on whether or not the domestic firms are connected to FDI firms through local suppliers.

In Columns (4) to (5) I further replace industry foreign presence with its two components,

\[
\text{IFP}_{jt} = \text{IFP}_{jt}^{DS} + \text{IFP}_{jt}^{NDS},
\]

Please refer to the Appendix for a discussion on the related literature on this area.
where $IFP_{jt}^{DS}$ is the industry foreign presence of those FDI firms that have domestic siblings. These are the FDI firms that share local suppliers with domestic firms. Likewise, $IFP_{jt}^{NDS}$ is the industry foreign presence of those FDI firms that do not have domestic siblings. These are the FDI firms that do not share local suppliers with domestic firms. Column (4) shows that, for those domestic firms that have foreign siblings, the increased industry presence of FDI that share local suppliers with domestic firms clearly improve their productivity. In other words, positive horizontal spillovers happen between domestic firms and FDI firms that share local input suppliers. This result is consistent with our previous findings of shared supplier spillovers. On the other hand, Column (5) shows that the presence of both types of FDI firms unambiguously hurt those domestic firms that do not share local suppliers with FDI firms. Presumably, this is because, without a channel for productivity spillovers, the presence of FDI firms only hurts the market share of these domestic firms and forces them to operate inefficiently. This validates the market-stealing finding of Aitken and Harrison (1999).

Overall, the results suggest that different domestic firms may be affected very differently from the presence of FDI firms. While the domestic firms that are not connected to FDI firms through local suppliers mostly hurt by the presence of FDI firms in the industry, those domestic firms that share local suppliers with FDI firms unambiguously benefit from the presence of these FDI firms. The overall effect on the industry depends on the proportion of domestic firms that have FDI siblings. In the current data set it is 36 percent. The strongly negative effect of industry foreign presence gradually fades away when the proportion of domestic firms that have FDI siblings increases. In other words, shared supplier spillovers may not show up at an industry level as horizontal spillovers if the proportion of domestic firms with FDI siblings is small.

Thus, this result may shed light as to why most papers in the past do not find strong supports for horizontal spillovers. First, those FDI firms may not have backward linkages which foreclose the possibility of any productivity spillovers to domestic firms in the same industry. Second, the proportion of domestic firms that share local suppliers with FDI firms could be low, which limits the influence of FDI firms on the domestic industry. In other words, the finding of shared supplier spillovers can still be consistent with overall negative horizontal spillovers in the industry, which may consist of a large proportion of domestic firms that do not have FDI siblings.
6.5 Greater Local Input Intensity of FDI

Our analysis thus far shows that the presence of FDI in the garment industry leads to higher productivity and product scope of domestic firms in the same industry when these firms share the common local input suppliers. For such results to make sense, it is necessary to show that FDI firms have a greater local input intensity than an otherwise identical domestic firms. Specifically, according to Proposition 1 of Rodriguez-Clare (1996), “if the linkage coefficient of multinationals is higher than the linkage coefficient of domestic firms, then an increase in \( M(NEs) \) generates an increase in \( n \) and \( w \) (more beneficial to host country).” The linkage coefficient is defined as “the level of employment generated in the intermediate-goods sector per unit of labor hired directly by domestic firms and multinationals, respectively.” In other words, for each unit of labor hired by the FDI firms, if it generates more employment in the upstream sector due to the use of domestic materials, then the linkage coefficient of FDI firms is considered higher than that of the domestic firms, and may lead to greater variety of domestic materials and benefit other domestic firms that use these new varieties of domestic materials.\(^{26}\)

To exam the hypothesis that in the garment sector of Bangladesh, the linkage coefficient of FDI firms is higher than that of domestic firms, I constructed two variables. The first is domestic material per total employment of each firm and the second is the share of domestic material in total material of each firm. Table 9 presents the empirical evidence. Controlling for industry-location-year fixed effects, firm characteristics such as age, size (log of output, log of material and log of employment), capital intensity (capital-labor ratio) and export markets (export share of EU and US as EU required more domestic materials to satisfy ROOs), FDI firms on average use more domestic materials per unit of employment, and has a higher domestic material share in total materials than otherwise identical domestic firms. To the extent that higher domestic material per employee and higher domestic material share in total materials for FDI imply higher employment generated in the intermediate goods sector per unit of labor hired directly by the FDI firms, then the regression results suggest that FDI firms are beneficial to the garment sector of Bangladesh as their presence lead to more variety of domestic materials being produced. The results are robust to whether I only focus on cross sectional comparisons (Columns (1), (2), (5) and (6)), or allowing

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\(^{26}\)I thank Gordon Hanson for suggesting this test.
for time series panel correlation (Columns (3), (4), (7) and (8)). These results suggest that in the garment sector of Bangladesh the domestic material intensity of FDI firms is indeed higher than that of domestic firms, which satisfies the sufficient condition of Proposition 1 of Rodriguez-Clare (1996) and is therefore consistent with the finding of shared supplier spillovers from FDI firms to domestic firms. Due to space constraint, in the Appendix, I present and estimate a simple model directly links the local intermediate input variety to product scope expansion and productivity gain of domestic firms when local intermediate input variety depends on the presence of FDI firms in the industry. Even though the model is highly stylized, it is consistent with the previous results of the reduced form regressions and support the finding of SSS.

6.6 Structural Regressions

To formally study the role of FDI in promoting the variety of local input which causes productivity of domestic firms to increase, I rely on the following structural model, motivated by Ethier (1982) and Rodriguez-Clare (1996). There are two sectors in the economy, a differentiated intermediate input sector, producing \( N \) variety of input, \( m_n, n = 1, \ldots, N \), and a differentiated final goods industry, producing output \( Y \), based on a production function which depends on labor, \( L \), capital, \( K \), and all the intermediate inputs, \( m_n \), with a constant elasticity of substitution, \( \sigma > 1 \) among the different varieties of intermediate input. The final goods industry has \( i = 1, \ldots, I \) firms, and some of these firms are FDI firms. The number of FDI firms are exogenously given in the model (regulated by the government). Specifically, a typical firm \( i \) in the final goods sector has the following production function (year subscript omitted),

\[
Y_i = \phi_i \left[ \sum_{n=1}^{N} m_n^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \alpha \lambda_i^\alpha \kappa_i^\kappa.
\]

Please note that in the previous version of the paper, I have compared the level of domestic materials of FDI firms to that of domestic firms (Table 10). I wasn’t trying to compare the linkage coefficient of FDI to that of domestic firms. I was just trying to show that FDI firms use more domestic materials in “level”, not necessarily intensively. Even if the result on Table 10 could be affected by firm size, it does not support or invalidate the results I have just discussed which are based on the linkage coefficient of firms. In addition, I have also included Firm Size Sibling Presence as a robustness check in Table 7, Columns (3) and (7), to show that the result of shared supplier spillovers of FDI is not driven by firm size.

The reasons why FDI firms in the garment industry of Bangladesh use local intermediate input more intensively is beyond the scope of this paper.
In a symmetric equilibrium where \( m_{ni} = m_i \), (16) can be rewritten as

\[
Y_i = \phi_i N^{\frac{\alpha_M}{\sigma-M}} M_i^{\alpha_M} L_i^{\alpha_L} K_i^{\alpha_K},
\]

where \( M_i = Nm_i \), is the total amount of intermediate inputs used in the production of \( Y_i \). Holding \( M_i \) fixed, (17) shows that an increase in \( N \) raises \( Y_i \). Taking logs on both sides of (17), and defining the total factor productivity (TFP) of firm \( i \) as the following:

\[
\ln TFP_i \equiv \ln Y_i - \alpha_M \ln M_i - \alpha_L \ln L_i - \alpha_K \ln K_i,
\]

then it is clear that an increase in \( N \) will raise \( i \)'s TFP, given that \( \sigma > 1 \):

\[
\ln TFP_i = \ln \phi_i + \frac{\alpha_M}{\sigma-1} \ln N.
\]

In an open economy, the total variety of intermediate inputs available for the final goods sector is the sum of the locally produced variety, \( N^D \), and the imported variety, \( N^I \),

\[
N = N^D + N^I,
\]

which implies that an increase in the local variety of input will increase the productivity of the final good sector,

\[
\ln TFP_i = \ln \phi_i + \frac{\alpha_M}{\sigma-1} \ln \left( N^D + N^I \right).
\]

In equilibrium, \( N^D \) depends on the aggregate demand of the final good industry, which could increase due to the entry of FDI firms,

\[
N^D = f (FDI).
\]

Equation (19) presents the structural relationship between firm productivity and the number of input variety. This equation can be easily estimated, based on data for the number of local and imported inputs. I proxy \( N^D \) using the number of local input suppliers and \( N^I \) based on the number
of imported intermediate inputs variety. The sum of the number of local input suppliers and the number of imported input variety gives me \( N \). Given that the number of local input suppliers and the number of imported input variety probably measure \( N^D \) and \( N^I \) with errors, the least square estimate could have a downward bias.

Columns (1) and (2) of Table 10 present the least squares results. Column (1) ignores the number of imported input variety, \( N^I \), and only focuses on the relationship between productivity and local input variety, while Column (2) includes both local and imported input variety in the regression. Firm fixed effects are used to control for \( \ln \phi_i \), and given that \( N^D \) and \( N \) are common across all firms within a year, the standard errors are clustered by year. Both columns show that there is a positive and significant relationship between the productivity of domestic firm and the number of input varieties. However, these results can be downward biased given that \( N^D \) and \( N \) are measured with errors.

To show, empirically, that an increase in the number of FDI firms in the final good industry may lead to an increase in the number of local input variety and, thus the TFP of domestic firm in the final sector, I instrument \( N^D \), using the number of FDI firms in a first stage regression. In addition, I use the international price of cotton fabrics as an instrument for \( N^I \). Here, the exclusion restriction is that the total number of FDI firms in the Bangladeshi garment sector is exogenous and has no direct impact on the productivity of individual domestic firms other than through local intermediate inputs. This is justifiable given that during the sample period, foreign investment in the garment sector was highly restrictive under the Bangladesh Investment Policy (1999). While existing FDI firms may invest and expand their capacity, new FDI firm entry was tightly regulated by the government, which makes the total number of FDI firms de facto exogenous during the sample period. From 1999 to 2003, only 6 new FDI firms were established, all were green field investments, and half were new additions to the existing FDI conglomerates in Bangladesh from South Korea. Comparatively, 54 percent of the domestic firms in the data were set up during the sample period, suggesting that the number of FDI firms were, in fact, tightly controlled by the

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29 In the survey, firms report the HS 6 digit codes for the inputs they used for production. For each of these HS 6 digit inputs, I consider imports from different countries as different varieties. I match these HS codes with Bangladesh bilateral import data from Comtrade to construct the number of unique imported input variety for each year, from 1999 to 2003, respectively.

30 The international price of cotton fabrics is constructed using the unit value of Indian’s export of cotton fabrics to the world, according to data from Comtrade.
government. In other words, the exclusion restriction assumes that the productivity and product scope of any one domestic owned firms do not affect the number of FDI firms in the industry, which is determined only by the government. On the other hand, the world price of cotton fabrics clearly should not affect the productivity of domestic garment firms other than through its negative impact on imported fabrics variety.

Columns (3) and (4) of Table 10 present the second stage results. The IV estimates are both positive and statistically significant. These estimates are also larger than the least squares estimates, suggesting that the IV estimates are better in handling measurement errors in \( N^D \) and \( N^I \). Due to the space constraint, the first stage results are not reported but is available upon request. Instead, I report the first stage F statistics in Table 10. In both cases, the first stage regressions have F statistics that are greater than 10 and the coefficients have the expected signs. These results confirm that an increase in the number of FDI firms raises the number of local input variety and the total input variety, which leads to higher productivity for domestic firms.

To study the effect of FDI on product variety of the final goods sector, consider that for each firm \( i \), \( Y_i \) represents a composite output of different final varieties,

\[
Y_i = \left[ \sum_{v_i=1}^{V_i} \frac{y_{v_i}}{y_{v_i}} \right]^{\frac{\lambda}{\lambda-1}}, \lambda < 0.
\]  

(21)

One can think of \( Y_i \) as the production possibility frontier (PPF) of firm \( i \) (e.g. GAP, Old Navy), and each firm \( i \) produces many varieties of the final good (e.g. T-shirts, sweaters). The concavity of \( Y_i \) is ensured by \( \lambda < 0 \), which is the constant elasticity of substitution in production between the different varieties of \( y_{v_i}, v_i = 1, ..., V_i \). Combining (17) with (21) shows that an expansion of the variety of intermediate inputs works much like a positive productivity shock which causes a outward shift in firm \( i \)'s PPF and, at given prices of each final good variety, may lead to an expansion in the output variety as some previously not profitable varieties may now become profitable. Figure 4 demonstrates this for a two variety case. Under the fixed price level, in the original equilibrium, firm \( i \) only produces variety 1, but as the PPF shifts out due to an increase in input variety, firm \( i \) also produces variety 2 in the new equilibrium.

To formally show that, I consider a symmetric equilibrium, where within each firm \( i \), the price for each variety of \( Y \) is the same ensuring that the quantity produced for each variety is also the
same,
\[ p_{vi} = p_i, \text{ and } y_{vi} = y_i. \quad (22) \]

This implies that the aggregate bundle of goods produced by \( i \) equals the quantity of each variety times the total output variety of \( i \) raised to a positive power:
\[ Y_i = V_i^{\lambda-1} y_i. \]

One can, therefore, rewrite the production function, in terms of output per variety, as the following,
\[ y_i = V_i^{\lambda-1} \phi_i N^{\alpha_M} M^\alpha_i L^\alpha_i K^\alpha_i, \quad (23) \]

which shows that, given the same amount of inputs, if firm \( i \) produces more varieties of output, the quantity for each variety is smaller.

To produce each unit of \( y_i \), firm \( i \) minimizes the cost of production, which results in the following unit cost function (assuming \( \alpha_M + \alpha_L + \alpha_K = 1 \)),
\[ c_i = \kappa V_i^{\lambda-1} \left[ \phi_i N^{\alpha_M} \right]^{-1} P_M^{\alpha_M} P_L^{\alpha_L} P_K^{\alpha_K}, \quad (24) \]

where \( P_j, \forall j = \{M, L, K\} \), is the price of intermediate input, labor and capital, and \( \kappa \) is a constant which depends on the \( \alpha \)'s. Equation (24) implies that an increase in the variety of intermediate inputs pushes down the unit cost of producing \( y_i \). In contrast, given input prices and variety, an increase in output variety raises the cost for each variety. Given \( c_i \), to maximize profit, firm \( i \) will set the price for each variety to be a fixed markup over \( c_i \),
\[ p_i = \mu c_i = \mu \kappa V_i^{\lambda-1} \left[ \phi_i N^{\alpha_M} \right]^{-1} P_M^{\alpha_M} P_L^{\alpha_L} P_K^{\alpha_K}, \quad (25) \]

where \( \mu > 1 \) depends on the constant elasticity of substitution between different firm \( i \)'s. Equation (25) implies that, given prices of inputs and output, an increase in input variety leads to an increase
in output variety:

\[
V_i^{\lambda_i} = \left[ \phi_i N_i^{\frac{\theta M}{\sigma - 1}} \right] \frac{p_i}{P_{M}^i P_{L}^i P_{K}^i} \frac{1}{\mu_i} \Rightarrow \\
\ln V_i = \frac{\lambda - 1}{\lambda} \left[ \theta + \phi_i + \frac{\alpha M}{\sigma - 1} \ln N + \ln p_i - \sum_{j=(M,L,K)} \alpha_j \ln P_j \right].
\] (26)

Equation (26) presents a structural relationship between product scope and the input variety of a multi-product profit maximizing firm. It shows that an increase in input variety leads to the expansion of product scope of a firm, controlling for productivity, output price, and the industry prices of materials, labor, and capital. It also neatly shows that a rise in input variety has the similar expansionary effect on product scope as a positive productivity shock that increases the productivity of a firm. Recalling Figure 4, an increase in input variety or productivity will both shift the PPF out such that, under constant prices, a firm will find it profitable to produce more output varieties. Given that I have shown that more FDI firms lead to more local input varieties, more FDI firms, therefore, cause the product scope of domestic firms to be larger. Equation (26) also shows that any reduction in input prices will also lead to an expansion in product scope for domestic firms. The finding here, that increases in input variety and reduction in input prices lead to the proliferation of output variety, is very similar to that of Goldberg, Khandelwal, Pavcnik and Topalova (2010). In their paper, the authors show that trade liberalization in India in the 1990s caused an explosion in the variety of imported intermediate inputs and a reduction in the prices of these inputs, which led to an expansion in product scope within firms. Here, I show that a more liberalized FDI regime will also lead to an increase in local input variety, which causes domestic firms in the same industry to be more productive and has a higher product scope.

Given the linear structure, (26) can easily be estimated using the following log linear specification (the time subscript is reintroduced for clarity):

\[
\ln V_{it} = \beta_i + \beta_N \ln N_t + \beta_{TFP} \ln \phi_{it} + \beta_p \ln p_{it} + \beta_M \ln P_{Mt} + \beta_L \ln P_{Lt} + u_{it},
\] (27)

where one would expect \( \beta_N, \beta_{TFP} \), and \( \beta_p \) to be positive, and the coefficients for input prices to be negative. The regression error in (27) includes the price of capital which is unobserved. To estimate (27), I use the firm specific output price index to proxy \( p_{it} \), the augmented OP estimates of TFP
for $\phi_{it}$, the average firm specific input price index for $P_{Mt}$, and wages for $P_{Lt}$. However, it is clear that in addition to $N_t$ being endogenous, which I will instrument using the number of FDI firms, some other right-hand side variables are also endogenous, and may depend on the number of FDI firms in the garment sector too. At least one independent instrument for each of the right-hand side variables is needed for (27) to be identified. Here I use the following instrumental variables: average productivity of the industry for $\phi_{it}$, and the international prices of cotton and fabrics for $p_{it}$ and $P_{Mt}$. Wages are assumed to be exogenous due to the tremendous hidden unemployment or under-employment in Bangladesh which provide a large pool of workers relative to the size of the industry.

Table 10 presents the results. Columns (5) and (6) first present the least squares estimates when I only include firm fixed effects and the number of local suppliers or the number of total input variety on the right-hand side. While the coefficients are positive and significant, they are likely to be contaminated with measurement errors. The IV estimates are presented in Columns (7) and (8), which are positive and significant. Here again the reported first stage F statistics are larger than 10 in both regressions, and the coefficients have the expected signs.

Columns (9) to (12) estimate (27). Columns (9) and (10) present the least squares estimates. While the least squares estimates of $N_t$ are positive and significant, the majority of the remaining coefficients either have wrong signs or are insignificant. Columns (11) and (12) show the second stage of the IV estimates. Now, all the coefficients have the correct signs and are mostly significant. Most importantly, the results confirm that an increase in the number of FDI firms leads to increases in local input variety and total input variety, which raise the product scope of domestic firms. The IV estimates for $\beta_{N}$ are smaller than the least squares estimates due to reverse causality – larger product scope may cause an increased demand for locally produced intermediate inputs which causes an upward bias in the least squares estimates. On the contrary, the IV estimates are based on exogenous increases in local input variety as the number of FDI firms rises to pin down the effect on domestic product scope. The first stage results are also good, where all the coefficients have the expected signs. Here instead of reporting all the 4 first stage F statistics for each regression, I only report the lowest first stage F statistics in Table 10. The point here is to show that if the lowest F statistics are still larger than 10, then all the first stage F statistics are larger than 10, suggesting that all the first stage regressions have significant explanatory power.
Overall, the results confirm that FDI firms in the garment sector cause the number of local input variety to increase, which leads to significant gains for domestic firms, in terms of product scope and productivity.

7 Conclusions

This paper studies and finds support for shared supplier spillovers of FDI firms, whereby, the product scope and productivity of domestic firms improve, due to the increased presence of their FDI siblings. Siblings are firms that share local intermediate input suppliers. This effect is, primarily, driven by increased firm access to new or better local input varieties as the expanding FDI firms push up industry demand for local intermediate inputs, and not through selection or pecuniary externalities. I present some empirical evidence, based on reduced form regressions, showing that when FDI and domestic firms share common local input suppliers, an exogenous increase in the presence of FDI firms in the industry will cause domestic firms to perform better in terms of product scope, sales per worker, output per worker and productivity. In the Appendix, I present a simple theoretical model of a multi-product firm with a love of variety for intermediate inputs. The model predicts that productivity and product scope of the firm rise with the expansion of intermediate inputs in the industry. Given that FDI firms increase industry demand for intermediate inputs, which leads to the proliferation of local input variety, more FDI firms will, therefore, lead to higher productivity and product scope for domestic firms in the same industry. Structural regressions based on the model confirm the results.

Thus, the results of this paper provide support to endogenous growth models which emphasize the importance of new intermediate inputs in explaining productivity growth. Most importantly, this paper suggests a new channel via which the presence of FDI firms may bring non-pecuniary externalities to domestic firms. Finally, besides lowering tariffs on imported intermediate inputs, what else can the governments do to enhance the product scope and productivity of domestic firms? This paper would suggest that a well designed FDI policy that attracts FDI with significant backward linkages, may come a long way in promoting the intermediate input industries, and may also benefit the domestic final good firms.
References


Figure 1: Numbers of Garment FDI firms and Local Suppliers In Bangladesh (1984=1)

Figure 2: The Share of FDI Firms in Bangladesh’s Apparel Sector, 1999-2003
Figure 3: An Example of the Calculations of Industry Foreign Presence and Foreign Sibling Presence

Industry foreign presence = \( FP_{2t} + FP_{3t} + FP_{4t} \)
Foreign sibling presence for A = \( (FP_{1t} + FP_{3t}) + (FP_{2t} + FP_{4t}) \)
Foreign sibling presence for B = \( (FP_{2t} + FP_{3t}) + FP_{4t} \)

Figure 4: Output variety increases as PPF shifts out due to an increase in input variety
Table 1: Sample Averages

<table>
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<th>Woven</th>
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<td>Domestic</td>
<td>FDI</td>
<td>Domestic</td>
<td>FDI</td>
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<tr>
<td>Sales</td>
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<td>2656.05</td>
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<td>3662.36</td>
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<td>Investment</td>
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<td>137.59</td>
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<tr>
<td>Capital</td>
<td>580.10</td>
<td>1582.38</td>
<td>734.65</td>
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<td>Age (year)</td>
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<tr>
<td>Number of firms</td>
<td>89</td>
<td>15</td>
<td>167</td>
<td>26</td>
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Note: All values are in US$000’s, except where otherwise specified.

Table 2: Sample Averages for Domestic firms

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<tr>
<td>Industry foreign presence ((IFP_{jt}))</td>
<td>28.68</td>
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<td>FDI siblings ((FDIS_{jt} = 1))</td>
<td>15.57</td>
<td>51.91</td>
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<tr>
<td>Foreign sibling presence ((FSP_{jt}))</td>
<td>0.48</td>
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<tr>
<td>Share of domestic firms that have a common product with a FDI firm</td>
<td>89.52</td>
<td>92.93</td>
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<td>Product foreign presence ((PF_{jt}))</td>
<td>13.48</td>
<td>36.61</td>
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<tr>
<td>Share of domestic firms that have a common market with a FDI firm</td>
<td>97.60</td>
<td>97.31</td>
</tr>
<tr>
<td>Market foreign presence ((MF_{jt}))</td>
<td>2.12</td>
<td>10.58</td>
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Note: All values are in percent.

Table 3: First Stage Regressions: Dependent variable – Sibling Foreign Presence

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<td>FDI siblings that export to EU</td>
<td>0.09***</td>
<td>0.04***</td>
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<tr>
<td></td>
<td>(0.01)</td>
<td>(0.01)</td>
</tr>
<tr>
<td>FDI siblings that export to EU*</td>
<td>0.04***</td>
<td>0.01***</td>
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<tr>
<td>Woven*EBA</td>
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<td>(0.00)</td>
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<td>F-stat</td>
<td>202.79***</td>
<td>13.46***</td>
</tr>
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</table>

Notes: All columns include firm fixed effects, industry-region-year fixed effects, firm age, share of imported materials, share of material in sales, and firm specific time trends. *, **, *** indicate statistical significance at 90%, 95%, and 99% confidence levels, respectively. Column (1) consists of Bangladeshi firms that do not export to the EU; Column (2) consists of Bangladeshi firms that may or may not export to the EU.
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<th>(4)</th>
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<td>LS</td>
<td>IV</td>
<td>LS</td>
<td>IV</td>
<td>LS</td>
<td>IV</td>
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<tr>
<td>Foreign sibling presence</td>
<td>2.21*</td>
<td>7.30***</td>
<td>4.85*</td>
<td>18.43***</td>
<td>4.92*</td>
<td>18.40***</td>
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<td>9.05***</td>
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<td>8.33***</td>
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<tr>
<td></td>
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<td>(2.23)</td>
<td>(1.07)</td>
<td>(2.27)</td>
<td>(1.15)</td>
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Notes: All dependent variables are in logs. TFP_OLS is from (39) and (40); TFP_AOP is from (37) and (38).
Firm fixed effects and industry-region-year fixed effects are included in all columns.
Robust standard errors in parentheses are clustered by industry-year, with degree of freedom adjustment for small sample.
*, **, *** indicate statistical significance at 90%, 95%, and 99% confidence levels, respectively.
Sample only consists of Bangladeshi firms that do not export to the EU. All columns include firm specific time trends.
Table 5: Full Sample of Domestic Firms with Firm Specific Time Trends

<table>
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<td>Product Scope</td>
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<td>Foreign sibling presence</td>
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<td>0.61***</td>
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<td>0.44***</td>
<td>0.42***</td>
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<td>(0.08)</td>
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Notes: All dependent variables are in logs. TFP_OLS is from (39) and (40); TFP_AOP is from (37) and (38).
Firm fixed effects and industry-region-year fixed effects are included in all columns.
Robust standard errors in parentheses are clustered by industry-year, with degree of freedom adjustment for small sample.
* , ** , *** indicate statistical significance at 90%, 95% and 99% confidence levels, respectively.
Sample consists of Bangladeshi firms that may or may not export to the EU. All columns include firm specific time trends.
Table 6: Robustness Checks – Other Sources of Spillovers

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<td>-0.05</td>
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<td>-1.00**</td>
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</table>

Notes: All dependent variables are in logs. TFP_AOP is from (37) and (38).
Firm fixed effects and industry-region-year fixed effects are included in all columns.
Unless otherwise stated, robust standard errors in parentheses are clustered by industry-year, with degree of freedom adjustment for small sample.
For (5) and (10) only, random matching of siblings are repeated 50 times. Coefficients and standard error reported are the average and standard deviation of the 50 regressions.
*, **, *** indicate statistical significance at 90%, 95%, and 99% confidence levels, respectively.
Sample consists of Bangladeshi firms that may or may not export to the EU. All columns include firm specific time trends.
Table 7: Full Sample of Domestic Firms with Firm specific Time Trends

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<th>Dependent Variables</th>
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<td>1.83***</td>
<td>0.17**</td>
<td>0.96***</td>
<td>0.22***</td>
<td>0.91***</td>
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<tr>
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<td>(0.04)</td>
<td>(0.15)</td>
<td>(0.34)</td>
<td>(0.14)</td>
<td>(0.34)</td>
<td>(0.06)</td>
<td>(0.15)</td>
<td>(0.07)</td>
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<td>0.04</td>
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<td>0.47**</td>
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<td>0.56***</td>
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<td>0.32**</td>
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<td>(0.16)</td>
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<td>(0.10)</td>
<td>(0.11)</td>
<td>(0.11)</td>
</tr>
<tr>
<td>Imported Materials/Materials</td>
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<td>-0.07**</td>
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<td>0.05</td>
<td>0.04</td>
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<td>(0.23)</td>
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<td>(0.12)</td>
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<td>(0.09)</td>
</tr>
<tr>
<td>Material/Sales</td>
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<td>-1.18***</td>
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<td>(0.07)</td>
<td>(0.29)</td>
<td>(0.35)</td>
<td>(0.26)</td>
<td>(0.31)</td>
<td>(0.23)</td>
<td>(0.21)</td>
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<td>(0.27)</td>
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Notes: All dependent variables are in logs. TFP_OLS is from (39) and (40); TFP_AOP is from (37) and (38). Firm fixed effects and industry-region-year fixed effects are included in all columns. Robust standard errors in parentheses are clustered by industry-year, with degree of freedom adjustment for small sample. *, **, *** indicate statistical significance at 90%, 95%, and 99% confidence levels, respectively. Sample only consists of Bangladeshi firms that may or may not export to the EU. All columns include firm specific time trends. Instruments: FDIS\_EU\_it, FDIS\_EU\_it * woven\_i * EBA\_i; 1st-stage F-Stat: 9.82*** with both coefficients positive and significant.
Table 8: Robustness Checks – Horizontal Spillovers

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<td>for FDI firms with domestic siblings</td>
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<td>for FDI firms without domestic siblings</td>
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<td>0.67*</td>
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<td>(0.06)</td>
<td>(0.33)</td>
<td>(0.13)</td>
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<td>Tariffs of US</td>
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<td>-0.30</td>
<td>0.30***</td>
<td>-1.91**</td>
<td>0.65**</td>
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<td>-0.36</td>
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<td>(0.47)</td>
<td>(0.56)</td>
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<td>622</td>
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Notes: All dependent variables are in logs. TFP_AOP is from (37) and (38). Firm fixed effects and year fixed effects are included in all columns; Robust standard errors in parentheses are clustered by industry-year; *, **, *** indicate statistical significance at 90%, 95%, and 99% confidence levels, respectively; Column (1) consists of all Bangladeshi firms; Columns (2) and (4) consists of all Bangladeshi firms with FDI siblings; Columns (3) and (5) consists of all Bangladeshi firms with no FDI siblings;
<table>
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<th>(3)</th>
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<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
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<td>FDI Domestic Material per Employee</td>
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<td>503.93***</td>
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<td>0.12***</td>
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<td>(349.94)</td>
<td>(218.46)</td>
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<td>(0.07)</td>
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<td></td>
<td>(631.60)</td>
<td>(551.19)</td>
<td>(250.87)</td>
<td>(435.66)</td>
<td>(0.114)</td>
<td>(0.11)</td>
<td>(0.07)</td>
<td>(0.12)</td>
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<td>Export Share of US</td>
<td>-385.35</td>
<td>-391.57</td>
<td>-580.81**</td>
<td>-580.81</td>
<td>-0.031</td>
<td>-0.11</td>
<td>-0.10</td>
<td>-0.10</td>
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<tr>
<td></td>
<td>(662.60)</td>
<td>(588.52)</td>
<td>(248.34)</td>
<td>(445.67)</td>
<td>(0.119)</td>
<td>(0.11)</td>
<td>(0.08)</td>
<td>(0.13)</td>
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<td>Log of Employment</td>
<td>-2058.54***</td>
<td>-1498.94***</td>
<td>-1346.67***</td>
<td>-1346.67***</td>
<td>-0.055*</td>
<td>-0.02</td>
<td>-0.01</td>
<td>-0.01</td>
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<tr>
<td></td>
<td>(669.29)</td>
<td>(148.56)</td>
<td>(246.84)</td>
<td>(272.16)</td>
<td>(0.031)</td>
<td>(0.03)</td>
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<td>Capital-Labor Ratio</td>
<td>-0.01</td>
<td>-0.01</td>
<td>-0.01***</td>
<td>-0.01***</td>
<td>0.000</td>
<td>0.00</td>
<td>0.00***</td>
<td>0.00***</td>
</tr>
<tr>
<td></td>
<td>(0.07)</td>
<td>(0.01)</td>
<td>(0.00)</td>
<td>(0.000)</td>
<td>(0.00)</td>
<td>(0.00)</td>
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<tr>
<td>Log of Materials</td>
<td>588.63**</td>
<td>610.92***</td>
<td>550.63***</td>
<td>550.63***</td>
<td>-0.020</td>
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<td></td>
<td>(264.40)</td>
<td>(96.51)</td>
<td>(111.98)</td>
<td>(139.11)</td>
<td>(0.021)</td>
<td>(0.02)</td>
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<tr>
<td>Log of TFP</td>
<td>-523.04</td>
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<td>-216.77</td>
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<td>(462.65)</td>
<td>(143.17)</td>
<td>(149.70)</td>
<td>(175.10)</td>
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<td>(0.03)</td>
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<td>Age</td>
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<td>-29.43</td>
<td>-190.80***</td>
<td>-190.80**</td>
<td>-0.047**</td>
<td>-0.02</td>
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<td>(103.92)</td>
<td>(117.62)</td>
<td>(64.78)</td>
<td>(77.03)</td>
<td>(0.019)</td>
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</tr>
<tr>
<td>Log of Output</td>
<td>981.98*</td>
<td>448.19***</td>
<td>480.05**</td>
<td>480.05**</td>
<td>0.017</td>
<td>-0.01</td>
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<tr>
<td></td>
<td>(571.81)</td>
<td>(125.20)</td>
<td>(196.67)</td>
<td>(199.31)</td>
<td>(0.025)</td>
<td>(0.02)</td>
<td>(0.01)</td>
<td>(0.02)</td>
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<td>Industry-Location Fixed Effects</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
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<td>Industry-Location-Year Fixed Effects</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Number of Observations</td>
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<td>1155</td>
<td>1155</td>
<td>1155</td>
<td>263</td>
<td>1155</td>
<td>1155</td>
<td>1155</td>
</tr>
</tbody>
</table>

Notes: (1) and (5) are based on cross sectional data in 2003. The rest of columns are based on panel data from 1999 to 2003. Standard errors in parenthesis.
(1) and (5) report the OLS estimates with bootstrap standard errors. (2) and (6) report the between estimates.
(3) and (7) report panel estimates with industry-location-year clustered standard errors.
(3) and (7) report panel estimates with firm clustered standard errors.
<table>
<thead>
<tr>
<th>Table 10: Structural Estimations</th>
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<tr>
<td><strong>Dependent Variables</strong></td>
</tr>
<tr>
<td><strong>Estimation Methods</strong></td>
</tr>
<tr>
<td>Number of local input suppliers</td>
</tr>
<tr>
<td>Number of total intermediate inputs</td>
</tr>
<tr>
<td>TFP</td>
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<tr>
<td>Price of output</td>
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<tr>
<td>Price of intermediate inputs</td>
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<tr>
<td>Wages</td>
</tr>
<tr>
<td>F-Statistics</td>
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<tr>
<td>Observations</td>
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</table>

Notes: Full sets of firm fixed effects are included in all columns. Standard errors in parentheses are clustered by year. TFP_AOP is from (36) and (38). All variables are in logs. Excluded instruments for IV estimations are: number of FDI firms, international cotton fabrics price (in (4), (8) and (12) only), industry average TFP (in (11) and (12) only), and international cotton price (in (11) and (12) only). For (11) and (12), I only report the lowest F-statistics from the 4 first stage regressions. First stage results are available upon request. *, **, *** indicate statistical significance at 90%, 95%, and 99% confidence levels, respectively.
A Appendix for On-line Publication

A.1 Horizontal Spillovers of FDI

There is a vast literature on the topic of horizontal spillovers. Theoretical papers in this area tend to conclude positive spillovers. Besides Rodriguez-Clare (1996) and Carluccio and Fally (2011), Findlay (1978) also provides a dynamic model to show the role of FDI firms in transferring technology from the advanced to the backward countries. Markusen and Venables (1999) presents an analytical model where FDI firms may act as a catalyst for industrial development if they generate enough demand to support the upstream industries through backward linkages, which further foster the downstream industries through forward linkages.

However, empirical evidence for horizontal spillovers are mixed. Earlier papers, based on case studies (e.g. Caves, 1974), or cross industry evidence (e.g. Blomstrom and Persson, 1983; Blomstrom and Wolff, 1994), tend to conclude that there exists a positive correlation between the presence of FDI in an industry and the average productivity of domestic firms, while papers based on firm or plant level statistics of developing countries have found the opposite (Aitken and Harrison, 1999; Haddad and Harrison, 1993; Djankov and Hoekman, 2000; Konings, 2001). The way horizontal spillovers are identified in this literature is to associate the productivity of domestic firms with the presence of all FDI firms in the industries. It is not until recently that the some fresh results started to emerge. Haskel, Pereira, and Slaughter (2007) found small but statistically significant evidence of positive spillovers in a study of UK manufacturing plants. Based on a matched establishment-worker database from Brazil, Poole (2013) finds some convincing evidence showing that worker turnover from FDI firms to domestic firms is an important channel for knowledge transfer.

Given that I have information on which are the FDI firms in the industries that have backward linkages and which are not, I can study the differential impacts of the presence of these different FDI firms in the industries on the productivity of domestic firms, who may or may not share common local suppliers with the FDI firms. In other words, this paper is able to take into account the heterogeneity of FDI firms in terms of their backward linkages, as well as the heterogeneity of domestic firms in terms of their connection with the FDI firms, through the use of common local input suppliers. The results are presented in Table 8 of this paper which I discuss in detail in
Section 6. In a nutshell, the results show that the negative horizontal spillover effects that have been predominantly highlighted in the literature only affect those domestic firms that do not have a FDI sibling. For these firms, the presence of FDI firms unambiguously hurt their productivity, regardless of whether or not the FDI firms have backward linkages. On the other hand, for those domestic firms that have FDI siblings, the presence of those FDI firms that have backward linkages clearly improves their productivity.

A.2 Survey Evidence on FDI Promoting Quality Upgrading and Variety Expansion of Local Input Suppliers

The whole premises of SSS hinge on the assumptions/assertions that FDI firms help promote a more vibrant local intermediate input industry with better quality (Javorcik, 2004) and more variety (Rodriguez-Clare, 1996) of local intermediate inputs. Is there any evidence suggesting that this is the case for the garment sector of Bangladesh? Between 2010 and 2011, a survey were conducted on the local suppliers that were identified by the garment firms in our sample, including those suppliers that were named top three by the FDI firms.\(^{31}\) Products of these local suppliers include all kinds of yarn, thread, fabric, padding, buttons, labels, elastics, fastening products (belts, buckles, laces, etc.), printing, dyeing, sewing, hangers and hanger accessories, tape, corrugated paper and cartons, back boards, enzymes, softeners, staining agents, silicone, synthetic fiber, polythene bags, etc.

Among the survey firms, 84 percent indicating that they served FDI firms during the first three years of their plants. The average share of FDI firms in their sales during the first three years is 35 percent. 26 percent of these firms suggesting that serving FDI firms was important in their decision to set up plants in Bangladesh. All these evidence indicating that FDI garment firms play an important role supporting the local intermediate input industry in Bangladesh.

With regard to quality upgrading and variety expansion, 68 percent of the surveyed local suppliers agree that FDI clients are known to be “pickier,” that demand highest quality products with lowest rejection rates, so to meet the expectation of FDI clients, suppliers need to improve their quality and efficiency. This provides evidence supporting the quality upgrading hypothesis of Javorcik (2004). On the other hand, 62 percent of the surveyed local suppliers agree that their FDI clients suggest new products for the suppliers to manufacture, which expand the product scope of

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\(^{31}\)The other local suppliers either have closed down, refused to participate or cannot be located in Bangladesh.
the suppliers, which validates the variety hypothesis of Rodriguez-Clare (1996). Finally, 68 percent of the respondents agree that FDI clients may have better procurement practices, better inventory management (bar codes and computerization), so the suppliers learn these technologies and apply them to their own businesses. This is consistent with the finding of Javorcik (2004) that FDI firms transfer technology to their local suppliers which makes them more productive.

With regards to the direct evidence of SSS, 82 percent of the respondents agree that their domestic garment firm clients benefit from them working with the FDI garment firms. Specifically, 35 percent of the sampled local suppliers indicating that they have sold some new products to the domestic garment firms which were originally suggested to them by their FDI clients; 68 percent of these suppliers apply the same procurement practice, inventory management they may have learned from their FDI clients to their domestic garment firm clients; and 35 percent of the respondents agree that their FDI clients make them upgrade their product quality and they subsequently also sell the better quality products to a domestic garment firm. Finally, 75 percent of the suppliers concur that FDI garment firms help promote and support a more vibrant supplier industry, which now have better quality garment accessories and fabrics, as well as more variety of accessories and fabrics. So domestic garment firms now have better access to more quality accessories and fabrics, cut down lead time and business costs for them.

Overall the survey evidence is consistent with the econometric findings of this paper. These evidence indicates that both the quality upgrading and variety expansion channels are relevant in the garment sector of Bangladesh, which help explain the shared-supplier spillovers of FDI.

A.3 Firm Level Price Indexes

To estimate the firm’s productivity, one needs to measure firm output and material input. Output and material input variables are constructed by deflating total value of sales and materials with output and material input price indexes, respectively. Due to the lack of data, industry level price indexes have long been used in the literature in place of firm price indexes. There are obvious problems in using industry price indexes to deflate firm sales and material costs. For example, many heterogenous firm models would suggest that more productive firms will charge a lower price. As such, using an industry price index, which reflects the average price level of all firms in the industry, to deflate sales of the more productive firms will underestimate the output level, which
leads to an under-estimation of firm productivity.

A unique strength of my data is the fact that there is information on prices at the firm level, which allows me to construct firm specific price indexes that are consistent across years and firms. Eslava, Haltiwanger, Kugler, and Kugler (2004) construct a Tornqvist price index for each firm which is consistent within firms over time. The firm price index is a weighted average of unit value changes for each of the product the firm produces in each year, with weights that reflect the average share of the product in total sales of the firms in two consecutive years. However, by setting each firm price index equal to 1 in the base year, cross firm variation is ignored. This can hide firm heterogeneity in terms of productivity.

In this firm survey, I have information on the value and quantity of the five main products for each firm in 2003. I can, therefore, construct a weighted average unit value of products for each firm in 2003 with weights reflecting the share of each product in the total sales of the firm. This will be the firm product price level in 2003. The industry price level in 2003 is constructed by taking the weighted average of the firm price level with weights reflecting the size of the firm in the industry. By dividing the firm price level by the industry price level, I obtain a cross sectional firm price index for 2003. Firms that have a firm price level higher than the industry price level will have a firm price index in 2003 exceeding unity. Conversely, firms that have a price level less than that of the industry in 2003, will have a firm price index below unity. In this manner, the cross sectional price index will capture firm heterogeneity in 2003. Finally, to extend the firm price index to the previous years, I rely on the information provided by the firms in the survey regarding the annual change in price of their main product. In this way, the constructed multi-year firm price index will be consistent within firms across years, as well as across firms within a year. A similar procedure is used to construct firm specific material price index. I use these firm level product and material price indexes to deflate total sales and material costs of the firms to obtain output and material inputs of the firms for the production function estimation.\footnote{There may be a concern that firm specific prices may convey information on the quality of the firm. Firms that have higher quality products (or more services per good), and thus, higher prices will have a higher firm price index. By deflating total sales using this firm price index, I obtain an output measurement that is quality free, i.e., is in terms of “effective units” of the good. Thus, the productivity estimates will not be contaminated with the quality of the firm’s products, which is a known problem in the existing literature, which uses an industry price index to deflate firm sales.}
A.4 The Production Function

I assume that the following Cobb-Douglas production function holds separately for woven and non-woven industries (industry subscripts are omitted):

\[ Y_{it} = \phi_{it}L_{it}^{\alpha_L}M_{it}^{\alpha_M}K_{it}^{\alpha_K}, \] (28)

where \( i \) and \( t \) are the indexes for firm and year, respectively, and \( Y_{it}, L_{it}, M_{it} \) and \( K_{it} \) are the output, labor, materials, and capital of firm \( i \) in year \( t \). Output and material input are obtained by deflating total sales and material cost using firm specific price indices which are constructed using detailed price information from the firm survey. The total factor productivity (TFP) of firm \( i \) in year \( t \) is \( \phi_{it} \). Assume that in log, \( \phi_{it} \) can be decomposed linearly into the following,

\[ \ln \phi_{it} = \omega_{it} + \alpha_t + \alpha_Aa_{it} + \alpha_FFDI_{it} + \eta_{it}, \] (29)

where \( \omega_{it} \) is observable to the firms at the beginning of each period before variable input choices are made, but not to the researchers. The year specific productivity, \( \alpha_t \), may capture the effects of time and others factors that are common to all firms during a year (within an industry) and \( \alpha_Aa_{it} \), is the effect of (log of) age on productivity.\(^{33}\) I further allow FDI firms to have a different productivity than domestic firms by including a FDI dummy variable in (29). Whether or not age and FDI status have a direct impact on the productivity of a firm remains an empirical question. While older firms may be more established and therefore can withstand a low productivity shock, they may also be more organized and therefore more productive. Likewise, FDI firms may be able to weather low productivity draw, but they may also be more productive due to the transfer of technology from the parent firms. These scenarios cause \( \alpha_A \) and \( \alpha_F \) to have ambiguous signs a priori. I will be able to test the effect of age and FDI status on productivity in the empirical section. The last term, \( \eta_{it} \), is the truly unobserved classical error term.

Taking log of \( (28) \) and using \( (29) \), I have

\[ y_{it} = \alpha_t + \alpha_Aa_{it} + \alpha_FFDI_{it} + \alpha_LL_{it} + \alpha_MM_{it} + \alpha_Kk_{it} + \omega_{it} + \eta_{it}, \] (30)

\(^{33}\)Given that all firms are exporters in this data set, \( a_Aa_{it} \), may also capture the effect of export experience on productivity, due to possibly learning-by-exporting.
where all lower case letters are in logs. In logs, output is linearly related to the two variable inputs, labor and materials, as well as the fixed input, capital stock. Given that $\omega_{it}$ is observable to the firms (but not to the researchers) before the variable input choices are made, it could be positively correlated with $l_{it}$ and $m_{it}$, which would cause the least squares estimates of $\alpha_L$ and $\alpha_M$ to be biased upward. However, for the woven industry, $\omega_{it}$ and $m_{it}$ could be negatively correlated since more productive firms could manage to use less material while satisfying ROOs, and this would cause the least squares estimate of $\alpha_M$ to be downward biased. In addition, if larger, older firms tend to stay in business despite low productivity, while younger, smaller firms tend to quit more easily, such endogenous exit decisions on the part of firms will bias the least squares estimates of the $\alpha_A$ and $\alpha_K$ downwards.

### A.5 Estimating Productivity

To address such input endogeneity and selectivity bias, Olley and Pakes (1995) (OP) derive a 3-step procedure to obtain consistent estimates of the $\alpha'$s. In their model, firms choose to exit or not once they know their productivity. If they do not exit, they decide on how much to invest and also make other output and input decisions. The productivity, $\omega_{it}$, is assumed to be the only unobserved state variable in each year $t$ that follows a common exogenous Markov process, which, jointly with fixed input, $k_{it}$, and its age, determines the exit decision and investment demand, $i_{it}$, of the firms in each period. They consider the Markov perfect Nash equilibrium, so firm’s expectations match the realization of future productivity. Then a polynomial function of $i_{it}$, $k_{it}$, and (the log of ) age, $a_{it}$, can be used to proxy for the unobserved productivity, $\omega_{it}$. This is possible because, given $k_{it}$ and $a_{it}$, $i_{it}$ is an increasing function of $\omega_{it}$, which makes the investment function invertible. The assumption that investment is monotonically increasing with the unobserved productivity is crucial, since without it, invertibility is likely not possible. Furthermore, to control for the exit decision, they estimate a Probit regression to obtain the surviving probability and use that to control for the part of unobserved productivity that is negatively correlated with $k_{it}$.

In the current data set, it is likely that (in addition to the unobserved productivity) firm’s investment decisions also depend on the FDI status of the firms, since FDI firms may choose to stay in business and continue to investment despite low productivity draws. This is quite evident from Table 1, where FDI firms are shown to be larger and invest more than the domestic firms. This
may also suggest that FDI firms face different market structure and factor prices as the domestic firms.

To accommodate such facts, I modify OP along the lines suggested by Ackerberg, Benkard, Berry and Pakes (2007) and De Loecker (2007). Specifically, when studying the effect of exporting on firm productivity, De Loecker (2007) allows exporters to have a different investment function. In the current context, given that all firms are exporters, but only some firms are FDI firms, I allow the investment function to be indexed by their FDI status,

$$i_{it} = i_{FDI,t}(k_{it}, a_{it}, \omega_{it}).$$

This allows FDI firms to react differently from domestic firms when it comes to investment decision, as capital, age, or productivity of the firms change. Controlling for capital, age and FDI status, the investment function is assumed to be invertible, as in the original OP set up, such that I can use a separate polynomial function of investment, capital and age as controls for the unobserved productivity, for the FDI firms and domestic firms.

$$\omega_{it} = i_{FDI,t}^{-1}(k_{it}, a_{it}, i_{it}) = h_{FDI,t}(k_{it}, a_{it}, i_{it}).$$

In other words, I can proxy the unobserved firm productivity parsimoniously with a polynomial function $h_{FDI,t}(k_{it}, a_{it}, i_{it})$. In addition to the FDI status, I also allow the polynomial function to be different in different time periods, which explains why I index the function with $t$. This is because the EU, the main market for garment exporters from Bangladesh, introduced the “Everything-but-Arms” (EBA) initiative in 2001, which officially removed all quota restrictions and tariffs

34 I thank Ariel Pakes for a detailed discussion on the productivity estimation technique and for the suggestions of using Ackerberg et al (forthcoming).

35 Alternatively, one could have modeled FDI status as a state variable, similar to capital, age, and productivity, as the past exporter status in Van Biesebroeck (2006). However, this requires that FDI status changes within firms over time for some firms in the sample. This is not the case for the current data set. All firms are observed to either have no foreign ownership for the whole sample period, or to have the same FDI status throughout the sample period. Without the evolution of FDI status, it is not possible to model it as a state variable.

36 FDI dummy equals one when the firms have any foreign equity. In the current sample, the minimum foreign ownership is 25 percent.

37 Using the same data set, Demidova, Kee, and Krishna (2012) estimate firm productivity, allowing for firm-market specific demand shocks. In their context, it is crucial to control for market demand shocks as they are trying to explain the breakdown of the hierarchy of firm in terms of productivity in sorting themselves into different markets. In the current application, I am most concerned about how FDI firms affect the productivity of domestic firms endogenously through the spillover channels.
on Bangladeshi garment exports. Such policies may significantly alter the market structure and factor prices of the firms. To accommodate this, I allow the polynomial function to differ between the pre- and post-EBA period. In other words, I proxy the unobserved firm productivity with 4 different polynomial functions — domestic firms in period 1999-2000; FDI firms in period 1999-2000; domestic firms in period 2001-2003; FDI firms in period 2001-2003. The coefficients of these polynomial functions are free to be different to reflect the different market conditions.

Thus the first stage estimation involves using a polynomial function \( h_{FDI,t}(k_{it}, a_{it}, i_{it}) \) to control for \( \omega_{it} \) in order to estimate the \( \alpha \) coefficients on the variable inputs, \( l_{it} \) and \( m_{it} \), which are decided after \( \omega_{it} \) are observed.

\[
y_{it} = \alpha_t + \alpha_L l_{it} + \alpha_M m_{it} + \alpha_K k_{it} + \alpha_A a_{it} + \alpha_F FDI_i + h_{FDI,t}(k_{it}, a_{it}, i_{it}) + \eta_{it}
\]

\[
\nu_{FDI,t}(k_{it}, a_{it}, i_{it}) = \alpha_t + \alpha_K k_{it} + \alpha_A a_{it} + \alpha_F FDI_i + \omega_{it},
\]

combines \( \alpha_t, \alpha_K k_{it}, \alpha_A a_{it} \) and \( \alpha_F FDI_i \) with \( h_{FDI,t}(.) \). Provided that \( h_{FDI,t}(.) \) is successful in controlling for \( \omega_{it} \), the least squares estimates for \( \alpha_L \) and \( \alpha_M \) are consistent, and I denote them as \( \hat{\alpha}_L \) and \( \hat{\alpha}_M \).

To estimate \( \alpha_K \) and \( \alpha_A \), one needs to control for the propensity to exit to address the endogenous exiting which is affected by the size and age of the firms. For each firm \( i \), in order to maximize the present discounted value of current and future profits, the optimal exit rule having observed \( \omega_{it} \) is

\[
\chi_{it} = \begin{cases} 
1 & \text{if } \omega_{it} \geq \bar{\omega}_{FDI,t}(k_{it}, a_{it}) \\
0 & \text{otherwise}
\end{cases}
\]

where \( \bar{\omega}_t \) is the cutoff productivity to continue exporting.

Thus, the probability for firm \( i \) to survive in year \( t+1 \) given information set in year \( t \), \( J_t \), is

\[
\text{Pr}(\chi_{it+1} = 1|J_t) = \text{Pr}(\omega_{it+1} \geq \bar{\omega}_{FDI,t+1}(k_{it+1}, a_{it+1}) |J_t)
\]

\[
= \tilde{\varphi}_t(\omega_{it}, \bar{\omega}_{FDI,t+1}(k_{it+1}, a_{it+1}))
\]

\[
= \tilde{\varphi}_{FDI,t}(\omega_{it}, k_{it+1}, a_{it+1})
\]

\[
= \varphi_{FDI,t}(k_{it}, a_{it}, i_{it}) = P_{it+1}
\]

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where the first equality holds because of the exit rule (32), the second and third equalities hold due to the assumption of the exogenous Markov process of \( \omega_{lt} \), and the last equality holds because the investment function \( i_{lt} = i_{FDI,t}(k_{lt}, a_{lt}, \omega_{lt}) \) is a bijection in \( \omega_{lt} \) conditional on \( (k_{lt}, a_{lt}) \), and \( k_{lt+1} \) and \( a_{lt+1} \) can be inferred from \( k_{lt}, i_{lt} \) and \( a_{lt} \), from their laws of motion,

\[
K_{lt+1} = K_{lt} (1 - \delta) + I_{lt+1}, \quad \text{and } A_{lt+1} = A_{lt} + 1. \tag{34}
\]

In other words, in the second stage, I can estimate the survival probability in \( t+1 \) non-parametrically using a period specific polynomial function of \( (k_{lt}, a_{lt}, i_{lt}) \) in a probit regression. This would allow factors like the existence of the EBA to affect exit decisions. I denote the estimated survival probability in \( t+1 \) as \( \hat{P}_{lt+1} \).

According to (30), the expected value of output net of influence of labor and material in \( t+1 \), given the information set in \( t \) and survival in \( t+1 \) is

\[
E \left[ y_{lt+1} - \alpha_L l_{lt+1} - \alpha_M m_{lt+1} | J_{lt}, \chi_{lt+1} = 1 \right] = \alpha_{t+1} + \alpha_A a_{lt+1} + \alpha_F FDI_i + \alpha_K k_{lt+1} + E \left[ \omega_{lt+1} | J_{lt}, \chi_{lt+1} = 1 \right]
\]

\[
= \alpha_{t+1} + \alpha_A a_{lt+1} + \alpha_F FDI_i + \alpha_K k_{lt+1} + g(\omega_{lt}, P_{lt+1})
\]

\[
= \alpha_{t+1} + \alpha_A a_{lt+1} + \alpha_F FDI_i + \alpha_K k_{lt+1} + g'(\nu_t - \alpha_t - \alpha_K k_{lt} - \alpha_A a_{lt} - \alpha_F FDI_i, P_{lt+1}) \tag{35}
\]

where the first equality holds because \( a_{lt+1} \) and \( k_{lt+1} \) are known in \( t \) due to (34). Given the assumption of the Markov process, \( \omega_{lt+1} \) only depends on \( \omega_{lt} \) and the probability of surviving in \( t+1 \) is given in (33).

Equation (35) suggests that I run the following nonlinear estimation in the third stage with \( g'(\nu_t - \alpha_t - \alpha_K k_{lt} - \alpha_A a_{lt} - \alpha_F FDI_i, P_{lt+1}) \) being approximated parsimoniously with a polynomial function, to obtain \( \alpha_t, \alpha_A, \alpha_F \) and \( \alpha_K \),

\[
y_{lt+1} - \hat{\alpha}_L l_{lt+1} - \hat{\alpha}_M m_{lt+1} = (\alpha_L - \hat{\alpha}_L) l_{lt+1} + (\alpha_M - \hat{\alpha}_M) m_{lt+1} + \alpha_{t+1} + \alpha_A a_{lt+1} + \alpha_F FDI_i + \alpha_K k_{lt+1} + g'(\hat{\nu}_t - \alpha_t - \alpha_K k_{lt} - \alpha_A a_{lt} - \alpha_F FDI_i, \hat{P}_{lt+1}) + \zeta_{lt} + \eta_{lt+1}, \tag{36}
\]

where, by construction, \( E \left[ \zeta_{lt+1} + \eta_{lt+1} | J_{lt}, \chi_{lt+1} = 1 \right] = 0 \), and \( \hat{\alpha}_L, \hat{\alpha}_M \) and \( \hat{\nu}_t \) are obtained from
the first stage least squares regression and $\hat{P}_{t+1}$ is from the second stage probit regression. The results of the industry specific regressions are presented in Table 11. Overall the augmented OP procedure works well in correcting for input endogeneity and selection bias. Variable inputs have no explanatory power in the second stage, as emphasized in Ackerberg, Benkard, Berry and Pakes (2007). Firm productivity is constructed based on the following results which forms the basis of the empirical exercise,$^{38}$

\[
\text{Non-Woven: } \ln \text{TFP}_{\text{AOP}}_{it} = y_{it} - 0.156m_{it} - 0.283l_{it} - 0.303k_{it}, \quad (37)
\]

\[
\text{Woven: } \ln \text{TFP}_{\text{AOP}}_{it} = y_{it} - 0.549m_{it} - 0.357l_{it} - 0.122k_{it}. \quad (38)
\]

Note that, since the production functions are estimated separately for the two industries, I restrict the empirical exercises only to within firm comparisons of productivity over time, in order to avoid questionable cross-regression comparisons.$^{39}$ For comparison, without any correction, the TFP estimates from OLS are constructed as the following:

\[
\text{Non-Woven: } \ln \text{TFP}_{\text{OLS}}_{it} = y_{it} - 0.177m_{it} - 0.416l_{it} - 0.121k_{it}, \quad (39)
\]

\[
\text{Woven: } \ln \text{TFP}_{\text{OLS}}_{it} = y_{it} - 0.524m_{it} - 0.396l_{it} + 0.013k_{it}. \quad (40)
\]

References


$^{38}$ How different are these estimates compared to Demidova, Kee and Krishna (2012), when market specific demand shocks are controlled for instead of the FDI status of the firms? While the point estimates of $\alpha_L$, $\alpha_M$, and $\alpha_K$ are slightly different between the two versions, simple t-tests reveal that the differences are not statistically significant with 95% confidence level.

$^{39}$ There may be a concern that the non-woven industry appears to have decreasing returns to scale, based on the point estimates of Equation (37),

$$\hat{\alpha}_M + \hat{\alpha}_L + \hat{\alpha}_K = 0.8.$$ 

I tested for the following null hypothesis of constant returns to scale:

$$H_0 : \alpha_M + \alpha_L + \alpha_K = 1.$$ 

Based on the bootstrapped standard error of 0.33, the t-statistic is -0.61, which is not statistically different from 0. Thus, the constant returns to scale hypothesis is not rejected.


Table 11: Dependent variable: Log of output

<table>
<thead>
<tr>
<th>Industry</th>
<th>Dependent Variable</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$y_{it}$</td>
<td>$y_{it}$</td>
<td>$y_{it+1} - 0.156m_{it+1}$</td>
<td>$y_{it+1} - 0.283l_{it+1}$</td>
<td>$y_{it}$</td>
<td>$y_{it+1} - 0.549m_{it+1} - 0.357l_{it+1}$</td>
</tr>
<tr>
<td>Materials</td>
<td>0.177***</td>
<td>0.156***</td>
<td>-0.004</td>
<td>0.524***</td>
<td>0.549***</td>
<td>0.013</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.051)</td>
<td>(0.046)</td>
<td>(0.040)</td>
<td>(0.044)</td>
<td>(0.045)</td>
<td>(0.028)</td>
<td></td>
</tr>
<tr>
<td>Labor</td>
<td>0.416***</td>
<td>0.283***</td>
<td>-0.019</td>
<td>0.396***</td>
<td>0.357***</td>
<td>-0.012</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.086)</td>
<td>(0.099)</td>
<td>(0.085)</td>
<td>(0.076)</td>
<td>(0.085)</td>
<td>(0.056)</td>
<td></td>
</tr>
<tr>
<td>Capital</td>
<td>0.121***</td>
<td>-0.085</td>
<td>0.303***</td>
<td>-0.013</td>
<td>0.122***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.048)</td>
<td>(0.281)</td>
<td>(0.081)</td>
<td>(0.032)</td>
<td>(0.053)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>-0.085</td>
<td>-0.226</td>
<td>-0.370</td>
<td>-0.421</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.281)</td>
<td>(0.162)</td>
<td>(0.555)</td>
<td>(0.305)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FDI</td>
<td>-0.370</td>
<td>-0.421</td>
<td>(0.555)</td>
<td>(0.305)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Endogeneity correction
1 A 2nd order polynomial function of age, capital, investment, FDI status are included.
2 A 3rd order polynomial function of propensity to stay in business and the fitted output net of labor and capital are included.

Notes: Heteroscedasticity corrected white robust standard errors in parentheses.

Columns (2) and (5) are for observations with positive investments.
Columns (3) and (6) lose one year of observations due to the lead variables.
*, **, *** indicate statistical significance at 90%, 95% and 99% confidence levels.