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TECHNOLOGY SPILLOVERS FROM FOREIGN DIRECT INVESTMENT IN VIETNAM: HORIZONTAL OR VERTICAL SPILLOVERS?

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Abstract

This paper uses firm-level data to examine how technology spillovers through FDI affect the productivity of domestic firms in Vietnam. We advance the understanding as to when, where and under what conditions FDI generates technology spillovers to domestic firms. We find that domestic firms gain technology spillovers through vertical linkages with foreign firms, but the effect of the horizontal presence of foreign firms on the productivity of domestic firms is negative. This suggests that potential technology transfer between foreign firms and their local competitors is more than offset by the competition induced by the entry of foreign firms. The existence and strength of horizontal and vertical spillovers depend on industry and firm characteristics and on the types of FDI.

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1. Introduction

It is widely recognized that FDI plays an important role in the process of international technology transfer. While theoretical analyses have made reasonably clear prescriptions regarding the mechanisms and conditions of technology transfer through FDI[1], empirical studies at the firm level provide mixed evidence of the impact on the host country[2]. Most empirical studies focus on horizontal (intra-industry) spillovers and find no or negative effects of FDI on the productivity of domestic firms (e.g., studies of Morocco by Haddad and Harrison, 1993; Venezuela by Aitken and Harrison, 1999; Bulgaria and Romania by Konings, 2001; Russia by Yudaeva et al., 2003; the Czech Republic by Kosova, 2004). Several studies, particularly on vertical (inter-industry) spillovers, provide positive evidence of technology spillovers from foreign to domestic firms (e.g., Blalock and Gertler, 2002 for Indonesia; Schoors and Van der Tol, 2002 for Hungary; Smarzynska, 2004 for Lithuania). The contradictory results are not surprising, as the circumstances through which FDI actually creates and increases spillovers are left open in these studies. The research has mainly focused on the question of whether or not spillovers exist, and few studies explore the conditions which influence the existence and magnitude of spillovers. Thus, there is need for further investigation to provide answers to the questions of when, where and under what conditions FDI generates technology spillovers to domestic firms.

This paper examines technology transfer through FDI in Vietnam by using firm level data from 2000 to 2004. The paper distinguishes between horizontal spillovers and vertical spillovers, and examines the impacts of characteristics of the country and of domestic firms on the strength of horizontal and vertical spillovers. In particular, the technological gap between MNCs and domestic firms, ownership structure, firm size, trade orientation, and absorptive capacity of local firms are considered in searching for different effects of spillovers. We also address the issue of whether the characteristics of the foreign investor affect the existence and magnitude of technology spillovers by looking at types of foreign ownership and trade orientation of foreign firms.

The paper is organised as follows. Section 2 reviews the literature on FDI and technology spillovers at the firm level. The empirical framework is described in Section 3 and the data are discussed in Section 4. The empirical results are in Sections 5-7, which report the baseline findings on horizontal and vertical spillovers, the relationships between industry and firm characteristics and technology spillovers, and the impacts of the different types of FDI. Section 8 presents conclusions.

2. Technology Spillovers from FDI

Horizontal Spillovers

Horizontal spillovers refer to knowledge spillovers within an industry due to the presence of multinational enterprises (MNEs). The entry of MNEs may provide technology externalities to local firms through a number of mechanisms. First, local firms may be able to learn simply by observing and imitating product innovations or novel forms of organization adapted to

[1] See, for example, Wang and Blomstrom (1992) and Markusen and Venables (1999).
[2] For survey of the literature on spillovers from FDI see Blomstrom and Kokko (1998) and Gorg and Greenaway (2004).

local conditions. It may be very costly for local firms to collect information on new technology or processes in the absence of MNEs. In addition, domestic firms may have little information on the costs and benefits of innovations and new technology, and they may thus regard them to be highly risky. As they make direct contacts with MNE affiliates, information is diffused, uncertainty is reduced, and the possibility of adoption increases (Blomstrom and Kokko, 1996).

Secondly, a more observable mechanism of technology spillovers within the same industry is the movement of employees. Labour turnover may disseminate technology from MNEs to other firms as workers trained or employed by MNEs move to domestic firms or start their own businesses. This spillover is especially important for sectors which are strongly competitive or in which human capital formation is very costly. This is also crucial for firms that lack the technological capability and managerial skills to compete in world markets. However, since MNEs naturally tend to discourage highly trained workers from leaving by paying salaries above local standard, labour turnover would be low in countries where MNEs have substantial advantages over domestic firms (Meyer, 2003).

Thirdly, technology spillovers may come from competition generated by the presence of MNEs. If MNEs have advantages over domestic firms in technology, then greater competitive pressure may induce domestic firms to introduce new products or new technology to defend their market share, and to adopt new management method to increase productivity. However, MNEs may have negative effects on domestic firms because they may attract demand away from domestic firms, thus forcing the domestic firms to reduce their output and productivity (Aitken and Harrison, 1999).

Many empirical studies have used different types of datasets to assess the incidence of horizontal spillovers to domestic firms. Most studies that use industry level data find positive spillvers to local firms. Early studies that employ industry level data, e.g., Caves (1974) for Australian manufacturing industries and Globerman (1979) for Canadian manufacturing, find that foreign presence has a positive impact on the productivity of domestic firms. Other studies which also find positive spillovers are Blomstrom and Persson (1983) for Mexican manufacturing industry, Blomstrom and Sjoholm (1999) for Indonesian manufacturing sectors, and Liu (2002) for Chinese manufacturing industries. However, aggregate data at the industry level have been unable to control for productivity differences across industries. The positive correlation between the foreign presence and the productivity of domestic firms might be partially due to the fact that foreign firms invest in more productive industries. Thus, using industry data may lead to an endogeneity problem and an upward bias.

With firm-level data, most studies find no or negative evidence of horizontal spillovers to domestic firms. Haddad and Harrison (1993) employ data on Morocco and show that there is no evidence of spillovers and competition seems to push local firms towards the best practice frontier in industries with low level of technology. For Venezuela, Aitken and Harrison (1999) find that increases in foreign ownership in an industry negatively affect the productivity of domestic plants in that industry. They describe this negative spillover as a market stealing effect as foreign firms force domestic firms to cut production. The authors report similar findings for Indonesia, except that negative effects are smaller in Indonesia than in Venezuela. Using panel data of UK manufacturing industries, Girma et al. (2001) find no significant effect of foreign presence on the labour productivity or total factor productivity of UK firms from 1991 to 1996. In contrast, Griffith (1999), Liu et al. (2000), Haskel et al. (2002), and Harris and Robinson (2003) use the UK micro data for manufacturing firms and

present a significantly positive correlation between a domestic firm's total factor productivity and the foreign affiliate share of activity in that industry. More interestingly, Haskel et al. (2002) show that positive spillovers are found to come from US and French presence, but Japanese presence produces negative spillovers.

Studies on transition economies also show negative or insignificant spillover impacts. Konings (2001) finds that FDI is important for transferring technology to an affiliate, but provides evidence of negative spillovers to local firms in Bulgaria and Romania from 1993 to 1997 and no evidence of spillovers in Poland. Using firm level data for the Czech Republic for the period 1992-1996, Djankov and Hoeckman (1998) also find negative effects of spillovers on domestic firms. Damijan et al. (2003) find that spillovers are rare in 10 transition economies in Eastern Europe, but there is no evidence of negative spillovers.

The mixed evidence on horizontal spillovers may be explained by differences in local firm characteristics and the host country condition. The negative effect is usually attributed to the absorptive capacity of local firms together with the technology gap between foreign and domestic firms. Some studies find evidence of spillovers from foreign presence in domestic firms that engaged in R&D activity (Kinoshita, 2000 for the Czech Republic; Kathuria, 2000 for India). Other studies show that the skill level of the industry and of domestic firms is positively correlated to the productivity spillovers (Girma et al. 2001 for the UK; Schoors and Van der Toll, 2002 for Hungary).

With respect to the technology gap, Kokko (1994) shows that spillovers are smaller in Mexican industries with a larger labour productivity gap between local and foreign firms. Kokko et al. (1996) find a similar result in Uruguayan manufacturing sectors; if the productivity gap is small, foreign technology appears to be more useful for domestic firms because they have skills needed to learn the foreign technology. In contrast, using Indonesian manufacturing data, Sjohlom (1999) finds evidence of spillovers to domestic firms only in a sub-sample with a large technology gap.

The occurrence of horizontal spillovers is related to competition in the domestic market. Using industry data on Mexican manufacturing, Blomstrom et al. (1992) find that local competition is positively related to imports of technology by affiliates of multinationals. Sjoholm (1999) presents evidence supporting the idea that higher technology spillovers are found in industries with higher domestic competition. Girma et al. (2001) also point out the importance of competition in determining the extent of spillovers in UK manufacturing. They find that the greater the degree of foreign competition in the industry, the larger the spillover.

Another factor that may influence technology spillovers is the export orientation of domestic firms. Blomstrom and Sjoholm (1999), who study Indonesian manufacturing, show that while non-exporting domestic firms experience significantly positive spillovers, exporting domestic firms do not gain significant spillovers. Sinani and Meyer (2004) show a similar result in Estonia; since export oriented firms already face competitive pressure from the world market, their productivity is not significantly affected by the presence of foreign enterprises in the domestic market.

Vertical spillovers

Vertical spillovers occur between MNEs and local enterprises across industries. Vertical technology spillovers may occur through both backward linkages (from buyer to supplier) and forward linkages (from supplier to buyer).

Backward linkages create technology spillovers through several mechanisms. First, MNEs may transfer technology directly to their local suppliers by training or technical assistance in order to increase the quality of supplier products. Secondly, close linkages between MNEs and local suppliers may induce workers in MNEs to turn to local suppliers, thereby disseminating technology from MNEs. Thirdly, higher requirements for product quality and on-time delivery set by MNEs may provide incentives to local suppliers to improve their production process or technology (Smarzynska, 2004).

Forward linkages may induce technology spillovers through various channels. First, domestic firms may benefit from supplies of intermediate goods and machinery from MNEs that provide better quality products and lower costs. Secondly, as marketing outlets for MNEs, domestic firms may receive support in the form of training in sales techniques and supply of sales equipment, therefore generating more technology externalities. Thirdly, FDI in infrastructure and business services directly improves the productivity of its customers if these services are introduced or improved (Meyer, 2003).

While there are numerous empirical studies on horizontal spillovers, there are relatively few studies on vertical spillovers. Kugler (2001), using Colombian manufacturing data, shows that spillovers from FDI are primarily inter-industry and not intra-industry. With firm level data from Indonesia Blalock and Gertler (2002) provide evidence of positive FDI spillovers through backward linkages; Indonesian firms in industries with growing downstream FDI experience greater productivity growth than other firms. Schoors and Van der Tol (2002), in a study on Hungary, find that while there are positive and significant effects of backward linkages, forward linkages generate negative effects. Based on firm level panel data from Lithuania, Smarzynska (2004) finds a similar result; technology spillovers from FDI take place through contacts between foreign firms and their local suppliers in upstream sectors.

Thus, the empirical literature has provided strong evidence in support of vertical spillovers. However, the existing empirical literature has mainly focused on the basic questions of whether or not vertical spillovers exist and with little evidence on which circumstance would determine the strength of such spillovers. In fact, the second question merits most attention because the major policy debates are no longer on whether or not to allow FDI, but how maximize the benefits of FDI spillovers for local firms. This paper fills the gap by considering the role of specific actors involved, foreign enterprises and local firms, and the relationships between them in the existence and strength of vertical spillovers.

3. Empirical Framework

The production function of domestic firm is assumed to be Cobb-Douglas and homogeneous of degree one:

$$Y_{ijt} = (K_{ijt})^{\alpha} (L_{ijt})^{1-\alpha} e^{Z_{ijt}} \qquad (1)$$

where Y_{ijt}, K_{ijt}, and L_{ijt} are output, capital and labour of domestic firm *i* in industry *j* at time *t* respectively. Z_{ijt} represents exogenous shocks to production and is explained in detail below. Dividing both sides of equation (1) by L_{ijt} gives the following function for labour productivity of domestic firm *i*.

$$\frac{Y_{ijt}}{L_{ijt}} = \left(\frac{K_{ijt}}{L_{ijt}} \right)^{\alpha} e^{Z_{ijt}} \qquad (2)$$

Felipe (1999, p.6) in a survey of the literature on total factor productivity describes Z as "a measure of elements such as managerial capabilities and organizational competence, R&D, inter-sector transfer of resources, increasing return to scale, embodied technical progress, and diffusion of technology". Hence, labour productivity of domestic firm *i* can be expressed as follows:

$$\frac{Y_{ijt}}{L_{ijt}} = \left(\begin{array}{l} \frac{K_{ijt}}{L_{ijt}}, Labour\ \ Quality_{ijt}, Scale_{ijt}, Concentration_{jt}, Technology\ Gap_{ijt}, \\ Technology\ \ Spillovers_{jt} \end{array} \right) \qquad (3)$$

$\frac{Y_{ijt}}{L_{ijt}}$ is average labour productivity of domestic firm *i* in industry *j* and is measured as the ratio of gross output to total employees. $\frac{K_{ijt}}{L_{ijt}}$ is domestic firm *i*'s capital intensity, which is measured as the ratio of fixed assets to total employees in firm *i*. Foreign firms may be more capital-intensive and larger than domestic firms, and these characteristics may account for some of productivity differentials between foreign firms and domestic firms. Thus, we use this variable to control for the impact of capital intensity on productivity.

$Labour\,Quality_{ijt}$ represents the skills of workers that affect the productivity of firm *i*. Since firm-specific data on the number of skilled workers are not available, labour costs (including wages and training costs) per employee are used as a proxy for the human capital stock of the firm. This is based on an assumption that firms with higher average labour costs per worker employ higher skilled labour.

To account for the impact of scale on productivity, we measure the scale effect ($Scale_{ijt}$) as the ratio of sales in firm *i* to total industry sales.

The level of concentration in industry *j* ($Concentration_{jt}$) is proxied by the Herfindahl index for domestic firms and is calculated as follows:

$$HERF_{jt} = \sum_{i=1}^{n} \left(\frac{x_{ijt}}{X_{jt}} \right)^2 \qquad (i=1,\ldots,n) \qquad (4)$$

where x_{ijt} is the sales of domestic firm *i* in industry *j*; X_{jt} denotes the total sales of industry *j*. A higher value of the Herfindahl index indicates a high degree of industry concentration, thus less competition.

To examine the effect of technology gap on technology spillovers, we define the technology gap for each domestic firm as the percentage difference between its labour productivity and that of the average foreign firm in the same industry:

$$Technology\ Gap_{ijt} = (AverageLP_{jt} - LP_{ijt}) / LP_{ijt} \quad (5)$$

where $AverageLP_{jt}$ is the mean of the labour productivity of foreign firms in industry *j* at time *t* and LP_{ijt} is the labour productivity of domestic firm *i* in industry *j* at time *t*. A negative value of the variable indicates that domestic firm *i* is more productive than the average foreign firm in the same industry and a positive value indicates that firm *i* is less productive than the average foreign firm in the same industry. A positive value shows that a technology gap exists between the domestic firm and the average foreign firm in the same industry.

Technology spillovers from FDI ($Technology\ Spillovers_{jt}$) are considered under two categories: horizontal spillovers (between domestic firms and foreign firms within the same industry) and backward spillovers (from foreign firms to their domestic suppliers). Because most foreign firms in Vietnam are export-oriented and generally do not supply Vietnamese customers, we do not consider technology spillovers through forward linkages (from foreign firms to domestic customers).

Horizontal spillover (HS_{jt}) is measured as the share of employment accounted by all foreign firms in industry *j* at time *t*:

$$HS_{jt} = \frac{\sum_{k=1}^{m} FL_{kjt}}{\sum_{k,i=1}^{m,n} (FL_{kjt} + DL_{ijt})} \quad (6)$$

where FL_{kjt} *(k=1,…,m)* is employment of foreign firms *k* in industry *j* and year *t*, and DL_{ijt} *(i=1,…,n)* is employment of domestic firms *i* in industry *j* and year *t*. This measure reflects mainly the competitive pressures that encourage domestic firms to introduce new products to defend their market share and adopt new management methods to increase productivity. Imitation, reverse engineering, personal contact and industrial espionage are also captured by this measure.

Backward spillover (BS_{jt}) is derived from the extent of foreign presence in industry *j* that is being supplied by other industries. It captures the extent of potential contacts between domestic suppliers and foreign firms in industry *j* and is defined as follows:

$$BS_{jt} = \sum_{r=1}^{p} \alpha_{jrt} * HS_{rt} \qquad (r=1,\ldots,p) \quad (7)$$

where α_{jrt} $(0 \le \alpha_{jrt} \le 1)$ is the proportion of industry *r*'s output that is supplied to industry *j*[3]. Inputs supplied within the industry are not included, since they are already captured by the *HS* variable. The values of α_{jrt} from 2000 to 2004 are based on the 2000 input-output

[3] Industries are defined at the two-digit level of Vietnamese Standard Industrial Classification (VSIC). We measure backward spillovers from FDI by industry, rather than by firm, for two reasons. First, the data do not reveal which specific domestic firms supply foreign firms. Secondly, estimation with industry measures of backward spillovers avoids the endogeneity of a particular firm's decision to sell its products to foreign firms.

table[4]. Besides data limitation, this approach may be justified on the grounds that industrial structures do not change rapidly. Although the coefficients taken from the IO table remain fixed, horizontal values do change, so the measures of backward spillovers are time-varying sector-specific variables (Smarzynska, 2004).

We use OLS with the correction for heteroskedasticity. We restrict our attention to domestic firms in order to avoid a potential bias if foreign investors tend to acquire stakes in the largest and most successful domestic firms. We control for the potential endogeneity of foreign presence and region or industry characteristics by adding fixed effects for industry, region and time. Foreign firms may choose to locate in a given region where there is better infrastructure, which also improves the efficiency of domestic firms. If foreign investors are attracted to industries with higher labour productivity, then the observed correlation between foreign presence and domestic productivity may overestimate the positive impact of the foreign sector. The industry, region, and time dummies control for unobserved variables that may be driving changes in, for example, the attractiveness of a given industry or region. We also use lagged values of relevant variables as instruments to account for endogeneity.

4. Data

The data come from the annual enterprise survey conducted by the General Statistics Office of Vietnam (GSO) and provide information on formal economic entities in Vietnam from 2000 to 2004. The data set contains information on the property structure of the enterprise, sales, output, labour, total costs, capital stock, investment, location, ownership, research and development (R&D) activity, international trade, and other specialized questions. The number of firms per year varies from a low of 10,945 firms in 2000 to a high of 23,121 firms in 2004. After deleting firms with missing values, zero sales, zero output, zero employment, and observations failing to satisfy other basic error checks, the useable data set is an unbalanced panel of 7,140 domestic firms and 1,461 foreign firms[5]. All variable are deflated to 1994 prices using the appropriate producer price index deflators.

The sectoral classification of enterprises is at the two-digit VSIC, which includes 29 sectors from three industrial groups. There are four sectors in mining and quarrying, twenty three in manufacturing, and two in electricity, gas and water supply.

The domestic sector is defined to include state owned enterprises, non-state collective establishments, and domestic private firms and households. Foreign firms are defined as all establishments with foreign investors (joint ventures and 100% foreign-invested firms). Distinction between joint ventures and 100% foreign-invested firms is made in order to

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[4] The IO table was published in 2000 with three variants: domestic transactions at producer prices, domestic transactions at basic prices, and domestic transactions at purchaser prices. This study considers domestic transactions at purchaser prices.
The 2000 IO table classified industrial production into 119 categories. Sectors in the IO table were regrouped so as to match the industry classification of two-digit level industries (VSIC).

[5] A two-stage cleaning process was used for labour, wages, output, capital, and sales. First, the earliest and latest years in which a firm reported were identified, and interpolation was used to fill-in gaps of up to two missing years within the reporting window. If more than two continuous years of data were missing, the firm was dropped from the sample. Second, firms with unreasonably large jumps or drops in key variables not accompanied by corresponding movement in other variables (for example, large increase in labour not accompanied by any increase in output) were dropped.

examine the impact of foreign ownership on domestic firms' performance through technology transfer.

5. Horizontal and Vertical Spillovers from FDI

This section reports results on the effect of FDI through both horizontal and vertical linkages on the productivity of domestic firms. The results in Table 1 show that the effect of backward spillovers on productivity is positive and significant. This implies that greater amounts of backward linkages from foreign firms increase the labour productivity of domestic firms in the Vietnamese industry. The spillover estimates suggest that an increase of backward linkages by 1% points would increase the labour productivity of domestic firms by 1.09%. Several reasons can explain why backward linkage is an important channel of technology diffusion from foreign firms to domestic ones in Vietnam. Foreign firms are more likely to share their know-how and technology with domestic firms because the intermediate goods supplied are specific to their production processes. Moreover, domestic firms may benefit from technology spillovers through the training and turnover of workers provided by foreign firms, and through visits to domestic firms by technical staff of foreign firms.

The effect of foreign presence on domestic firms within the same industry (horizontal spillover) is negative and significant. This result is consistent with the existing literature that finds evidence of negative intra-industry effect in developing countries. The reason for negative horizontal spillovers in Vietnam may come from the fact that the presence of foreign firms reduces the productivity of domestic firms through competition effects. Foreign firms have advantages, which allow them to attract demand away from domestic firms and force domestic firms to increase their average costs and to reduce their productivity. The negative competition effects may outweigh the positive effects of demonstration and imitation generated by the presence of foreign firms.

Since technology spillovers from foreign firms to domestic firms may take time to manifest, we re-estimate the model with lagged horizontal and backward spillover variables. The results in column 2 of Table 1 confirm those with contemporaneous spillover variables that there are positive technology spillovers from backward linkages, but negative effects from the presence of foreign firms in the same industry.

Among the other control variables, labour productivity is positively related to capital intensity. The results suggest that a 1% increase in the ratio of capital to labour in a domestic firm will lead to a 7.2% increase in its labour productivity. The coefficient of labour quality is positive and significant at the 1% level in all regressions and similar in magnitude, suggesting that a larger share of skilled workers increases the labour productivity of domestic firms. The effect of competition on productivity captured by the concentration variable is negative and significant. A reduction of industry concentration (an increase in the level of competition) by 10% increases the productivity of domestic firms in that industry by 6.1%. This suggests that competition from a domestic firm appears to induce other domestic firms to use their resources better in order to maintain their market share, which in turn enhances their productivity. The production scale of a domestic firm has a positive and significant effect on its productivity. This implies that a firm that is smaller than the most efficient firm in the industry can take advantage of scale economies. The technology gap between domestic and foreign firms negatively affects the productivity of domestic firms, suggesting that domestic firms lagging behind foreign technology seem to have lower productivity.

The horizontal variable is measured at the industry level and therefore does not account for geographical proximity between firms. Geographical proximity may affect the extent of technology diffusion. Demonstration of new products and production techniques are more likely to be observed and copied by neighbouring firms (Aitken and Harrison, 1999; Sjoholm, 1999). In addition, domestic firms may benefit from the infrastructure installed by foreign affiliates located in the same province. In order to capture the effect of geographical proximity on technology spillovers, we calculate a provincial horizontal spillover. The provincial horizontal spillover is measured as the share of employment employed by foreign firms in the same industry and the same province. Since data on the linkages between foreign firms and local suppliers are not available at the provincial level, it is impossible to test the impact of geographical proximity on backward spillovers. The result in column 3 of Table 1 shows that there is a competition effect generated by foreign firms in the same industry within the same province. The absolute value of the coefficient on provincial horizontal spillover is smaller than that of the coefficient on industrial horizontal spillover. This implies that the effect of competition at the provincial level is smaller than at the industry level.

The absorptive capacity of domestic firms may facilitate technology spillovers. To account for the absorptive capacity of domestic firms in determining the extent of spillovers, we interact labour quality and technology gap with the spillover variables. The results in column 4 of Table 1 show that the interactions between labour quality and the spillover variables are positive and significant. This means that the technology spillovers from FDI to domestic firms are bigger in firms with higher level of labour quality. The technology gap is related to the extent of technology transfer through horizontal linkages, as the coefficient on the interaction between the technology gap and horizontal is negative and significant. This suggests that domestic firms with a narrow technology gap may have a certain level of technological capacity to compete with foreign firms, reducing the negative effects of competition generated by foreign firms. However, the technology gap does not affect the extent of backward spillovers. This may be due to the fact that foreign firms may provide technical assistance to local suppliers to help them raise the quality of intermediate products.

6. Industry and Firm Characteristics and Technology Spillovers

Firm and industry heterogeneity may explain part of the nexus between FDI and technology spillovers. In this section we examine the relationship between various industry and firm characteristics and technology spillovers. We focus on differences in ownership structure, technology level, scale economies, R&D activities and trade orientation.

Table 2 presents the results of the impact of ownership structure on technology spillovers. The results from columns 1, 3 and 5 show that the presence of foreign firms does not affect the productivity of state firms and collective firms. However, private firms are negatively influenced by the presence of foreign firms. This may be due to the fact that private firms are small in terms of skilled labour, technology and capital, so that they are less able to absorb technology and cope with competition from foreign presence than state firms and collective firms. In contrast, state and collective firms may have more skilled workers and technological ability to compete with foreign firms in the same industry. The results from all regressions show that all types of domestic firms benefit from backward linkages from foreign firms.

The size of domestic firms can be linked to their capacity for obtaining the benefits associated with the presence of foreign firms. Small firms measured in terms of employment or production may not have a sufficient production scale to imitate or adopt technologies

introduced by foreign firms. We examine the impact of firm size on the existence of technology spillovers by considering two types: large firms, and small and medium firms. A large firm is defined as one with more than 100 employees and a small and medium firm is one with less than 100 employees. The results from columns 1 and 3 in Table 3 show that the impact of foreign firms' presence on the productivity of domestic firms is negative for both types of firms, but only significant for small and medium firms. This result confirms the idea that small and medium firms have less capacity to compete with foreign firms, therefore suffering more significant losses. Both large firms and small-medium firms benefit from technology spillovers due to backward linkages from foreign firms. These effects are stronger for large firms and are related to the size of the technology gap. Large firms with a small technology gap benefit more from backward linkages while small and medium firms benefit less from backward linkages and the size of the technology gap is not statistically significant. In both types of domestic firms, backward spillovers are stronger in firms with higher levels of labour quality.

The pooling of all domestic firms in the sample to estimate the spillover effects may hide important variations in spillover effects for different types of industry. Separating all domestic firms into different groups of industry allows examination of how spillover in each group occurs. The sample is divided into low technology, medium technology and high technology industries, based on the classification of the General Statistics Office of Vietnam. The results in Table 4 shows that while the presence of foreign firms generates a negative effect on the productivity of domestic firms in low technology industries, domestic firms in industries of medium and high technology are not influenced by the competition from foreign firms. This finding is consistent with the hypothesis that the competition effects imposed by foreign firms differ across industries. Domestic firms operating in low technology industries like textiles and clothing seem to be damaged by the competition effect since the success of these kinds of firms depends on market and input costs. Conversely, domestic firms in industries whose products involve higher technological levels have stronger abilities to compete with foreign firms. There is a positive and significant effect of backward linkages on the productivity of domestic firms operating in the industries of medium and high technology, but domestic firms in low technology industries do not benefit from backward spillovers.

As trade-oriented domestic firms produce for foreign markets, they may have more opportunities to learn about advanced technology. As shown in column 1 of Table 5, foreign firms generate negative horizontal spillovers to domestic-oriented firms, but not to trade-oriented firms. This result supports the argument of Sinani and Meyer (2004) that international trade oriented firms are influenced by international competitors, rather than by foreign firms in the domestic market. Both domestic-oriented firms and trade-oriented firms benefit from backward linkages. Backward linkages from foreign firms have a greater effect on the productivity of trade-oriented firms than those established with domestic-oriented firms. This may be explained by the fact that trade-oriented firms may have higher quality products than domestic-oriented firms, thus allowing them to serve better quality requirements from foreign firms.

The R&D activity of domestic firms plays an important role in generating technology spillovers. It affects not only the amount of technology transferred, but also increases the absorptive capacity of domestic firms. While there are negative effects of competition from foreign firms on domestic firms without R&D performance in the same industry, R&D performing firms are not affected by this competition (Table 6). These results support the argument that domestic firms with R&D activities tend to have a better capability to compete

with foreign firms than firms without R&D, and the absorptive capability depends not only on human capital, but also on R&D activities. Both domestic firms with and without R&D activities benefit from technology spillovers from backward linkages to foreign firms, and the magnitude of backward spillovers for R&D performing firms is larger than for non R&D performing firms.

7. Foreign Firm Characteristics and Technology Spillovers

The ownership structure of foreign firms may affect the degree of both horizontal and backward spillovers. With respect to horizontal spillovers, foreign firms with the sophisticated technologies may fear technology leakage, especially in countries with limited rule of law (Smarzynska and Wei, 2000). They will therefore shy away from shared ownership and instead choose to invest only in fully-owned subsidiaries. In addition, foreign investors are more likely to transfer technology within wholly owned networks of multinational's subsidiaries than to joint ventures (Ramachandran, 1993). As a result, wholly-owned foreign firms may generate potentially stronger spillovers than partially owned foreign firms. With respect to backward spillovers, it has been argued that affiliates established through joint ventures are more likely to source their inputs locally than those taking the form of full foreign ownership. This is due to the fact that while wholly owned foreign firms need to set up linkages with local suppliers, partially owned foreign firms can take advantage of the existing supplier relationships with local partners. Moreover, wholly owned foreign firms may have higher requirements on their local suppliers than partially owned foreign firms because they may use more sophisticated technologies. Thus, only a limited number of domestic firms can meet these requirements and gain benefit from backward spillovers generated by wholly owned foreign firms.

To examine the effects of ownership structure of foreign firms on technology spillovers to domestic firms, two measures of horizontal and backward spillovers are calculated for two types of foreign firms. The measures for fully owned foreign firms are defined as follows:

$$HS\ (Fully\ foreign\ owned\ firms\ (FFOF))_{jt} = \frac{\sum_{k=1}^{n} FO_{kjt} * FL_{kjt}}{\sum_{k,j=1}^{n,m} (FL_{kjt} + DL_{ijt})} \qquad (8)$$

$$BS\ (FFOF)_{jt} = \sum_{r=1}^{p} \alpha_{jrt} * HS\ (FFOF)_{rt} \qquad (9)$$

where FL_{kjt}, DL_{ijt} and α_{jrt} are as in section 3. FO_{kjt} is a dummy for fully foreign-owned firms, it is equal to one for foreign firms with fully foreign ownership, otherwise zero. The measures of horizontal and backward spillovers for partially foreign-owned firms are calculated analogously.

The results in Table 7 show that while domestic firms are not significantly affected by the presence of partially foreign-owned firms, fully foreign-owned firms exert a negative impact on the productivity of domestic firms in the same sector. This may be because fully foreign-owned firms have more advanced technology, allowing them to impose a higher level of competition on domestic markets, thus forcing domestic firms to reduce their productivity. Both fully foreign-owned firms and partially foreign-owned firms generate positive spillovers to domestic firms through backward linkages. Moreover, domestic firms benefit more from backward spillovers from partially foreign-owned firms than from fully foreign-owned firms.

This finding is consistent with partially foreign-owned firms being more likely to source their inputs locally, thus creating greater scope for spillovers to domestic firms operating in upstream sectors.

The export intensity of foreign firms may affect the extent of technology spillovers from both horizontal and backward linkages. Since export-oriented foreign firms serve essentially foreign markets, they may exert less competitive pressure on domestic firms than host-market-oriented foreign firms, and negative horizontal spillovers may be mitigated. Regarding backward spillovers, foreign firms that serve local markets are more likely to have vertical linkages with domestic suppliers than foreign firms which are export-oriented since they need to adapt their products to local market conditions and tend to be more integrated into the local economy (Altenburg, 2000). In addition, export-oriented foreign firms may have higher quality requirements on inputs supplied by domestic firms because they are generally part of global sourcing and distribution networks managed by the parent company, and these requirements can be difficult for the domestic suppliers to meet. As a result, export-oriented foreign firms are less likely to transfer technology to domestic suppliers than domestic-market-oriented foreign firms.

To examine whether the export orientation of foreign firms is important for technology spillovers, two measures of horizontal and backward spillovers are calculated: one for foreign firms supplying international markets, and one for foreign firms targeting only the domestic market:

$$HS\ (Export-oriented\ firms(EOF))_{jt} = \frac{\sum_{k=1}^{n} TO_{kjt} * FL_{kjt}}{\sum_{k,j=1}^{n,m} (FL_{kjt} + DL_{ijt})} \qquad (10)$$

$$BS\,(EOF)_{jt} = \sum_{r=1}^{p} \alpha_{jrt} * HS\ (EOF)_{rt} \qquad (11)$$

where FL_{kjt}, DL_{ijt} and α_{jrt} are as in section 3, and TO_{kjt} is a dummy for export-oriented foreign firms. $TO_{kjt} = 1$ if foreign firm *k* is involved in international trade and zero otherwise. The measures of horizontal and backward spillovers for foreign firms with domestic market orientation are calculated analogously.

The results in column 1 in Table 8 indicate that domestic-oriented foreign firms exert a negative impact on the productivity of domestic firms. However, domestic firms are not significantly affected by the presence of export-oriented foreign firms in the same industry. These results are in line with the idea that, the larger the export intensity, the less the perceived competition from foreign firms. Domestic firms benefit from backward linkages with both export-oriented foreign firms and domestic-oriented foreign firms, and domestic firms seem to benefit more from the latter than the former. These results support the hypothesis that the higher level of backward spillovers from domestic-oriented foreign firms is determined by the stronger linkages which these firms establish with local suppliers.

8. Conclusions

This paper examines technology spillovers from FDI to domestic firms in Vietnam. Using firm level data for the period 2000-2004, the paper investigates technology spillovers taking place through horizontal and backward linkages. Moreover, the paper considers the impact of

the characteristics of industries, domestic and foreign firms on the existence and magnitude of such spillovers.

The empirical results provide evidence that backward linkage is the most important mechanism of technology transfer from foreign to domestic firms. Domestic firms in industries with backward linkages from industries with a large foreign presence have higher productivity, ceteris paribus, than other firms. This backward spillover is affected by the size of the domestic firm, the quality of its labour force, and the technology gap.

The effect of the horizontal presence of foreign firms on the productivity of domestic firms is negative. This implies that the competition effect induced by the entry of foreign firms is stronger than the potential technology transfer between foreign firms and their domestic competitors. The existence of this competition effect depends on the firm and industry characteristics. While state firms, collective firms, trade-oriented firms, R&D performing firms and firms in industries of medium and high technology are not significantly affected by the competition generated by foreign firms, the presence of foreign firms affects negatively the productivity of private firms, domestic-oriented firms, non R&D performing firms, and firms in low technology industries.

The characteristics of foreign firms also influence the existence and strength of negative horizontal spillovers. The productivity of domestic firms is negatively associated with the presence of fully owned foreign firms, but not with the entry of partially owned foreign firms. While domestic-oriented foreign firms have negative effects on domestic firms' productivity, export-oriented foreign firms do not have significant impact. In sum, although technology spillovers from FDI to domestic producers are widespread in Vietnam and can be both horizontal and vertical, their incidence is related to industry and firm characteristics.

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Table 1. Horizontal and vertical spillovers from FDI

Dependent variable: Labour productivity of domestic firms

Independent variables	1	2	3	4	5
Horizontal	-1.19		-1.02	-2.08	-0.92
	(0.58)**		(0.58)*	(0.01)***	(0.58)
Backward	1.09		1.10	0.35	1.02
	(0.29)***		(0.29)***	(3.04)	(0.29)***
Horizontal - province			-0.39		
			(0.14)***		
Lagged Horizontal		-1.64			
		(1.01)*			
Lagged Backward		1.01			
		(0.33)***			
Capital intensity	0.50	0.64	0.50	0.51	0.50
	(0.009)***	(0.01)***	(0.009)***	(0.009)***	(0.009)***
Labour quality	7.49	8.19	7.49	2.67	7.40
	(0.26)***	(0.29)***	(0.26)***	(0.41)***	(0.26)***
Scale	3.18	3.52	3.15	3.54	3.36
	(0.32)***	(0.42)***	(0.32)***	(0.32)***	(0.32)***
Concentration	-0.61	-0.88	-0.60	- 0.66	- 0.63
	(0.08)***	(0.14)***	(0.08)***	(0.08)***	(0.08)***
Technology gap	-0.87	-0.90	-0.87	-0.88	-0.26
	(0.05)***	(0.07)***	(0.05)***	(0.05)***	(0.08)***
Labour quality * Horizontal				0.07	
				(0.01)***	
Labour quality * Backward				0.59	
				(0.04)***	
Technology gap* Horizontal					-0.05
					(0.005)***
Technology gap* Backward					0.006
					(0.01)
Time dummies	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes	Yes	Yes
Number of firms	7140	7140	7140	7140	7140
Number of observations	34536	34536	34536	34536	34536
R-squared	0.22	0.25	0.22	0.23	0.23

Notes: *, ** and *** indicate statistically significant at the 10%, 5% and 1% respectively. Standard errors are in parentheses.

Table 2. The impact of ownership structure on technology spillovers

Dependent variable: Labour productivity of domestic firms

Independent variables	State firms		Private firms		Collective firms	
	1	2	3	4	5	6
Horizontal	-0.07	0.18	-1.72	-3.06	0.15	-0.23
	(1.01)	(0.11)	(0.76)**	(0.84)***	(0.50)	(0.55)
Backward	1.39	-0.47	1.11	-0.08	0.20	0.17
	(0.53)***	(0.55)	(0.39)***	(0.40)	(0.10)*	(0.24)
Capital intensity	0.25	0.25	0.82	0.81	0.52	0.51
	(0.01)***	(0.01)***	(0.01)***	(0.01)***	(0.03)***	(0.03)***
Labour Quality	8.49	6.29	7.58	9.42	3.38	1.35
	(0.37)***	(0.53)***	(0.37)***	(0.67)**	(0.39)***	(0.79)***
Scale	5.07	5.03	7.52	8.47	5.39	5.14
	(0.41)***	(0.41)***	(0.81)***	(0.82)***	(0.47)***	(0.46)***
Concentration	-1.36	-1.31	- 1.13	-1.27	-2.87	-2.59
	(0.15)***	(0.15)***	(0.14)***	(0.14)***	(0.48)***	(0.48)***
Technology Gap	-1.69	-1.24	-1.36	-1.63	-1.80	-0.39
	(0.16)***	(0.28)***	(0.09)***	(0.19)***	(0.02)***	(0.28)*
Labour Quality* Horizontal		-0.11		0.12		0.05
		(0.03)***		(0.02)***		(0.02)**
Labour Quality* Backward		0.80		0.66		0.05
		(0.07)***		(0.07)***		(0.06)
Technology gap* Horizontal		-0.03		-0.03		-0.01
		(0.01)**		(0.01)***		(0.003)***
Technology gap* Backward		0.01		0.13		-0.03
		(0.03)		(0.01)***		(0.007)***
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes	Yes	Yes	Yes
Number of firms	1397	1397	4971	4971	772	772
Number of observations	6900	6900	23837	23837	3769	3769
R-squared	0.40	0.42	0.22	0.23	0.29	0.31

Notes: *, ** and *** indicate statistically significant at the 10%, 5% and 1% respectively. Standard errors are in parentheses.

Table 3. The impact of firm size on technology spillovers

Dependent variable: Labour productivity of domestic firms

Independent variables	Large firms		Small and medium firms	
	1	2	3	4
Horizontal	-0.64	0.07	-1.97	-3.57
	(0.65)	(0.73)	(0.91)**	(0.98)***
Backward	1.52	0.95	0.91	-0.39
	(0.43)***	(0.45)**	(0.37)***	(0.38)
Capital intensity	0.35	0.38	0.58	0.57
	(0.01)***	(0.01)***	(0.01)***	(0.01)***
Labour quality	6.70	5.86	7.70	-0.19
	(0.34)***	(0.51)***	(0.36)***	(0.63)
Scale	5.17	5.39	20.03	19.98
	(0.39)***	(0.39)***	(1.33)***	(1.33)***
Concentration	-1.38	-1.39	- 2.88	-2.89
	(0.14)***	(0.14)***	(0.20)***	(0.20)***
Technology gap	-0.35	-0.07	-1.42	-1.13
	(0.06)***	(0.07)	(0.09)***	(0.18)***
Labour quality* Horizontal		-0.03		0.14
		(0.02)		(0.02)***
Labour quality* Backward		0.26		0.80
		(0.06)***		(0.06)***
Technology gap* Horizontal		-0.04		-0.02
		(0.006)***		(0.009)***
Technology gap* Backward		0.03		0.02
		(0.01)**		(0.02)
Time dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes	Yes
Number of firms	2192	2192	4948	4971
Number of observations	10817	10817	23719	23837
R-squared	0.37	0.42	0.20	0.23

Notes: *, ** and *** indicate statistically significant at the 10%, 5% and 1% respectively. Standard errors are in parentheses.

Table 4. The impact of types of industry on technology spillovers

Dependent variable: Labour productivity of domestic firms

Independent variables	1	2	3
Horizontal (domestic firms in low	-1.40	-1.56	-1.12
technology industries - HL)	(0.69)**	(0.76)**	(0.69)*
Horizontal (domestic firms in medium	3.00	-1.73	0.58
technology industries - HM)	(2.58)	(2.86)	(0.26)*
Horizontal (domestic firms in high	-0.53	-2.70	-0.94
technology industries - HH)	(1.36)	(1.51)*	(1.37)
Backward (domestic firms in low	-0.32	0.45	-0.33
technology industries - BL)	(0.52)	(0.53)	(0.52)
Backward (domestic firms in medium	1.38	2.88	1.11
technology industries - BM)	(0.43)***	(0.52)***	(0.43)***
Backward (domestic firms in high	2.02	2.56	2.02
technology industries - BH)	(0.57)***	(0.62)***	(0.57)***
Capital intensity	0.51	0.51	0.51
	(0.01)***	(0.01)***	(0.01)***
Labour quality	7.79	4.90	7.64
	(0.28)***	(0.55)***	(0.28)***
Scale	4.94	5.50	5.37
	(0.40)***	(0.40)***	(0.40)***
Concentration	-0.76	-0.84	-0.81
	(0.09)***	(0.09)***	(0.09)***
Technology gap	-1.33	-1.38	-1.09
	(0.07)***	(0.07)***	(0.18)***
Labour quality*HL		0.03	
		(0.02)	
Labour quality*HM		1.57	
		(0.12)***	
Labour quality*HH		0.16	
		(0.04)***	
Labour quality*BL		-0.32	
		(0.08)***	
Labour quality*BM		-1.17	
		(0.21)***	
Labour quality*BH		-0.37	
		(0.16)**	
Technology gap* HL			-0.05
			(0.008)***
Technology gap* HM			-0.23
			(0.02)***
Technology gap* HH			-0.001
			(0.01)
Technology gap* BL			0.11
			(0.01)***
Technology gap*BM			0.25
			(0.03)***
Technology gap*BH			0.04
			(0.04)
Time dummies	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes
Number of firms	7140	7140	7140
Number of observations	34536	34536	34536
R-squared	0.22	0.24	0.23

Notes: *, ** and *** indicate statistically significant at the 10%, 5% and 1% respectively. Standard errors are in parentheses.

Table 5. The effect of trade orientation of domestic firms on technology spillovers

Dependent variable: Labour productivity of domestic firms

Independent variables	1	2	3
Horizontal (domestic firms with trade orientation - HTO)	-1.05 (1.59)	-0.91 (0.67)	-0.86 (0.59)
Horizontal (domestic firms with domestic orientation - HDO)	-1.58 (0.61)***	-3.27 (0.67)***	-1.18 (0.61)**
Backward (domestic firms with trade orientation - BTO)	1.02 (0.29)***	0.48 (0.30)	0.94 (0.29)***
Backward (domestic firms with domestic orientation - BDO)	1.29 (0.30)***	-0.50 (0.31)	1.21 (0.30)***
Capital intensity	0.50 (0.009)***	0.51 (0.009)***	0.50 (0.009)***
Labour quality	7.38 (0.26)***	2.67 (0.41)***	7.28 (0.26)***
Scale	2.96 (0.33)***	3.31 (0.33)***	3.08 (0.33)***
Concentration	-0.56 (0.08)***	-0.61 (0.08)***	-0.57 (0.08)***
Technology gap	-0.87 (0.05)***	-0.89 (0.05)***	-0.23 (0.08)***
Labour quality*HTO		-0.02 (0.02)	
Labour quality*HDO		0.15 (0.02)***	
Labour quality*BTO		1.13 (0.07)***	
Labour quality*BDO		0.14 (0.06)**	
Technology gap* HTO			-0.03 (0.007)***
Technology gap* HDO			-0.06 (0.007)***
Technology gap* BTO			0.01 (0.01)
Technology gap*BDO			-0.003 (0.01)
Time dummies	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes
Number of firms	7140	7140	7140
Number of observations	34536	34536	34536
R-squared	0.22	0.23	0.23

Notes: *, ** and *** indicate statistically significant at the 10%, 5% and 1% respectively. Standard errors are in parentheses.

Table 6. The impact of R&D activity of domestic firms on technology spillovers

Dependent variable: Labour productivity of domestic firms

Independent variables	1	2	3
Horizontal (domestic firms with R&D activities - HRD)	-0.57 (0.62)	-0.81 (0.73)	-0.59 (0.63)
Horizontal (domestic firms without R&D activities - HNRD)	-1.41 (0.58)**	-2.82 (0.64***	-1.02 (0.58)***
Backward (domestic firms with R&D activities - HRD)	1.17 (0.29)***	0.61 (3.06)	1.06 (0.0.29)***
Backward (domestic firms without R&D activities - HNRD)	0.90 (0.30)***	0.11 (0.32)	0.92 (0.30)***
Capital intensity	0.50 (0.009)***	0.50 (0.09)***	0.50 (0.09)***
Labour quality	7.51 (0.26)***	2.48 (0.41)***	7.40 (0.26)***
Scale	3.21 (0.33)***	3.91 (0.33)***	3.33 (0.33)***
Concentration	-0.61 (0.08)***	-0.73 (0.08)***	-0.63 (0.08)***
Technology gap	-0.87 (0.05)***	-0.87 (0.05)***	-0.26 (0.08)***
Labour quality*HRD		0.02 (0.03)	
Labour quality*HNRD		0.11 (0.02)***	
Labour quality*BRD		0.69 (0.05)***	
Labour quality*BNRD		0.38 (0.08)***	
Technology gap* HRD			-0.03 (0.008)***
Technology gap* HNRD			-0.06 (0.006)***
Technology gap* BRD			-0.02 (0.01)**
Technology gap* BNRD			-0.10 (0.03)***
Time dummies	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes
Number of firms	7140	7140	7140
Number of observations	34536	34536	34536
R-squared	0.22	0.23	0.23

Notes: *, ** and *** indicate statistically significant at the 10%, 5% and 1% respectively. Standard errors are in parentheses.

Table 7. The effect of ownership structure of foreign firms on technology spillovers

Dependent variable: Labour productivity of domestic firms

Explanatory variable	1	2	3
Horizontal - Fully foreign ownership (HFO)	-1.37	-0.58	-2.08
Horizontal - Partially foreign ownership	(0.69)**	(0.09)***	(0.71)***
(HPO)	-0.72	-0.76	-0.26
Backward - Fully foreign ownership (BFO)	(1.28)	(0.14)***	(1.28)
Backward - Partially foreign ownership	0.92	-0.77	0.82
(BPO)	(0.32)***	(0.48)	(0.32)***
Capital intensity	1.54	1.93	1.58
	(0.47)***	(0.34)***	(0.47)***
Labour quality	0.50	0.50	0.50
	(0.009)***	(0.09)***	(0.09)***
Scale	7.50	3.76	7.35
	(0.26)***	(0.44)***	(0.26)***
Concentration	3.18	3.77	3.33
	(0.32)***	(0.32)***	(0.32)***
Technology gap	-0.61	-0.70	-0.63
	(0.08)***	(0.08)***	(0.08)***
Labour quality*HFO	-0.87	-0.88	-0.26
	(0.05)***	(0.05)***	(0.08)***
Labour quality*HPO		-0.59	
		(0.06)***	
Labour quality*BFO		0.54	
		(0.06)***	
Labour quality*BPO		-0.81	
		(0.09)***	
Technology gap* HFO		1.63	
		(0.07)***	
Technology gap* HPO			0.10
			(0.02)***
Technology gap* BFO			-0.16
			(0.01)***
Technology gap* BPO			0.05
			(0.02)***
Time dummies			-0.11
Industry dummies			(0.02)***
Region dummies	Yes	Yes	Yes
Number of firms	Yes	Yes	Yes
Number of observations	Yes	Yes	Yes
R-squared	7140	7140	7140
F test for equal coefficients on Horizontal	34536	34536	34536
(HFO = HPO)	0.22	0.24	0.23
F test for equal coefficients on Backward	3.18**	45.01***	2.38*
(BFO = BPO)			
	4.59**	28.35***	4.41**

Notes: *, ** and *** indicate statistically significant at the 10%, 5% and 1% respectively. Standard errors are in parentheses.

Table 8. The impact of export orientation of foreign firms on technology spillovers

Dependent variable: Labour productivity of domestic firms

Explanatory variable	1	2	3
Horizontal - Export-oriented foreign firms (HEO)	-0.89 (1.28)	-0.42 (0.99)	-0.27 (1.28)
Horizontal - Domestic-oriented foreign firms (HDO)	-1.33 (0.69)**	-0.61 (0.14)***	-2.24 (0.71)***
Backward - Export-oriented foreign firms (BEO)	0.92 (0.30)***	-0.78 (0.46)	0.82 (0.30)***
Backward - Domestic-oriented foreign firms (BDO)	1.79 (0.45)***	2.13 (0.33)***	1.83 (0.45)***
Capital intensity	0.50 (0.009)***	0.50 (0.09)***	0.50 (0.09)***
Labour quality	7.49 (0.26)***	2.93 (0.45)***	7.36 (0.26)***
Scale	3.18 (0.32)***	3.82 (0.32)***	3.34 (0.32)***
Concentration	-0.61 (0.08)***	-0.71 (0.08)***	-0.63 (0.08)***
Technology gap	-0.87 (0.05)***	-0.88 (0.05)***	-0.13 (0.08)***
Labour quality*HEO		-0.46 (0.06)***	
Labour quality*HDO		0.39 (0.05)***	
Labour quality*BEO		-1.14 (0.11)***	
Labour quality*BDO		2.06 (0.09)***	
Technology gap* HEO			-0.17 (0.01)***
Technology gap* HDO			0.12 (0.02)***
Technology gap* BEO			-0.07 (0.03)**
Technology gap* BDO			0.05 (0.03)*
Time dummies	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes
Number of firms	7140	7140	7140
Number of observations	34536	34536	34536
R-squared	0.22	0.24	0.23
F test for equal coefficients on Horizontal (HEO = HDO)	3.08**	27.51***	3.62**
F test for equal coefficients on Backward (BEO = BDO)	4.57**	41.79***	5.94**

Notes: *, ** and *** indicate statistically significant at the 10%, 5% and 1% respectively. Standard errors are in parentheses.