In Search of Export Spillovers in a Developing Country

Matthew A. Cole

Robert J.R. Elliott

Supreeya Virakul

Department of Economics, University of Birmingham, UK

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Abstract

This paper presents an empirical investigation of the spillovers from foreign direct investment (FDI) using a firm-level panel data from Thailand between 2001 and 2004. We examine export spillovers, both intra- and inter-industry. The evidence shows that FDI inflows into Thailand generate some positive externalities to domestic firms. Foreign firms generate positive export spillovers to their domestic customers on the decision to participate in export markets. Once domestic firms enter export markets, the competitive effect generated by foreign firms in the same industry forces them to improve their export intensity. Although our findings confirm that overall FDI generates benefits to domestic firms, different incentives to FDI generate different spillovers to different types of domestic firms. These results may be used as guidance for policymakers to attract certain types of FDI inflows. One implication is that government may wish to encourage export-oriented FDI as it generates positive export spillovers to domestic firms whilst protecting domestic firms in some industries that are affected by the negative export spillovers from domestic market-oriented FDI.

1. Introduction

Policymakers and governments across the world implement policies aimed at attracting FDI. One important motivation is that FDI inflows can stimulate economic growth and foreign investors act as an efficient channel for knowledge and technology transfer that could benefit domestically-owned firms in the host economy (see e.g. Aitken *et al.* 1997, Görg and Greenaway 2004, Bwalya 2006, Girma *et al.* 2007, Bitzer *et al.* 2008). Because foreign firms have more advanced technology, employ higher numbers of highly skilled workers and invest more in R&D compared to domestic firms, there is the possibility that such proprietary assets can leak to domestic firms which in turn has a beneficial effect on productivity (Caves, 1996).

Channels of possible leakage from foreign to domestic firms are via productivity, wage, technology and export spillovers. Blomström and Kokko (1998), Görg and Strobl (2001), and Görg and Greenaway (2004) provide a survey of empirical studies on different channels of spillovers. However, the empirical studies on export spillovers are not as extensively explored as productivity spillovers (Görg and Greenaway, 2004). Evidence on export spillovers is also mixed. Aitken *et al.* (1997), Greenaway *et al.* (2004) and Kneller and Pisu (2007) find positive export spillovers while Barrios *et al.* (2003), and Ruane and Sutherland (2005) find insignificant or even negative results.

The mechanism for export spillovers is that the presence of foreign firms may have an influence on a firm's export market participation, especially on the entry decision into export markets by local firms based on information, imitation or competition effects (Kneller and Pisu, 2007). Before beginning to export, domestic firms must incur fixed costs to set up for example international networks and channels of distribution. Foreign firms can act as a natural source of such information that would assist domestic firms to enter export markets (Aitken *et al.,* 1997). An increase in the presence of foreign-owned firms also boosts the level of competition which

forces domestic firms to increase productivity in order to remain in the market which in turn can positively influence the probability of entering export markets. In contrast, Aitken *et al.* (1999) argue that there are possibilities of productivity reductions which tend to decrease the export intensity of domestic firms. Some domestic firms that are unable to compete with foreign firms are also forced to exit the market.

For Thailand, Diao *et al.* (2005) point out that the openness of a country has a positive effect on economic growth that is driven by capital investment from foreign countries. The Thai government encourages FDI, providing various incentives and privileges to potential foreign investors. The manufacturing sector has received the majority of FDI inflows in recent years. Consequently, this paper searches for evidence export spillovers from FDI to domestic firms by examining both horizontal and vertical linkages using a detailed firm-level dataset from the annual survey of Thailand's manufacturing industry between 2001 and 2004.

Our results suggest significant evidence of export spillovers. For the export participation decision, there is positive evidence of information externalities generated by contact between foreign firms and their domestic customers. Competition effects are also observed since there is a negative and weakly significant coefficient on horizontal export spillovers. Such negative effects are explained by the dominant effects from the presence of domestic market orientation of foreign firms operating in the same industry. The increased competition generated by the domestic market orientation of foreign firms enforces domestic firms need to compete in the production sold in domestic markets rather than place emphasis on export markets which is likely to reduce the probability of exporting. In terms of export intensity, no evidence is found for vertical spillovers but we find significant evidence for horizontal spillovers. Foreign firms in the same industry increase the export intensity of domestic firms driven by the presence of foreign exporters. This result indicates that domestic exporters can benefit from both information and competition effects which therefore enhances export intensity. Other firm-level

characteristics also affect the productivity of domestic firms as well as the decision to export and how much to export.

The structure of the remainder of this paper is organised as follows. Section 2 discusses horizontal and vertical spillovers and the empirical literature on productivity and export spillovers. Section 3 describes and discusses the empirical models, variables and data. Our empirical results are presented in Section 4. Section 5 concludes.

2. Literature Review

2.1 Spillovers from FDI

Why is it important for policymakers to implement policy that attracts FDI inflow? The presence of foreign investors is often seen as one means to stimulate economic growth (Girma *et al.*, 2008). Foreign firms are believed to have both a direct and indirect impact that would possibly benefit the host economy. The direct impact on the host economy would be for example an increase in capital inflows, employment creation, and R&D and training investments. At the same time, foreign firms can indirectly benefit domestic firms in the host economy due to the externalities arising from proprietary assets. Caves (1996) points out foreign firms are likely to have more advanced technology in the production, superior knowledge and strategic management compared to local producers. The possibility of spillovers can then be generated through knowledge and technology transfers as multinationals experience leakages of their intangible proprietary assets. These positive spillovers induce domestic firms to learn from multinationals and enhance their performance through the development of new products as well as production techniques and production processes.

Bloomström and Kokko (1997) describe the channels to which spillovers from FDI can be transferred. The first channel is through the mobility of workers. If there is a movement of well trained and high skilled workers from foreign to domestic firms, domestic firms can benefit from the knowledge and technology used in the production of foreign firms by workers who were trained and used to work in foreign firms. The second channel is through contacts and the arm's length relationship between foreign and domestic firms. Domestic firms can learn from advanced production technologies, know-how, and management strategy and, therefore, adapt that knowledge to improve their own production and management techniques. The final channel is through competition effects. The increased competition generated by foreign firms forces domestic firms to improve production techniques to become more productive.

Channels for spillovers from FDI also depend upon how foreign and domestic firms are contacted horizontally or vertically. Horizontal spillovers take place if contacts between foreign and domestic firms are in the same industry. However, if contacts are between industries, vertical spillovers are likely to occur. In terms of horizontal spillovers, the competitive firms in the same industry either benefit or suffer from the presence of foreign-owned firms. Competitive firms in the same industry can benefit from positive leakages of knowledge and new technology transfer if they employ some high-skilled workers who previously worked in the foreign firms. The entry of foreign firms in the same industry can also results in increased competition which forces domestic firm to improve the quality of their products and/or become more productive. In contrast, Aitken and Harrison (1999) argue that foreign investment can generate negative spillovers to domestic firms through a reduction in the productivity of domestic firms in the same industry. If foreign firms can produce with lower marginal costs, they are likely to compete with domestic firms by increasing their production. Domestic firms would therefore lose their market shares to the foreign-owned firms and have to cut the volume of their production which results in a decline in their productivity.

The definition of vertical spillovers follows Hirschman (1958). Vertical spillovers can be generated by foreign firms towards downstream (forward linkages) and/or upstream firms (backward linkages). Forward linkages are the spillovers from foreign producers that supply intermediate inputs to their potential domestic customers while backward linkages are linkages from foreign firms to their potential local suppliers of intermediate inputs. These are also recognised as buyer-supplier linkages between foreign and domestic firms. Inter-industry contact between foreign and domestic firms can lead to arm's length relationships which can induce demonstration effects where domestic firms can easily learn and gain from technology and knowledge transfers. For example, foreign firms may demand high quality of intermediate goods from suppliers. If this is the case, suppliers may have to upgrade or improve the quality of goods, with foreign firms potentially sharing technology with their suppliers.

Theoretically, Rodríguez-Clare (1996) develops a model to explain how foreign multinationals generate spillovers through the vertical linkages. The model shows that local firms in the host country benefit from the positive vertical spillovers when intermediate inputs are used intensively in the production at foreign multinationals plants. Local firms also benefit from spillovers when there are large communication costs between the headquarters and production plants and when the varieties of intermediate input between the home and host country are relatively similar that can be substituted in the production.

2.2 Empirical Evidence of Export Spillovers from FDI

Blomström and Kokko (1998), Lipsey (2002), Görg and Greenaway (2004) provide literature surveys of the empirical evidence of spillovers to domestic firms that arise from FDI through the presence of foreign firms or MNEs in the host country. Although domestic firms may be affected via different channels such as export spillovers, productivity spillovers, wage spillovers,

knowledge and technology spillovers, this paper only considers those export spillovers from FDI.

The key mechanism of export spillovers is the assumption that domestic firms may learn and gain knowledge from the export activities and firm specific advantages of MNEs which help to enhance their productivity and, therefore, has an impact on the entry decision into export markets and the export intensity of existing exporters.

One of the first empirical studies by Aitken *et al.* (1997) links spillovers with export behaviour and FDI by emphasising the role of foreign investment has as a catalyst for domestically-owned firms to enter export markets. These export spillovers from foreign investment arise from the fact that MNEs appear to have greater access to information, foreign markets, distribution services and advance production technology. These same factors could benefit domestically-owned firms if they learn from MNEs. Using plant-level data from the Mexican manufacturing industry between 1986 and 1990, they find evidence for export spillovers from MNEs that act as export catalysts for domestically-owned firms. The probability of domestically-owned firms exporting is positively associated with the proximity of MNEs who export.

Kokko *et al.* (2001) use cross sectional data for 1998 manufacturing firms in Uruguay to search for export spillovers. At different periods of time, the government implements policy aimed at attracting different types of MNEs.[1] Kokko *et al.* (2001) define two types MNEs according to their year of establishment. There is no evidence for export spillovers from MNEs established in the inward-oriented period (before 1972). However, MNEs established in the outward-oriented period (after 1973) generate positive export spillovers to domestic firms in Uruguay and also its neighbouring markets in Brazil and Argentina.

[1] The policies implemented by government are inward- and outward-oriented policy. The explanation of the former is based on the framework of protectionism. The government subsidises import substitution aimed at replacing the imported goods and services with domestic production. The latter is implemented in order to stimulate more exports by providing various incentives to the new and existing exporters for example reduces tariff and non-tariff barriers, and maintains competitive exchange rate.

In terms of developed countries, evidence for export spillovers from FDI to domestic firms in different European countries is mixed. Barrios *et al.* (2003) emphasise the importance of export spillovers from R&D expenditure and export activity of both domestic firms and MNEs using Spanish firm-level panel data from 1990 to 1998. The presence of MNEs in this study is measured by their R&D expenditure and export activity. Results from a probit model on the entry decision shows that there is no significant evidence for export spillovers from either R&D or export activities of MNEs in the same sector. However, positive and significant results are found on the export activity of domestic firms. In the tobit model, only R&D expenditures of MNEs have positive spillovers effects on export ratio of domestic firms.

For the UK, Greenaway *et al.* (2004) try to explain an indirect channel for productivity spillovers from FDI generated through exports using firm-level panel data from 1992 to 1996. They measure the presence of MNEs based on their employment and export share. They find positive evidence for export spillovers from both measures. The presence of MNEs has a positive effect on the export participation decision of domestic firms and the propensity to export. Further investigation by Kneller and Pisu (2007) look at the effect of industrial linkages and export spillovers from FDI between 1992 and 1999. The empirical results from Heckman selection model show that MNEs generate export spillovers to domestic firms. Firstly, there is a positive and significant relationship between vertical spillovers through backward linkages and export share. Secondly, a positive and significant coefficient on horizontal export spillovers from export-oriented MNEs indicates that exported-oriented MNEs have a significant effect on the probability of exporting for those domestic firms operating in the same industry.

Ruane and Sutherland (2005) compute the presence of foreign firms using an identical methodology to Greenaway *et al.* (2004). Using data from Irish manufacturing industry during the period 1991 and 1998, they investigate export spillovers from foreign firms on the export decision and export intensity of domestic firms. The empirical evidence reveals two contrasting

findings which are a positive and significant effect of export spillovers from employment share of foreign firms but a negative and significant effect on export spillovers from the export share of foreign firms. The negative effect is explained by the fact that US-owned firms invest in Ireland in order to use the country as an export platform to produce and distribute products to other countries in Europe.

As regards to recent studies from a developing country perspective, Alyson (2006) investigates export spillovers to Chinese-owned firms using data from 29 provinces between 1993 and 2000. The presence of foreign firms is measured by their export activity. Foreign firms owned by different countries generate different effects on the entry decision of domestic firms. The evidence indicates a positive relationship between the presence of foreign firms from OECD countries and the decision of domestic firms to enter export markets. Alvarez (2007) investigates factors that determine the export participation decision in Chile during 1990 and 1996. Results show that multinationals generate positivity spillovers on the probability of becoming a permanent exporter which can be explained either by the competition effects or information effects through technology and knowledge transfer that encourage other firms to improve efficiency and export performance.

3. Model Specification, Variables and Data

3.1 Empirical Models

In this section, we present empirical models for the estimation of the relationship between FDI, MNEs in Thailand and the export behaviour of domestic firms. Factors included in each model are in line with previous theoretical and empirical literature. Our main focus is on the variables that capture export spillovers from foreign to domestic firms for both horizontal and vertical

linkages. In addition to spillovers variables, we also include the standard firm-level specific characteristics that are assumed to affect the export behaviour of domestic firms.

We investigate two aspects of export spillovers which are the export participation decision and how much to export. This is known as a two-stage decision process as firms firstly have to decide whether to export or not and secondly the amount firms should export (Kneller and Pisu, 2007). In order to enter export markets, firms have to invest in sunk entry costs, so not every firm decides to export. The export intensity is, therefore, restricted to the subset of firms that do export. As a result, a Heckman selection model is used in order to avoid sample selection bias in the coefficients of our estimated results (Heckman, 1979).[2] We estimate our equations using a Heckman model with maximum likelihood estimation method because it is more appropriate and more efficient than the two-step estimation method.[3] The model consists of two equations:

Export share equation:

$$s_{it}^{*} = X_{it}\beta + \omega_{it} \tag{1}$$

Export decision equation:

$$d_{it}^{*} = Z_{it}\alpha + \nu_{it} \tag{2}$$

where $s_{it} = s_{it}^{*}, d_{it}=1 \; if \; d_{it}^{*} > 0$ and $s_{it} = 0, \; d_{it} = 0 \; if \; d_{it}^{*} \leq 0$

From both equations, identifying export intensity is dependent upon whether a firm exports or not. The export value (s_{it}) is not observed if a firm does not export $(d_{it} = 0)$ but if a firm

[2] This estimation technique is also used in UK studies by Greenaway *et al.* (2004) and Kneller and Pisu (2007).

[3] The maximum likelihood estimation method uses a full maximum likelihood procedure to jointly estimate the inverse Mills ratio and the coefficients in the two equations (export decision and export share). For the two-step estimation, the first step is to regress the probit model of the export decision and compute the invest Mill ratio as the prediction of a binomial probit. Then, the invest Mill ratio is inserted as a regressor in the export share regression in the second step. The two-step method is easy but it is less efficient than the maximum likelihood method.

exports ($d_{it}=1$), we observe positive export sales. The unobserved errors (ν_{it} and ω_{it}) are conditional upon whether $\nu_{it} \sim N(0,1)$, $\omega_{it} \sim N(0,\delta)$, $corr(\nu_{it},\omega_{it})=\rho$ and (ν_{it},ω_{it}) ~bivariate normal $[0,0,1,\delta,\rho]$.

In terms of our Heckman selection model, some factors included in both equations should be different (Baum, 2006). If variables included in vector X and Z are the same, the coefficients and the error terms in both equations would be equal ($\beta=\alpha$ and $\omega_{it}=\nu_{it}$) so the model would reduce to standard tobit model.[4] For this reason, we include an additional variable which is the lag of export dummy ($EX_{i(t-1)}$) in the selection equation (export decision equation) because this variable is theoretically consistent with recently developed models of exports by Melitz 2003, Helpman *et al.* 2004 and Bernard *et al.* 2003 that take into account sunk costs of export.[5] In general, this variable is included in the standard regression model to empirically identify the factors that influence the entry decision into export market (see e.g. Roberts and Tybout 1997, Bernard and Jensen 2004, Kimura and Kiyota 2006). If the lag of export dummy is positive and significant, it is usually interpreted as an evidence of sunk costs of export. Apart from the lag of export dummy, other variables are likely to appear in both equations. All independent variables apart from spillovers are lagged by one year to avoid possible simultaneity problems. Our full specification of the export decision (Equation (3)) and export share (Equation (4)) equations are as follows:

$$\begin{aligned} EX_{it} = {} & \alpha_0 + \alpha_1 EX_{i(t-1)} + \alpha_2 FORW_{jt} + \alpha_3 HOR_{jt} + \alpha_4 BACK_{jt} \\ & + \alpha_5 INRDSHARE_{j(t-1)} + \alpha_6 INEXSHARE_{j(t-1)} \\ & + \alpha_7 TFP_{i(t-1)} + \alpha_8 TFP^2_{i(t-1)} + \alpha_9 SMALL_{i(t-1)} + \alpha_{10} LARGE_{i(t-1)} \\ & + \alpha_{11} VLARGE_{i(t-1)} + \alpha_{12} wage_{i(t-1)} + \alpha_{13} wage^2_{i(t-1)} \\ & + \alpha_{14} SKILL_{i(t-1)} + \alpha_{15} TRAIN_{i(t-1)} + \sum_{r=1}^{5} \alpha_r REGION_r + \nu_{it} \end{aligned} \quad (3)$$

[4] See Verbeek (2004) for a detailed discussion.

[5] A recent study of export spillovers by Kneller and Pisu (2007) also uses a Heckman model and includes the lag of export dummy in the selection equation.

$$
\begin{aligned}
EXSHARE_{it} = {} & \beta_0 + \beta_1 FORW_{jt} + \beta_2 HOR_{jt} + \beta_3 BACK_{jt} \\
& + \beta_4 INRDSHARE_{j(t-1)} + \beta_5 INEXSHARE_{j(t-1)} \\
& + \beta_6 TFP_{i(t-1)} + \beta_7 TFP^2_{i(t-1)} + \beta_8 SMALL_{i(t-1)} \\
& + \beta_9 LARGE_{i(t-1)} + \beta_{10} VLARGE_{i(t-1)} + \beta_{11} wage_{i(t-1)} \\
& + \beta_{12} wage^2_{i(t-1)} + \beta_{13} SKILL_{i(t-1)} + \beta_{14} TRAIN_{i(t-1)} \\
& + \sum_{r=1}^{5} \beta_r REGION_r + \omega_{it}
\end{aligned}
\tag{4}
$$

where the subscripts *i, j, r, t* refer to firm, industry, region and time respectively.

EX is a dummy for export status of firm i.

$EXSHARE$ is the ratio of export sale to total sale of firm i.

$EX_{i(t-1)}$ represents the export experience of a firm.

$FORW$ is a measure of vertical spillovers via forward linkages.

HOR is a measure of horizontal spillovers.

$BACK$ is a measure of vertical spillovers via backward linkages.

$INRDSHARE$ is a share of industry R&D expense.

$INEXSHARE$ is the industry export share.

TFP is total factor productivity of a firm.

TFP^2 is a quadratic term of total factor productivity of a firm.

$SMALL$ is a dummy variable to represent a small firm.

$LARGE$ is a dummy variable to represent a large firm.

$VLARGE$ is a dummy variable to represent a very large firm.

$wage$ is the log of wages per employee.

$wage^2$ is a quadratic term of the log of wages per employee.

$SKILL$ is a ratio of skilled labour to total labour.

$TRAIN$ is a dummy variable for both in-house and outside training.

REGION is a vector of five regional dummies which indicates the regional location of a firm.

In addition to region dummies, we include industry and year dummies to control for the unobserved, industry and time varying effects. We also allow for robust clustering at the industry level which relaxes the independence assumption and requires only that the observations are independent across industries.

3.2 Variables

We use two indicators to identify a firm's export behaviour. The first indictor is used to determine whether a firm exports or not which is a dummy variable for export status (*EX*) which equals 1 if the firm has positive export sales and 0 otherwise. The second indicator is the value of a firm's export share (*EXSHARE*) which is used to determine the export intensity of a firm.

Total factor productivity (*TFP*) is a measurement for efficiency in the production process. The higher the value of TFP determines the greater effectiveness use of inputs and hence a greater shifts of production function. Thus, we expect a positive relationship between TFP and both a firm's decision to export and export intensity.[6] We use a semi-parametric approach following Levinsohn and Petrin (2003) that takes account of unobserved firm-specific productivity shock (TFP^{LP}).[7] In a sensitivity analysis, we use another measurement of productivity which is the standard labour productivity ($TFP^{LABPROD}$) defined as the log of value added divided by total labour.

[6] Our expectation of the positive relationship is based on the empirical evidence that supports the fact that highly productive firms are more likely to enter export markets (see e.g. Bernard and Jensen 1999 and 2004, Kneller and Pisu 2004) and increase export intensity (see e.g. Kneller and Pisu 2007).

[7] Due to limitations of space, we do not include the methodology for TFP calculation of our Levinsohn and Petrin (2003). This information is available from the authors upon request.

Firm size is expected to be one of the important firm characteristics that affect the export behaviours. We believe the productivity is positively correlated to firm size. Small firms are less likely to increase their productivity whilst large firms seem to have more advanced technology and higher production efficiency that affects the increase in productivity. This therefore can possibly induce firms to enter export markets as well as enhance export sales among the existing exporters. We categorise firm size into small (*SMALL*), medium (*MEDIUM*), large (*LARGE*) and very large (*VLARGE*) by following the quartile distribution of the total employment for all firms operating in the same two-digit industry. We omit *MEDIUM* firms in our analysis.

In terms of labour force, we used different measures to capture the quality of the labour. First, wage ($wage$) is defined as the log of wages per employee where wages per employee are the ratio of total salaries to total worker less owners who do not receive salaries. If employees receive high wages, they tend to be the skilled and professional workers. In contrast, employees who receive low wages tend to be the unskilled workers. Our second measure is the ratio of skilled labour to total labour (*SKILL*). Finally, we include a measure of training (*TRAIN*) where a dummy variable equals 1 if employees within a firm receive formal training either in-house or outside training or both at least once and 0 otherwise. Specialisation and working expertise tend to be increased in those workers who are trained. Therefore, we expect that the higher the wage, the more superior the quality of labour. The higher the ratio of skilled labour or workers who received training should also have a positive impact on the firms' export behaviour.

For horizontal and vertical spillovers variables from foreign to domestic firms, we compute indices at the industry level to capture the presence of foreign firms for both intra- and inter-

industry.[8] Foreign ownership is defined as if at least 10% of shares are owned by foreign investors. The index that captures horizontal spillovers effects (HOR) is defined as:

$$HOR_{jt} = \frac{Y_{jt}^{f}}{Y_{jt}} \tag{5}$$

The horizontal spillover variable is the ratio of total sales of foreign firms operating in Thailand (Y_{jt}^{f}) in industry j at time t to total sales of all firms (Y_{jt}) that includes both foreign and domestic firms. The empirical evidence for horizontal export spillovers is mixed so the coefficients could be either negative or positive.

Moreover, we take into account the difference between export-oriented and domestic market-oriented FDI by computing additional indices for horizontal spillovers as we assume that the different market orientation of foreign firms may have different spillover effects on domestic firms. For example, foreign exporters may have firm specific advantages, such as information about foreign markets that are able to generate positive export spillovers to domestic firms, and advanced production processes that would have positive productivity spillovers to domestic firms. Two indices that capture horizontal spillovers from foreign firms according to domestic market orientation ($HOR-Domestic$) and export market orientation ($HOR-Export$) are computed as:

$$HOR-Domestic_{jt} = \frac{Y_{jt}^{df}}{Y_{jt}} \tag{6}$$

$$HOR-Export_{jt} = \frac{Y_{jt}^{ef}}{Y_{jt}} \tag{7}$$

[8] Different definitions are used to measure foreign presence such as share of foreign equity participation (Aitken and Harrison 1999, Javorcik 2004), growth rate of sales of foreign firms (Driffield, 2001), employment share and export share of foreign firms (Greenaway *et al.* 2004, and Ruane and Sutherland 2005), total production of foreign firms (Kneller and Pisu 2007, Javorcik and Spatareanu 2008 and Girma *et al.* 2008).

$HOR-Domestic_{jt}$ is the ratio of total domestic sales in a host country of foreign firms (Y_{jt}^{df}) in industry *j* at time *t* to total sales of all firms (Y_{jt}) whilst $HOR-Export_{jt}$ is the ratio of total export sales of the same foreign firms (Y_{jt}^{ef}) in industry *j* at time *t* to total sales of all firms in the same industry and same time.

For the vertical spillovers variables, an Input-Output (I-O) table is used to calculate backward and forward linkages. The I-O table contains information on the value of output of one industry supplies as inputs to another industry. We compute the backward and forward linkages in the same way as Javorcik (2004), Kneller and Pisu (2007) and Girma *et al.* (2008).

Backward linkages index ($BACK$) captures the contact between foreign firms and their potential local suppliers of intermediate inputs. The measurement of backward linkages is computed as:

$$BACK_{jt} = \sum_{k} \alpha_{kjt} HOR_{kt} \quad for\ k \neq j \tag{8}$$

where the variable α_{kjt} represents the proportion of industry *k*'s output supplied to industry *j* that can be specified as $\alpha_{kjt} = \frac{Y_{kjt}}{Y_{kt}}$. Y_{kjt} is the output of industry *k* that is provided to industry *j* and Y_{kt} is the total output of industry *k*.

The forward linkage variable ($FORW$) is an index that captures the contact between foreign firms and their domestic customers. As a consequence, we measure the forward variable in the similar way to the backward variable. However, instead of using α_{kjt}, we use β_{jht} which corresponds to the proportion of the output that industry *j* supplies to industry *h* that can be specified as $\beta_{jht} = \frac{Y_{jht}}{Y_{ht}}$. The measurement of forward index is thus defined as:

$$FORW_{jt} = \sum_{h} \beta_{jht} HOR_{ht} \quad for\ h \neq j \tag{9}$$

In addition, we measure the industry-level variables which are the industry export share (*INEXSHARE*) defined as the ratio between total export sales and total sales of industry *j* in the same year, and industry R&D expense (*INRDSHARE*) defined as the ratio of R&D expenses in industry *j* to total R&D expense of all industry in the same year.

3.3 Descriptive and Data

Since Thailand faced economic recession following the financial crisis of 1997 and 1998, one of the tools that helped the country to recover from the economic crisis is through FDI inflows. The government has attempted to encourage FDI inflows by providing an attractive investment environment such as good infrastructure, efficient transportation, and reasonable wage rates. The Thai government via the Board of Investment (BOI) has also provided various incentives including investment promotion services to prospective new investors.[9]

From Table 1, the depreciation of Thai currency in 1997 caused a large increase in FDI inflows of over US$ 5.1 billion in 1998 because the cost of investing in Thailand was cheaper relative to other countries and the government relaxed restrictions on the percentage of foreign equity in financial institutions. There was also an increase in M&A since MNEs took over domestic firms that faced severe liquidity problems. The financial crisis affected foreign investors' confidence, so the value of FDI fell to US$ 3.6 billion in 1999 and US$ 2.8 billion in 2000. However, in 2001 FDI inflows were more than doubled because of high investment from Japan and

[9] One example of investment promotions from BOI is the privileges received by the establishment location. Due to the decentralisation of industrial investment, since 1993 the BOI has divided the country into three different investment promotion zones which are Zone 1, Zone 2, Zone 3-Group 1 (high income provinces) and Zone 3-Group 2 (low income provinces). Approved foreign applicants will receive different privileges (tax-based and non-tax privileges) according to their establishment location.

Singapore. Over the years, Thailand experienced fluctuations in FDI inflows. Recent figures show that the FDI inflows were more than US$ 10 billion in 2006 and 2007.

The main sources of FDI inflows have generally been from Japan, the ASEAN region particularly Singapore, the US and the EU-15. Since the 1970s, Japan has been the largest source of FDI except 1999. The large decrease of Japanese FDI in 1999 was mainly because of the economic circumstances in the home country. FDI from Japan increased again in 2000. Singapore has been the second largest source of FDI inflows since 2001. Foreign investors from Singapore invested in different sectors such as banking, telecommunications and especially in automotives and electronics industries.

Table 2 illustrates the net FDI inflows by sector. Each year, the industrial sector received the highest percentage of FDI inflows. During 2000 and 2005, the percentages of manufacturing FDI to total FDI were more than 50 percent on average whilst only 38.83 and 35.80 percent in 2006 and 2007, respectively. The second largest recipient of FDI was the trade sector in 1998 and 1999. However, the trade sector was overtaken by the financial sector during 2007 and 2007. In the manufacturing sector, FDI inflows tend to be concentrated in the production of highly-technological goods such as machinery and transport equipment, electrical appliances, metal and non-metallic. These figures for FDI inflows are in line with the export features of Thailand of which the largest export volumes tend to be highly-technological products. For example, the second largest export industry of Thailand is the automotive industry with numerous foreign automotive manufacturers from Japan, the US and Europe using Thailand as an export platform.

[Table 1 and 2 about here]

For the empirical analysis, we use a firm-level panel data from the annual survey of Thailand's manufacturing industry by the Office of Industrial Economics (OIE), Ministry of Industry, Thailand between 2001 and 2004. The survey includes all sizes of establishments which covers 79 types of manufacturing activities at the four-digit ISIC level in 23 industries at the two-digit ISIC level.[10] According to the report from OIE (2001), the sampling from this survey is representative of the Thai manufacturing sector because the value added of firms included in the survey accounts for 95% of total GDP in the manufacturing sector. The questionnaire includes twenty-five major questions that cover different aspects of a firm's characteristics and performance such as the detailed information on the establishment location, structure of ownership, employment, output, sales, training and R&D. We also control for possible outliers by excluding 0.5 percent tails of all the regression variables apart from the binary dummies. Thus, our final unbalanced panel comprises of 15,115 observations for the 4 years period.[11] We use the 2000 I-O table from Office of the National Economic and Social Development Board (NESDB), Thailand to calculate our spillovers indices.[12]

Details of definitions are presented in Table A1 of the Appendix A. As all regressors in the model except the spillovers variables are lagged by one year to avoid possible simultaneity problems, the data in the estimated sample includes 6,768 observations. Descriptive statistics are provided in Tables A2 of the Appendix A. Table 3 presents summary statistics of a firm's characteristics where we report the means and standard deviations for different types of firms. Amongst different characteristics and performances such as output, sales, capital stock and

[10] For example, a questionnaire was sent out to 6,735 firms in 2001. The response rate was around 60% which includes 35 percent of small, 32 percent of medium and 33 percent of large firms.

[11] The reason for the unbalanced panel structure of our data is because in each year there are some firms that either do not respond or have shut down. In order to compensate for the closure or none response of some firms, the sampling was extended and data collected for additional plants in 2004 (OIE, 2004). Unfortunately we do not have specific data on firm deaths.

[12] From the I-O table of Thailand, we use 58x58 sectors but only restrict ourselves to sectors that relate to manufacturing activities so 30 sectors are selected. Since the classification of sectors in the I-O table and two-digit ISIC in the manufacturing survey are different, we have to group 30 sectors and 22 two-digit ISIC in order to create a 18x18 matrix used to calculate measurements of vertical spillovers through backward and forward linkages. Details of the construction are available from authors upon request.

employment, we observe that foreign firms have superior performance compared to domestic firms. Employees who work in foreign firms receive higher wages compared to those working in domestic firms. The means reported also shows that foreign firms are slightly more productive than domestic firms. If we make a distinction between domestic exporters and domestic non-exporters, the former perform better. For example, domestic exporters have more assets, are more productive, and pay higher wages.

Our figures of Thailand are in line with the explanation provided by Caves (1996), that foreign firms are larger, perform better, and have greater knowledge, technology and production capacity than domestic firms. These attributes can be observed by domestic firms, based on the explanation from information and/or competition effects, hence we search the presence of spillovers from foreign firms to domestic firms and present the results in the next section.

[Table 3 about here]

4. Results

Results from a Heckman selection model are presented in Tables 4 and 5. We begin with an investigation of the relationship between export market entry and the performances of domestic firms (both the export participation decision and export intensity) and the measurement of spillover variables without controlling for other covariates. We then extend the model by adding industry-level variables to a number of firm-level characteristics that are assumed to affect the export behaviour of domestic firms. In both tables, our preferred specifications are Column (6.1) for export participation decision and Column (6.2) for export intensity or export share. We also present the marginal effects of the Heckman selection model in Table 6. Our spillover results for the aggregate sample are presented in Table 7 in order to clarify similarity and/or dissimilarity with other studies.

In terms of the export participation decision equation, the results in Table 4 show that measures on the presence of foreign firms are insignificant for both horizontal and backward variables. However, a significant result is found on the forward linkages variable which indicates that contacts between foreign multinationals and their domestic customers have positive impact on the probability of exporting. Because domestic firms purchase intermediate inputs from foreign firms, spillover effects may be generated through the greater access to less costly or even the quality improvement of intermediate inputs produced by foreign firms. These would reduce the production costs of domestic firms as well as improve the quality of their products that would enable domestic firms to enter export markets. Other industry-level variables, both industry R&D share and industry export share, have insignificant effects on the entry decision into the export market. Such insignificant results can be explained by the inclusion of the fixed industry effects (Kneller and Pisu, 2007).

In terms of our firm-level characteristics, in the probit regression for the export participation decision, the coefficients have the expected signs that are in line with the empirical evidence from other countries studies provided for example by Roberts and Tybout (1997) for Columbia, Bernard and Jensen (1999 and 2004) for the US, Greenaway and Kneller (2004) for the UK, Kimura and Kiyota (2006) for Japan. The export participation decision of domestic firms is positively affected by the export status in the previous period at the 1% significant level. If a domestic firm had export experience in the previous year, the probability of current period exporting is likely to increase. This importance is typically interpreted as the evidence of sunk costs of exports, an initial large and one-off investment faced by a firm in order to enter the export market, which positively influences the entry decision of a firm (see e.g. Roberts and Tybout 1997, Bernard and Jensen 2004, Greenaway and Kneller 2004).

Productivity is positive while a quadratic term of TFP is negative. Both variables are significant at the 1% level. The probability of exporting increases with productivity but at a decreasing rate. Firm size is another important factor that affects the export decision of firms. Three categories of firm size provide different results. The negative and significant coefficient on small firms indicates that small firms are less likely to become exporters. However, we observe increasingly positive and significant results when firm sizes increase. The coefficients of large and very large firms indicate that the larger the size, the more likely the firm is to enter the export market.

The results on different measures of the quality of labour show that wage, a quadratic term of wage rate and a dummy for training have the expected signs but insignificant coefficients. One plausible explanation arises from the differences in the characteristic of products exported. Some products do not require high quality of labour or training in their production while some do. Moreover, some firms tend to export mass-produced products or intermediate inputs that are produced using cheap labour costs. We find that only the ratio of skilled labour significantly affects the increase in the probability of exporting. This positive and significant result is in line

with the findings from other countries such as the UK by Roper and Love (2002), the US by Bernard and Jensen (2004) and Chile by Alvarez and López (2005).

Regarding the export share equation, we observe different results on the measurement of foreign presence compared to the export participation decision. We do not find any significant evidence to support the effect of vertical spillovers through forward and backward linkages. However, the coefficient on horizontal variable is positive and significant at the 1% level which means that once a firm enters an export market, their export intensity tends to increase as a consequence of an increase in the presence of foreign firms in the same industry. Domestic exporters may gain from information externalities generated by foreign firms operating in the same industry and such information externality encourages domestic exporters to enhance their export intensity. Another possible explanation is that competition with foreign firms within the industry obliges exporters to improve their production efficiency and facilitates them to an increase in export share.

Once more, the industry-level variables for both industry R&D share and industry export share are insignificant. For firm-level variables, the relationship between export intensity and firm characteristics are generally consistent with the results from the export participation equation of which productivity and large firm have positive and significant effects on the export intensity whereas a quadratic term of productivity and being a small firm have a negative and significant effect.

[Table 4 about here]

In further analysis, we make a distinction between types of FDI (domestic market- and export-oriented FDI) as we intend to investigate whether market oriented FDI generates possible export spillover effects. Previous research such as Kneller and Pisu (2007) also use the same measure

for export orientation of foreign firms in order to capture the idea that export spillovers are perhaps caused by information externalities. Results from a Heckman selection model are presented in Table 5 where we include horizontal domestic and horizontal export indices to capture domestic market orientation and export orientation of foreign firms, respectively.

For the reason that other industry- and firm-level variables are unchanged, we only discuss the coefficients of our spillover variables. The coefficient on forward linkages remains positive but does not significantly affect the probability of exporting (except for Column (6.1)) and export intensity. Our backward linkage variable is found to be insignificant. The negative coefficient on horizontal spillovers in the export participation decision from Table 4 is now explained by the negative and weakly significant coefficient of the horizontal domestic index which can be interpreted as to mean that the domestic market orientation of foreign firms operating in the same industry significantly decreasing the probability of exporting. The result implies that there is an increase in the level of competition in the domestic market between domestic and foreign firms in the same industry. Domestic firms may lose some of their market share to foreign firms operating in the same industry whilst domestic firms face the same fixed costs. It is less likely that domestic firms would be able to generate enough profit to cover the sunk entry cost of exporting. In contrast to the UK study by Kneller and Pisu (2007), we do not find a significant relationship between a horizontal export index and the probability of exporting. However, our finding supports evidence of Mexican firms provided by Atiken *et al.* (1997) who do not find evidence of spillovers from the general export activity. Export-oriented foreign firms are able to protect leakages from their export activities and do not really provide information about foreign market opportunities that helps domestic firms to overcome or even reduce sunk costs of exports.

In the export share equation, a positive and significant coefficient on horizontal spillovers in Table 4 is now explained by a dominant effect from a positive and significant effect of the of

horizontal export index. The export orientation of foreign firms operating in the same industry helps domestically-owned firms to enhance their export intensity. After domestic firms enter export markets, they benefit from the export orientation of foreign firms operating in the same industry through imitation, knowledge spillovers or even foreign market specific information. An increase in the presence of export-oriented foreign firms can also cause an increase in the level competition with domestic exporters in the same industry that forces domestic exporters to become more productive and thus increase their export intensity. We also perform another sensitivity check on productivity variable by using the standard labour productivity ($TFP^{LABPROD}$). The results are generally consistent and are available from the authors upon request.

To understand the economic magnitude of the our spillover variables discussed in Table 5, we present in Table 6 the coefficients obtained from the marginal effects of the Heckman selection model. The marginal effects are calculated at the mean of each continuous independent variable (except for the dummy variable) keeping all other variables constant. We, therefore, compute the marginal effects separately for the export decision and export share regression. For the export decision, adding one percentage point to the forward index will add to the probability of exporting about 0.024 percentage points. In contrast, adding one percentage point to horizontal domestic index will reduce to the probability of exporting around 0.009 percentage points. The significance on the coefficients of TFP and a quadratic term suggest that the probability of exporting is increased with productivity but at a decreasing rate. The turning point is when TFP equals to approximately 11.[13] Different size categories also significantly affect the probability of exporting. For example, the interpretation for *SMALL* is that being a small firm is likely to decrease the probability of exporting by 8.4 percentage points. Another factor that determines the probability of exporting is the ratio of skilled labour of which adding one unit increase in the

[13] The figure is calculated as [0.197/(0.009*2)]=10.94.

ratio of skilled labour will increase the probability of exporting by around 5.9 percentage points. In terms of export share regression, horizontal export index has a positive and significant coefficient that is explained as adding one percentage point to horizontal export index increases the export share by 0.004 point.

[Table 5 and 6 about here]

In Table 7, we compare our findings for export spillovers with results from other studies. Some studies find positive export spillovers while some find different results when distinguishing between horizontal and vertical spillovers. Our result is consistent with Kneller and Pisu (2007) on the horizontal export spillovers when the export share is used as the dependent variable. We do not find any significant evidence for backward spillovers but Kneller and Pisu (2007) find a positive and significant result. One explanation for the differences in the results is because of dissimilarity between developed and developing countries. Lipsey and Sjöholm (2005) also mention that different country may find dissimilar results because of the difference in the characteristics of firms in each country. For instance, Kneller and Pisu (2007) find that horizontal export spillovers are driven by significance of export-oriented foreign firms operating in the same industry. Imitation or information externalities allow domestic firms to compete successfully in order to participate in the export market. However, in the case of Thailand, horizontal export spillovers are negatively determined by the domestic market orientation of foreign firms operating in the same industry that implies a negative competition effect. Domestic firms may gain from knowledge and information externalities generated by foreign firms operating in the same industry, and also from competition effects as their intensities to export are increased following the entry into export market.

[Table 7 about here]

5. Conclusions

Policymakers in both developed and developing countries have attempted to implement policies to encourage FDI inflows assuming that they benefit the host country. The direct impact of FDI is through increases in capital inflows, employment, as well as R&D investment all of which can be seen as ways to stimulate economic growth. Foreign firms may particularly indirectly benefit domestic firms through externalities arising from the proprietary assets of foreign firms. This paper presents an empirical investigation into the existence or otherwise of export spillovers from FDI through the presence of foreign firms using an unbalanced panel of firm-level data from Thailand between 2001 and 2004. We search for both intra- and inter-industry spillovers from foreign firms. Furthermore, we differentiate between different types of FDI and whether the foreign firms are domestic market oriented or export oriented and how this affect the export behaviour, for both the export participation decision and how much to export, of domestic firms.

Our findings show significant evidence on export spillovers. The export participation decision of domestic firms is determined by vertical spillovers through forward linkages suggesting the importance of contacts between foreign firms and their domestic customers. Regarding horizontal spillovers, a negative and weakly significant result is found which can be explained by the dominant effect from domestic market- oriented foreign firms operating in the same industry. An increase in competition among domestic firms and domestic market-oriented foreign firms in the same industry diminishes the probability of exporting. We observe different results in the export share equation. Foreign firms, especially export-oriented foreign firms, operating in the same industry have a positive effect on the export intensity of domestic exporters. This indicates that domestic exporters can benefit from both information and competition effects. Other firm-level characteristics also have a significant impact on the productivity, export participation decision and export intensity of domestic firms.

Our results prove that domestic firms in Thailand do indeed gain from FDI measured by the presence of foreign-owned firms operating in the same and across industries. Different incentives for FDI have different spillover effects towards domestic firms. In addition, export spillovers are diverse and affect exporters and non-exporters differently. Therefore, government have to carefully design the right policy that stimulate growth in economy as well as benefit domestic firms. Export-oriented FDI show the Thai government should stress on as the empirical evidence show that export-oriented foreign firms horizontally generate positive export spillovers to domestic firms. Another implication is that the government should cautiously consider protecting some industries lose market share or face significant competitions pressures due to the inflows of FDI because there is evidence suggesting negative export spillovers from domestic market-oriented foreign firms to domestic firms.

Since we find evidence that the export decision of domestic non-exporters seems to be affected by contacts they have with foreign firms, the policy design should also emphasise on the impact of FDI via vertical linkages between foreign and domestic firms that can be generated through technology, knowledge and skill transfers. The government should carry out targeted investment promotion activities so as to fill technology gaps and technology needs. This implication would enhance the possibility of spillovers. Moreover, rather than attracting new investment, the government should work more closely with the existing MNEs in the country in order to increase arm length relationship with domestic firms and enhance spillovers benefit.

Table 1: Foreign Direct Investment Net Inflows to Thailand Classified by Country

Country	Value : US$ Million									
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Japan	1,484.69	488.35	869.86	1,955.12	1,892.41	2,297.67	2,749.93	2,926.51	2,576.42	3,135.72
US	1,283.31	641.22	617.57	395.01	182.34	336.23	540.42	750.48	165.78	570.06
EU-15	912.30	1,368.46	509.59	282.91	-216.12	607.55	697.31	335.02	955.41	1,561.89
Other EU	-1.07	-0.04	0.70	-1.07	0.99	2.07	3.49	-0.07	4.70	19.32
ASEAN-5	569.65	569.57	381.78	1,709.95	1,403.52	1,053.86	683.37	1,107.34	4,597.15	2,560.17
-Brunei Darussalam	0.02	0.00	0.00	0.00	0.10	0.07	2.09	4.71	2.20	-3.92
-Indonesia	2.71	1.19	4.26	2.81	7.43	6.72	5.87	1.06	-6.35	6.10
-Malaysia	17.15	27.06	21.33	10.66	-32.55	41.24	147.31	38.36	321.82	21.30
-Philippines	7.78	3.21	0.50	2.88	-0.41	5.43	182.96	-5.54	-0.46	7.10
-Singapore	541.97	538.10	355.68	1,693.59	1,428.95	1,000.38	345.12	1,068.74	4,279.94	2,529.58
Other ASEAN	5.26	2.47	7.25	0.73	4.77	6.58	5.31	-6.02	29.35	6.75
Hong Kong	393.91	233.65	331.31	150.58	86.25	613.08	141.40	7.16	-77.84	390.37
Taiwan	106.25	121.49	158.96	156.83	103.70	75.25	124.20	29.24	-94.55	91.50
South Korea	72.72	5.46	-3.69	50.64	93.22	23.83	93.53	29.51	79.48	75.33
China	5.01	-2.14	7.23	-2.50	20.90	23.83	-3.82	11.55	49.87	73.71
Canada	3.15	2.97	9.45	5.90	15.04	21.17	28.53	-11.22	7.06	25.52
Australia	34.58	12.94	26.60	0.56	-0.42	32.47	99.85	-1.09	11.18	69.36
Switzerland	73.22	60.37	32.16	55.34	48.07	124.12	167.30	99.81	153.90	172.37
Other	199.14	56.93	-135.55	287.94	-223.71	-52.75	-374.87	1224.89	2021.78	1446.98
Total	5,142.18	3,561.69	2,813.26	5,048.00	3,411.00	5,165.00	4,956.00	6,503.16	10,479.74	10,199.09

Source: Bank of Thailand

Table 2: Foreign Direct Investment Net Inflows to Thailand Classified by Sector

Sector	Value : US$ Million									
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Industry	2,206.35	1,268.63	1,810.66	2,960.26	1,844.53	2,408.58	3,785.98	3,429.86	4,068.87	3,651.17
-Food & Sugar	73.38	94.01	93.00	155.06	21.28	265.14	337.32	-24.76	118.13	120.62
-Textiles	123.96	20.81	-3.47	105.56	43.29	64.46	37.95	77.87	-7.88	71.18
-Metal & Non Metallic	341.65	262.40	-83.66	378.35	259.82	255.75	480.07	221.43	354.65	507.51
-Electrical appliances	264.31	424.99	507.23	981.29	214.93	327.44	797.01	908.29	1,080.91	380.53
-Machinery & Transport equipment	661.17	392.84	655.48	578.81	644.45	653.10	1,280.34	1,369.98	1,402.81	1,236.34
-Chemicals	226.00	7.48	393.38	167.77	334.09	295.90	387.34	472.39	173.95	-141.95
-Petroleum Products	328.66	8.57	29.30	179.93	-50.16	95.25	22.49	-72.60	332.18	378.58
-Construction materials	23.35	37.87	57.82	0.18	31.37	-7.89	45.05	21.66	7.85	31.42
-Others	163.82	19.62	161.58	413.27	345.42	459.39	398.36	455.58	606.25	1,066.92
Financial Institutions	842.14	247.13	132.97	-186.17	67.34	-24.52	221.65	1,550.89	2,490.21	1,882.23
Trade	1,051.45	1,042.29	67.79	1,069.13	682.21	817.88	182.91	295.19	787.97	602.79
Construction	191.69	-151.77	-1.70	4.53	19.32	42.98	70.67	29.89	-86.00	46.33
Mining & Quarrying	21.71	-41.82	-274.74	759.32	146.61	270.62	192.29	-110.99	206.05	808.43
Agriculture	0.49	1.90	0.70	-4.22	3.20	28.22	5.72	12.60	-1.94	3.19
Services	276.16	485.02	448.28	155.90	740.64	362.23	303.27	330.94	711.19	1,055.78
Investment	363.77	570.80	99.12	-33.69	-655.97	374.70	-236.66	173.64	2,133.33	321.81
Real Estate	27.71	148.53	69.11	70.88	67.58	126.40	-343.96	43.34	262.64	1,207.13
Others	160.70	-9.04	461.05	252.04	495.50	757.88	774.10	747.77	-92.60	620.19
Total	5,142.19	3,561.69	2,813.26	5,048.00	3,411.00	5,165.00	4,956.00	6,503.16	10,479.74	10,199.09

Source: Bank of Thailand

Table 3: Summary Statistics

	Foreign Firms	Domestic Firms	Domestic Exporters	Domestic Non-Exporters
Output	327.499	77.233	128.94	45.148
	(765.61)	(267.06)	(327.99)	(214.84)
Sales	403.826	95.706	161.60	54.789
	(906.57)	(342.03)	(445.18)	(249.48)
Assets	375.241	127.339	181.32	78.098
	(857.42)	(598.03)	(782.44)	(347.12)
Capital stock	156.790	38.065	72.518	16.631
	(454.61)	(325.61)	(516.46)	(69.92)
Labour	642.338	271.601	519.64	117.592
	(1204.26)	(561.93)	(792.21)	(245.62)
Wage	42.082	23.546	25.531	22.313
	(87.80)	(17.91)	(14.01)	(19.86)
Productivity	9.848	9.118	9.552	8.849
	(1.91)	(1.56)	(1.47)	(1.56)
Observation	2,558	6,529	2,501	4,028

Notes: Standard deviations are reported in parentheses. Capital stock is a firm's total fixed assets. Labour is total employment including owners. Productivity is obtained from the estimation technique of Levinsohn and Petrin (2003). Wage is the ratio of total labour costs to total employment less owners who do not receive wage. Output, sales and capital stock are measured in hundreds of thousands of US Dollars while wage is measured in hundred of US Dollars.

Table 4: Heckman Selection Model for Export Spillovers to all Domestic Firms

	(1)		(2)		(3)	
	(1.1) ***EX Decision***	(1.2) ***EX Share***	(2.1) ***EX Decision***	(2.2) ***EX Share***	(3.1) ***EX Decision***	(3.2) ***EX Share***
$EX_{i(t-1)}$	3.684***		3.687***		3.617***	
	(0.069)		(0.067)		(0.066)	
$FORW_{jt}$	0.077**	0.004	0.079**	0.004	0.073**	0.005
	(0.031)	(0.005)	(0.031)	(0.005)	(0.034)	(0.005)
HOR_{jt}	-0.003	0.003***	-0.003	0.003**	-0.004	0.003***
	(0.004)	(0.001)	(0.005)	(0.001)	(0.005)	(0.001)
$BACK_{jt}$	-0.002	0.001	-0.010	0.002	-0.010	0.002
	(0.033)	(0.002)	(0.031)	(0.002)	(0.031)	(0.002)
$INRDSHARE_{j(t-1)}$			-0.245	0.005	-0.207	0.007
			(0.204)	(0.018)	(0.215)	(0.020)
$INEXSHARE_{j(t-1)}$			0.546	-0.237	0.835	-0.206
			(1.986)	(0.231)	(2.006)	(0.233)
$TFP^{LP}_{i(t-1)}$					0.755***	0.111*
					(0.205)	(0.063)
$(TFP^{LP}_{i(t-1)})^2$					-0.028***	-0.007**
					(0.010)	(0.003)
$SMALL_{i(t-1)}$						
$LARGE_{i(t-1)}$						
$VLARGE_{i(t-1)}$						
$wage_{i(t-1)}$						
$wage^2_{i(t-1)}$						
$SKILL_{i(t-1)}$						
$TRAIN_{i(t-1)}$						
Constant	-2.552*	0.479***	-2.731	0.607***	-6.991**	0.117
	(1.523)	(0.132)	(1.984)	(0.100)	(2.787)	(0.331)
ρ	-0.450***		-0.449***		-0.458***	
	(0.062)		(0.061)		(0.064)	
λ	-0.152***		-0.152***		-0.154***	
	(0.023)		(0.023)		(0.024)	
Observations	6768	6768	6768	6768	6768	6768

Notes: Robust clustered standard errors in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%. Region, two-digit industry and time dummies are included. ρ is the estimated correlation between the error terms of the two equations; if it is different from zero it suggests that the two equations are related and that the selection model is appropriate. λ is the estimated coefficient of the inverse Mills ratio; if it is different from zero it suggests that there is sample selection.

Table 4: Continued

	(4)		(5)		(6)	
	(4.1) ***EX Decision***	(4.2) ***EX Share***	(5.1) ***EX Decision***	(5.2) ***EX Share***	(6.1) ***EX Decision***	(6.2) ***EX Share***
$EX_{i(t-1)}$	3.537***		3.533***		3.531***	
	(0.058)		(0.061)		(0.062)	
$FORW_{jt}$	0.079**	0.004	0.080**	0.004	0.081**	0.004
	(0.033)	(0.005)	(0.033)	(0.005)	(0.032)	(0.005)
HOR_{jt}	-0.004	0.003***	-0.004	0.003***	-0.004	0.003***
	(0.006)	(0.001)	(0.006)	(0.001)	(0.006)	(0.001)
$BACK_{jt}$	-0.012	0.002	-0.012	0.002	-0.013	0.002
	(0.032)	(0.002)	(0.032)	(0.002)	(0.033)	(0.002)
$INRDSHARE_{j(t-1)}$	-0.244	0.008	-0.246	0.007	-0.246	0.005
	(0.201)	(0.021)	(0.201)	(0.020)	(0.201)	(0.020)
$INEXSHARE_{j(t-1)}$	0.707	-0.196	0.799	-0.168	0.816	-0.170
	(2.034)	(0.243)	(2.037)	(0.250)	(2.036)	(0.249)
$TFP^{LP}_{i(t-1)}$	0.621***	0.101*	0.554***	0.098*	0.561***	0.104*
	(0.196)	(0.056)	(0.202)	(0.058)	(0.200)	(0.057)
$(TFP^{LP}_{i(t-1)})^2$	-0.026***	-0.006**	-0.025**	-0.005*	-0.025***	-0.006*
	(0.010)	(0.003)	(0.010)	(0.003)	(0.010)	(0.003)
$SMALL_{i(t-1)}$	-0.236***	0.085*	-0.233***	0.085*	-0.240***	0.077
	(0.076)	(0.050)	(0.077)	(0.050)	(0.079)	(0.047)
$LARGE_{i(t-1)}$	0.225**	0.064***	0.231**	0.061***	0.232**	0.062***
	(0.094)	(0.019)	(0.091)	(0.019)	(0.093)	(0.020)
$VLARGE_{i(t-1)}$	0.307***	0.059	0.326***	0.050	0.327***	0.053
	(0.082)	(0.054)	(0.086)	(0.048)	(0.086)	(0.047)
$wage_{i(t-1)}$			0.700	0.508	0.526	0.492
			(0.903)	(0.419)	(0.805)	(0.442)
$wage^2_{i(t-1)}$			-0.032	-0.036	-0.022	-0.035
			(0.056)	(0.027)	(0.050)	(0.029)
$SKILL_{i(t-1)}$					0.166*	0.062
					(0.095)	(0.042)
$TRAIN_{i(t-1)}$					0.078	-0.008
					(0.082)	(0.023)
Constant	-5.889**	0.124	-8.954**	-1.677	-8.387**	-1.634
	(2.744)	(0.270)	(3.876)	(1.505)	(3.654)	(1.579)
ρ	-0.456***		-0.457***		-0.459***	
	(0.061)		(0.062)		(0.063)	
λ	-0.153***		-0.153***		-0.153***	
	(0.023)		(0.023)		(0.023)	
Observations	6768	6768	6768	6768	6768	6768

Notes: Robust clustered standard errors in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%. Region, two-digit industry and time dummies are included. ρ is the estimated correlation between the error terms of the two equations; if it is different from zero it suggests that the two equations are related and that the selection model is appropriate. λ is the estimated coefficient of the inverse Mills ratio; if it is different from zero it suggests that there is sample selection.

Table 5: Heckman Selection Model for Export Spillovers (Domestic Market- and Export-Oriented FDI) to all Domestic Firms

	(1)		(2)		(3)	
	(1.1) ***EX Decision***	(1.2) ***EX Share***	(2.1) ***EX Decision***	(2.2) ***EX Share***	(3.1) ***EX Decision***	(3.2) ***EX Share***
$EX_{i(t-1)}$	3.691***		3.693***		3.623***	
	(0.070)		(0.068)		(0.067)	
$FORW_{jt}$	0.062	0.003	0.065*	0.003	0.059	0.004
	(0.038)	(0.006)	(0.039)	(0.006)	(0.043)	(0.006)
$HOR-Domestic_{jt}$	-0.026*	0.002	-0.024*	0.002	-0.026*	0.002
	(0.014)	(0.002)	(0.014)	(0.002)	(0.015)	(0.002)
$HOR-Export_{jt}$	0.007	0.003***	0.007	0.003***	0.005	0.003***
	(0.009)	(0.001)	(0.009)	(0.001)	(0.010)	(0.001)
$BACK_{jt}$	0.003	0.002	-0.002	0.003*	-0.003	0.003
	(0.032)	(0.002)	(0.031)	(0.002)	(0.031)	(0.002)
$INRDSHARE_{j(t-1)}$			-0.218	0.008	-0.180	0.009
			(0.185)	(0.018)	(0.199)	(0.020)
$INEXSHARE_{j(t-1)}$			0.310	-0.291	0.592	-0.249
			(2.125)	(0.234)	(2.174)	(0.238)
$TFP^{LP}_{i(t-1)}$					0.746***	0.111*
					(0.205)	(0.063)
$(TFP^{LP}_{i(t-1)})^2$					-0.028***	-0.007**
					(0.010)	(0.003)
$SMALL_{i(t-1)}$						
$LARGE_{i(t-1)}$						
$VLARGE_{i(t-1)}$						
$wage_{i(t-1)}$						
$wage^2_{i(t-1)}$						
$SKILL_{i(t-1)}$						
$TRAIN_{i(t-1)}$						
Constant	-3.235**	0.474***	-3.281	0.624***	-7.459**	0.133
	(1.617)	(0.129)	(2.049)	(0.110)	(2.919)	(0.331)
ρ		-0.450***		-0.450***		-0.457***
		(0.061)		(0.055)		(0.064)
λ		-0.152***		-0.152***		-0.154***
		(0.023)		(0.023)		(0.024)
Observations	6768	6768	6768	6768	6768	6768

Notes: Robust clustered standard errors in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%. Region, two-digit industry and time dummies are included. ρ is the estimated correlation between the error terms of the two equations; if it is different from zero it suggests that the two equations are related and that the selection model is appropriate. λ is the estimated coefficient of the inverse Mills ratio; if it is different from zero it suggests that there is sample selection.

Table 5: Continued

	(4)		(5)		(6)	
	(4.1) ***EX Decision***	(4.2) ***EX Share***	(5.1) ***EX Decision***	(5.2) ***EX Share***	(6.1) ***EX Decision***	(6.2) ***EX Share***
$EX_{i(t-1)}$	3.542***		3.538***		3.536***	
	(0.060)		(0.062)		(0.063)	
$FORW_{jt}$	0.066	0.003	0.067	0.002	0.068*	0.002
	(0.041)	(0.006)	(0.041)	(0.006)	(0.040)	(0.006)
$HOR-Domestic_{jt}$	-0.025*	0.002	-0.025*	0.002	-0.025*	0.002
	(0.015)	(0.002)	(0.015)	(0.002)	(0.014)	(0.002)
$HOR-Export_{jt}$	0.005	0.003***	0.005	0.003***	0.005	0.003***
	(0.010)	(0.001)	(0.010)	(0.001)	(0.010)	(0.001)
$BACK_{jt}$	-0.006	0.003	-0.006	0.003	-0.007	0.002
	(0.032)	(0.002)	(0.033)	(0.002)	(0.033)	(0.002)
$INRDSHARE_{j(t-1)}$	-0.221	0.011	-0.222	0.010	-0.221	0.008
	(0.186)	(0.021)	(0.186)	(0.020)	(0.186)	(0.020)
$INEXSHARE_{j(t-1)}$	0.520	-0.248	0.616	-0.224	0.627	-0.222
	(2.191)	(0.251)	(2.193)	(0.258)	(2.184)	(0.254)
$TFP^{LP}_{i(t-1)}$	0.612***	0.101*	0.544***	0.098*	0.551***	0.104*
	(0.194)	(0.056)	(0.201)	(0.057)	(0.198)	(0.057)
$(TFP^{LP}_{i(t-1)})^2$	-0.025***	-0.006**	-0.024**	-0.005*	-0.025**	-0.006*
	(0.010)	(0.003)	(0.010)	(0.003)	(0.010)	(0.003)
$SMALL_{i(t-1)}$	-0.236***	0.085*	-0.234***	0.085*	-0.240***	0.077
	(0.076)	(0.050)	(0.077)	(0.050)	(0.079)	(0.047)
$LARGE_{i(t-1)}$	0.222**	0.064***	0.228**	0.061***	0.230**	0.063***
	(0.093)	(0.019)	(0.090)	(0.019)	(0.092)	(0.019)
$VLARGE_{i(t-1)}$	0.307***	0.059	0.326***	0.051	0.326***	0.053
	(0.081)	(0.054)	(0.085)	(0.048)	(0.085)	(0.047)
$wage_{i(t-1)}$			0.719	0.511	0.544	0.494
			(0.899)	(0.421)	(0.802)	(0.444)
$wage^2_{i(t-1)}$			-0.033	-0.036	-0.023	-0.036
			(0.056)	(0.027)	(0.050)	(0.029)
$SKILL_{i(t-1)}$					0.166*	0.062
					(0.094)	(0.042)
$TRAIN_{i(t-1)}$					0.082	-0.008
					(0.081)	(0.023)
Constant	-6.381**	0.142	-9.524**	-1.669	-8.951**	-1.625
	(2.884)	(0.267)	(4.028)	(1.512)	(3.801)	(1.585)
ρ	-0.455***		-0.456***		-0.459***	
	(0.061)		(0.062)		(0.062)	
λ	-0.153***		-0.153***		-0.153***	
	(0.023)		(0.023)		(0.023)	
Observations	6768	6768	6768	6768	6768	6768

Notes: Robust clustered standard errors in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%. Region, two-digit industry and time dummies are included. ρ is the estimated correlation between the error terms of the two equations; if it is different from zero it suggests that the two equations are related and that the selection model is appropriate. λ is the estimated coefficient of the inverse Mills ratio; if it is different from zero it suggests that there is sample selection.

Table 6: Marginal Effects of the Heckman Selection Model from Column (6) of Table 5

	(1) *EX Decision*	(2) *EX Share*
$EX_{i(t-1)}$	0.922***	
	(0.006)	
$FORW_{jt}$	0.024*	0.010
	(0.014)	(0.010)
$HOR-Domestic_{jt}$	-0.009*	-0.001
	(0.005)	(0.002)
$HOR-Export_{jt}$	0.002	0.004***
	(0.004)	(0.001)
$BACK_{jt}$	-0.003	0.001
	(0.012)	(0.004)
$INRDSHARE_{j(t-1)}$	-0.079	-0.016
	(0.066)	(0.033)
$INEXSHARE_{j(t-1)}$	0.224	-0.152
	(0.779)	(0.376)
$TFP^{LP}_{i(t-1)}$	0.197***	0.165***
	(0.071)	(0.057)
$(TFP^{LP}_{i(t-1)})^2$	-0.009**	-0.008***
	(0.003)	(0.003)
$SMALL_{i(t-1)}$	-0.084***	0.050
	(0.027)	(0.050)
$LARGE_{i(t-1)}$	0.084**	0.088***
	(0.034)	(0.017)
$VLARGE_{i(t-1)}$	0.121***	0.089
	(0.033)	(0.052)
$wage_{i(t-1)}$	0.194	0.555
	(0.286)	(0.463)
$wage^2_{i(t-1)}$	-0.008	-0.038
	(0.018)	(0.030)
$SKILL_{i(t-1)}$	0.059*	0.080
	(0.033)	(0.048)
$TRAIN_{i(t-1)}$	0.029	0.002
	(0.028)	(0.025)

Notes: Standard errors in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%. Region, two-digit industry and time dummies are included.

Table 7: Summary of Results on Export Spillovers

Author	Dependent Variable	Country	Period	Results[a]			
				Overall	Hor	Forw	Back
Virakul (2009)	Export Dummy	Thailand	2001-2004	N/A	?	+	?
	Export Share	Thailand	2001-2004	N/A	+	?	?
Aitken *et al.* (1997)	Export Dummy	Mexico	1986/1989	N/A	+	N/A	N/A
Kneller and Pisu (2007)	Export Dummy	UK	1992-1999	N/A	?	?	?
	Export Share	UK	1992-1999	N/A	+	?	+
Kokko *et al.* (2001)[c]	Export Dummy	Uruguay	2001	?	N/A	N/A	N/A
Ma (2006)[c]	Export Dummy	China	1993-2000	+	N/A	N/A	N/A
Alvarez (2007)[c]	Export Dummy	Chile	1990-1996	+	N/A	N/A	N/A

Notes:

[a] The symbol+ indicates positive and significant, + indicates negative and significant, and ? indicates mixed or insignificant results on the measurement of foreign presence for the aggregate sample. N/A means not applicable.

[c] Do not distinguish between intra- and inter-industry spillovers.

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Appendix A: Definition of Variables and Descriptive Statistics

Table A1: Definition of Variables

Level	Variable	Definition
Firm	EX_{it}	A dummy variable for export status where a dummy equals 1 if firm i has positive export sales and 0 otherwise.
	$EX_{i(t-1)}$	The lagged of export status represents for the past export experience or the sunk entry costs.
	$EXSHARE_{it}$	The share of export sale total sale of firm $\boldsymbol{i}$.
	$TFP^{LP}_{i(t-1)}$	Total factor productivity that is obtained from the estimation of the semi-parametric approach of Levinsohn and Petrin (2003).
	$TFP^{LABPROD}_{i(t-1)}$	Labour productivity calculated as the log of value added divided by total labour.
	$SMALL_{i(t-1)}$	A dummy variable equal to 1 if the total labour of firm i at time $t-1$ is in the first quartile of the distribution of the total labour of all firms operating in the same two-digit industry level as firm i at time $t-1$.
	$LARGE_{i(t-1)}$	A dummy variable equal to 1 if the total labour of firm i at time $t-1$ is in the third quartile of the distribution of the total labour of all firms operating in the same two-digit industry level as firm i at time $t-1$.
	$VLARGE_{i(t-1)}$	A dummy variable equal to 1 if the total labour of the firm i at time $t-1$ is in the forth quartile of the distribution of the total labour of all firms operating in the same two-digit industry level as firm i at time $t-1$.
	$wage_{i(t-1)}$	The log of wage per employee calculated as the ratio of total labour payments over total labour less owner's wage.
	$SKILL_{i(t-1)}$	Skilled labour is the ratio of skilled labour to total employment.
	$TRAIN_{i(t-1)}$	A dummy variable for training whether workforce within a firm receive either in house- or outside training at least once or not. A dummy equals 1 if workforce of firm i has received some training and 0 otherwise.
Industry	$FORW_{jt}$	An index for vertical spillovers through forward linkages where the computation was described in Expression (9).
	HOR_{jt}	An index for horizontal spillovers captures the presences of foreign firms in each industry of which the computation was described in Expression (5).
	$HOR-Domestic_{jt}$	Horizontal domestic index is an index that captures the production of foreign firms sold in Thailand only. The computation was described in Expression (6).
	$HOR-Export_{jt}$	Horizontal export index is an index that captures the presence of the export activity of foreign firms only. The computation was described in Expression (7).
	$BACK_{jt}$	An index for vertical spillovers through backward linkages where the computation was described in Expression (8).

	$INRDSHARE_{j(t-1)}$	A share of industry R&D expense is defined as the ratio between industry R&D spending and total R&D expense of all industries in the same year.
	$INEXSHARE_{j(t-1)}$	The industry export share is defined as the ratio between export sales and total sales of the same industry and same year.
Region	*BKKM*	A dummy variable identifies whether firm locates in Bangkok and Metropolitan Area or not.
	CENTRAL	A dummy variable equals 1 if a firm locates in Central region excluding Bangkok and Metropolitan Area and 0 otherwise.
	EAST	A dummy variable equals 1 if a firm locates in Eastern region and 0 otherwise.
	NORTHEAST	A dummy variable equals 1 if a firm locates in the Northeast of Thailand and 0 otherwise.
	NORTH	A dummy variable equals 1 if a firm locates in the North of Thailand and 0 otherwise.
	SOUTH	A dummy variable equals 1 if a firm locates in the South of Thailand and 0 otherwise.

Table A2: Descriptive Statistics for the Estimated Sample on Export Spillovers

Variable	Obs	Mean	Std. Dev.	Min	Max
$EXSHARE_{it}$	6768	0.20	0.34	0	1
EX_{it}	6768	0.39	0.49	0	1
$EX_{i(t-1)}$	6768	0.38	0.49	0	1
$TFP^{LP}_{i(t-1)}$	6768	9.05	1.56	1.35	16.69
$(TFP^{LP}_{i(t-1)})^2$	6768	84.38	28.70	1.83	278.47
$TFP^{LABPROD}_{i(t-1)}$	6801	8.73	0.93	1.45	13.65
$(TFP^{LABPROD}_{i(t-1)})^2$	6801	77.11	16.64	2.10	186.34
$wage_{i(t-1)}$	6768	7.57	0.47	3.08	10.29
$wage^2_{i(t-1)}$	6768	57.52	7.07	9.50	105.83
$SMALL_{i(t-1)}$	6768	0.31	0.46	0	1
$LARGE_{i(t-1)}$	6768	0.24	0.43	0	1
$VLARGE_{i(t-1)}$	6768	0.19	0.39	0	1
$SKILL_{i(t-1)}$	6768	0.54	0.32	0	1
$TRAIN_{i(t-1)}$	6768	0.85	0.36	0	1
$INRDSHARE_{j(t-1)}$	6768	0.24	0.15	0.01	0.76
$INEXSHARE_{j(t-1)}$	6768	0.42	0.19	0.04	0.83
$FORW_{jt}$	6768	24.81	21.79	0.00	66.20
HOR_{jt}	6768	49.51	22.52	7.50	97.67
$HOR-Domestic_{jt}$	6768	25.44	15.33	2.65	93.72
$HOR-Export_{jt}$	6768	24.07	18.14	0.00	83.06
$BACK_{jt}$	6768	29.17	19.36	0.88	79.27