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Export Orientation and Spillovers from FDI in Thailand: Evidence from Plant-level Analysis

By

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Abstract

This study examines export orientation and export spillovers from foreign direct investment (FDI) in Thai manufacturing, using cross-sectional data from the 2007 Industrial Census. Spillovers are examined at the 2-digit and 4-digit industry levels by spillover variables, foreign employment share and foreign output share. The research is based on Heckman's selection model by analyzing various aspects of the data. We find that foreign presence has significant impacts on the export performance of domestic plants and such impacts are heterogeneous. On average, FDI generates positive export spillovers to domestic plants in both export decision and export intensity. However, different plants, due to their different absorptive capacity, are affected differently which can be determined by their characteristics such as labor productivity, plant scale, age, and technology gap. The results suggest that both foreign presence and characteristics of plants strongly affect the likelihood for domestic plants to export and their export behavior, but foreign impacts are also conditioned by size, location and form of organization of domestic plants.

JEL classification: F21, F23, O12

Key Words

FDI, Export Participation, Export Spillovers, Thailand

1. Introduction

Over the past two decades in Thailand, foreign direct investment (FDI) has become one of the major engines for increasing the integration of the Thai economy into the global economy. FDI affords a number of benefits that both directly and indirectly help promote and support economic development and fundamentals. Multinational enterprises and corporations (MNEs/MNCs) have the potential to generate considerable positive impacts on

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development in host economies. Hence, it is likely that domestic firms can become more export-oriented in response to the presence of multinationals, namely, when there is an "export spillover" to domestic firms. It is well-known that one channel for export spillovers is through domestically-owned firms acquiring knowledge from export activities of foreign affiliates in the host country via information externalities (Aitken et al., 1997; Greenaway and Kneller, 2004). Consequently, MNCs indirectly help and guide other firms, especially domestically-owned ones, in finding a way to improve their products for export and may encourage domestic firms to consider joining export activities and participating in foreign markets.

In addition, MNC affiliates can also increase the degree of competition and ultimately force domestic firms to become more productive, allowing them to begin exporting. Increased competition in the domestic market may be responsible for strengthening the demonstration effect, as it also creates an incentive to engage in more efficient production techniques, thereby assisting domestic firms in entering foreign markets. For this reason, apart from productivity and wage spillovers, the indirect effect of FDI from multinational firms to domestically-owned firms on "export orientation" is referred to as "export spillover".

As stated by Jongwanich and Kohpaiboon (2009)[1], the Thai manufacturing sector is an outstanding example of this phenomenon for at least three reasons. First, Thailand has kept a "market-friendly" attitude towards foreign investors in its manufacturing sector since the early 1960s. Thus, multinational corporations began their involvement in Thai manufacturing in Thailand's earliest phases of industrialization and have continued to play a role in Thai manufacturing for nearly four decades. Second, due to the characteristics of MNC affiliates, which are firms with relatively large size (as opposed to locally non-affiliated firms), we can expect that MNC affiliates should be the dominant firms in Thai manufacturing. Third, the Thai experience regarding industrialization appears to be one of the more successful cases among developing economies, as suggested by the fact that the Thai manufacturing sector is relatively broad based, compared to those of neighboring countries. Furthermore, Thailand is a major global exporter of several manufactured goods such as processed foods (e.g., canned tuna, canned pineapple, and frozen shrimp), hard disc drives, electrical appliances, and apparel. Moreover, Thailand is also a good example of the effects of export spillover, as FDI has played an important part in shifting the country's main exports from resource-based products in the agricultural sector to labor-intensive products that employ more advanced technologies and imported raw materials in the production process. By and large, Thailand has consistently been referred to as an emerging economy that has been successful in pursuing export-led and FDI-related growth strategies.

FDI is considered to play an important role in the economy of many countries, especially Thailand, and has received considerable interest in among researchers in the field of international business and economics during the past decades. Foreign firms may give rise to different types of externalities in the host country, which in turn generate spillovers for domestic firms. These spillovers can occur both in the sector where foreign firms are present (horizontal spillovers) and among related companies such as suppliers (vertical spillovers).

To more precisely illustrate the inflows of FDI and information on features of Thai manufacturing plants, Table 1 shows detailed information classified by industry on FDI in Thailand from 2005 to 2012. The figure reveals that FDI inflows have generally increased

[1]This study is one of the first studies to systematically investigate exports and MNCs export spillovers in Thai manufacturing. See this study for more details on the export composition and trends of FDI inflows before 2008.

since 2005 for the manufacturing sector. Although there was a financial crisis during 2008–2009, total FDI inflows continuously picked up and increased to over 7 billion USD during the period 2010–2012. The manufacturing sector in Thailand has been the largest destination of direct investment, particularly after the mid-1980s. This influx of manufacturing FDI was a result of export-oriented and labor-intensive FDI (Jongwanich and Kohpaiboon, 2009).

Table 2 summarizes basic features of Thai manufacturing plants using the 2007 Industrial Census, and shows that very few MNCs (defined as plants with foreign ownership shares of 10 percent or greater) are small plants (141 of 2,657), which accounted for only 0.15–0.16 percent of all workers, paid workers, and output in MNCs. Specifically, the vast majority of local plants in the 2007 Industrial Census dataset are small (47,497 of 71,274) but small plants accounted for only 6.7 percent of all workers, 4.7 percent of paid workers, and 1.5 percent of output in sample local plants (Ramstetter and Kohpaiboon, 2012). As a result, with the increase in exports and MNC involvement in Thailand, an interesting question to ask is whether rising foreign presence in the Thai economy helped exports to expand or generated benefits for local firms in Thai manufacturing.

Despite the importance of the issue of export performance and export spillovers from FDI in Thailand, the topic has not yet been widely explored and relatively little is known about the features and factors that affect MNCs' export spillovers (Kohpaiboon, 2006). Because the Thai manufacturing sector has received the majority of FDI inflows in recent years, and given the increasing importance of MNCs in Thailand in the face of limited empirical evidence on their impacts on Thai plants' export decisions, this paper searches for evidence of export spillovers from FDI to domestic plants by examining in detail horizontal export spillovers in various aspects by using a detailed plant-level dataset from the 2007 Industrial Census of Thailand.

This paper carefully examines the impacts of horizontal export spillovers from foreign plants on (1) the decision of domestic plants to export and (2) the export share of domestic plants, conducted by means of Heckman's selection model. This study contributes to the existing literature and represents departures from the model used in previous empirical studies for the Thai case in three ways. Firstly, in our econometric analysis, the impacts of foreign presence on the decision and intensity of domestic plants to export are examined at both the 2-digit and 4-digit ISIC industry levels. These export spillover variables are observed by both foreign output share and foreign employment share using Heckman's selection model with maximum likelihood estimator. Secondly, we meticulously examine the existence and strength of export spillovers under different conditions and characteristics of plants such as plant size, location, and form of economic organization, and compare our results with both spillover variables in order to ensure the accuracy of estimated results. Thirdly, this study is one of the first to consider the effects of foreign presence separately in key industries and explore whether the spillover effects are concentrated in any particular industries. The results generally reveal that the presence of foreign plants in the Thai manufacturing sector has positive effects on domestic manufacturing plants' decision to export and on their export share. Various characteristics of plants also strongly affect the likelihood for domestic plants to export and their export behavior.

The remainder of this paper is organized as follows. Section 2 provides a brief summary of empirical studies on export spillovers. Section 3 contains analytical framework, the econometric model used, and describes the variables and data used in the analysis. Next, empirical results and discussion are given in section 4. Finally, section 5 concludes our

Table 1 Foreign Direct Investment of Thailand Classified by Industry/Sector

		2005	2006	2007	2008	2009	2010	2011	2012
1	A Agriculture, forestry and fishing	13	−3	3	9	7	6	11	12
2	B Mining and quarrying	−111	257	1,307	−2	641	419	296	−424
3	C Manufacturing	3,501	5,161	4,495	4,891	2,412	4,623	4,296	5,291
4	Of which :								
5	Manufacture of food products	76	104	191	137	140	107	803	254
6	Manufacture of beverages	−101	48	41	34	54	37	−90	−30
7	Manufacture of paper and paper products	−9	−43	14	389	24	35	26	35
8	Manufacture of coke and refined petroleum products	−73	365	1,238	−438	182	−21	93	262
9	Manufacture of chemicals and chemical products	500	198	−122	616	507	873	508	772
10	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0	0	0	0	0	0	0	0
11	Manufacture of rubber and plastics products	468	494	313	390	305	332	520	657
12	Manufacture of computer, electronic and optical products	319	792	485	341	36	986	741	968
13	Manufacture of electrical equipment	692	940	376	1,302	290	−80	200	355
14	Manufacture of machinery and equipment n.e.c.	88	138	145	119	191	65	332	286
15	Manufacture of motor vehicles, trailers and semi-trailers	1,162	1,537	1,080	914	384	1,398	612	634
16	Manufacture of furniture	4	−5	0	−0.8	−3	7	13	−6
17	D Electricity, gas, steam and air conditioning supply	−88	354	33	200	222	−56	70	26
18	F Construction	30	−94	30	−34	1	27	−79	−191
19	G Wholesale and retail trade; repair of motor vehicles and motorcycles	260	845	−263	132	345	−59	290	367
20	H Transportation and storage	155	81	−43	450	118	−132	156	238
21	I Accommodation and food service activities	−30	125	167	−51	46	114	31	161
22	K Financial and insurance activities	3,270	692	2,815	1,766	274	2,280	1,337	681
23	L Real estate activities	73	1,419	1,103	1,203	768	984	1,110	1,009
24	Others	976	623	1,684	−17	19	906	260	67
25	Total	8,048	9,460	11,331	8,547	4,854	9,112	7,778	7,235

Unit: Millions of US Dollars

Notes: The table displays net flow of FDI data for all sectors. Positive figures reflect that the volume of transactions associated with the increase in investment during the period (either in the form of equity capital, reinvested earnings, or borrowing from affiliates) was higher than those associated with the decreases in investment (either in the form of divestment, or affiliates' repayment on their inter-company borrowings). Negative figures reflect that the increases in investment during the period are lower than the decreases.

Source: Bank of Thailand.

Table 2 Features and Characteristics of Thai Manufacturing Plants

Sample	Number of Plants	Thousands		Values in Billion Baht			
		Workers	Paid Workers	Average Fixed Assets	Electricity, Fuel	Output	Value Added
Published industrial census estimates (National Statistical Office 2009)							
All plants	457,968	4,460.3	3,819.0	3,183.2	317.7	7,304.5	1,758.8
1–15 workers	431,675	983.4	396.1	300.6	10.7	262.4	91.1
16+ workers	26,293	3,476.9	3,422.9	2,882.6	307.0	7,042.2	1,667.7
All plants in database underlying National Statistical Office (2009)							
All plants	73,931	3,726.4	3,591.5	2,972.9	311.6	7,146.6	1,716.6
1–15 workers	47,638	249.5	168.7	90.3	4.6	104.4	44.2
16+ workers	26,293	3,476.9	3,422.9	2,882.6	307.0	7,042.2	1,672.5
20+ workers	22,934	3,418.6	3,371.0	2,859.4	305.0	7,001.2	1,661.7
Local plants in database (foreign shares 0–9%)							
All plants	71,274	2,782.5	2,648.9	1,764.9	188.7	4,093.3	1,007.1
1–15 workers	47,497	248.0	167.2	88.8	4.5	99.4	43.3
16+ workers	23,777	2,534.5	2,481.7	1,676.1	184.2	3,993.9	963.8
20+ workers	20,503	2,477.7	2,431.3	1,654.5	182.4	3,956.4	953.6
Minority-foreign plants in database (foreign shares 10–49%)							
All plants	1,220	304.9	304.6	381.2	42.0	992.4	166.3
1–15 workers	97	1.0	1.0	0.6	0.1	2.0	0.5
16+ workers	1,123	303.9	303.6	380.5	41.9	990.4	165.8
20+ workers	1,063	302.9	302.6	379.6	41.8	988.6	165.6
Majority-foreign plants in database (foreign shares 50–89%)							
All plants	440	178.1	178	270.4	27.9	495.7	95.7
1–15 workers	20	0.2	0.2	0.2	0.0	0.7	0.1
16+ workers	420	177.9	177.8	270.2	27.9	495.0	95.6
20+ workers	409	177.7	177.6	269.9	27.8	494.0	95.5
Heavily-foreign plants in database (foreign shares 90–100%)							
All plants	997	460.8	460.1	556.5	53.0	1,565.2	447.6
1–15 workers	24	0.3	0.3	0.7	0.0	2.2	0.3
16+ workers	973	460.6	459.8	555.8	53.0	1,563.0	447.2
20+ workers	959	460.3	459.6	555.3	52.9	1,562.2	447.1

Notes: See "Report of the 2007 Industrial Census" by the NSO for full explanation.
Source: Retrieved from Ramstetter and Kohpaiboon (2012) and data compiled from the 2007 Industrial Census of Thailand by the National Statistical Office of Thailand (NSO).

examination of the estimated results and suggests possible policy implications.

2. Empirical Studies on Export Spillovers from FDI

Empirical studies of export spillovers from FDI have gained importance as governments in developing countries now realize the important role of exports in the development process. Exports are usually considered as an indication of a firm's enhanced productivity, since exporting firms must improve their production efficiency to overcome higher trade barriers and confront the different consumer tastes and fierce competition of international markets. While the growth-enhancing role of export is widely recognized, why only some firms can export in a given industry remains a puzzle, and the topic is still essential for empirical analysis (Bernard and Jensen, 2004; Wagner, 2007). Until now, every study on export spillovers from FDI has incorporated at least one spillover channel reflected by MNC employment (or output), exports, or technology into their search for export spillovers at the industry level using either cross-sectional or panel data. Many studies also take account of the influence of firm heterogeneity on the export decisions of domestic firms.

The first study regarding the importance of export spillovers from MNCs to domestic firms was presented by Aitken et al. (1997) by using panel data on Mexican manufacturing plants from 1986 to 1990. They developed a simple model of the firm production decision by including two measures of MNC presence, a general measure of MNC output and a separate measure of MNC export activity, and derived a reduced form for the probability of a firm exporting. They argued that proximity to multinational activity has a positive effect on the probability that domestic firms in the same sector will engage in export activities. Similarly, Kokko et al. (2001) used cross-sectional data of manufacturing firms in Uruguay for 1998 to search for export spillovers, and found that the entry of foreign firms enhances the probability that domestic firms will be involved in export activities. In addition, Greenaway and Kneller (2004) explained an indirect channel for productivity spillovers from FDI generated through exports in the United Kingdom by using firm-level panel data from 1992 to 1996. Their main objective was to investigate whether spillovers affect a firm's probability of exporting, but extended their analysis to examine what affects a firm's export ratio (assuming that the firm decides to export) by explicitly considering three different channels for export spillovers. In addition to the information spillovers explored in Aitken et al. (1997), they attempted to introduce the idea of demonstration, imitation, and competition effects. In recent studies, Kneller and Pisu (2007) examined the impact of FDI-related horizontal and vertical linkages on export spillovers between 1992 and 1999 in the United Kingdom. The study utilized Heckman's selection model, which involves two decisions: (i) whether to export and (ii) how much to export. They found that a domestic firm's decision to export is positively associated with the presence of foreign firms in the same industry. Furthermore, export-oriented foreign firms appeared to be the main source of export spillover effects. The decision concerning how much to export (i.e., the export share) was influenced positively by foreign firms in downstream industries and by those in the same industry that do not export. In conclusion, many studies in the literature have confirmed export spillover effects generated by FDI. However, these results are not conclusive, indicating both positive and negative impacts.

Regarding Thai manufacturing, some notable studies are presented in Kohpaiboon (2008), Jongwanich and Kohpaiboon (2009), Cole et al. (2009), and Cole et al. (2010).[2] Specifically, these studies investigate the relationship among foreign presence, firm heterogeneity, and a firm's decision to export, using the annual survey of Thai manufacturing firms or the industrial census data. In short, they find that entry sunk costs, the ownership structure of the firm, and firm characteristics are important factors in predicting a firm's decision to participate in the export market, with foreign-owned firms having a higher

[2] See also Greenaway and Kneller (2007) for a comprehensive literature review and see Kohpaiboon (2006) for input on the decision to export and MNE export spillover in Thai manufacturing.

probability of exporting than domestic firms both for export participation and intensity.

3. Empirical Model and Data

3.1 Analytical Framework: Econometric Models

Entering a foreign market is costly and incurs considerable sunk costs to firms, which in turn affect firms' decision to export. Firms must obtain information on different consumer preferences, distribution channels, marketing, and so forth (Wagner, 2007; Greenaway and Kneller, 2007), and MNC presence is a crucial factor in influencing firms' export decision. By definition, MNCs have an international network and are familiar with not only their home countries but also other markets. Hence, they can benefit from their networked economies and knowledge of international market management, as well as distribution and servicing of their products (Greenaway and Kneller, 2004). With these advantages, one would therefore expect that MNC affiliates would be in a better position to overcome the fixed costs incurred by the export process and thus have a higher chance of successfully exporting. In addition, MNC presence could indirectly promote locally non-affiliated firms towards exporting. Existing studies have suggested that the presence of foreign firms can reduce domestic firms' export costs through knowledge spillovers such as learning by doing, research and development, human resource movement, training courses, technical assistance, and technology transfer. Hence, the presence of foreign firms can promote domestic firms' export activities.

In order to test for the export spillover effects arising from the presence of foreign plants in Thailand, we utilize an empirical model based on the one used by Aitken et al. (1997), Greenaway and Kneller (2004), and Kneller and Pisu (2007). The well-known Heckman's selection model allows one to test (i) whether the presence of foreign plants influences the decision of domestic firms to export and (ii) whether the presence of foreign plants affects the export share of domestic plants. 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 plants to domestic plants. We include all plant level-specific characteristics that are assumed to affect the export behavior of domestic plants. Our Heckman's selection model consists of two equations as follows:

$$\text{Export Decision}_{ij} = f\,(\text{Capital Intensity}_{ij}, \text{Labor Productivity}_{ij}, \text{Size}_{ij}, \text{Labor Quality}_{ij}, \text{Average Wage}_{ij}, \text{Scale}_{ij}, \text{Age}_{ij}, \text{Concentration } (\text{HERF}_{ij}), \text{Trade Policy } (\text{ERP}_{ij}), \text{Technology Gap}_{ij}, \text{FDI Spillovers}_{ij}, \text{Control variables } (X_{ij}), \varepsilon_{ij}) \quad (1)$$

$$\text{Export Intensity}_{ij} = g\,(\text{Capital Intensity}_{ij}, \text{Labor Productivity}_{ij}, \text{Size}_{ij}, \text{Labor Quality}_{ij}, \text{Average Wage}_{ij}, \text{Scale}_{ij}, \text{Age}_{ij}, \text{Concentration } (\text{HERF}_{ij}), \text{Trade Policy } (\text{ERP}_{ij}), \text{Technology Gap}_{ij}, \text{FDI Spillovers}_{ij}, \text{Control variables } (X_{ij}), \mu_{ij}) \quad (2)$$

In both equations, we also include region dummies and 2-digit industry dummies to control for the unobserved region and industry effects. As a result, the linear version of Equations (1) and (2) is estimated after including appropriate dummy variables to account for unobserved effects, a common practice in this field of analysis.

Here, i indexes the plant and j indexes the sector or industry. *Export_decision* (EX_{ij}) is a dichotomous variable that takes the value of 1 if plant i in industry j exports and 0 otherwise.

Export_intensity (*EXshare*$_{ij}$) is the share of plant's exports in industry *j* (percentage of exports). As for error terms, ε_{ij} and μ_{ij} are random variables that capture the effect of other omitted variables. Equation (1) and Equation (2) suggest that the decision to export and export intensity depend on certain characteristics of plants, industry, and FDI- linked spillovers. We investigate two aspects of export spillovers: the export participation decision and export intensity. This is known as a two-stage decision process, as a plant firstly has to decide whether to export or not, and secondly the amount it should export (Kneller and Pisu, 2007). Moreover, to enter export markets, plants have to invest in sunk entry costs; therefore not every plant decides to export. The export intensity is therefore restricted to the subset of plants that do export. As a result, for export spillovers, the Heckman selection model is used to avoid sample selection bias in the coefficients of our estimated results (Heckman, 1979).

Specifically, the model given above involves a two-stage decision process. In the first stage, plants decide whether or not to export, in the second stage, plants decide on the export intensity. Accordingly, using simple OLS estimation in the present case is inappropriate as such estimation is likely to result in inconsistent and biased coefficient estimates. Therefore, it is highly appropriate to make use of Heckman's maximum likelihood estimator.[3] This method involves estimation of the probability of export in the first step, and the factors that affect the export share of the plant in the second step. The Wald test is used to test for the overall significance of the two-equation model and the likelihood-ratio test is used to validate the choice of the Heckman's selection model. Equation (1) is based on the probit model whereas Equation (2) is based on the tobit model. Therefore, Heckman's sample selection model is the main methodology used throughout this study to test the export orientation and export spillovers from FDI. In summary, the framework of empirical analysis outlined above provides us with not only the results for those of all plants but also those by size, location, form of organization, and those in some selected industries.

3.2 Variable Construction and Data

The data set for the 2007 Industrial Census of Thailand was collected by Thailand's National Statistical Office (NSO) which surveyed all establishments in 2006. The collected information is one of the most current plant-level data sets in Thailand. The original sample size consists of 73,931 observations, of which 71,154 observations are domestic plants, and 2,777 observations are foreign plants.[4] The census covers 34,625 firms, belonging to 127 4-digit industries of the International Standard Industrial Classification of All Economic Activities (ISIC Rev3.0). Of these, 62,723 are enumerated observations (plants which were still in existence at the time the census was conducted). Due to missing information for some key variables, the census was cleaned up by first deleting plants that had not responded to one or more key questions and that had provided seemingly unrealistic information such as a negative value added and inputs used or total employment being less than one. As described in more detail (Ramstetter, 2004; Kohpaiboon, 2008), there are some duplicated records in both the data from manufacturing surveys and in the Industrial Census, presumably because plants belonging to the same firm completed the questionnaire using the same records. The procedure followed to address this problem was to treat the records that

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[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 intensity). This estimation technique has been widely used in recent studies of export spillovers.

[4] In this study, if foreign investment in a plant is reported, we consider the plant as a foreign plant and if there is no report of foreign equity participation, we consider the plant as a domestic plant.

reported the same value for the seven key variables of interest in this study as one record.[5] Industries that are either for serving niches in the service sector's domestic market or are explicitly preserved for local enterprises were excluded.[6] As a result, the final dataset contains 49,432 plants (1,931 foreign-owned plants and 47,501 domestic-owned plants) in 115 industries at the 4-digit ISIC industry level and 22 industries at the 2-digit ISIC industry level. These plants will be the main sample of our analysis.

The data set contains information of individual plants in the manufacturing sector on employment (skilled and unskilled workers), wages and salaries, input materials used, labor inputs (men and women), fixed assets, ownership, number of days worked, years of operation, detailed receipts, cost of establishments, and so on. The explanatory variables adopted in the econometric investigation basically follow the theoretical and empirical literature reviewed in section 2, except that two different spillover variables are used with regard to the presence of foreign plants in order to carefully capture the FDI spillover effects. The explanation of these important explanatory variables is described as follows.

KI is capital intensity, measured as the ratio of fixed assets to total number of employees in each plant, indicates average physical capital stock per worker. *VAL* is labor productivity or value added per worker of a plant, defined as the ratio of total sales net change in inventories of each plant to total number of workers in that plant. *L* is labor inputs employed at each plant. The Herfindahl (*HERF*) index of industry concentration is constructed using the information on total sales of the industrial census at the 4-digit ISIC classification. Following Kohpaiboon (2008), for measuring labor quality, supervisory and management workers are defined as employees not directly engaged in production or in other related activities. The actual number of supervisors and management workers was not available in the census; therefore, the number of non-production workers reported would also include clerical and administrative staff. *Scale* is plant scale, measured as a plant's total sales over the average sales in the sector at the 4-digit industry level. *Age* is the period of plant's operating years. *AvrRemu* is an abbreviation for average remunerations or wages of an employee at a plant. *TechGap* is the technology gap for each plant as the percentage difference between the plant's labor productivity (value added per worker) and that of the average of foreign plants in the same industry. An increase in the technology gap means that domestic plants may become relatively less productive and hence their export share is more likely to decrease. The negative relationship between technology gap and export activity is expected. Concerning the data on Effective Rate of Protection (*ERP*) as a proxy for trade policy regime and protection, all estimates are obtained from Kohpaiboon (2009).[7] The role of protection determines export activity. That is, export activity tends to deteriorate under a restricted trade policy regime. The negative relationship between protection and export activity is expected.

Other control variables (X) include: 1) *Capacity* utilization, which measures plant utilization of overall inputs; 2) *BOI* (Board of Investment) status (equal to 1 if plants are investment-promoted by the BOI of Thailand and zero otherwise); 3) *Municipal* area dummy (equal to 1 if plants are in a municipal area and zero otherwise); 4) *Central* area dummy (equal to 1 if plants are in the central area, e.g. Bangkok and the central region, and zero otherwise); 5) Nationality of FDI- Japanese (*JPN*), Chinese (*TCS*), and American (*US*); 6) *Government* dummy (equal to 1

[5] See details in Ramstetter (2004) footnote 5. In addition, there are near-duplicate records. A careful treatment to maximize the coverage of the samples is used as described in more detail in Ramstetter (2004).

[6] See details in Kohpaiboon and Ramstetter (2008).

[7] See the source of the data and the method used to calculate ERP in detail in Kohpaiboon (2009).

if plants are state-owned and zero if they are private enterprises). For plant characteristics, control variables include product development (*Product*) dummy (equal to 1 if product development is reported, and zero otherwise), improved production technology (*ProTech*) dummy (equal to 1 if improved production is reported, and zero otherwise), form of economic organization dummy (equal to 1 if plants are Head Branch type and zero if they are Single Unit type). For our FDI spillover variable, Horizontal FDI is measured as follows:

EFOR4 = Proxy for foreign presence, defined as the ratio of the *employment* of foreign plants to total employment in each subsector at the *4-digit* ISIC (narrowly defined industry level)

YFOR4 = Proxy for foreign presence, defined as the ratio of the *output* of foreign plants to total output in each subsector at the *4-digit* ISIC

EFOR2 = Proxy for foreign presence, defined as the ratio of the *employment* of foreign plants to total employment in each subsector at the *2-digit* ISIC (broadly defined industry level)

YFOR2 = Proxy for foreign presence, defined as the ratio of the *output* of foreign plants to total output in each subsector at the *2-digit* ISIC

A statistically significant and positive coefficient on EFOR or YFOR suggests that domestic plants benefit from export spillover effects from plants with foreign ownership in the same industry. The more enriched data of the Industrial Census is appropriate for this paper since we analyze export spillovers from FDI in various aspects. As previously indicated, cross-sectional data is used and heteroskedasticity is often present. For this reason, statistical diagnostic tests are necessary to determine the appropriate statistical models and estimation techniques to avoid misleading econometric results.[8] The statistical summary of the key variables for our analysis of export spillovers is shown in Table 3 and the details of industry classification of Thai manufacturing and its Code of Industry can be found in Table 4 at the end of this section.

Finally, when a cross-sectional econometric procedure is applied, our study may suffer from causality problems. Panel data would be able to resolve this issue. However, as suggested and indicated by Kohpaiboon (2009), in the case of Thai FDI panel analysis of technology spillovers, unobserved effects are relatively unimportant in the data. Additionally, because panel analysis has already been explored for the Thai dataset, our estimation here would better contribute to the body of knowledge on the subject and differ from previous studies if other methods were applied, with a newer dataset and different focuses, and the level of analysis was broadened. Thus, our estimation will focus on export spillovers at both the 2-digit and 4-digit industry levels and the analysis will be broadened by considering the size of plants, their location and form of organization. Our analysis will also consider the existence and strength of export spillovers under different conditions and characteristics of plants. Furthermore, detailed results in selected manufacturing industries are also provided for the first time in the Thai case.

[8] Statistical diagnostic tests are not included in the paper but can be shown upon request.

Table 3 Statistical Summary of the Key Variables for Export Spillovers

Variable	Unit	Obs.	Mean	Std. Dev.	Min	Max
EX	zero-one dummy	49432	0.078	0.268	0.000	1.000
LnEXshare	(ln) proportion	3862	0.380	0.249	0.010	0.693
LnKI	(ln) baht	49432	11.508	1.894	1.222	20.218
LnVAL	(ln) baht	49432	11.192	1.678	2.562	19.282
LnL	(ln) workers	49432	2.362	1.411	0.693	9.262
LnLQ	(ln) workers	49432	0.597	0.191	0.000	0.693
LnAvrRemu	(ln) baht	49432	10.555	0.606	9.904	11.486
LnScale	(ln) baht	49432	0.257	0.580	0.000	6.418
LnAge	(ln) years	49432	2.057	0.862	0.000	4.595
LnHERF	(ln) proportion	49432	0.063	0.073	0.005	0.640
LnERP	(ln) proportion	49432	0.125	0.127	−0.357	0.457
LnTechGap	(ln) proportion	49432	2.451	1.760	−5.550	12.849
LnEFOR2	(ln) proportion	49432	0.012	0.064	0.000	0.589
LnEFOR4	(ln) proportion	49432	0.012	0.067	0.000	0.646
LnYFOR2	(ln) proportion	49432	0.015	0.078	0.000	0.614
LnYFOR4	(ln) proportion	49432	0.015	0.078	0.000	0.685
LnCapacity	(ln) proportion	49432	0.562	0.114	0.010	1.099
BOI	zero-one dummy	49432	0.068	0.251	0.000	1.000
Government	zero-one dummy	49432	0.160	0.367	0.000	1.000
MUN	zero-one dummy	49432	0.438	0.496	0.000	1.000
Central	zero-one dummy	49432	0.439	0.496	0.000	1.000
JPN	zero-one dummy	49432	0.016	0.124	0.000	1.000
TCS	zero-one dummy	49432	0.011	0.104	0.000	1.000
US	zero-one dummy	49432	0.002	0.045	0.000	1.000
Product	zero-one dummy	49432	0.031	0.174	0.000	1.000
ProTech	zero-one dummy	49432	0.028	0.164	0.000	1.000
FormEcon	zero-one dummy	49432	0.070	0.256	0.000	1.000

Notes: Mean = simple average; Std. Dev = standard deviation; Min = minimum; and Max = maximum
Variables in the unit of (ln) proportion are the variables which are converted from original units into logarithmic form as ln $(1+x)$ where x is the variable.
Source: Author's calculation.

Notes for estimated statistics in Heckman's selection model:

1) **Wald-χ2** is used to test for the overall significance of the two-equation model. In some models of estimated equations, if Wald-χ2 is not reported, the model would simply reduce to the Tobit model.

2) **Rho** – Correlation between the errors in the two equations. If rho = 0, the likelihood

Table 4 List of 2-digit ISIC Industry Codes in Thai Manufacturing

2-digit	Division of Industry
15	Manufacture of food products and beverages
16	Manufacture of tobacco products
17	Manufacture of textiles
18	Manufacture of wearing apparel; dressing and dyeing of fur
19	Manufacture of tanning and dressing of leather
20	Manufacture of wood and product of wood and cork
21	Manufacture of paper and paper products
22	Manufacture of publishing, printing and reproduction of recorded media
23	Manufacture of coke, refined petroleum products and nuclear fuel
24	Manufacture of chemicals and chemical products
25	Manufacture of rubber and plastics products
26	Manufacture of non-metallic and mineral products
27	Manufacture of basic metals
28	Manufacture of fabricated metal products
29	Manufacture of machinery and equipment
30	Manufacture of office, accounting, and computing machinery
31	Manufacture of electrical machineries and apparatus
32	Manufacture of radio, television and communication equipments and apparatus
33	Manufacture of medical, precision and optical instruments, watches and clocks
34	Manufacture of motor vehicles, trailers and semi-trailers
35	Manufacture of other transport equipment
36	Manufacture of furniture
37	Manufacture of recycling

Source: National Statistical Office of Thailand (NSO).

function can be split into two parts: a probit for the probability of being selected and an OLS regression for the expected value of Y in the selected subsample.

3) **Sigma** – The error from the outcome equation.

4. Empirical Results

The estimated results of export orientation, horizontal linkages, and export spillover effects by Heckman's selection model are summarized in Table 5. Specifically, Table 5 shows the estimated results for the decision of domestic plants to export, export decision (Equation 1), and for the export share of domestic plants, export intensity (Equation 2). For Equation 1, the benchmark results are from the probit model; however, we also compare the results with the logit model to observe whether the results are consistent in terms of signs of the coefficients and magnitude.[9] For Equation 2, the benchmark results are from the Heckman maximum likelihood estimator but we also compare the results with the Heckman two-step estimator to observe whether the estimation yields the same result in terms of

[9] The estimated results from the logit model are not reported to save space, but are available upon request. It is also a common practice to compare estimated results from both logit and probit models.

Table 5 Heckman Selection Model for Export Spillovers to All Domestic Plants

	(1)		(2)		(3)		(4)	
	EX	LnEXshare	EX	LnEXshare	EX	LnEXshare	EX	LnEXshare
LnKI	0.0690***	−0.00642	0.0677***	−0.00646	0.0231	−0.00707*	0.0236	−0.00717*
	(7.04)	(−1.91)	(6.91)	(−1.93)	(1.62)	(−2.16)	(1.65)	(−2.20)
LnVAL	0.0418	−0.0341***	0.0349	−0.0362***	−0.0519	−0.0355***	−0.0563	−0.0376***
	(1.42)	(−3.60)	(1.17)	(−3.81)	(−1.09)	(−3.73)	(−1.18)	(−3.94)
LnL	0.589***	0.0428***	0.589***	0.0456***	0.315***	0.0313***	0.315***	0.0332***
	(39.45)	(6.59)	(39.61)	(7.47)	(14.24)	(6.38)	(14.30)	(6.99)
LnLQ	0.121*	−0.00180	0.115	−0.00215	0.131	−0.00472	0.129	−0.00509
	(1.99)	(−0.09)	(1.89)	(−0.11)	(1.34)	(−0.25)	(1.31)	(−0.27)
LnAvrRemu	0.303*	0.189***	0.305*	0.194***	−0.721**	0.170**	−0.721**	0.173**
	(2.26)	(3.58)	(2.28)	(3.67)	(−2.88)	(3.22)	(−2.89)	(3.28)
LnScale	−0.102***	−0.0152*	−0.106***	−0.0189**	−0.103*	−0.0116	−0.104*	−0.0148*
	(−3.96)	(−2.23)	(−4.16)	(−2.87)	(−2.41)	(−1.72)	(−2.45)	(−2.28)
LnAge	0.0319*	−0.0270***	0.0342*	−0.0264***	0.0976***	−0.0258***	0.0976***	−0.0251***
	(1.99)	(−5.06)	(2.13)	(−4.92)	(3.78)	(−4.79)	(3.78)	(−4.65)
LnHERF	0.810***	0.0778	0.730**	0.0575	0.783*	0.0698	0.729	0.0497
	(3.47)	(1.15)	(3.09)	(0.86)	(2.00)	(1.05)	(1.83)	(0.75)
LnTechGap	−0.232***	−0.0496***	−0.238***	−0.0529***	−0.216***	−0.0434***	−0.220***	−0.0462***
	(−8.32)	(−5.68)	(−8.46)	(−6.08)	(−4.78)	(−5.10)	(−4.83)	(−5.43)
LnEFOR2	2.211***	0.0979			−0.361	0.0583		
	(5.61)	(1.23)			(−0.44)	(0.71)		
LnEFOR4	0.573	0.186**			0.674	0.183**		
	(1.53)	(2.83)			(0.98)	(2.75)		
LnYFOR2			0.885*	−0.0227			−1.255	−0.0342
			(2.22)	(−0.29)			(−1.64)	(−0.43)
LnYFOR4			1.406***	0.262***			1.600*	0.249***
			(3.51)	(3.68)			(2.18)	(3.48)
LnCapacity					0.366	0.135***	0.367	0.137***
					(1.91)	(3.89)	(1.92)	(3.95)
BOI					4.048***	0.0411	4.050***	0.0420
					(49.55)	(1.38)	(49.68)	(1.43)
Government					0.222*	−0.0912*	0.221*	−0.0904*
					(2.04)	(−2.46)	(2.04)	(−2.44)
Central					1.151***	−0.234***	1.148***	−0.237***
					(4.67)	(−4.95)	(4.66)	(−5.02)
TCS					0.464**	−0.00392	0.436**	−0.0109
					(3.05)	(−0.25)	(2.67)	(−0.69)
Product					0.280**	−0.0129	0.281**	−0.0135
					(2.88)	(−1.02)	(2.88)	(−1.07)
Observations	49432		49432		49432		49432	
Censored obs.	45570		45570		45570		45570	
Uncensored obs.	3862		3862		3862		3862	
Wald-$\chi 2$	1196.73		1219.74		1386.59		1401.96	
Rho	0.148**		0.16**		0.095*		0.099*	
Sigma	0.223***		0.223***		0.221***		0.221***	

Notes: (1) Robust t-statistics in parentheses; (2) *** significant at 1%, ** significant at 5%, and * significant at 10%.
Source: Author's calculation.

signs of the coefficients and magnitude.[10] For this reason, although the Heckman's selection model with maximum likelihood estimator is our preferred estimation method, we also perform additional estimation techniques for both Equation 1 and Equation 2 to check the sensitivity of our results. The comparison shows that there is no significant difference when comparing the models and that the coefficients of estimated results do not differ in signs, only in magnitude. Therefore, from this section on, we will discuss our estimated results mainly from the calculated results of the Heckman's selection model with maximum likelihood estimator.[11]

As can be seen, the export decision of domestic plants is strongly and positively associated with the presence of foreign plants in the same sector at both the 2-digit and 4-digit industry levels, especially by the measure of YFOR when not including other control variables. This implies that domestic plants are more likely to enter the export market if they are in a sector where the presence of foreign plants is strong. Moreover, the export share of domestic plants is greater in sectors where foreign plants are prevalent. However, when other control variables are included, the positive horizontal effect in the export decision is weakened and we only observe weak evidence of positive horizontal export spillovers by YFOR4. For export intensity, when including other control variables, we can still observe the strong and positive horizontal export spillovers by both EFOR4 and YFOR4. The estimated results show that, in several ways, domestic plants can benefit and may gain access to new and improved innovations introduced by foreign plants. Among all control variables, it should be noted that plants with BOI (the Thai Board of Investment)-promoted status, private plants, plants in the central region, plants with Chinese nationality (the coefficients on plants with Japanese and American nationality are not significant, so they are omitted to save space), and plants that report product improvement are more likely to export (showing a positive relationship with export decision). Moreover, once plants decide to export, only plants with high-capacity utilization tend to export in high quantity, whereas plants in the central region and state-owned plants tend to export in less volume.

Besides these variables, other plant-level characteristics including plant scale (by average total sales compared to the industry sales), size (by total employment), average wage (by average wages per worker), age (by years of operation), technology gap, and industry -level characteristics such as industry concentration (HERF) in Table 5 suggest that relatively large domestic plants in the total workforce with lower total sales, relatively new and efficient plants, and plants with a higher level of industrial concentration environment are more likely to be able to compete successfully in the export market. Our results here can be considered robust because we also confirmed the model through other techniques and results only change in magnitude, not coefficient sign.

More importantly, for our Heckman selection model to be able to provide unbiased results, we take into account the issue of exclusion restriction. This requires that some factors included in both equations should be different. If variables included are the same, the coefficients and the error terms in both equations should be equal, and the model would reduce to a standard tobit model. For this reason, we also include (not shown in Table 5) an

[10] Likewise, the estimated results from the two-step method are not reported here but are available upon request. It is well-known that sometimes the two-step method is less efficient than the maximum likelihood method (see details in Greene, 2003).

[11] For theoretical discussion and explanation regarding the application of Heckman's selection model with maximum likelihood estimator in empirical model for FDI export spillovers, details can be found in Kneller and Pisu (2007) and Cole et al. (2009 and 2010).

additional variable which is the production technology (ProTech) dummy in the selection equation (export decision equation) because this variable is theoretically consistent with recently developed models of exports by Bernard et al. (2003) that take into account sunk costs of exporting. This variable is included in the standard regression model to empirically identify the factors that influence the entry decision into the export market. Because the data used in our study is cross-sectional, the lag of export dummy, which is commonly used in recent studies of export spillovers, cannot be applied. As a result, we use production technology dummy (equal to 1 if improved production is reported, and zero otherwise) as a near-proxy for the lag of export dummy to address the issue of exclusion restriction.

4.1 Size and Location and Export Spillovers

In order to examine the role of plant size and location, the data was divided into four subsamples: 1) small plants (1–50 employees), 2) large plants (total employment greater than 50 employees), 3) plants in the central region, and 4) plants not in the central region.[12] Linear versions of Equations (1) and (2) were re-estimated by using each of the four subsamples. Based on the sample size, we can clearly see that a higher proportion of Thai manufacturing plants can be categorized as small plants and that almost half of the plants are located in the central region. The estimated results are summarized in Table 6. The impact of horizontal linkages between foreign and domestic plants on the decision to export and export share is positive and significant for almost all groups, especially large plants and plants in the central region. This suggests that generally the presence of foreign plants encourages domestic plants in the same sector to (a) enter the export market and (b) increase their export volume. These findings are consistent with previous general conclusions from the existing literature. Based on the results presented in Table 6, it can be argued that for Thai manufacturing the impact of export spillovers on the decision to export and the export share varies with plant size and location of the plant. For small plants, we observe that export spillovers from FDI only affect the decision to export but do not affect the export intensity.

Overall, from both Table 5 and Table 6, caution should be taken regarding export spillover variables (EFOR2, EFOR4, YFOR2, YFOR4) where it is necessary to cross-check the estimated results to confirm if the results are sensitive to different measurements of FDI or not. Apart from FDI spillover effects to domestic plants through horizontal and vertical linkages in many previous studies, it is the main focus of our analysis to notice that export spillovers can also occur in various industry levels (both the 2-digit and 4-digit industry levels) and different channels (foreign employment participation-EFOR and foreign output participation-YFOR) in view of horizontal spillovers. Specifically in Table 6, at the 4-digit industry level, the estimated coefficients for YFOR4 are significantly stronger than those of EFOR4. In contrast, at the 2-digit industry level, the results for EFOR2 are relatively stronger than those of YFOR2.

4.2 Form of Organization and Export Spillovers

The purpose of this subsection is to examine whether the impact of export spillovers to domestic plants varies with the form of organization. The empirical model was re-estimated for each of the following four subsamples groups: (1) plants with high production technology, (2) plants that are private and not state-owned, (3) plants that are Head Branch type, and (4)

[12] Originally, there were 5 regions (Bangkok, Vicinity and Central, Northern, Northeastern, and Southern regions) in the census data. For our analysis, we created the central region dummy variable which takes the value of 1 if plants are in Bangkok or the Vicinity and Central regions and zero otherwise.

Table 6 Plant Size, Plant Location, and Export Spillovers

• Measured by EFOR (Foreign employment share)

	Small		Large		Central		Not Central	
	EX	LnEXshare	EX	LnEXshare	EX	LnEXshare	EX	LnEXshare
LnKI	0.0704***	−0.00693	0.0787***	−0.00627	0.0573***	−0.00443	0.119***	−0.00667
	(5.15)	(−0.99)	(5.32)	(−1.49)	(4.96)	(−1.19)	(5.47)	(−0.82)
LnVAL	0.0603	0.00327	−0.00766	−0.0499***	0.0851*	−0.0295**	−0.155*	−0.0635**
	(1.47)	(0.20)	(−0.17)	(−4.32)	(2.43)	(−2.71)	(−2.45)	(−3.28)
LnL	0.613***	0.0000195	0.482***	0.0432***	0.555***	0.0506***	0.688***	0.0336**
	(21.27)	(0.00)	(15.88)	(5.94)	(31.38)	(7.16)	(22.00)	(2.88)
LnLQ	0.139	0.0215	0.150	−0.00553	0.0665	−0.00377	0.275*	0.0158
	(1.55)	(0.53)	(1.77)	(−0.26)	(0.92)	(−0.17)	(2.25)	(0.40)
LnAvrRemu	−0.177	0.0540	0.557*	0.237***	0.588***	0.0260	0.0386	0.0905
	(−0.80)	(0.45)	(2.47)	(3.97)	(7.44)	(1.06)	(0.23)	(1.39)
LnScale	−0.0662	−0.0491*	−0.0701*	−0.0119	−0.0918**	−0.0197**	−0.0568	−0.000464
	(−1.20)	(−2.36)	(−2.13)	(−1.53)	(−3.13)	(−2.59)	(−0.92)	(−0.03)
LnAge	0.0603**	−0.0265**	0.0183	−0.0292***	0.0304	−0.0312***	0.0525	−0.00745
	(2.79)	(−2.69)	(0.72)	(−4.50)	(1.65)	(−5.21)	(1.52)	(−0.65)
LnHERF	1.031***	0.0192	0.608	0.102	0.592*	0.0993	1.288**	−0.163
	(3.45)	(0.17)	(1.67)	(1.11)	(2.23)	(1.40)	(2.86)	(−0.97)
LnERP	0.191	0.191*	−0.198	−0.00483	0.167	0.0188	−0.257	0.0420
	(0.96)	(2.10)	(−0.86)	(−0.09)	(0.92)	(0.35)	(−1.02)	(0.49)
LnTechGap	−0.196***	−0.0104	−0.269***	−0.0606***	−0.181***	−0.0474***	−0.426***	−0.0742***
	(−5.04)	(−0.62)	(−6.67)	(−5.80)	(−5.52)	(−4.86)	(−6.72)	(−3.91)
LnEFOR2	2.786***	−0.131	1.706***	0.120	2.264***	0.155	3.178*	0.201
	(4.89)	(−0.65)	(3.40)	(1.33)	(5.53)	(1.77)	(2.30)	(1.03)
LnEFOR4	1.335*	0.153	0.502	0.160*	0.502	0.170*	0.273	0.0664
	(2.42)	(1.09)	(1.07)	(2.08)	(1.28)	(2.30)	(0.23)	(0.49)
Observations	43085		6347		21692		27740	
Censored obs.	41980		3590		18499		27071	
Uncensored obs.	1105		2757		3193		669	
Wald-$\chi 2$	N/A		1148.89		N/A		N/A	
Rho	−0.25		0.14**		0.266***		−0.081	
Sigma	0.231***		0.22***		0.23***		0.191***	

• Measured by YFOR (Foreign output share)

LnYFOR2	1.310*	0.0774	0.620	−0.0802	0.819	−0.0165	2.332*	0.126
	(2.24)	(0.32)	(1.25)	(−0.91)	(1.94)	(−0.19)	(2.04)	(0.73)
LnYFOR4	2.010***	0.0295	1.211*	0.313***	1.456***	0.285***	0.619	0.106
	(3.34)	(0.11)	(2.46)	(3.81)	(3.42)	(3.56)	(0.56)	(0.72)
Observations	43085		6347		21692		27740	
Censored obs.	41980		3590		18499		27071	
Uncensored obs.	1105		2757		3193		669	
Wald-$\chi 2$	N/A		1160.85		N/A		N/A	
Rho	−0.081		0.134*		0.268***		−0.07	
Sigma	0.226***		0.218***		0.23***		0.19***	

Notes: (1) Robust t-statistics in parentheses; (2) *** significant at 1%, ** significant at 5%, and * significant at 10%. Other independent variables (not reported here) are the 2-digit industry dummies and region dummies and constants from all equations.

Source: Author's calculation.

plants that are Single Unit type. The estimated results are summarized in Table 7. Overall, the results show that the impact of horizontal linkages on the decision to export and export share is positive for both plants that are Head Branch type and those that are Single Unit type. However, the effect is highly significant for private plants. This result is unsurprising, as private plants are better organized and hence have better access to information on export markets, making them better equipped to adapt to and imitate the products of foreign plants in the same sector. This suggests that private plants may have better access to intermediate inputs of good quality, which may help them reduce production costs. As a result, private plants are able to increase their export share. In the Thai case, the form of legal organization (private or state-owned) is crucial for export spillovers in both export decision and export intensity of domestic plants. However, we do not observe a difference in the effect of export spillovers from plants with different forms of economic organization (Head Branch type and Single Unit type). Specifically, from Table 5, we can clearly see that state-owned (government) plants are less likely to export (the coefficients for Government are all weakly significant) and might be, in turn, less likely to absorb export spillover effects when compared with the results in Table 7 for private plants. Similarly in Table 7, we again see that at the 2-digit industry level, FDI spillover effects are more obvious in the case of EFOR (observed by EFOR2). On the contrary, at the 4-digit industry level, positive spillover effects are clearer for the case of YFOR (observed by YFOR4).

More importantly, we learn that the production technology (ProTech) and technology gap between foreign and domestic plants can play an important role as a determinant and absorptive capacity in the export orientation of domestic plants. Surprisingly, although it has been noted in many previous studies regarding the Thai case that trade policy (reflected by ERP) is one of the most influential factors in the export decision, we find almost no evidence for the role of ERP in this study, possibly as a result of differences in research design. In contrast, firm heterogeneity (reflected by other control variables included in the estimation) plays a principal role in the export decision and export intensity, especially plant capacity utilization, BOI status of the plant, form of legal organization, and location.

4.3 Export Spillovers in Selected Industries

In this subsection, we analyze more deeply and examine carefully the export spillovers from FDI in some selected industries. We choose only industries that provide sufficient observations and industries that have high proportions of foreign plants (proxied by EFOR4 and YFOR4) in the census data. From Table 8, we find strong evidence for export spillovers via horizontal linkages by both EFOR and YFOR in most industries. Plants in the following industries are significantly affected by positive export spillovers in both export decision and export intensity: textiles, leather and footwear, rubber and plastics, non-metallic products, and furniture. For the food products industry, we observe export spillovers in only the export decision but not in export intensity. Generally, we find strong evidence for export spillovers in most industries; this suggests that foreign presence plays an important role in deciding whether a plant exports and how much to export. Within an industry with positive export spillovers and strong foreign ownership, it is likely that plants become more export-oriented and export more in value once they make the initial decision to enter the export market.

Table 7 Form of Organization and Export Spillovers

• Measured by EFOR (Foreign employment share)

	ProTech EX	ProTech LnEXshare	Private EX	Private LnEXshare	Head EX	Head LnEXshare	Single EX	Single LnEXshare
LnKI	−0.00187	−0.00565	0.0544***	−0.00686*	0.0733***	−0.00245	0.0610***	−0.00726
	(−0.06)	(−0.78)	(5.10)	(−2.04)	(3.53)	(−0.45)	(5.35)	(−1.71)
LnVAL	−0.123	−0.0424	0.0455	−0.0339***	−0.114*	−0.0773***	0.0447	−0.0107
	(−1.46)	(−1.89)	(1.49)	(−3.54)	(−2.07)	(−5.15)	(1.24)	(−0.89)
LnL	0.412***	0.0593***	0.592***	0.0427***	0.458***	0.0379***	0.571***	0.0422***
	(8.81)	(3.56)	(38.99)	(6.79)	(14.50)	(4.16)	(31.42)	(5.11)
LnLQ	−0.0278	−0.0847	0.0750	−0.00181	0.00347	0.0220	0.127	−0.0127
	(−0.14)	(−1.93)	(1.16)	(−0.09)	(0.03)	(0.70)	(1.78)	(−0.53)
LnAvrRemu	0.727	−0.0549	0.230	0.193***	0.00756	0.238**	0.391*	0.150*
	(1.26)	(−0.41)	(1.58)	(3.63)	(0.03)	(3.16)	(2.32)	(2.01)
LnScale	−0.0260	−0.0234	−0.0977***	−0.0132	−0.0756	−0.0147	−0.0728*	−0.00570
	(−0.40)	(−1.58)	(−3.74)	(−1.92)	(−1.71)	(−1.46)	(−2.17)	(−0.60)
LnAge	0.0579	−0.0438***	0.0203	−0.0270***	0.0230	−0.0285**	0.0415*	−0.0222**
	(1.06)	(−3.39)	(1.24)	(−5.03)	(0.68)	(−3.28)	(2.24)	(−3.29)
LnHERF	0.0857	0.0923	0.775**	0.0914	0.947*	0.0436	0.723*	0.0983
	(0.14)	(0.55)	(3.23)	(1.36)	(2.20)	(0.34)	(2.56)	(1.27)
LnERP	0.166	−0.0479	0.125	0.0210	−0.269	−0.00456	0.0421	0.0488
	(0.36)	(−0.49)	(0.83)	(0.45)	(−0.88)	(−0.06)	(0.25)	(0.82)
LnTechGap	−0.222**	−0.0583**	−0.226***	−0.0488***	−0.308***	−0.0821***	−0.219***	−0.0301**
	(−3.05)	(−2.86)	(−7.87)	(−5.58)	(−6.16)	(−5.80)	(−6.40)	(−2.71)
LnEFOR2	1.403*	0.391*	2.223***	0.101	0.889	−0.282*	2.627***	0.247**
	(2.32)	(2.02)	(5.65)	(1.28)	(1.15)	(−1.99)	(5.82)	(2.68)
LnEFOR4	0.973	0.0372	0.566	0.185**	1.129	0.465***	0.569	0.112
	(0.97)	(0.23)	(1.51)	(2.82)	(1.55)	(3.82)	(1.33)	(1.50)
Observations	1367		41499		3476		45956	
Censored obs.	726		37684		2077		43493	
Uncensored obs.	641		3815		1399		2463	
Wald-$\chi 2$	344.82		1237.19		592.55		N/A	
Rho	0.411		0.161**		0.274***		0.15*	
Sigma	0.213***		0.223***		0.22***		0.223***	

• Measured by YFOR (Foreign output share)

	ProTech EX	ProTech LnEXshare	Private EX	Private LnEXshare	Head EX	Head LnEXshare	Single EX	Single LnEXshare
LnYFOR2	0.317	0.0952	0.894*	−0.0181	−0.169	−0.337*	1.386**	0.133
	(0.36)	(0.55)	(2.25)	(−0.23)	(−0.25)	(−2.56)	(2.95)	(1.42)
LnYFOR4	1.602*	0.229	1.402***	0.259***	1.858**	0.502***	1.220*	0.160
	(1.99)	(1.42)	(3.51)	(3.63)	(2.75)	(4.06)	(2.57)	(1.88)
Observations	1367		41499		3476		45956	
Censored obs.	726		37684		2077		43493	
Uncensored obs.	641		3815		1399		2463	
Wald-$\chi 2$	329.25		1259.55		610.9		825.77	
Rho	0.402		0.172***		0.294***		0.155*	
Sigma	0.213***		0.223***		0.221***		0.223***	

Notes: (1) Robust t-statistics in parentheses; (2) *** significant at 1%, ** significant at 5%, and * significant at 10%. Other independent variables (not reported here) are the 2-digit industry dummies and region dummies and constants from all equations.

Source: Author's calculation.

Table 8 Export Spillovers in Selected Industries

Variables	Food products		Textiles		Leather and Footwear		Wood Products		Rubber and Plastics		Non−metallic Mineral Products		Furniture	
	EX-De	EX-In	EX-De	EX-In	EX-De	EX-In	EX-De	EX-In	EX-De	EX-In	EX-De	EX-In	EX-De	EX-In
FDI Spillovers measured by foreign employment share														
EFOR4	**6.71**	0.17	**6.84**	**0.58**	**4.31**	**0.49**	5.86	**4.50**	**2.96**	**0.18**	**5.68**	**0.60**	**2.40**	**0.12**
	(5.19)	(0.89)	**(4.96)**	**(2.55)**	**(3.01)**	**(2.01)**	(0.69)	**(3.11)**	**(6.23)**	**(2.04)**	**(4.33)**	**(3.11)**	**(4.94)**	**(2.12)**
Censored obs.	12283		4675		729		3211		1543		4130		4221	
Uncensored obs.	521		211		133		166		389		185		510	
Wald-$\chi 2$	107.73		27.74		N/A		58.59		143.62		117.3		35.86	
Rho	−0.11		0.21*		0.36*		−0.11		0.03		0.24		−0.23	
Sigma	0.228***		0.214***		0.24***		0.20***		0.22***		0.20***		0.201***	
FDI Spillovers measured by foreign output share														
YFOR4	**4.75**	0.29	**4.10**	**0.41**	**3.76**	0.38	3.17	1.03	**2.58**	**0.19**	**4.89**	**0.58**	**2.38**	**0.11**
	(6.23)	(1.75)	**(6.07)**	**(2.98)**	**(3.11)**	(1.66)	(0.83)	(1.57)	**(6.84)**	**(2.31)**	**(4.33)**	**(3.62)**	**(5.49)**	**(2.02)**
Censored obs.	12283		4675		729		3211		1543		4130		4221	
Uncensored obs.	521		211		133		166		389		185		510	
Wald-$\chi 2$	108.59		30.89		83.21		55.24		144.97		128.9		36.1	
Rho	0.01		0.29*		0.39**		−0.11		0.03		0.3		−0.22	
Sigma	0.22***		0.22***		0.24***		0.20***		0.22***		0.202***		0.20***	

Notes: (1) Robust t-statistics in parentheses; (2) *** significant at 1%, ** significant at 5%, and * significant at 10%.
Other independent variables (not reported here) are the 2-digit industry dummies and region dummies and constants from all equations. EX-De stands for Export Decision and EX-In stands for Export Intensity. The results shown here are only the coefficients of export spillover variables and all other independent variables used in the estimation are omitted to save space.
Source: Author's calculation.

5. Conclusions and Policy Implications

This paper aimed to study the factors that influence a plant's export decision and export intensity and the export spillovers from FDI using a plant-level dataset collected by the National Statistical Office (NSO) of Thailand in 2007. The main study concentrated on the roles of MNEs in export. This paper contributes to the existing literature that deals with the impact of horizontal spillovers arising from FDI-generated linkages between domestic and foreign plants on exporting activities in various aspects.

In order to examine in detail the impact of the horizontal linkages between domestic and foreign plants on export performance of domestic plants in Thai manufacturing, we utilized the Heckman's selection model and estimated the models by means of Heckman's maximum likelihood estimator in selection models. The empirical analysis, which was based on plant-level data from the Thai manufacturing sector, generally revealed that the presence of foreign plants has a positive and significant effect on (i) the decision of domestic plants to export and (ii) the export share of domestic plants through horizontal linkages. The results confirmed the results of previous studies where horizontal linkages have resulted in positive and significant export spillover effects from foreign plants to domestic plants. Firm heterogeneity and other plant-level characteristics also had a significant impact on the export participation and export intensity of domestic plants. The empirical analysis also showed that plant size, plant location, and form of organization affect the decision and intensity to export. Thus, more focus should be paid to industry policies that help domestic plants face the challenges of FDI and help to maximize export benefits. In our study, the results emphasized that the presence of foreign plants has a positive effect on the export decision and export intensity of domestic plants. It also implied that domestic plants are more likely to export if they operate in a sector where the presence of foreign plants is relatively high.

Our main results first show that domestic plants in Thailand indeed benefit from FDI (measured by the presence of foreign-owned plants operating in the same industry and operating across industries), and that foreign presence is also an important determinant of export probability of domestic plants in Thailand. Our results also suggest that while domestic plants may not rely solely on FDI to successfully enter the export market, the presence of FDI in exporting plants helps contribute to their success in the export market. Plant characteristics such as size, location, and form of organization are also vital determinants for domestic plants in deciding whether and how much to export. Regarding export spillovers, different incentives for FDI have different spillover effects towards domestic plants. Therefore, the government must carefully design appropriate policies that stimulate growth in the economy as well as assist domestic plants in benefitting from FDI.

Concerning the type and nature of the data set, although panel data analysis might be preferred when estimating spillover effects from FDI, the sample coverage in Thai manufacturing surveys from the NSO is somewhat low and inconsistent, such that it is difficult to consider these samples representative (Ramstetter, 2009).[13] More importantly, apart from considering both horizontal and vertical spillovers, we should also pay careful attention to the spillover variables (foreign employment participation and foreign output participation),

[13]See Ramstetter (2009) for the full review of issues concerning the sample coverage in Thai manufacturing and the type of data sets available in Thailand and other Southeast Asian countries.

control variables, and other conditions when estimating spillover effects, because estimated results can be significantly different when these variables are included and other control variables are not included. Despite the presence of some limitations, we hope that this study can be treated as a new approach for examining empirically and systematically the effects of export spillover in Thai manufacturing.

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