PRODUCTIVITY AND WAGE SPILLOVERS FROM FDI IN THAILAND: EVIDENCE FROM PLANT-LEVEL ANALYSIS

*Thanapol Srithanpong**

1. INTRODUCTION

Foreign direct investment (FDI) by multinational corporations/enterprises (MNCs/MNEs) has long been recognized as a major growth-enhancing factor in host countries. It can be considered as a significant means through which the international transfer of technology takes place and leads to increased productivity and wages.[1] With a view to attracting more FDI, authorities in many countries, especially developing countries, have liberalized their FDI regulations and adopted an investment-friendly policy in recent years.

In theory, two types of spillovers exist, horizontal spillovers and vertical spillovers. On one hand, spillovers from the presence of foreign firms in the same industry are called horizontal spillovers. Horizontal spillovers occur through such channels as demonstration effect, competition effect and labor mobility. Demonstration effect enables domestic firms to acquire superior technologies, marketing and managerial practices from foreign firms. Competition effect forces domestic firms to operate more efficiently and to introduce new technologies. Spillovers through labor mobility take place when employees of foreign firms establish their own businesses or move on to domestic firms. On the other hand, spillovers which occur with the diffusion of positive effects at inter-industry levels, benefiting from foreign suppliers or customers in the production chain, are called vertical spillovers. Specifically, vertical spillovers can take place through backward linkages and forward linkages. Backward linkages are relationships that domestic firms establish as suppliers of foreign firms, and forward linkages are relationships that domestic firms establish as customers of intermediate inputs produced by foreign-owned firms.[2] When domestic firms in the host country have access to new technologies and skills introduced by inward FDI, this

* *Mr. Thanapol Srithanpong is a Ph.D. candidate at the Graduate School of Business and Commerce, Keio University, Japan.* *The author would like to express his gratitude to: Professor Masahiro Endoh for his guidance and support; Professor Hitoshi Hayami and Keio Economic Observatory for providing the primary data set; and members of the International Trade and Investment Seminar at Keio University. The opinions expressed and errors in this paper are the sole responsibility of the author who prepared the paper in April 2014.*

Corresponding author. Mr. Thanapol Srithanpong; Tel.: +81-80-4473-2330, Address: 5-38-4 Minami-magome, Ota-ku, Tokyo, Japan, 143-0025, Homay Residence Minami-magome Room 303 E-mail: thanapol.srithanpong@outlook.com

[1] *See Görg and Greenaway (2004) and Crespo and Fontoura (2007).*

[2] *See the recent review of the literature on productivity spillovers in Erdogan (2011).*

may lead to improvements in the host country's labor productivity, wage levels, the competitiveness and overall welfare of the host country. However, some local firms may also suffer from the competitive presence of the more efficient foreign counterparts, as they may be forced to reduce their output or stop their activities (Aitken and Harrison 1999).

A large amount of research and study has succeeded in providing both the theoretical foundations and empirical results concerning the impact of FDI on the economy of the host country. These theoretical developments have encouraged many empirical investigations into the role that FDI has played in the transfer of technology in both developed and developing countries. Data at the industry, firm, or plant levels have been used in those studies. The conclusions from empirical studies on both productivity and wage spillovers from FDI are mixed (Erdogan 2011). Nevertheless, it is broadly accepted that the entry of foreign firms has the potential to benefit domestic firms through the spillover of their technological know-how, innovative capability, and managerial skills. For Thai manufacturing, one of the most recent studies is presented in Kohpaiboon (2009). In the present paper, the analysis is based on panel data from Thai manufacturing surveys; not only are both horizontal and vertical FDI technology spillovers examined, but the former is also assumed to vary across industries. The results also emphasize the important role of trade policy regime as a conditional gain of horizontal FDI spillovers, and positive horizontal FDI spillovers are found only in an industry operating in a relatively liberal environment.[3]

In this paper, the FDI spillover effects on labor productivity and average wages in Thai manufacturing are examined; the analysis is extended to spillover effects in various aspects compared with the findings of previous studies. A cross-sectional econometric analysis is applied, using the Industrial Census 2007 which was conducted by the *Thai National Statistical Office (NSO)* in 2006. This is the most current and reliable plant census available so far in Thailand. In the empirical model, the

productivity and wage equations of domestic plants in the manufacturing sector are estimated and the statistical relationship between plants' productivity or wages and the level of foreign presence is examined. This paper contributes to the existing literature in three ways. First, in the econometric analysis, the impact of foreign presence on productivity and wages is examined at both the 2-digit and 4-digit ISIC industry levels and observed by both foreign output share and foreign employment share. Second, the existence and strength of both productivity and wage spillovers are examined under different conditions and characteristics of plants, such as plant size and location, to provide more evidence for this issue, especially wage spillovers where there is a scarcity of empirical studies. Third, the effects of foreign presence are considered at the regional level and industry level to explore whether the spillover effects are concentrated in the region or in some industries.

The remainder of the paper is organized as follows. Section 2 presents a testable estimation strategy and econometric models. Section 3 presents the data and variable construction in detail. Esti-

[3] See Kohpaiboon (2006b) for more details regarding the basic features of plants in Thailand, and Kohpaiboon (2009) for trends of FDI and patterns of labor productivity in Thai manufacturing.

mation results are discussed in depth in section 4. Finally, section 5 concludes the study and provides some possible policy implications and suggestions.

2. ESTIMATION FRAMEWORK AND STRATEGIES: ECONOMETRIC MODELS

Based on a brief review of the literature as discussed in the previous section, it can be assumed that FDI is expected to bring the host country superior technology, marketing and managerial practices, among other intangible assets, which can "spill" to local partners and other domestic plants. The most commonly used approach to test productivity spillovers to locally owned plants is by estimating an augmented Cobb-Douglas production function. Following Dimelis and Louri (2004), a simple form of an augmented production function for the manufacturing sector is used as starting point. To estimate the presence of productivity spillovers, the methodology of Aitken and Harrison (1999) is followed, and the following log linear production function is estimated:

$$\ln VAL_{ij} = \beta_0 + \beta_1 \ln KI_{ij} + \beta_2 \ln MI_{ij} + \beta_3 \ln L_{ij} + \beta_4 \ln LQ_{ij} + \beta_5 \ln Age_{ij} + \beta_6 BOI_{ij} + \beta_7 HERF_j + \beta_8 ERP_j + \beta_9 FOR_{ij} + \beta_k X_{ij} + \varepsilon_{ij} \quad (1)$$

Here, i indexes the plant and j indexes the sector or industry. As for the variables, *VAL* is value added per worker of a plant, *KI* represents capital intensity, *MI* represents material input intensity, *L* represents labor inputs. *LQ* is labor quality, defined as the share of skilled workers in the total workforce of each plant. *Age* represents years of operation. *FOR* is the share of foreign ownership (percentage of capital equity held by foreign investors in plant i) at the plant level, which varies from 0 to 1 (100 percent). *BOI* is the Board of Investment dummy—promotion status of a plant (equal to 1 if a plant is investment-promoted, and zero otherwise). *HERF* is the Herfindahl index for industry concentration. *ERP* is the effective rate of protection in industry reflecting trade policies implemented in that industry. *X* is the vector of other control variables which affect labor productivity.

Similarly, to examine the presence of wage spillovers, we also follow the standard practice in the literature and use:

$$\ln AvrRemu_{ij} = \beta_0 + \beta_1 \ln KI_{ij} + \beta_2 \ln MI_{ij} + \beta_3 \ln L_{ij} + \beta_4 \ln LQ_{ij} + \beta_5 \ln Age_{ij} + \beta_6 GOV_{ij} + \beta_7 HERF_j + \beta_8 TECH_j + \beta_9 FOR_{ij} + \beta_k X_{ij} + \varepsilon_{ij} \quad (2)$$

Here, i indexes the plant and j indexes the sector or industry. As for the variables, *AvrRemu* is average wage per worker of a plant. *GOV* is the form of legal organization of a plant (equal to 1 if plants are state enterprises or cooperatives, and zero otherwise). *TECH* is the technology gap between foreign plant and domestic plant. Following the definition given above, *X* is the vector of other control variables, including: (a) capacity utilization; (b) export and import status (equal to 1 if plants are exporting or importing, and zero otherwise); (c) municipal area dummy (equal to 1 if plants are in a municipal area, and zero otherwise); (d) central area dummy (equal to 1 if plants are in central area—Bangkok and central region, and zero otherwise); and (e) national origin of FDI—Japanese, Chinese, or United States of America.

For plant characteristics, control variables include product development dummy (equal to 1 if product development is reported, and zero otherwise), improved production technology 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).

When measuring spillover, the following variables are especially useful and will be used to capture the impact and effects of foreign presence on both productivity and wage spillovers. They are defined as follows:

FORshare = The share of foreign ownership (percentage of capital equity held by foreign investors in a plant) at the plant level

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 (narrowly defined industry level)

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 (broadly defined industry level)

REG_YFOR = Foreign ownership at the regional level measured by foreign *employment* participation (more broadly defined)

REG_EFOR = Foreign ownership at the regional level measured by foreign *output* participation (more broadly defined)

FOR_EFOR (2 or 4) = The interaction term between plant FDI and sector FDI measured by *employment* at the 2-digit or 4-digit ISIC

FOR_YFOR (2 or 4) = The interaction term between plant FDI and sector FDI measured by *output* at the 2-digit or 4-digit ISIC

FOR_REG_EFOR (ON YFOR) = The interaction term in regional level for both EFOR and YFOR measure

All the spillover variables above are constructed from the 2007 Industrial Census following the definition and methodology described in the literature mentioned above.[4]

3. DATA AND VARIABLE CONSTRUCTION

In the present econometric investigation into the effects of FDI on labor productivity and average wages, a detailed data set was used at plant level from the 2007 Industrial Census of Thailand. This data set was compiled by Thailand's National Statistical Office (NSO) which surveyed all establishments in 2006. The information is the newest and most extensive set of Thai industrial census data. The original sample size consisted of 73,931 observations, of which 71,154 were on domestic plants, and 2,777 on foreign plants.[5] 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, 62,623 are enumerated observations (plants which had still existed by the time the census was conducted). Due

[4] *See Dimelis and Louri (2004) and Kohpaiboon (2009) for full details on variable construction.*

[5] *In this study, if the foreign investment in a plant is reported, the plant is considered as a foreign plant, and if there is no report of foreign equity participation, the plant is considered to be a domestic plant.*

to missing information on some key variables, the census was cleaned up by first deleting plants which had not responded to one or more the key questions and which had provided seemingly impossible information, such as the negative value added and inputs used and total employment being less than one. As described in more detail (Ramstetter 2004 and Kohpaiboon 2008), there are some duplicated records in both the data from manufacturing surveys and the Industrial Census, presumably because plants belonging to the same firm answered the questionnaire using the same records. The procedure followed in dealing with this problem was to treat the records that reported the same value for the seven key variables of interest in this study as one record.[6] Industries that were either to serve niches in the domestic market in the service sector or explicitly preserved for local enterprises were excluded.[7] As a result, the final data set contains information on 49,432 plants (1,931 foreign-owned plants and 47,501 domestically owned plants) in 115 industries at the 4-digit ISIC industry level and 22 industries at the 2-digit ISIC industry level. The explanation and construction of important explanatory variables can be described as follows.

KI – capital intensity, measured as the ratio of fixed assets to total number of employees in each plant, indicates average physical capital stock per worker. *MI*–material input intensity defined as the ratio of raw material input purchases of each plant to total number of workers in that plant. *L*–labor inputs employed in each establishment. *FORshare* is the share of foreign ownership (percentage of capital equity held by foreign investors in a plant). A statistically significant and positive coefficient suggests that establishments with foreign ownership enjoy higher labor productivity or average wage gains than their domestically owned counterparts. The Herfindahl (*HERF*) index of industry concentration is constructed using the industrial census at the 4-digit ISIC classification. Following Kohpaiboon (2008), for measuring labor quality the supervisory and management workers are defined as employees not directly engaged in production or other related activities. The actual number of supervisors and management workers is not available in the census. Therefore, the number of non-production workers reported would also include clerical and administrative staff. *TECH* is the technology gap for each plant as the percentage difference between plants' labor productivity and that of the average of foreign plants in the same industry. For data on effective rate of protection (*ERP*), all estimates were obtained from Kohpaiboon (2009).[8] Finally, concerning the type and nature of the data set, although panel data analysis is preferred when estimating spillover effects from FDI, the sample coverage in Thai manufacturing surveys from the NSO is so low and inconsistent that it is difficult to consider these samples as representative (Ramstetter 2009). Moreover, we can see later that, on the contrary, the more enriched data of the Industrial Census are appropriate for use in the present paper since productivity and wage spillovers from FDI are analyzed in various aspects.

4. ESTIMATION RESULTS

To examine the spillover effects from FDI in this study, a cross-sectional econometric procedure is applied; however, the results may suffer from an endogeneity problem. As indicated in Kohpaiboon (2006a) for a cross-industry analysis of Thai manufacturing using the Industrial Census 1997, the two-stage least square (2SLS) estimator and ordinary least square (OLS) estimator provide remarkably similar results for the census data. For this reason, the results here will be based only on the ordinary least square estimation with robust standard errors. The results of the analysis can be divided into eight sections as shown below.

[6] *See details in Ramstetter (2004) footnote 5. In addition, there are near-duplicate records. A careful treatment to maximize the coverage of samples was used as described in more detail in Ramstetter(2004: 9-10).*

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

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

Table 1 *Impact of foreign ownership (FOR) on value added per worker (labor productivity spillovers: dependent variable; value added per worker)*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
LnFORshare	0.200***	0.703***	0.608***	0.607***	0.587***	0.562***	0.553***	0.198***
LnEFOR4		0.162		-0.951		-0.909		
LnFOR_EFOR4		-1.256***		-0.251		-0.306		
LnYFOR4			0.307**		0.186		-0.0149	
LnFOR_YFOR4			-1.090***		-1.049		-0.973	
LnEFOR2				1.275*		1.057		
LnFOR_EFOR2				-0.993		-0.545		
LnYFOR2					0.131		0.173	
LnFOR_YFOR2					-0.0165		0.221	
LnCapacity						0.454***	0.453***	0.453***
EX						0.0361	0.0349	0.0364
IM						0.0461**	0.0459**	0.0461**
MUN						0.216***	0.216***	0.216***
Central						0.397***	0.397***	0.398***
JPN						-0.0151	-0.00887	0.0101
TCS						-0.0679	-0.0694	-0.0190
US						0.0772	0.0660	0.0890
Product						0.0593**	0.0605**	0.0632**
FormEcon						0.199***	0.201***	0.202***
Observations	48,841	48,841	48,841	48,841	48,841	48,841	48,841	48,841
Adjusted R-sq	0.708	0.708	0.708	0.708	0.708	0.727	0.727	0.727

*Notes: Robust t-statistics are omitted to save space, but available upon request. ***, **, * indicate statistical significance at 1, 5, 10 percent, respectively. All numbers shown for each variable are estimated coefficient in each model.*
Source: Author's calculation.

4.1 Impact of Foreign Ownership/Presence on Value Added per Worker

Table 1 presents the basic results from estimating equation (1) on the 2007 Industrial Census of Thailand. The main findings can be summarized as follows. First, a positive own-plant effect can be observed. The coefficients on the indicator FORshare are all positive and statistically significant (foreign presence at the plant level has positive effects on the labor productivity of domestic plants). Second, an increase in the share of FDI measured by foreign output (YFOR4) leads to an increase in labor productivity (positive horizontal spillovers from FDI to domestic plants at the 4-digit industry level). Third, for plants with foreign equity participation, the interaction terms show negative spillovers from FDI (joint ventures benefit from FDI at the plant level, but not from FDI in other plants within the same sector). Fourth, an increase in the share of FDI measured by foreign employment (EFOR2) leads to an increase in labor productivity (positive horizontal spillovers from FDI to domestic plants at the 2-digit industry level). Furthermore, when the spillover effects are considered at the 2-digit and 4-digit industry levels simultaneously, only weak positive spillovers are observed at the 2-digit industry level (EFOR2). Fifth, when other control variables are included and the spillover effects at the 2-digit and 4-digit industry levels are considered at the same time, no previous positive spillovers from FDI are found at the 2-digit industry level (a positive sign on EFOR2 disappears). Sixth, it seems that labor productivity does not rely on export status and the national origin of FDI and is instead highly correlated with capacity utilization, import status, municipal area and central area dummy, product development dummy and form of the econ organization dummy variables.

4.2 Impact of FOR by Plant Size (Small, Large)/ Location (Central, Municipal)/Form of Economic Organization (Head Branch, Single Unit)

The analysis of FDI spillovers is taken further by imposing various aspects and conditions on

Table 2 *Impact of FOR by plant size (small, large)/location (central, municipal)/economic form (head branch, unit)*

• **Measured by foreign employment share (EFOR)**

	Small	Large	Central	Not central	Municipal	Not municipal	Head	Single
LnKI	0.211***	0.252***	0.153***	0.205***	0.136***	0.232***	0.229***	0.206***
LnMI	0.509***	0.424***	0.442***	0.501***	0.458***	0.502***	0.373***	0.507***
LnL	0.196***	0.0195	0.152***	0.111***	0.173***	0.156***	0.00125	0.152***
LnLQ	0.102***	0.0770	-0.0804*	-0.0166	-0.113**	0.0119	0.0962	0.0635**
LnAge	0.0683***	0.0767***	0.00179	0.0867***	0.0330***	0.0637***	0.0467**	0.0670***
BOI	0.235***	0.115***	0.0365*	0.254***	0.0292	0.0891***	0.0865**	0.0781***
LnHERF	0.196***	0.427**	0.203**	0.216**	0.0374	0.299***	0.351	0.172**
LnERP	-0.371***	-0.205*	-0.284***	-0.368***	-0.198***	-0.486***	-0.524***	-0.348***
LnFORshare	0.873***	0.515***	0.745***	0.382	0.901***	0.566***	0.524***	0.738***
LnEFOR4	0.367	0.0596	0.0730	0.401	0.0801	0.248	-0.0297	0.281
LnFOR_EFOR4	-0.988*	-0.664**	-1.128***	-1.133*	-1.319***	-1.225***	-0.444	-1.429***
Observations	42,534	6,307	21,571	27,270	21,470	27,371	3,457	45,384
Adjusted R-sq	0.665	0.705	0.639	0.646	0.619	0.734	0.583	0.685

*Notes: Robust t-statistics are omitted to save space, but available upon request. ***,**, * indicate statistical significance at 1, 5, 10 percent, respectively. All numbers shown for each variable are estimated coefficient in each model.*
Source: Author's calculation.

• **Measured by foreign output share (YFOR)**

	Small	Large	Central	Not central	Municipal	Not municipal	Head	Single
LnFORshare	0.765***	0.390***	0.665***	0.0218	0.807***	0.427**	0.345*	0.635***
LnYFOR4	0.471	0.173	0.199	0.871*	0.297	0.331*	0.140	0.408**
LnFOR_YFOR4	-0.818	-0.488*	-0.956***	-0.959	-1.219***	-0.925***	-0.253	-1.218***
Observations	42,534	6,307	21,571	27,270	21,470	27,371	3,457	45,384
Adjusted R-sq	0.665	0.705	0.639	0.646	0.618	0.734	0.583	0.685

*Notes: Robust t-statistics are omitted to save space, but available upon request. ***,**, * indicate statistical significance at 1, 5, 10 percent, respectively. All numbers shown for each variable are estimated coefficient in each model. Other independent variables (not reported here) are the same as in the case of EFOR above.*
Source: Author's calculation.

equation (1) to seek more information regarding the source of productivity spillovers from FDI. To our knowledge, only a few researchers who use Thai data have conducted this kind of analysis, so the results here are among the first and may provide insight from various aspects regarding productivity spillovers from FDI in the Thai case. The main results are shown in Table 2 and should be interpreted as follows. First, positive FDI effects at the plant level are discovered in every case except for plants which are not in the central region both from employment and output spillover variables. This suggests that, when considering the plant location, only in the central region do foreign plants exhibit higher labor productivity. Second, in almost all cases, EFOR4, YFOR4 are not statistically significant (no horizontal spillovers at the 4-digit industry level, but some weak evidence is found when looking at foreign employment share, YFOR4). Third, there is strong evidence for negative spillovers from FDI in other foreign plants within the same 4-digit industry level, especially for large plants, plants in the central region and plants which are the single unit type.

4.3 Effects of Foreign Ownership on Labor Productivity in the Region

To test whether it is possible that spillovers are transferred at the regional level, the analysis is broadened to include both regional and industrial foreign share variables in the same regression. Table 3 reports the estimated results, which can be discussed in the following fashion. First, there seems to be no clear evidence that foreign presence in the region has a large and positive effect on labor productivity this year. Almost no evidence is found from regional FDI. However, we find weak

Table 3 *Effects of foreign ownership on labor productivity in the region*

	(1)	(2)	(3)	(4)
LnKI	0.209***	0.191***	0.210***	0.191***
LnMI	0.504***	0.471***	0.504***	0.471***
LnL	0.154***	0.112***	0.153***	0.111***
LnLQ	0.0563*	-0.0193	0.0558*	-0.0199
LnAge	0.0649***	0.0469***	0.0650***	0.0469***
BOI	0.0592***	0.0896***	0.0581***	0.0881***
LnHERF	0.197***	0.241***	0.192***	0.237***
LnERP	-0.376***	-0.361***	-0.371***	-0.357***
LnFORshare	0.598**	0.876***	0.528*	0.714***
LnEFOR4	-0.231	-0.444		
LnFOR_EFOR4	-0.745*	-0.303		
LnREG_EFOR	0.521	0.485		
LnFOR_REG_EFOR	-0.436	-1.249*		
LnReAvrRemu		0.415***		0.415***
LnYFOR4			0.457	-0.0692
LnFOR_YFOR4			-1.302***	-0.478
LnREG_YFOR			-0.143	0.178
LnFOR_REG_YFOR			0.488	-0.738
Observations	48,841	48,841	48,841	48,841
Adjusted R-sq	0.708	0.726	0.708	0.726

*Notes: Robust t-statistics are omitted to save space, but available upon request. ***, **, * indicate statistical significance at 1, 5, 10 percent, respectively. All numbers shown for each variable are estimated coefficient in each model. Model 2 is used when a regional control variable (LnReAvrRemu) is included for the EFOR case, and Model 4 is for the YFOR case. For the regional control variable, LnReAvrRemu is used as a regional control variable because the data in the census do not provide enough observations for skilled wages and information on energy prices. (The observations will be sharply reduced.)*
Source: Author's calculation.

evidence for negative spillovers for joint ventures in the same region (they do not benefit from FDI in other plants within the same region). Second, if the proxy for regional productivity (regional average remuneration—ReAvrRemu) is excluded, the coefficients on REG_EFOR and REG_YFOR are not statistically significant. When the proxy for regional productivity is included, the coefficients on REG_EFOR and REG_YFOR are still insignificant. However, the coefficients on FOR_EFOR4 and FOR_YFOR4 become statistically insignificant (negative spillovers at the industry level disappear when ReAvrRemu is included).[9] Interestingly, variations in the real wage for skilled workers across regions could reflect locational advantages, such as infrastructural differences, local agglomeration economies, or unobserved differences in the quality of labor. Rauch (1991), for example, provides empirical evidence for the United States that variations in human capital accumulation across cities are reflected in higher wages for individuals. Third, ReAvrRemu is highly and positively correlated with individual plant productivity. This suggests that foreign investment is likely to occur in regions with highly productive workers (workers with high ReAvrRemu).

4.4 Impact of Foreign Ownership/Presence within Each Industry Level (Labor Productivity Spilloevers in Each 2-digit ISIC Industry Level)

When each industry is analyzed more deeply and looked at carefully, Table 4 yields an important result that is broadly consistent with results from previous studies. Although foreign presence and foreign employment/output share (or participation) seems to have some positive effects in overall industries and foreign MNCs appear to have higher labor productivity than domestic plants, they do not appear to have higher labor productivity when careful consideration is made for each industry.

[9] *Aitken and Harrison (1999) used real skilled wages and energy prices as regional controls but the census data do not provide enough observations for skilled wages and information on energy prices. (The observations will be sharply reduced if skilled wages and energy prices are used for regional control variables.)*

Table 4 *Impact of for on labor productivity spillovers at the 2-digit industry level*

Variables, R^2	Food products		Textiles		Apparel		Paperproducts		Publishing andprinting		Chemicals		Rubber andplastics	
	All	Large	All	Large	All	Large	All	Large	All	Large	All	Large	All	Large
FDI spillovers measure foreign employment share/foreign output share														
LnFORshare	**0.92**	**0.66**	0.29	0.43	0.09	-0.13	**1.21**	**1.24**	0.64	**1.70**	0.00	0.07	**0.53**	**0.52**
EFOR	**-1.94**	**-2.24**	0.83	-0.24	-0.05	-0.35	**-1.60**	-1.48	**-1.94**	**-2.50**	0.02	0.13	-0.08	-0.02
Observations	12,408	877	4,519	488	2,653	437	745	208	1,686	172	1,844	457	1,906	634
R^2	0.66	0.77	0.76	0.79	0.57	0.55	0.72	0.61	0.56	0.41	0.86	0.83	0.53	0.52
LnFORshare	0.00	0.29	0.15	0.49	0.09	-0.13	**1.15**	1.19	0.82	**1.92**	-0.19	-0.29	**0.46**	**0.54**
YFOR	0.81	-0.61	0.58	-0.21	-0.03	-0.21	**-0.76**	-0.71	-2.84	-3.29	0.27	**0.61**	0.04	-0.05
Observations	12,408	877	4,519	488	2,653	437	745	208	1,686	172	1,844	457	1,906	634
R^2	0.66	0.77	0.76	0.79	0.57	0.55	0.72	0.61	0.56	0.39	0.86	0.83	0.53	0.52
Variables, R^2	Non-metallic mineral products		Basic metals		Metal products		Machinery and equipment		Communication equipment		Motor vehicles		Furniture	
	All	Large	All	Large	All	Large	All	Large	All	Large	All	Large	All	Large
FDI spillovers measure foreign employment share/foreign output share														
LnFORshare	0.58	0.35	-0.23	-0.27	0.31	0.55	0.73	0.07	-0.18	-0.08	0.19	0.41	0.12	0.34
EFOR	-1.84	-1.03	0.21	0.33	0.28	-0.16	-0.64	0.27	0.12	0.10	0.18	-0.03	0.01	-0.08
Observations	4,262	349	679	151	5,159	428	1,495	256	330	197	579	241	4,609	601
R^2	0.62	0.52	0.71	0.76	0.60	0.49	0.63	0.47	0.60	0.54	0.69	0.67	0.68	0.63
LnFORshare	0.59	0.37	-0.33	-0.32	0.05	0.47	0.38	-0.13	-0.48	-0.33	0.23	0.40	-0.04	0.26
YFOR	-1.58	-0.93	0.26	0.28	0.54	0.00	-0.13	0.38	0.44	0.39	0.10	-0.01	0.20	0.03
Observations	4,262	349	679	151	5,159	428	1,495	256	330	197	579	241	4,609	601
R^2	0.62	0.52	0.71	0.76	0.60	0.49	0.62	0.48	0.60	0.55	0.69	0.67	0.68	0.63

Notes: All – samples of all plants; large – samples of large plants with total employment more than 50 employees. Other independent variables (not reported here) include LnKI, LnMI, LnL, LnLQ, LnAge, BOI, and LnERP. Coefficients come from ordinary least square estimates of each equation in plant-level cross sections for samples of all plants and large plants in each industry. Industries with few observations and robust tstatistics are all omitted to save space, but available upon request. Bold numbers indicate significant estimated coefficient.
Source: Author's calculation.

Our findings from Table 4 and the previous results from Table 1 suggest that foreign plants are more productive than domestic plants when the sample is considered as a whole (the overall nationwide effect in the sample). Nevertheless, when each industry is considered separately, only some evidence of FDI-positive effects is found at the plant level in some industries, namely food products, paper products, publishing and printing, rubber and plastics, non-metallic and mineral products, and machinery and equipment. Negative horizontal spillovers are also observed in almost all industries (except for chemicals) which report statistically significant spillover variables (negative signs on EFOR and YFOR indicate that an increase in the share of FDI in the industry results in a decrease in labor productivity in that industry). This is surprising since some positive horizontal spillovers are observed when considering the whole sample (Table 1). In contrast, negative horizontal spillovers are observed in each separate industry.

4.5 Impact of Foreign Ownership/Presence on Wages per Worker (Wage Spillovers)

This section reports results regarding the effects of FDI on wage spillovers in domestic plants obtained by estimating equation (2). So far, to the knowledge of the author, there have been few studies analyzing wage spillovers in the case of Thai manufacturing. Therefore, the present analysis is one of the first attempts in using industrial census data to extensively analyze and explore the effects of FDI on wage spillovers in the Thai manufacturing sector. The main findings can be summarized from Table 5 as follows.

First, in the analysis of wage spillovers, a positive own-plant effect can be observed, the same as in the case of productivity spillovers. The coefficients on FORshare are all positive and statistically significant (foreign presence at the plant level has positive effects on the average wages of workers in domestic plants). Second, an increase

Table 5 *Impact of foreign ownership (FOR) on wages per worker (wage spillovers: dependent variable; remunerations per worker)*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
LnFORshare	0.136***	0.354***	0.324***	0.281***	0.262***	0.261***	0.264***	0.0991**
LnEFOR4		0.360***		-0.522		-0.547*		
LnFOR_EFOR4		-0.897***		-0.0902		0.0674		
LnYFOR4			0.369***		-0.000343		-0.172	
LnFOR_YFOR4			-0.783***		-0.644		-0.447	
LnEFOR2				1.009***		0.934**		
LnFOR_EFOR2				-0.801		-0.728		
LnYFOR2					0.399		0.467	
LnFOR_YFOR2					-0.0700		-0.0933	
EX						-0.0164	-0.0168	-0.0154
IM						0.0743***	0.0742***	0.0757***
MUN						0.165***	0.165***	0.165***
Central						0.356***	0.356***	0.357***
JPN						-0.0562*	-0.0511	-0.00872
TCS						-0.0232	-0.0237	0.0383
US						-0.0769	-0.0762	-0.0393
ProTech						-0.000334	-0.000372	0.000716
FormEcon						0.0418***	0.0425***	0.0432***
Observations	37,867	37,867	37,867	37,867	37,867	37,867	37,867	37,867
Adjusted R-sq	0.604	0.604	0.604	0.604	0.604	0.643	0.642	0.642

*Notes: Robust t-statistics are omitted to save space, but available upon request. ***, **, * indicate statistical significance at 1, 5, 10 percent, respectively. All numbers shown for each variable are estimated coefficient in each model. As is the same in the case of productivity spillovers (Table 1), other independent variables (not reported here) are LnKI, LnMI, LnL, LnLQ, LnAge, LnHERF, and BOI, and LnERP for productivity spillovers and TECH and Government for wage spillovers.*
Source: Author's calculation.

in the share of FDI (by EFOR4 and YFOR4) leads to an increase in average wages of workers in domestic plants (positive horizontal spillovers from FDI to domestic plants at the 4-digit industry level). Third, plants with foreign equity participation show negative spillovers from FDI (joint ventures benefit from FDI at the plant level, but not from FDI in other plants within the same industry at the 4-digit level). Fourth, an increase in the share of FDI (by foreign employment, EFOR2) leads to an increase in average wages at the industry level (positive horizontal spillovers from FDI to domestic plants at the 2-digit level). When the spillover effects at the 2-digit and 4-digit industry levels are considered simultaneously, only positive spillovers are observed at the 2-digit level from foreign employment share (EFOR2), and not from foreign output share (YFOR2). Fifth, when other control variables are included and the spillover effects at the 2-digit and 4-digit industry levels are considered at the same time, it is found that previous positive spillovers from FDI at the 4-digit level become negative but weakly significant (the sign on the coefficients of EFOR4 changes from positive to negative). Sixth, average wages do not rely on export status and the national origin of FDI. This is the case for both productivity and wage spillovers. The indicator wages per worker is highly correlated with the import status dummy, the municipal area and central area dummy, the product development dummy, form of the econ organization dummy variable. With regard to Tables 1 and 5, nearly the same results are found for the effects of the control variables.

4.6 Impact of FOR by Plant Size (Small, Large)/ Location (Central, Not Central) Improved Production Technology/Economics Form (Head Branch, Single Unit)

As can be seen from Table 6, the main findings can be discussed in a similar manner as in the case of productivity spillovers. First to be noted are the FDI-positive effects at the plant level in every case, except for the case where plants that are not in

Table 6 *Impact of FOR by plant size (small, large)/location (central, not central)/improved production technology (yes,no)/economic form (head branch, unit)*

- **Measured by foreign employment share (EFOR**

	Small	Large	Central	Not central	ProTech	No ProTech	Head	Single
LnKI	0.0592***	0.0458***	0.0309***	0.0708***	0.0395***	0.0524***	0.0429***	0.0538***
LnMI	0.155***	0.107***	0.121***	0.154***	0.0997***	0.157***	0.0911***	0.158***
LnL	0.333***	0.0425***	0.181***	0.213***	0.0785***	0.230***	0.0671***	0.243***
LnLQ	0.112***	0.108***	0.0796***	0.0505*	0.170*	0.0681***	0.180***	0.0743***
LnAge	0.0105*	0.0729***	0.00883	0.0237***	0.0766***	0.0161***	0.0663***	0.0143***
LnHERF	-0.0280	0.0999	0.0274	-0.110	0.109	-0.0652	0.208	-0.0799
TECH	-0.0104***	-0.00823***	-0.00939***	-0.0101***	-0.0120**	-0.0102***	-0.00902	-0.0102***
Government	-0.658***	-0.820***	-0.852***	-0.367***	-0.504**	-0.620***	-0.833***	-0.615***
LnFORshare	0.692***	0.236***	0.386***	0.157	0.425**	0.337***	0.393***	0.307***
LnEFOR4	0.703***	0.307***	0.301***	0.478	0.402*	0.404***	0.212	0.495***
LnFOR_EFOR4	-0.954**	-0.250*	-0.749***	-0.712	-0.647*	-0.934***	-0.535*	-0.987***
Observations	31,664	6,203	19,143	18,724	1,345	36,522	3,430	34,437
Adjusted R-sq	0.558	0.512	0.51	0.491	0.331	0.596	0.302	0.583

*Notes: Robust t-statistics are omitted to save space, but available upon request. ***,**, * indicate statistical significance at 1, 5, 10 percent, respectively. All numbers shown for each variable are estimated coefficient in each model.*
Source: Author's calculation.

- **Measured by foreign output share (YFOR)**

	Small	Large	Central	Not central	ProTech	No ProTech	Head	Single
LnFORshare	0.724***	0.149*	0.381***	0.0749	0.470**	0.278***	0.351**	0.254**
LnYFOR4	0.605***	0.293***	0.291***	0.573*	0.335*	0.414***	0.198	0.506***
LnFOR_YFOR4	-0.888**	-0.0997	-0.664***	-0.663	-0.622*	-0.774***	-0.399	-0.848***
Observations	31,664	6,203	19,143	18,724	1,345	36,522	3,430	34,437
Adjusted R-sq	0.558	0.513	0.51	0.491	0.331	0.596	0.301	0.583

*Notes: Robust t-statistics are omitted to save space, but available upon request. ***,**, * indicate statistical significance at 1, 5, 10 percent, respectively. All numbers shown for each variable are estimated coefficient in each model. Other independent variables (not reported here) are the same as in the case of EFOR above.*
Source: Author's calculation.

the central region, from both foreign employment share and foreign output share. Second, the positive sign on the coefficients of EFOR4 and YFOR4 can be observed, and almost all coefficients are strongly and statistically significant except for the case in which plants that are not in the central region and plants that are head branch type (positive horizontal wage spillovers at the 4-digit industry level). Third, strong evidence can be found of negative wage spillovers from FDI in other plants within the same 4-digit industry level, especially for small plants, plants in the central region, plants with no report of improved production technology, and plants which are the single unit type. Similar to the case of productivity spillovers, from Tables 5 and 6, it can be seen again that it is very important to cross-check the results when observing spillover effects, considering both EFOR and YFOR.

4.7 Effects of Foreign Ownership on Wage/Remuneration in the Region

Apart from the analysis at the plant and industry levels, following the analysis of productivity spillovers, the analysis of wage spillovers is extended to the regional level. As can be seen in Table 7, there is no clear evidence that foreign presence in the region has a large and positive effect on average wages of workers in domestic plants. Almost no clear evidence from regional FDI is found. Still, weak evidence is found of negative wage spillovers for joint ventures in the same region (they do not benefit from FDI in other plants within the same region). Next, if a proxy for regional productivity (regional average remuneration—ReAvrRemu) is excluded, the coefficients on REG_EFOR and REG_YFOR are not statistically significant. When the proxy for regional productivity is included,

Table 7 *Effects of foreign ownership on wages/remunerations in the region*

	(1)	(2)	(3)	(4)
LnKI	0.0518***	0.0508***	0.0519***	0.0509***
LnMI	0.156***	0.132***	0.156***	0.132***
LnL	0.224***	0.184***	0.224***	0.184***
LnLQ	0.0658***	0.0347*	0.0656***	0.0345*
LnAge	0.0172***	0.00857*	0.0172***	0.00857*
LnHERF	-0.0586	-0.00166	-0.0613	-0.00350
TECH	-0.0102***	-0.0103***	-0.0102***	-0.0103***
Government	-0.620***	-0.437***	-0.620***	-0.436***
LnFORshare	0.465**	0.828***	0.444**	0.722***
LnEFOR4	0.127	-0.0520		
LnFOR_EFOR4	-0.589*	-0.195		
LnREG_EFOR	0.274	0.257		
LnFOR_REG_EFOR	-0.649	-1.617***		
LnReAvrRemu		0.379***		0.380***
LnYFOR4			0.429*	-0.0522
LnFOR_YFOR4			-0.851***	-0.0986
LnREG_YFOR			-0.0778	0.239
LnFOR_REG_YFOR			-0.169	-1.520***
Observations	37,867	37,867	37,867	37,867
Adjusted R-sq	0.604	0.648	0.604	0.647

*Notes: Robust t-statistics are omitted to save space, but available upon request. ***, **, * indicate statistical significance at 1, 5, 10 percent, respectively. All numbers shown for each variable are estimated coefficient in each model. Model 2 is used when a regional control variable (LnReAvrRemu) is included for the EFOR case, and Model 4 is for the YFOR case. For the regional control variable, LnReAvrRemu is used as a regional control variable because the census data do not provide enough observations for skilled wages and information on energy prices. (The observations will be sharply reduced.)*
Source: Author's calculation.

the coefficients on REG_EFOR and REG_YFOR remain insignificant. However, the coefficients on FOR_EFOR4 and FOR_YFOR4 become statistically insignificant (negative spillovers at the industry level disappear). The interaction terms, identical to the case of productivity spillovers, (FOR_REG_EFOR and FOR_REG_YFOR) become statistically significant after including a regional control. The same conclusion can be made that ReAvrRemu is highly and positively correlated with plants' average wages. From Table 7, it may be noted that, when including REG_EFOR and REG_YFOR, the coefficients on EFOR4 and YFOR4 become statistically insignificant; this means that when the spillover effects are looked at simultaneously in the plant level, the (4-digit) industry level, and the regional level, only strong positive effects are observed at the plant level, weakly negative horizontal spillovers at the industry level, and no clear evidence of effects at the regional level.

4.8 Impact of Foreign Ownership/Presence within Each Industry Level (Wage Spillovers in each 2-digit ISIC Industry Level)

Table 8 gives an important result that is broadly consistent with the results of previous studies. Foreign plants do not appear to have higher wages per worker when each industry is considered individually. The findings from Tables 8 and 5 suggest that a greater presence of foreign plants is positively associated with higher average wages of workers in domestic plants when the whole sample (the overall nationwide effect in the sample) is considered. This suggests that the presence of foreign plants causes a shift in labor demand leading to upward pressure on wages faced by both foreign plants and domestic plants. Nevertheless, when each industry is considered separately, only some evidence is found of FDI positive effects at the plant level in some industries, namely food products, textiles, rubber and plastics, non-metallic and mineral products, metal products, machinery and equipment, communication equipment, motor vehicles, and furniture.

In contrast to the case of productivity spillovers, positive horizontal spillovers are observed in almost all industries which report statistically sig-

Table 8 *Impact of for on wage spillovers at the 2-digit industry level*

Variables, R^2	Food products		Textiles		Apparel		Paperproducts		Publishing andprinting		Chemicals		Rubber and plastics	
	All	Large	All	Large	All	Large	All	Large	All	Large	All	Large	All	Large
FDI spillovers measure foreign employment share/foreign output share														
LnFORshare	**0.44**	-0.02	0.07	**0.35**	-0.25	-0.12	0.36	0.46	0.21	0.30	-0.17	0.13	**0.33**	**0.41**
EFOR	-1.02	-0.35	0.43	0.43	0.79	0.82	-0.77	-0.83	-1.14	-0.17	0.29	0.03	0.10	-0.15
Observations	8,318	878	3,775	478	2,153	435	685	207	1,386	172	1,571	448	1,864	641
R^2	0.55	0.62	0.68	0.70	0.53	0.51	0.62	0.35	0.52	0.15	0.78	0.69	0.38	0.25
LnFORshare	-0.07	-0.11	0.08	**0.37**	-0.25	-0.12	0.37	0.49	0.18	-0.07	-0.06	0.19	0.14	**0.27**
YFOR	0.63	-0.01	0.18	0.15	0.49	0.51	-0.44	-0.50	-1.15	1.17	0.04	-0.07	**0.44**	0.14
Observations	8,318	878	3,775	478	2,153	435	685	207	1,386	172	1,571	448	1,864	641
R^2	0.55	0.62	0.68	0.70	0.53	0.51	0.62	0.35	0.52	0.16	0.78	0.69	0.38	0.24
Variables, R^2	Non-metallic mineral products		Basic metals		Metal products		Machinery and equipment		Communication equipment		Motor vehicles		Furniture	
	All	Large	All	Large	All	Large	All	Large	All	Large	All	Large	All	Large
FDI spillovers measured foreign employment share/foreign output share														
LnFORshare	**0.71**	0.39	0.31	0.09	-0.22	-0.06	0.22	0.01	-0.29	**-0.36**	**0.43**	**0.55**	-0.02	0.17
EFOR	-0.74	-0.15	0.16	0.62	0.45	0.56	-0.23	**0.41**	**0.49**	**0.50**	-0.27	-0.35	**0.59**	0.40
Observations	3,620	350	619	151	4,428	428	1,329	256	317	197	556	240	3,423	590
R^2	0.52	0.34	0.56	0.44	0.53	0.19	0.52	0.24	0.49	0.33	0.52	0.27	0.61	0.66
LnFORshare	**0.59**	0.36	**0.45**	0.24	**-0.42**	-0.25	0.10	-0.08	-0.29	**-0.40**	**0.39**	**0.51**	-0.09	0.14
YFOR	-0.31	-0.05	-0.09	0.20	**0.64**	**0.72**	-0.04	**0.43**	**0.57**	**0.63**	-0.16	-0.23	**0.61**	0.39
Observations	3,620	350	619	151	4,428	428	1,329	256	317	197	556	240	3,423	590
R^2	0.52	0.34	0.56	0.43	0.53	0.20	0.52	0.25	0.49	0.34	0.52	0.27	0.61	0.66

Notes: All – samples of all plants; large – samples of large plants with total employment more than 50 employees. Other independent variables (not reported here) include LnKI, LnMI, LnL, LnLQ, LnAge, BOI, and LnERP. Coefficients come from ordinary least square estimates of each equation in plant-level cross sections for samples of all plants and large plants in each industry. Industries with few observations and robust t-statistics are all omitted to save space, but available upon request. Bold numbers indicate significant estimated coefficient.
Source: Author's calculation.

nificant spillover variables (positive signs on EFOR and YFOR indicate that an increase in the share of FDI in the industry results in an increase in average wages in that industry). In comparing Tables 5 and 8, positive horizontal spillovers can be found both in the whole sample and the samples for each industry. This finding is in line with that of the previous study by Ramstetter (2004), which indicates that the relationship between labor productivity and foreign ownership in general is rather weak but the relationship between wages and foreign ownership is somewhat stronger in Thai manufacturing.

5. CONCLUDING REMARKS AND POLICY IMPLICATIONS

In this paper, productivity and wage spillovers from FDI in Thailand are analyzed using many plant-level analyses. It is one of the few papers to study productivity and wage spillovers simultaneously, and to combine various methods necessary for the analysis and examine a wide range of spillover features regarding the impact and effects of FDI on productivity and wage spillovers.The main contribution of this paper can be described as follows. First, consideration is given to the impact of foreign ownership (FORshare) on labor productivity and average wages, which is observed for both foreign employment share and foreign output share at both the 2-digit and 4-digit industry levels. Second, the impact of foreign presence is considered as conditioned by plant size, location and form of organization, and so forth. The effects of foreign presence are then extended into the regional level. Third, the effects of foreign presence in each industry are carefully and simultaneously examined for both productivity and wage spillovers.

The major finding of the present study is that increases in foreign equity participation (foreign presence) are positively correlated with increases in labor productivity and average wages of domestic plants. The impact of FDI on labor productivity and average wages in the Thai manufacturing sector is examined on the basis of a number of relevant variables, such as capital intensity, material, labor inputs, labor equality, years of operation of establishments, investment promotion status from the BOI, and trade policy effect according to the effective rate of protection (ERP), among others. Two proxies for the presence of foreign-owned plants are used as it has been expected that such presence could be reflected in terms of either the

employment or output levels. Several statistical diagnostic tests are carried out to prevent misleading econometric results. The analysis shows that the coefficients of the two proxy variables for the influence of foreign plants are significant on average, signifying that FDI plays a positive role in enhancing labor productivity and average wages in the Thai manufacturing sector. Similarly, capital intensity, material, labor inputs, labor equality, years of operation of establishment, and investment promotion status from BOI are all shown to positively affect domestic labor productivity. Moreover, other control variables, such as capacity utilization, import status, and location dummies, are also shown to positively affect labor productivity and average wages. Conversely, as expected, ERP appears to negatively affect labor productivity, and the form of legal organization (Government) and technology gap also seem to negatively affect average wages of workers in domestic plants.

This study makes it possible to draw attention to some policy implications for Thai government representatives and business managers. Since, on balance, FDI has a positive impact on productivity and wages, the country's investment-friendly policy should continue to be adopted and implemented so that more inward FDI might be attracted. It would be desirable to examine the issue of spillovers more closely in the Thai case, especially for wage spillovers, for which there are few studies at the moment, in order to provide more solid evidence concerning the impact of FDI spillover effects on productivity and wages which can occur at various industry levels in view of horizontal spillovers.

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