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FDI and Export Spillovers through Horizontal and Vertical Linkages in South Korea Using Heckman's Two Step Approach*

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We investigate spillovers from inward foreign direct investment (FDI) on domestic firms' export activity. Using firm-level data of South Korea's manufacturing industries for the recent period of 2006-2009, this paper examines whether absorptive capacity of domestic firms matters for capturing the spillovers from FDI. In particular, horizontal (intra-industry) and vertical (inter-industry) spillovers from FDI are examined by using Heckman's two-step estimation strategy to control for selection bias. This approach allows us to examine the impact of spillovers from horizontal and vertical linkages on the export intensity and the export market participation of domestic firms. We find that absorptive capacity seems to play an important role in capturing the positive spillovers from FDI; however, this result becomes less significant and inconsistent when the econometric concern of a potential endogeneity problem is considered in the regression. Therefore, this paper provides no clear empirical evidence of positive export spillovers from foreign presence and the role of absorptive capacity to capture the benefits from foreign multinationals.

JEL Classification: F13, F23
Keywords: Foreign Direct Investment (FDI), export spillovers, absorptive capacity, horizontal linkage, vertical linkage

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1. INTRODUCTION

Foreign direct investment (FDI) is considered an important source in enhancing productivity and efficiency for domestic firms, contributing to economic growth of a host country. In particular, for developing countries, the presence of foreign multinationals is viewed as an important vehicle for the transfer of new technology and information to domestic firms through horizontal and vertical production linkages. Like other developing countries, the South Korean government has also spent considerable effort to attract more FDI through the enforcement of the Foreigner Investment Promotion Act with the strong belief of positive spillovers from FDI. In addition, the incentive policy that grants cash or land to FDI investors has been implemented in legislation since 2003.

Empirical and theoretical analysis in Bernard and Jensen (2004) and Melitz (2003) show that export activity involves sunk costs. The literature shows that there exists a high degree of persistence in the export behavior of firms and suggests that it is related with sunk costs of export market entry. These sunk costs might include the establishment of distribution channels, international market research, and development of new product for global market (Kneller and Pisu, 2007). Foreign multinationals usually have better knowledge about international markets and foreign consumers than domestic firms do. However, such knowledge-based assets can have public-good characteristics that make foreign multinationals hard to fully internalize them, as discussed in Ruane and Sutherland (2005). Therefore, domestic firms are able to obtain new information associated with exporting activity from foreign multinationals. The knowledge spillovers from FDI can reduce the sunk cost associated with export market participation of domestic firms, as discussed in Aitken, Hanson, and Harrison (1997). In other words, knowledge spillovers from FDI can reduce the entry cost of foreign market access for domestic firms, which can facilitate domestic firm's export market participation, as pointed out in Kneller and Pisu (2007). Lee (2004) finds a significant role of FDI in knowledge diffusion from U.S. firms to Korean firms by using firm-level data

for Korean firms' U.S. patents and their citations. These knowledge spillovers can occur between firms in the same industry, indicating intra-industry (horizontal) spillovers, and between firms in the different industries, indicating inter-industry (vertical) spillovers (Kaiser, 2002).

In addition, the theoretical studies including Melitz (2003), Helpman, Melitz, and Yeaple (2004), and Bernard, Eaton, Jensen, and Kortum (2003) show that more productive firms enter the export market. As discussed in Kneller and Pisu (2007), only those highly productive firms that can meet the sunk cost associated with export activity gain positive profit from export market participation and continue to export. The presence of foreign multinationals can affect the productivity of domestic firms through industrial production linkages and therefore have impacts on domestic firms' export behavior. These productivity spillovers can arise through horizontal and vertical production linkage, and the rationales for production linkage spillovers are extensively explained in Görg and Greenaway (2004) and Javorcik (2004). For instance, increase in market competition due to the entry of foreign multinationals will force domestic firms to become more productive and therefore allowing them to become exporters. In addition, foreign multinationals have an incentive to transfer knowledge to their local intermediate input supplier in order to be supplied with a higher quality of inputs from their local supplier. Furthermore, new entry of foreign multinationals increase the demand for intermediate input from local suppliers and therefore domestic intermediate input supplier can take advantage of scale economics. Moreover, the availability of better intermediate inputs produced by foreign multinationals in an upstream sector enhances the productivity of domestic firms that use these high quality inputs in the downstream. As a result of these effects, domestic firms can increase their productivity and therefore become exporters. On the other hand, the reverse may be possible as discussed in Aitken and Harrison (1999). They argued that foreign multinationals may steal market demand from domestic firms since they are more competitive than domestic firms. If this market-stealing effect is large, the presence of foreign multinationals forces domestic firms to reduce their

production and increase their average cost of production. If this is the case, the presence of foreign multinational may reduce the productivity of domestic firms and thereby diminish their export propensity.

While there is a large amount of empirical literature that examines the impact of FDI on productivity of domestic firms, few empirical studies investigate the export spillovers from foreign multinationals to domestic firms. In addition, whereas the theoretical analysis of Rodriguez-Clare (1996) shows that FDI can also affect the export activities of domestic firms in upstream and downstream industries through vertical linkages, empirical studies that analyze the export spillovers from FDI have mainly focused on horizontal spillover and provided mixed evidences of spillover effects. Aitken *et al*. (1997) on Mexico, Kokko, Zejan, and Tansini (2001) on Uruguay, and Alvarez and Lopez (2008) on Chile find positive horizontal spillover from FDI on the export performance of domestic firms. On the other hand, Aitken and Harrison (1999) on Venezuela and Greenaway, Sousa, and Wakelin (2004) on the U.K. find no or negative export spillovers. Recently, empirical studies have paid more attention to export spillovers through vertical linkages. Kneller and Pisu (2007) on the U.K., and Anwar and Nguyen (2011) on Vietnam find positive horizontal and vertical spillovers on export activities of domestic firms.

However, there are only a few studies that examine the role of absorptive capacity of domestic firms, which enable them to capture spillovers from FDI. Keller (2004) and Chudnovsky, López, and Rossi (2008) discusses the role of absorptive capacity for capturing successful international technology diffusions and spillovers from FDI and trade. Girma and Görg (2005) find the importance of absorptive capacity to capture spillovers from FDI that can enhance the productivity of firms. In addition, Girma (2005) investigates if the minimum level of technological capacity is required for domestic firms to benefit from FDI spillovers. It is reasonable to think that spillovers may affect only a set of domestic firms with absorptive capacity, rather than affecting all firms in general. However, these previous studies focus on the spillovers from FDI on productivity growth rather than on export performance.

This paper considers firm heterogeneity to absorb spillovers from FDI and investigates the impact of horizontal, forward, and backward spillovers on export activities of domestic firms using a firm-level dataset for South Korean manufacturing industries. Based on the definition from Cohen and Levinthal (1990), this paper considers several measures of a firm's absorptive capacity by using rich information on the firm's R&D expenditure and numbers of patents held.

This paper contributes to the existing literature in several ways. Considering firm's ability to absorb spillovers, this paper investigates horizontal, backward, and forward spillovers from foreign multinationals on the export activity of a domestic firm by using the firm level unbalanced panel dataset collected by Statistics of Korea. This data set includes all manufacturing industries for the recent period of 2006-2009. Firm's export performance is divided into two parts: (1) intensive margin (export share) and (2) extensive margin (export market participation). In addition, the two absorptive capacity measures using firm's R&D intensity and patent intensity are used to check the robustness of the results. Whereas Girma (2005) defines absorptive capacity as a ratio of firm's TFP to industry leader's TFP, we use information of R&D expenditure and the total numbers of patents of a firm to measure the absorptive capacity. In order to estimate consistent TFP, Levinsohn and Petrin (2003) method is used. The semi-parametric estimation procedure suggested by Levinsohn and Petrin (2003) solves the simultaneity problems associated with endogeneity of input choices that can arise in OLS. In addition, this paper takes into account the endogeneity of a firm's export decision and firm's absorptive capacity measures.

The result shows that, in general, there exist no positive export spillovers from foreign multinationals to domestic firms. However, this paper finds that significant positive export spillovers exist for a set of domestic firms with absorptive capacity. It is found that the absorptive capacity of a domestic firm is critical in receiving positive spillover benefits from foreign multinationals. In particular, there are positive horizontal and forward spillovers on the expert market participation decisions of domestic firms and

positive backward spillovers on the export intensity of domestic firms. However, when the econometric concern associated with endogeneity of a firm's export decision and absorptive capacity measures is taken into account in the regression, the role of absorptive capacity to capture the positive spillovers from foreign presence become less significant and inconsistent. Therefore, overall, there exists no clear evidence that foreign presence leads to positive export spillovers.

The paper is structured as follows: the data descriptions and estimation strategy are discussed in the second section, and the third section explains the empirical results, followed by the conclusion in the last section.

2. DATA AND ESTIMATION STRATEGY

In this paper, we use a firm-level dataset for South Korean manufacturing industries for the period of 2006-2009. The Survey of Business Activities covers all enterprises that have at least 50 regular workers and capital of at least 0.3 billion Korean Won. This survey was started in 2006 and data are collected annually by Statistics of Korea. This dataset is an unbalanced panel and the manufacturing industries are divided into 24 industries based on the Korean standard industrial classification. This data has been used in the empirical study in Kim (2013) which investigates the learning by exporting and self-selection hypothesis using quantile regression. The data provides firm level information about output, numbers of employees, capital inputs, material inputs, foreign capital share, R&D investment, numbers of patents, sales, and export. Table 1 shows the summary statistics of these variables.

ln$Y$ is the logarithm of the firm's real sale adjusted output which is calculated by using the sale and inventory change, similar to Javorcik (2004). Then, in order to change adjusted output in real term, we deflate it by the two digit industry level producer price index provided by Bank of Korea. ln$K$ is the logarithm of the real capital. Fixed asset deflated by the capital equipment price index is used to calculate the real capital. ln$L$ is the logarithm

Table 1 Summary Statistic

Variable	Number of Observations	Mean	Std. Dev.	Min	Max
ln*Y*	22,510	5.7838	1.2750	2.1019	14.0912
ln*L*	22,510	4.8481	0.8409	3.9120	11.3599
ln*K*	22,510	4.7994	1.4364	–2.3734	13.1337
ln*TFP*	22,510	0.2281	0.9458	–7.1780	4.6335
Foreign Share	22,510	7.8956	23.7318	0	100
R&D/Sale	22,510	0.0185	0.0495	0	3.7208
Patent/Sale	22,510	0.0005	0.0018	0	0.1376
Export/Sale	22,510	0.1719	0.2618	0	1

of the number of employees. In addition, ln*TFP* is the logarithm of the total factor productivity (TFP) estimated by Levinsohn and Petrin (2003)[1)] method. The foreign share indicates the share of foreign capital investment and implies the ownership structure of a firm. The bigger this variable, the larger share of foreign capital is invested. R&D/sale indicates the total expenditures on research and development divided by total sales and patent/sale is the total numbers of patents divided by total sales. Export/sale indicates the export intensity which is the share of output exported.

The descriptive statistics of domestic firms and foreign multinationals are presented in table 2. Following Djankov and Hoekman (2000) who define a firm with foreign ownership as a firm that has at least 20 percent of the equity owned by a foreign investor, I define domestic firms as those with less than 20 percent of foreign capital share and foreign firms as those with at least 20 percent of foreign capital share. Not surprisingly, foreign firms are on average superior to domestic firms in all aspects. The average value of the

[1)] The semi-parametric estimation procedure suggested by Levinsohn and Petrin (2003) solves the simultaneity problems of endogenous input choice variables. When OLS estimation is applied to estimate production function, the results are inconsistent due to the endogeneity problem. The semi-parametric estimation method developed by Levinsohn and Petrin (2003) provides consistent estimates of the parameters of the production functions for each industry; thus, resulting in consistent measures of firm-level TFP.

Table 2 Descriptive Statistic of Domestic Firms versus Foreign Firms

Variable	Domestic Firms	Foreign Firms
Number of observations	20,075	2,435
ln*TFP*	0.1539	0.8405
ln*L*	4.7817	5.3956
ln*K*	4.7249	5.4133
ln*Y*	5.6715	6.7092
R&D Expenditure	2,556	12,924
Patents	89	383
Export	47,128	238,014

logarithm of TFP of foreign firms is more than five times higher than that of domestic firms. In addition, foreign firms have greater R&D expenditure and hold greater numbers of patents. Furthermore, foreign firms are more export-oriented compared to domestic firms. Therefore, domestic firms may capture positive spillover benefits from foreign multinationals and start exporting if domestic firms are capable of utilizing the spillovers from foreign firms.

We follow the ideas in Javorcik (2004) and Kneller and Pisu (2007) to construct the spillover variables. The definitions of $Horizontal_{jt}$, $Backward_{jt}$, *and* $Forward_{jt}$ are as follows:

$Horizontal_{jt}$ captures the proportion of the total output of a given industry j in a given year t produced by foreign multinationals. The output of foreign multinationals is weighted by its foreign capital share. If the proportion of the total output of a given industry in a given year produced by foreign firm is large, the value of this variable becomes greater. This variable captures the intra-industry spillovers from foreign multinationals to domestic firms in the same industry.

$$Horizontal_{jt} = \frac{\sum_{i \text{ for all } i \in j} Foreignshare_{ijt} * Y_{ijt}}{\sum_{i \text{ for all } i \in j} Y_{ijt}}, \quad (1)$$

$Backward_{jt}$ represents the presence of foreign multinationals in the industries that are supplied by sector *j* at time *t*. This variable implies the level of production linkage between domestic intermediate input suppliers in an upstream market and multinational customers in a downstream market. Thus, if foreign multinationals buy a large proportion of intermediate inputs from domestic suppliers, the value of the $Backward_{jt}$ variable becomes bigger. This variable captures the spillovers from foreign multinational customers to domestic intermediate input suppliers.

$$Backward_{jt} = \sum_{k \ if \ k \neq j} \alpha_{jkt} \cdot Horizontal_{kt}, \tag{2}$$

Where α_{jkt} is a proportion of sector *j*'s output supplied to sector *k* at time *t*. We use input-output matrices of each year from 2006 to 2009 provided by the Bank of Korea for calculating α_{jkt}; thus, the coefficient varies over time, capturing the change in the inter-industry relationship over time.

The definition of $Forward_{jt}$ is the weighted share of output in supplying sectors produced by foreign multinationals. The value of the $Forward_{jt}$ variable becomes larger if foreign multinationals in an upstream market supply greater proportion of the intermediate inputs to domestic firms in a downstream market. This variable captures the spillovers from foreign multinational intermediate input suppliers to domestic customers.

$$Forward_{jt} = \sum_{m \ if \ m \neq j} \sigma_{jmt} \cdot Horizontal_{mt}, \tag{3}$$

where σ_{jmt} is a proportion of intermediate inputs supplied from industry *m* to industry *j* in total inputs purchased by industry *j* at time *t*. As previously discussed, the input-output matrices of each year from 2006 to 2009 provided by the Bank of Korea is used to calculate σ_{jmt}.

We follow Cohen and Levinthal (1990) and Cockburn and Henderson (1998) to measure absorptive capacity. Cohen and Levinthal (1990) investigate the dual roles of R&D investment, suggesting that R&D investment not only generates new information but also enhances a firm's ability to absorb

spillovers from other firms. Kathuria (2000) also shows that firms actively engaged in R&D benefit from external knowledge spillover. Therefore, R&D intensity and patent intensity are used to measure the firm's absorptive capacity. R&D intensity is defined as R&D expenditure divided by sales and patent intensity is defined as the total number of patents divided by sales.

The econometric analysis involves a two-stage decision process, using Heckman's two-step estimation to control for selection bias. The export intensity function estimated on selected samples of only exporters do not estimate population export intensity function. The presence of foreign multinationals affects the export decision behavior of all domestic firms, not only exporting domestic firms (Greenaway *et al*., 2004). Therefore, if functions of export participation decision and export intensity decision of a firm are separately estimated, the problem of selection bias rises. Thus, jointly estimating the export intensity and the export propensity functions can avoid the sample selection bias. According to Heckman (1979), in the first step, the probability of export participation choices is estimated using a probit model, and then, inverse Mill's ratios are calculated. In the second step, the inverse of the Mills ratio is included as an additional explanatory variable in the export intensity regression. With the inverse Mills ratio included in the export intensity equation, we can have consistent estimates of the population export intensity equation. This Heckman's two-step estimation methodology has been applied in several empirical studies such as Greenaway *et al*. (2004), Kneller and Pisu (2007), and Anwar and Nguyen (2011). Heckman two-step estimation procedure is as follows:

$$\begin{aligned} d_{ijt}^{*} = {} & \delta_0 + \delta_1 \ln TFP_{ijt} + \delta_2 capital/employment_{ijt} + \delta_3 foreinshare_{ijt} \\ & + \delta_4 age_{ijt} + \delta_5 Horizontal_{jt} + \delta_6 Backward_{jt} + \delta_7 Forward_{jt} \\ & + \delta_8 HHI_{jt} + \delta_9 PPI_{jt} + size_{ijt} + \alpha_t + \alpha_j + u_{ijt}, \end{aligned} \tag{4}$$

$$d_{ijt}=1 \quad if \quad d_{ijt}^{*} > 0,$$
$$d_{ijt}=0 \quad if \quad d_{ijt}^{*} \le 0.$$

$$
\begin{aligned}
y_{ijt}^{*} = {} & \delta_0 + \delta_1 \ln TFP_{ijt} + \delta_2 \, foreinshare_{ijt} + \delta_3 \ln wage_{ijt} \\
& + \delta_4 Horizontal_{jt} + \delta_5 Backward_{jt} + \delta_6 Forward_{jt} \\
& + \delta_7 HHI_{jt} + \delta_8 PPI_{jt} + size_{ijt} + \alpha_t + \alpha_j + v_{ijt},
\end{aligned} \tag{5}
$$

$$
\begin{aligned}
y_{ijt} &= y_{ijt}^{*} \quad if \quad d_{ijt} = 1, \\
y_{ijt} &= 0 \quad\;\; if \quad d_{ijt} = 0.
\end{aligned}
$$

The distribution of the error terms is $u_{ijt} \sim N(0, 1)$ and $v_{ijt} \sim N(0, \sigma^2)$ and it is assumed to be bivariate normal with correlation ρ. The equation (4) indicates the export market selection equation and the equation (5) indicates the observed export intensity equation. In other words, they indicate the export market participation decision and the export share decision of firm *i* in industry *j* in year *t*. The two equations are related since a correlation, $\rho \neq 0$, exists. Therefore, using simple OLS methodology to estimate the export share regression would result in inconsistent and biased coefficient estimates (Heckman, 1979).

Heckman two step estimation is performed with and without consideration of firm's absorptive capacity. Adding the interaction terms of absorptive capacity and spillover variables allows heterogeneous spillover effects on export behaviors of firms, depending on the firm's absorptive capacity. In addition to the spillover variables, firm-level and industry-level control variables such as TFP, foreign capital share, producer price index (PPI), and Herfindahl index (HHI) are included. TFP and foreign capital share are included both in export participation decision and export share decision in order to control for productivity and the specific effect for foreign multinational firms. A firm's age and capital/employment are included only in export participation decision since these variables are more likely to influence the decision to export, but not export intensity. Capital/employment implies the capital intensity which is more related to the possibility of exporting. Export intensity is more likely to be influenced by variable costs rather than fixed costs whereas export participation is more likely to be

influenced by fixed costs due to the sunk cost associated with export activity. Wage is included in the equation deciding how much to export since wage is more related to variable costs. In addition, the entry of multinational firms may decrease industry concentration, resulting in more competition. This competition effect forces domestic firms to improve their productivity, which may increase the probability of exporting as well as export intensity. Thus, similar to Javorcik (2004), we separate this competition effect from the spillover effects by including the Herfindahl index.[2] Producer price index (PPI) is included since the domestic price can affect the export activity of firms. The dummy variable for firm size[3] is included to control for technology differences across different sizes of firms, which influence both export participation and export intensity. Industry fixed effects are included to control for industry-specific factors. For instance, some industries are more export-oriented than others. A dummy variable for year is included to control for macroeconomic shocks. For instance, the shock of financial crisis in 2008 probably influences both export participation and export intensity.

3. ESTIMATION RESULTS

When absorptive capacity is not considered in the model, spillover effects are not found, as shown in table 3. However, when an absorptive capacity variable of R&D intensity is added into the model, the result shows that the interaction terms of absorptive capacity with horizontal and backward spillovers become significant in the export participation equation, and the interaction term of absorptive capacity with backward spillover becomes

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[2] The Herfindahl Index for industry j at time t is calculated by $HHI_{jt} = \sum_{i \in j} s_i^2$, where s_i is a market share of a firm i in industry j.

[3] The size dummy variable is constructed as follows. If a firm has the numbers of employees fewer than 100 employees, it belongs to ‘very small’; between 100 and 199 employees, it belongs to ‘small’; between 200 and 299 employees, it belongs to ‘medium’; between 300 and 999 employees, it belongs to ‘large’; and ‘very large’ for firms with 1,000 or more employees.

Table 3 Results with All Firms

	Without Absorptive Capacity		With Absorptive Capacity of R&D		With Absorptive Capacity of Patent	
	Export Participation	Export Share	Export Participation	Export Share	Export Participation	Export Share
Foreign Capital Share	0.0056***	0.0005***	0.0058***	0.0005***	0.0058***	0.0005***
	(0.0005)	(0.0001)	(0.0005)	(0.0001)	(0.0005)	(0.0001)
ln*TFP*	0.1204***	0.0211***	0.1355***	0.0224***	0.1431***	0.0210***
	(0.0152)	(0.0045)	(0.0153)	(0.0046)	(0.0153)	(0.0046)
ln*Wage*		0.0121**		0.0120**		0.0125**
		(0.0059)		(0.0059)		(0.0059)
Age	0.0161***		0.0165***		0.0166***	
	(0.0008)		(0.0008)		(0.0008)	
Capital/ Employment	0.0010***		0.0010***		0.0009***	
	(0.0002)		(0.0002)		(0.0002)	
Horizontal	–0.0021	0.0000	–0.0060*	–0.0002	–0.0057*	0.0001
	(0.0031)	(0.0007)	(0.0032)	(0.0008)	(0.0032)	(0.0008)
Backward	0.0111	0.0016	0.0091	0.0005	0.0106	0.0013
	(0.0108)	(0.0030)	(0.0109)	(0.0030)	(0.0109)	(0.0030)
Forward	–0.0077	–0.0001	–0.0097	–0.0004	–0.0085	–0.0004
	(0.0188)	(0.0050)	(0.0189)	(0.0050)	(0.0189)	(0.0050)
*Horizontal*A.C.*			0.1310***	0.0022	4.5990***	–0.1301
			(0.0273)	(0.0068)	(0.8306)	(0.1456)
*Backward*A.C.*			0.1084**	0.0559***	–1.3963	0.5562
			(0.0538)	(0.0174)	(1.8895)	(0.3560)
*Forward*A.C.*			–0.0778	–0.0230	2.9007	–0.0681
			(0.0512)	(0.0145)	(1.9091)	(0.2510)
HHI	–0.2451	–0.1351	–0.2052	–0.1521	–0.2881	–0.1410
	(0.8185)	(0.1921)	(0.8188)	(0.1918)	(0.8200)	(0.1920)
PPI	0.0004	–0.0005	0.0008	–0.0005	0.0010	–0.0006
	(0.0015)	(0.0004)	(0.0015)	(0.0004)	(0.0015)	(0.0004)
Obs	22,510	22,510	22,510	22,510	22,510	22,510

Notes: * significant at the 10% level. ** significant at the 5%. *** significant at the 1% level.

significant in the export share equation. Whereas no export spillovers exist for firms without any R&D expenditure, there exist positive spillovers for firms with higher R&D intensity. In addition, when an absorptive capacity variable of patent intensity is added into the model, the result shows that the interaction term of absorptive capacity with horizontal spillover becomes significant in the export participation equation. The significant positive signs of interaction terms imply that firms with absorptive capacity receive positive export spillovers from foreign multinationals whereas firms without absorptive capacity do not receive any positive export spillovers from foreign multinationals. Thus, absorptive capacity seems to be important to capture the positive export spillovers from FDI.

The estimation is now restricted to only domestic firms to investigate export spillovers from FDI on domestic firms. When the model is estimated with a subsample of domestic firms only, the result is similar to the one with a full sample, as shown in table 4. Without considering the absorptive capacity in the model, no spillover effects exist. However, when an absorptive capacity variable is added to the model, the result shows that the interaction terms of absorptive capacity with horizontal and forward spillovers become significant in export participation regression, and the interaction term of absorptive capacity with backward spillover becomes significant in export share regression. The estimation result using patent intensity as a measure of absorptive capacity is qualitatively similar to the one using R&D intensity. Therefore, the presence of foreign multinationals positively influences the export performance of domestic firms with absorptive capacity. However domestic firms without absorptive capacity do not receive any positive export spillovers form foreign multinationals.

However, we need to address an econometric concern of a potential endogenous problem of firms' export decision and firms' absorptive capacity measures. In order to reduce this issue, we include lagged variables for R&D intensity and patent intensity. The lagged variables of absorptive capacity measure are less likely to respond to the current year shock to firm's export behavior. In the similar way, we need to consider endogeneity problem of

Table 4 Results with Domestic Firms Only

	Without Absorptive Capacity		With Absorptive Capacity of R&D		With Absorptive Capacity of Patent	
	Export Participation	Export Share	Export Participation	Export Share	Export Participation	Export Share
Foreign Capital Share	0.0407*** (0.0061)	0.0017 (0.0012)	0.0386*** (0.0061)	0.0016 (0.0012)	0.0394*** (0.0061)	0.0016 (0.0011)
ln *TFP*	0.1341*** (0.0161)	0.0238*** (0.0050)	0.1516*** (0.0163)	0.0257*** (0.0050)	0.1586*** (0.0163)	0.0234*** (0.0050)
ln*Wage*		0.0128* (0.0066)		0.0123* (0.0066)		0.0130** (0.0066)
Age	0.0162*** (0.0009)		0.0168*** (0.0009)		0.0168*** (0.0009)	
Capital/ Employment	0.0011*** (0.0002)		0.0010*** (0.0002)		0.0010*** (0.0002)	
Horizontal	–0.0031 (0.0032)	0.0003 (0.0008)	–0.0057* (0.0034)	0.0000 (0.0008)	–0.0062* (0.0033)	0.0004 (0.0009)
Backward	0.0109 (0.0115)	0.0027 (0.0033)	0.0107 (0.0116)	0.0014 (0.0033)	0.0098 (0.0116)	0.0021 (0.0033)
Forward	–0.0147 (0.0196)	0.0009 (0.0053)	–0.0194 (0.0197)	0.0006 (0.0053)	–0.0171 (0.0197)	0.0006 (0.0053)
*Horizontal*A.C*			0.0906*** (0.0290)	0.0051 (0.0072)	3.5384*** (0.8456)	–0.1574 (0.1482)
*Backward*A.C.*			–0.0484 (0.0678)	0.0518*** (0.0181)	–0.5425 (2.0317)	0.6319* (0.3667)
*Forward*A.C.*			0.1501** (0.0682)	–0.0195 (0.0151)	4.5397** (2.0272)	–0.0692 (0.2538)
HHI	0.0601 (0.8554)	–0.2259 (0.2046)	0.1232 (0.8564)	–0.2435 (0.2045)	0.0187 (0.8576)	–0.2336 (0.2042)
PPI	0.0006 (0.0015)	–0.0005 (0.0004)	0.0008 (0.0015)	–0.0005 (0.0004)	0.0011 (0.0015)	–0.0006 (0.0004)
Obs	20,075	20,075	20,075	20,075	20,075	20,075

Notes: * significant at the 10% level. ** significant at the 5%. *** significant at the 1% level.

Table 5 Results with Domestic Firms Only Using Lagged Variables

	With Absorptive Capacity of Lagged R&D		With Absorptive Capacity of Lagged Patent	
	Export Participation	Export Share	Export Participation	Export Share
Foreign Capital Share	0.0383*** (0.0074)	0.0024* (0.0013)	0.0395*** (0.0075)	0.0024* (0.0013)
ln*TFP* $_{t-1}$	0.1482*** (0.0216)	0.0173*** (0.0060)	0.1544*** (0.0217)	0.0163*** (0.0061)
ln*Wage*		0.0290*** (0.0074)		0.0289*** (0.0074)
Age	0.0159*** (0.0011)		0.0160*** (0.0011)	
Capital/Employment	0.0011*** (0.0002)		0.0010*** (0.0002)	
Horizontal	0.0055 (0.0052)	–0.0004 (0.0013)	0.0012 (0.0051)	–0.0001 (0.0013)
Backward	0.0136 (0.0152)	0.0007 (0.0040)	0.0132 (0.0151)	0.0021 (0.0040)
Forward	–0.0382 (0.0278)	–0.0036 (0.0074)	–0.0326 (0.0278)	–0.0042 (0.0074)
*Horizontal*A.C.*$_{t-1}$	–0.0540* (0.0277)	–0.0020 (0.0071)	4.5315*** (1.0682)	–0.2549 (0.2160)
*Backward*A.C.* $_{t-1}$	–0.0209 (0.0951)	0.0591*** (0.0205)	3.4646 (2.6589)	0.1425 (0.5336)
*Forward*A.C.* $_{t-1}$	0.3889*** (0.1039)	–0.0175 (0.0196)	0.6750 (2.5706)	0.6452 (0.5322)
HHI	0.5369 (1.3672)	–0.0875 (0.3426)	0.7494 (1.3695)	–0.0681 (0.3423)
PPI	–0.0001 (0.0029)	–0.0003 (0.0008)	0.0002 (0.0029)	–0.0003 (0.0008)
Obs	13,814	13,814	13,814	13,814

Notes: * significant at the 10% level. ** significant at the 5%. *** significant at the 1% level.

firm's productivity and export decision due to the simultaneity of productivity and exporting behaviors. Therefore, we also include a lagged variable for productivity to reduce this endogeneity problem. As shown in table 5, it is found that the interaction terms of lagged R&D intensity with horizontal spillover variable is negative at 10 percent significance level and the interaction terms of lagged R&D intensity with forward spillover variable is positive at 1 percent significance level in the export participation decision equation. In addition, in the export share equation, the interaction terms of lagged R&D intensity with backward spillover variable is positive at 1 percent significance level. However, we find that the interaction term of lagged patent intensity with horizontal spillover variable is positive at 1 percent significance level in the export participation regression and none of interaction terms of lagged patent intensity with spillover variables are significant in the export share regression. When we take endogeneity of firm's export decision and firm's absorptive capacity measures into consideration in the regression, the role of absorptive capacity to capture the positive spillovers from foreign presence become less significant and inconsistent.

4. CONCLUSION

This paper examines the spillover effects of FDI on export decisions among manufacturing firms for the period 2006-2009 in South Korea. In particular, it examines the effects of FDI in the same industry and in vertically related industries on (1) the probability of exporting, and (2) the export intensity of firms. In addition, while previous literature pays little attention to the role of absorptive capacity in capturing benefits from export spillovers from foreign multinationals, the paper examines the role of absorptive capacity by including interaction terms between the spillover variables and measures of firm's absorptive capacity. The main result is that FDI does not generate significant spillover effects on export activities of domestic firms, in general. Without considering the endogeneity problem, the results seem to provide the evidence

of heterogeneous spillover effects from FDI on domestic firm's export activity. However when the econometric issue of the endogeneity problem of firm's export decision and firm's absorptive capacity measures is taken into account in the regression model, the role of absorptive capacity to capture the positive spillovers from foreign presence become less significant and inconsistent. Furthermore, the use of different measures of firm's absorptive capacity to check the robustness of the model results in inconsistent findings.

Therefore, the result shows that there exist no consistent positive spillovers from FDI on export activities of domestic firms. Without considering endogeneity, the misleading findings can be resulted. Based on the findings of this paper, the incentive policy to attract more FDI with the strong belief that FDI encourages domestic firms to export should be reconsidered. The government of South Korea provides foreign investors many forms of incentives. For instance, tax exemptions and reductions, financial support for employment and training, and cash grants for R&D investment and the business operation are provided (Ahn, 2008). In addition, 'Invest KOREA', Korea's national investment promotion agency, is established to offer one-stop service for foreign investors in order to attract more FDI (Ahn, 2008).

No clear evidence of positive spillovers can be explained by the recent period of data set used in this paper. Recently, the information about international market is easily gained through internet and other sources of media. Thus, there exists not much information barrier that can limit domestic firms to export market participation. The new information about global markets from foreign multinationals which can encourage domestic firms to export is less likely to exist in the era of information technology when the much information is easily available. In addition, the different objectives of FDI, depending on whether foreign multinationals are domestic market oriented or export-oriented, can have heterogeneous impact on export activity of domestic firms. Furthermore, geographical distance between foreign multinationals and domestic firms which is not taken into account in the analysis of this paper might matter for the export spillovers. Although the positive spillover effects from foreign multinationals exist, the market-stealing

effect may dominate the positive spillover effects. As a result, there exists no clear evidence of export spillover effects from FDI. Moreover, the econometric analysis of this paper may suffer from potential problems associated with the role of unobserved heterogeneity at the firm level, which results in inconsistent findings.

For future study, it would be interesting to examine the spillover effects from export-oriented FDI and market-seeking FDI. For instance, the objective of Japanese investment in China's manufacturing industries is more likely to be export-oriented by using China as a production base in order to serve the global market (Xing, 2006). When FDI is export oriented, there is less linkage between foreign firms and domestic firms. However, the objective of FDI is to serve domestic markets, foreign firms are more likely to have close relationship with domestic firms. Thus, the objective of FDI might matter for positive spillovers. In addition, it would be interesting to take into account the origin country of FDI in the model since FDI from an advanced country may play a different role compared to the one from a developing country. Furthermore, investigating how export activity by foreign multinationals rather than the presence of foreign multinationals affect the export participation and export share of domestic firms will be an interesting future study. This paper does not consider the case where domestic firms can use imported inputs which may be technologically advanced. The recent trade data shows that more than 70 percent of South Korea's imports are intermediate goods. Domestic firms that use these imported intermediate inputs may perform better than those which do not use them. As empirically shown in Fariñas and Martín-Marcos (2010), firms sourcing abroad have higher productivity than firms do not source abroad. Thus, it will be worthwhile to consider this feature of the recent trade flow for future study. Finally, this paper may suffer from a potential endogeneity problem due to the fact that using lagged variables of absorptive capacity measures may not perfectly solve the endogeneity. Therefore, it would be a future empirical study to find right instrument variables to solve the endogeneity in the model.

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