Industry Linkages and Productivity Spillovers from Foreign Direct Investment: Evidence from Firms in Cambodia*

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This paper studies horizontal and vertical productivity spillovers from Foreign Direct Investment (FDI) to the host country. By using firm-level data from Cambodia and regression method for panel data, the study reveals that domestic firms significantly benefit from the vertical and horizontal productivity spillovers when their level of technology is moderately below that of foreign competitors. The finding suggests that promoting FDI in upstream and downstream industries is needed in developing countries where the technology gap exists.

I. Introduction

The host country expects that technology brought by FDI can spill over to domestic firms and promote growth because theories of multinational firms and FDI suggest that foreign firms possess superior knowledge, which is their competitive advantage. Furthermore, the experience of Newly Industrialized Countries shows that such spillover promotes growth (Markusen and Venables, 1999).

In Cambodia, the amount of FDI recently increased from US$ 2.7 billion in 2007 to US$ 10.9 billion in 2008. The most-favored investment sector is the garment sector with US$ 148 million in fixed assets in 2008 (ASEAN Japan Center, 2008). Moreover, along with the policies to attract FDI, the Royal Government of Cambodia is also implementing several policies to support domestic small and medium-scale enterprises (SMEs). As the two policies are implemented simultaneously, examining the linkage between FDI and SMEs is very helpful for policy implication.

Productivity spillover from FDI takes place when foreign firms increase the productivity of domestic firms in a host country, and the multinationals do not fully internalize the values of these benefits (Javorcik, 2004). Two types of productivity spillover are usually mentioned in literatures: *horizontal spillover* and *vertical spillover* (Gorg and Greenaway, 2004; Smeets, 2008). Horizontal productivity spillover is also called within-industry spillover because it takes place when foreign and domestic firms are in the same industry. Through this channel, productivity spillover could occur in three possible ways. Firstly, in order to compete,

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domestic firms need to upgrade their technology. Secondly, domestic firms may imitate foreign firms' technology. Finally, workers may quit foreign firms to join domestic firms or set up their own firms (Blomstrom and Kokko, 1998).

Although the horizontal spillover, theoretically, can occur through the abovementioned channels, the effect remains empirically unclear. Existing studies have shown a mixed result of either positive or no spillover (Gorg and Greenaway, 2004).

Vertical productivity spillover is called *between-industry spillover* as it takes place between different industries. The linkage between FDI in one industry and firms in other industries could be created by two forms of FDI: *backward FDI* and *forward FDI*. Backward FDI is the FDI in final goods sectors that create demand for intermediate goods produced by domestic firms. This type of FDI has long been theoretically studied since Rodriguez-Clare (1996). In principle, backward FDI enables productivity spillover through three channels. Firstly, the fact that foreign firms need supplies of intermediate goods from domestic firms encourages domestic firms to upgrade their technology in order to be able to supply high quality intermediate goods to foreign firms. Secondly, domestic suppliers may imitate the technology of foreign firms' suppliers, so they can produce intermediate goods of similar quality. Finally, in order for domestic firms to be able to produce intermediate products of desired quality, foreign firms may opt to transfer the technology to their domestic suppliers directly.[1)]

In contrast, forward FDI is the FDI in the input industry that supplies intermediate goods to domestic producers of final products. By supplying intermediate goods of high quality, foreign firms indirectly help improve productivity of their domestic buyers. The relationship was empirically studied by Javorcik (2004).

Although it is clear in the theory about how backward or forward FDI facilitates the productivity spillover, empirical evidence of the effect of these two channels is mixed. Some researchers find positive productivity spillover (Jabbour and Mucchielli, 2007; Bitzer, Geishecker, and Gorg, 2008), while other researchers report only limited or weak vertical productivity spillover (Girma and Gong, 2008; Giuliani, 2008).

What explains these differentials in the findings on productivity spillover? Among all the myriad factors, two important explanations are *technology gap* and *absorptive capacity* of domestic firms.

Existing conceptual debates suggest that the technology gap between domestic firms and foreign firms influences the ability of domestic firms to benefit from the productivity spillover, but it is unclear whether a large gap or a small gap is better. Findlay (1978) argues that the rate of technological progress in the relatively "backward region" is an increasing function of the gap between its own level of technology and that of the "advanced region". The gap indicates the existence of new technological knowledge for domestic firms to learn. However, this disparity must not be too wide for the thesis to hold. In contrast, Wang and Blomstrom (1992) explain that the profit of the domestic firm is negatively related to the technology gap, while that of the multinationals is positively related to the gap. Therefore, when the gap is small, foreign firms transfer more advanced technology as they need to compete with domestic firms to guarantee their profits (Glass and Saggi, 1998).

Existing empirical studies also report conflicting findings on the effect of the technology gap on productivity spillover. Using the ratio of total factor productivity (TFP) to the maximum TFP in the UK electronic and engineering sector, Girma and Gorg (2007) show that reduction in the technology gap enhances the ability of domestic firms to benefit from the productivity spillovers. In contrast, Castellani and Zanfei (2003), measuring the technology gap by using the ratio of domestic firms' TFP to their industries's average TFP, find that a large gap positively affects the technology transfer.

On the other hand, how does absorptive capacity affect productivity spillover? Cohen and Levinthal (1989) define the term "absorptive capacity" as "the ability to recognize the value of new information, assimilate it and apply it for commercial end". They explain that an organization needs prior related knowledge to assimilate new knowledge. So-far, existing studies have employed various indicators of absorptive capacity, including research and development (R&D) and non-R&D, to investigate the effect of absorptive capacity on productivity spillover. R&D represents the absorptive capacity of firms because investment in R&D gives domestic firms prior knowledge that enables them to acquire new knowledge from foreign firms. In addition, they also postulate that there are costs associated with the imitation of new knowledge, but those costs are minimized by virtue of existing R&D conducted by the firm to enhance its absorptive capacity in the relevant field.

Findings from existing studies consistently suggest the positive impact of absorptive capacity on productivity spillover. For example, Cohen and Levinthal (1989) study the US firms and find that they have the high ability to acquire new knowledge due to their tremendous investment in R&D activities. Similarly, Griffith, Redding and Reenen (2004) have found that R&D enables domestic firms to imitate the technology of foreign firms in the case of Czech Republic and 12 OECD countries. Regarding non-R&D indicators, Barrios and Strobl (2002) and Girma, Gorg and Pisu (2008) show that the export status of domestic firms in Spain and UK, an indicator of absorptive capacity, affects their ability to benefit from the productivity spillover.

This study is conceived with the aim of filling two substantial gaps in the existing literature. Firstly, very few studies have examined the effect of vertical FDI and the technology gap on the productivity spillover on domestic firms. Moreover, notwithstanding the fact that the productivity spillover can occur through vertical and horizontal channels, only a limited number of studies have been conducted to examine the effect of vertical productivity spillover and the technology gap together (see for example, Wang, 2010). This study, therefore, extends the literature by incorporating both vertical and horizontal channels into the investigation. To put it another way, this paper examines how backward and forward FDI affect the productivity of domestic firms when there is a gap in the technology level between domestic firms and foreign firms. Secondly, this study attempts to introduce two new proxies of absorptive capacity that affect the productivity spillover.

This paper chooses Cambodia as a case study for three reasons. Firstly, Cambodia has enjoyed impressive economic growth due to the large in-flow of FDI. Secondly, along with efforts to attract FDI, the Royal Government of Cambodia is also working hard to promote SMEs. Finally, although there are a few studies examining the productivity spillover in manufacturing firms in Cambodia (see, for example, Cuyvers, Soeng, Plasmans and Bulcke, 2008) and reporting positive spillover from FDI, they did not investigate the effect of the vertical linkage and technology gap on productivity spillover.

The findings show that domestic firms can benefit from the productivity spillover when the level of their technology is moderately below that of the foreign firms. The absorptive capacity measured by workers' education and training do not have statistically significant effects on the productivity.

The remainder of this paper is organized into four sections. Section II describes methods and data used and is followed by Section III, which discusses the findings. Finally, Section IV concludes the paper and draws some implications from the findings.

Ⅱ. Methods and Data

1. Model specification

To estimate the productivity spillover, this paper follows the conventional method by regressing domestic firms' labor productivity on the presence of FDI in the same industries (horizontal FDI), upstream industries (forward FDI) and downstream industries (backward FDI). Gorg and Greenaway (2004) and Smeets (2008) do a thorough literature survey of this conventional method. The effect of productivity spillover is present if the coefficient of FDI is positive. However, this conventional method, as pointed out by Javorcik (2004) and Blalock and Gertler (2009), has problems of unobserved variables and simultaneity bias. This paper deals with these problems by using panel data and random and fixed effect models.

To study how the absorptive capacity and the technology gap affect the productivity spillovers, this paper uses interaction terms of FDI with proxies of absorptive capacity and technology gap. The interaction method is used due to its simplicity and the convenience of interpretation. Following Dimelis and Louri (2004), this paper uses the below specification:

$$V_{ijt} = L_{ijt}^{\beta_1} K_{ijt}^{\beta_2} e^{\beta_0+\beta_3 FDI_{jt}+\beta_4 FDI_{jt} * AC_{ijt}+\beta_5 AC_{ijt}+\beta_6 FDI_{jt} * TGap_{ijt}+\beta_7 TGap_{ijt}+\varepsilon_{ijt}} \quad (1)$$

where V_{ijt}, L_{ijt}, and K_{ijt} are the value added, labor and capital of firm i in sector j at time t respectively. AC_{ijt} is a proxy vector of absorptive capacity. FDI_{jt} is a variable representing horizontal, backward or forward FDI for firms in sector j. $TGap_{ijt}$ is the technology gap and ε_{ijt} is the error term.

By taking logarithm of both sides of (1) and rearranging the result, we obtain:

$$ln\left(\frac{V_{ijt}}{L_{ijt}}\right)=\beta_0+\theta lnL_{ijt}+\beta_2 ln\left(\frac{K_{ijt}}{L_{ijt}}\right)+\beta_3 FDI_{jt}+\beta_4 FDI_{jt} * AC_{ijt}+\beta_5 AC_{ijt}+\beta_6 FDI_{jt} * TGap_{ijt}+\beta_7 TGap_{ijt}+\varepsilon_{ijt} \quad (2)$$

where $\theta = \beta_1+\beta_2-1$. By rewriting the error term in equation (2) as $\varepsilon_{ijt}=d_t+\omega_i+\eta_{ijt}$, the following specification is obtained for the regression analysis.

$$\ln\left(\frac{V_{ijt}}{L_{ijt}}\right)=\beta_0+\theta \ln L_{ijt}+\beta_2 \ln\left(\frac{K_{ijt}}{L_{ijt}}\right)+\beta_3 FDI_{jt}+\beta_4 FDI_{jt} * AC_{ijt}+\beta_5 AC_{ijt}+\beta_6 FDI_{jt} * TGap_{ijt}+\beta_7 TGap_{ijt}+d_t+\omega_i+\eta_{ijt} \quad (3)$$

where d_t is the dummy for time. ω_i is firm's unobserved effect. η_{ijt} is an error term.

As mentioned in the first section, the technology gap indicates the existence of new technological knowledge for domestic firms to learn. The coefficients β_6 of the interaction term of *TGap* and *FDI* will capture the effect of technology gap on productivity spillover caused by *FDI*. Similarly, the absorptive capacity affects the ability of domestic firms to benefit from the productivity spillover caused by *FDI*. Therefore, the coefficient β_4 of the interaction term between *AC* and *FDI* will capture this effect.

This study employs two proxies of absorptive capacity, the percentage (*H*) of workers with education higher than lower secondary school in each firm and dummy of training (*TR*) which equals one if firm offers training to its workers. These proxies are more suitable as the proxy of absorptive capacity than R&D expenditure for two reasons.

Firstly, FDI to least-developed countries often brings less complicated technology, especially in labor-intensive and service firms of host countries; hence, domestic firms do not necessarily invest heavily in R&D activities to catch up with foreign firms. The high level of workers' education and additional training may do the work. Secondly, although R&D is probably needed, SMEs may not have a big budget to spend on it. For these reasons, R&D is probably less visible in the case of labor-intensive and service industries. Wang (2010) also uses workers' education to examine the effect of absorptive capacity in the vertical channel.

Equations (2) and (3) are estimated separately for horizontal FDI (HFDI), backward FDI (BFDI) and forward FDI (FFDI) because horizontal, backward and forward FDI are highly correlated as shown by results in section III. Blalock and Gertler (2008) also explain a similar strong correlation problem. Equation (2) is estimated using OLS, and equation (3) is estimated using fixed effect (FE) and random effect (RE) models to allow for firms' unobserved effects.

2. Data and main variables

Recently, Cambodia has been receiving a large amount of FDI (US$ 2.7 billion in 2007 and US$ 10.8 billion in 2008). The manufacturing industry received the largest number of FDI projects (66 projects with fixed assets of US$ 715 million in 2008) and is followed by the tourism industry (20 projects with fixed assets of US$ 8.7 billion in 2008), the service industry (nine projects with fixed assets of US$ 1.2 billion in 2008) and the agricultural industry (six projects with fixed assets of US$ 106 million in 2008). Within the manufacturing industries, the garment sector receives the largest number of FDI projects (38 projects) of US$ 148 million in 2008 (Cambodia Investment Board and ASEAN JAPAN Center, 2008).

In this paper, data from a firm survey conducted in 2006 by the World Bank (data available at the website of World Bank enterprise surveys) is used. Although the total sample size of the survey is 499, only 416 firms with complete information are used. The surveyed firms consist of both manufacturing firms and non-manufacturing firms. All the firms were asked about their sales and input use in 2005 and 2006. If the share of equity owned by foreign investors exceeds 50 percent, the firm is regarded as a foreign firm. This classification is based on the Company Law of Cambodia.[2)] Appendix 1 presents distribution of domestic and foreign firms in each sector.

To study the linkage between sectors, this paper uses the modified input-output table developed by Oum (2008) because the classification of sectors in the table is particularly suitable for the data used in this study and requires little modification. Appendix 2 presents coefficients of input-output table used in the empirical analysis.

To estimate equations (2) and (3), the following main variables are defined. The value added V is constructed by subtracting from sales expenditures on material and energy. Labor L is the number of permanent workers. Capital K is measured by spending on investment in land, building and equipment. The spending on investment is chosen to represent capital because there is no panel data on the book value of fixed assets. The value added and capital are deflated using consumer price index.

The horizontal FDI is calculated by following Javorcik (2004) and Blalock and Gertler (2008).

$$HFDI_{jt} = \frac{\sum_{i\epsilon j} Foreign\_Y_{ijt}}{\sum_{i\epsilon j} Y_{ijt}} \quad (4)$$

where $\sum_{i\epsilon j}$ indicates the summation is taken over firms in a given sector j. $Foreign\_Y_{ijt}$ is equal to the amount of sales Y_{ijt} of firm i if this firm is foreign and 0 otherwise.

As defined in the first section, the backward FDI is the FDI in final goods sectors that create demand for intermediate goods produced by domestic firms. Similarly to Marcin (2008), it is calculated as follows:

$$BFDI_{jt} = \sum_{k(\neq j)} \alpha_{jk} HFDI_{kt} \quad (5)$$

The coefficient α_{jk} is the share of sector j's output supplied to sector k in its total output, which is taken from input-output table.[3] Therefore, we can assume that FDI invested within sector k at time t, $HFDI_{kt}$, induces the backward FDI of α_{jk} $HFDI_{kt}$ of sector j which supplies intermediate goods to sector k. If that is the case, $BFDI_{jt}$ defined in equation (5) might be a plausible index of the backward FDI of sector j at time t.

Furthermore, the forward FDI is the FDI in the input industry that supplies intermediate goods to domestic producers of final products. It is calculated by following Marcin (2008).

$$FFDI_{jt} = \sum_{k(\neq j)} \alpha_{kj} HFDI_{kt} = \sum_{k(\neq j)} \alpha_{kj} \left[\left[\sum_{i\epsilon k} Foreign\_Y_{ikt} \right] / \left[\sum_{i\epsilon k} Y_{ikt} \right] \right] \quad (6)$$

The coefficient α_{kj} is the share of sector j's input bought from sector k in its total input, which is taken from the input-output table. Therefore, we can assume that FDI invested within sector k at time t, $HFDI_{kt}$, induces the forward FDI of $\alpha_{kj} HFDI_{kt}$ of sector j which buys intermediate goods from sector k. If that is the case, $FFDI_{jt}$ defined in equation (6) might be a plausible index of the forward FDI of sector j at time t.

Equation (6) is slightly different from the forward FDI defined by Javorcik (2004):

$$FFDI_{jt} = \sum_{k(\neq j)} \alpha_{kj} \left[\left[\sum_{i\epsilon k} Foreignshare_{ikt} * (Y_{ikt} - X_{ikt}) \right] / \left[\sum_{i\epsilon k} (Y_{ikt} - X_{ikt}) \right] \right] \quad (7)$$

where X_{ikt} is export of firm i in industry

k at time t, and $Foreignshare_{ikt}$ is the share of firm's total equity owned by foreign investor. The two forward FDI indexes in (6) and (7) differ in two points. First, equation (7) uses a weight *Foreignshare* to sum up sales over firms, while equation (6) uses a weight of zero for non-foreign firms whose share of equity owned by foreign investors falls short of 50%. Second, the former subtracts exports from sales, while the latter does not. A main reason for this difference comes from unavailability of the data of *Foreignshare* and exports for individual Cambodian firms. Some other studies also face the same difficulties and use a definition similar to equation (6) (see Marcin (2008) and Wang (2010)). Therefore, it might be allowed to use definition (6), although definition (7) is more preferable.

To calculate backward and forward FDI in equations (5) and (6), Cambodia input-output table 2003 is used. As pointed by Javorcik (2004), since relationship between sectors may change over time, using input-output table for different years would be ideal. Unfortunately, Cambodia input-output table is available only for 2003.

Table 1 presents horizontal, backward and forward FDI indexes calculated by sector. The results show that textile and garment sectors have higher FDI indexes than other sectors. For example, the horizontal, backward and forward FDI indexes of garment sector are 0.92, 0.68 and 0.99, respectively. *HFDI* index of this sector is very high because most of the output is produced by foreign firms. Furthermore, *HFDI* index in other sectors induces 0.68 units of backward FDI to garment sector by supplying intermediate goods to them. Similarly, *HFDI* in other sectors induces 0.99 units of forward FDI to garment sector by buying intermediate goods from them.

Regarding absorptive capacity, this paper uses the percentage H of workers with lower secondary education (grade 7^{th} or higher) and a dummy variable TR which indicates whether or not firms offer training to their workers. Table 2 presents mean of these variables. Although the garment sector absorbs the largest number of foreign firms, only 46 percent of firms in this sector provide training to their workers. On the other hand, the textile sector, despite its small share in the manufacturing industry, offers the largest amount of training. More sectors in the service industry employ workers with secondary education or higher than sectors in the manufacturing industry. Within the manufacturing industry, the garment sector hires the least number of workers with this level of education (41 percent).

In order to measure the technology gap $TGap_{ij}$, this paper uses the following formula:

$$TGap_{ij} = \frac{LP_j^* - Mean(LP_{ijt})}{LP_j^*} \quad (8)$$

where $LP_{ijt} = \frac{V_{ijt}}{L_{ijt}}$ and $Mean(LP_{ijt}) = \frac{(LP_{ij2005} + LP_{ij2006})}{2}$. LP_j^* is the mean of $Mean(LP_{ijt})$ of all foreign firms in sector j.[4] Positive technology gap means the firm's productivity is below that of foreign firms.

Table 2 presents mean of the technology gap for each sector. It shows that a large majority of firms are below the international frontier with the exception of garment, plastic, construction and IT sector. Technology in the garment sector is just slightly above that of foreign firms. IT and construction have technology higher standard than the international frontier.

Ⅲ. Estimation Results

The indexes HFDI, BFDI and FFDI defined in equations (4), (5) and (6) are strongly correlated. The correlation coefficient of HFDI and BFDI is 0.90, that of HFDI and FFDI is 0.86, and that of BFDI and FFDI is 0.88. For this reason, their effects on labor productivity in equations (2) and (3) are estimated separately.

The two-year panel data are used to estimate these equations. To deal with unobserved effects, we adopt random effect (RE) and fixed effect (FE) estimation as well as pooled OLS estimation. The Hausman test is run to test consistency of RE against FE estimator for the three types of FDI. Table 3 presents results of estimated coefficients as well as the Hausman test. It shows that the null hypothesis is strongly rejected. Therefore, FE is preferred to RE.

Based on the results for FE estimation, we now examine the interaction terms between the technology gap or absorptive capacity and the three types of FDI in Table 3. The coefficients of TGap*HFDI in column (1), TGap*BFDI in column (2) and TGap*FFDI in column (3) are all positive and statistically significant at 1% level. On the other hand, the coefficients of the interaction terms between FDI and education H (H*HFDI, H*BFDI and H*FFDI) and those between FDI and training TR (TR*HFDI, TR*BFDI, and TR*FFDI) are not statistically significant.

The positive and statistically significant coefficient of the interaction term TGap*HFDI suggests the potential role of the technology gap in enabling the horizontal productivity spillover. When the technology gap exists, it indicates an available learning opportunity for domestic firms from their foreign competitors in the same industry. Similarly, the positive and statistically significant coefficient of the interaction term TGap*BFDI implies that the technology gap leads to backward productivity spillover in two ways. In the case of contracted foreign buyers, they need to improve productivity of their domestic suppliers to obtain higher quality intermediate goods. In another relationship, domestic suppliers aiming at attracting foreign buyers must improve their productivity up to a level that enables them to gain confidence from potential foreign buyers. Finally, the positive and statistically significant coefficient of the interaction term TGap*FFDI shows that due to the presence of the technology gap between the domestic firms in the final goods sector and their foreign competitors, domestic firms need to improve their productivity by using higher quality intermediate goods produced by foreign suppliers. This purchasing channel leads to forward productivity spillover.

On the other hand, the statistically insignificant coefficients of the interaction term between FDI and two proxies of absorptive capacity may be explained in the following way. It may be caused partly by relatively small variations in H (percentage of workers with higher education) and TR (training dummy). In addition, the survey used in this study reports that less than 50% of domestic firms offer training. It also reports that most domestic firms still need more workers with higher skill and education for their operation, which means their workers do not have sufficient skill for their jobs. These situations are likely to weaken effects of those two proxies on productivity spillover from increased FDI.

The above results have limitation because FE estimation can only deal with endogeneity caused by correlation between explanatory variables and time-invariant unobservable effects. Nonetheless, they can be at least a first step to obtain better results that can be derived from more demanding methods.

Ⅳ. Conclusions and Implications

This paper aims at studying the effects of horizontal and vertical productivity spillover from FDI to domestic firms. By using the panel data of 416 firms in Cambodia, the study lends support to findings of existing studies on the effects of the technology gap on productivity spillover. The estimation results show that FDI leads to productivity spillover only under the condition of a positive technology gap. Whereas most of the existing studies investigate the effects of the technology gap in the context of horizontal FDI alone, this study finds that the technology gap has positive effect on the productivity spillover from both horizontal and vertical FDI to domestic firms. This finding adds more evidence to a scarce literature on the effect of the technology gap in the context of vertical FDI. On the other hand, this study could not find significant effects of education and training on productivity spillover from FDI.

The finding on the effect of the technology gap provides a significant policy implication for the Cambodian government. Similarly to most developing countries, domestic firms in Cambodia still have a technology gap when compared with foreign competitors. The gap indicates the need for domestic firms to improve their productivity. Under this circumstance, FDI can help domestic firms directly or indirectly overcome this technology gap and thus can lead to improvement in domestic firms' productivity. Therefore, with the existence of the technology gap, the Cambodian government should aim at policies that attract both horizontal and vertical FDI.

To produce a better estimation result, future research should focus on three things. Firstly, this paper estimates the productivity spillover by pooling firms across sectors due to small sample size. The findings can be enriched by using a large sample, which enables estimation of the model for each sector separately. Secondly, this paper uses a simple fixed effect and random effect models to deal with potential endogeneity. This method works well only with unobservable variables that are invariant across time. Alternative methods proposed by Blundell and Bond (2000) and Bond (2002) should be used if it is possible. Thirdly, it might be better to investigate alternative forms of production technology because all the coefficients of capital-labor ratio in Table 3 are insignificant. Finally, since deflators for each sector are not available, the study uses the overall consumer price index (CPI) to deflate relevant variables. Although deflating with overall CPI may at least give better estimated coefficients than those without deflating, future studies should use deflators for each sector.

Table 1 Horizontal, Backward and Forward FDI Indexes by Sector

Name of Sector	HFDI2005	BFDI2005	FFDI2005
Foods	0.68	0.08	0.24
Textile	0.99	0.74	1.07
Garments	0.92	0.68	0.99
Plastics and Rubber	0.68	0.57	0.21
Other Manufacturing	0.85	0.14	0.84
Wholesale (include export service)	0.25	0.05	0.11
Retail	0.10	0.02	0.04
Hotels and Restaurants	0.20	0.04	0.00
Other services (travel agencies, tour)	0.33	0.14	0.03
Construction	0.60	0.11	0.07
Transport	0.68	0.39	0.14
IT	0.11	0.06	0.02
Others	0.59	0.25	0.05

Table 2 Means of Two Proxies of Absorptive Capacity and Technology Gap

Name of Sector	Number of Firms (domestic and foreign)	TR	H	Technology Gap
Foods	9	0.33	0.66	0.67
Textile	6	0.83	0.54	0.13
Garments	73	0.46	0.41	-0.02
Plastics and Rubber	5	0.60	0.54	-0.53
Other Manufacturing	14	0.57	0.68	0.67
Wholesale (include export service)	29	0.68	0.87	0.13
Retail	61	0.34	0.90	0.80
Hotels and Restaurants	103	0.47	0.78	0.42
Other services (travel agencies, tour)	20	0.60	0.98	0.05
Construction	9	0.44	0.67	-2.34
Transport	21	0.52	0.95	0.49
IT	5	0.60	1.00	-0.44
Others	61	0.55	0.88	0.29

Note: The variable TR denotes a dummy variable which indicates whether or not firms offer training to their workers. The variable H denotes the percentage of employed workers with lower secondary education (grade 7^{th} or higher).

Table 3 Estimation Results of Equations (2) and (3)

	(1) Horizontal FDI				(2) Backward FDI				(3) Forward FDI		
Independent Variables	Log(Value added/Labor)			Independent Variables	Log(Value added/Labor)			Independent Variables	Log(Value added/Labor)		
	OLS	RE	FE		OLS	RE	FE		OLS	RE	FE
Constant	4.13***	3.79***	5.78***	Constant	3.63***	3.42***	5.78***	Constant	5.26***	3.40***	5.95***
	(0.51)	(0.30)	(0.34)		(0.33)	(0.25)	(0.33)		(1.51)	(0.24)	(0.45)
ln(L)	0.07*	-0.02	-0.68***	ln(L)	0.10**	-0.05	-0.67***	ln(L)	0.11***	-0.04	-0.66***
	(0.04)	(0.05)	(0.12)		(0.04)	(0.05)	(0.12)		(0.04)	(0.05)	(0.12)
ln(K/L)	0.02	0.02	0.05	ln(K/L)	0.01	0.01	0.06	ln(K/L)	0.01	0.01	0.06
	(0.02)	(0.02)	(0.06)		(0.02)	(0.03)	(0.06)		(0.02)	(0.03)	(0.06)
HFDI	-0.85	-0.34	-0.02	BFDI	-0.89	1.80*	-1.23	FFDI	-7.42	0.59	-0.99
	(0.72)	(0.54)	(1.04)		(1.69)	(1.08)	(2.56)		(6.33)	(0.58)	(9.13)
H	0.22	0.38		H	0.37**	0.67***		H	0.32**	0.58**	
	(0.23)	(0.31)			(0.18)	(0.25)			(0.16)	(0.24)	
TR	-0.13	-0.03		TR	-0.11	0.08		TR	-0.17**	0.02	
	(0.13)	(0.16)			(0.10)	(0.14)			(0.09)	(0.13)	
TGap	-0.93***	-0.89***		TGap	-0.61***	-0.67***		TGap	-0.57***	-0.53***	
	(0.06)	(0.07)			(0.05)	(0.06)			(0.04)	(0.05)	
H* HFDI	0.09	-0.20	-0.55	H*BFDI	-0.34	-2.30*	-0.36	H*FFDI	0.18	-0.13	-2.49
	(0.52)	(0.60)	(1.14)		(1.11)	(1.18)	(2.76)		(0.49)	(0.73)	(10.37)
TR *HFDI	0.01	0.14	-0.03	TR*BFDI	-0.37	-0.56	0.08	TR *FFDI	0.21	-0.13	-3.52
	(0.34)	(0.37)	(0.52)		(0.58)	(0.71)	(1.23)		(0.38)	(0.55)	(5.63)
TGap *HFDI	0.75***	0.73***	0.52***	TGap *BFDI	0.14	0.92***	1.55***	TGap *FFDI	-0.26	-0.12	4.43***
	(0.13)	(0.12)	(0.15)		(0.25)	(0.27)	(0.39)		(0.21)	(0.28)	(1.50)
R^2	0.55		0.19	R^2	0.52		0.20	R^2	0.52		0.18
N	560	560	560	N	560	560	560	N	560	560	560
	Hausman test of RE against FE				Hausman test of RE against FE				Hausman test of RE against FE		
Chi-square	57.01			Chi-square	63.05			Chi-square	64.96		
P-value	0.00			P-value	0.00			P-value	0.00		

Notes: 1) In OLS the dummy for sectors and time are included while in RE and FE, time dummy and firm fixed effect are taken into account.
2) *,**,***: significant at 10, 5 and 1%; ( ): standard error.
3) Hausman test with null hypothesis H0: RE is a consistent estimator.
4) The variable TR denotes a dummy variable which indicates whether or not firms offer training to their workers. The variable H denotes the percentage of workers with lower secondary education (grade 7th or higher).
5) The number of observations is 560 because eight observations have negative value added.

Notes

1) According to Javorcik (2004), even though multinational firms transfer technology to their suppliers, they cannot fully internalize the benefits that their suppliers got, thus there is still spillover.
2) See article 283 of Cambodian Law on Commercial Enterprise (2005).
3) The coefficients α_{jk} and α_{kj} in equations (5) and (6) do not have a time subscript t because we have only one input-output table over the years of analysis.
4) $TGap_{ij}$ has no subscript for time because labor productivity is averaged over the two years.

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Appendix 1 Distribution of Domestic and Foreign Firms in Each Sector

Industries	Code	Sectors	N	N1	FOR	DOC	FOR%	DOC%
MANU-FACTURE	101	Foods	11	9	2	7	0.22	0.78
	102	Textile	6	6	5	1	0.83	0.17
	103	Garments	92	73	65	8	0.89	0.11
	105	Plastics and Rubber	6	5	2	3	0.40	0.60
	109	Other Manufacturing	16	14	3	11	0.21	0.79
TRADE	201	Wholesale (include export service)	34	29	7	22	0.24	0.76
	202	Retail	71	61	2	59	0.03	0.97
TOUR	301	Hotels and Restaurants	119	103	9	94	0.09	0.91
	302	Other services (travel agencies, tour)	25	20	3	17	0.15	0.85
OTHER	401	Construction	9	9	2	7	0.22	0.78
	402	Transport	26	21	9	12	0.43	0.57
	403	IT	6	5	1	4	0.20	0.80
	404	Others	78	61	22	39	0.36	0.64
TOTAL			499	416	132	284	0.31	0.69

Note: DOC: number of domestic firms; FOR: number of foreign firms; N: original sample; N1: sample after removing observation with missing value. The distribution of firms in the sample indicates that this survey data is very suitable for analysis as it represents the whole population of firms in Cambodia very well. The table shows that the sector that has the largest number of foreign firms is the manufacturing industry (77 firms). Garment products absorb the highest number of foreign firms (65 firms). Totally, there are 132 foreign firms (31%) and 284 domestic firms (69%). There are two types of foreign firms: 100 percent owned (113 firms) and joint-ventured (19 firms).

Source: World Bank Survey on Business and Investment Climate in Cambodia (2006)

Appendix 2 Coefficients of Input-Output Table

	101	102	103	105	109	201	202	301	302	401	402	403	404
101	0.2376	0.0000	0.0000	0.0022	0.0003	0.0544	0.0544	0.0544	0.0859	0.0000	0.0073	0.0073	0.0859
102	0.0024	0.6457	0.6457	0.1971	0.0427	0.0345	0.0345	0.0345	0.0264	0.0046	0.0150	0.0150	0.0264
103	0.0024	0.6457	0.6457	0.1971	0.0427	0.0345	0.0345	0.0345	0.0264	0.0046	0.0150	0.0150	0.0264
105	0.0070	0.0056	0.0056	0.1673	0.0052	0.0026	0.0026	0.0026	0.0073	0.0045	0.1304	0.1304	0.0073
109	0.0153	0.0158	0.0158	0.0543	0.5028	0.0251	0.0251	0.0251	0.0417	0.1024	0.3161	0.3161	0.0417
201	0.0336	0.0238	0.0238	0.1452	0.0304	0.0044	0.0044	0.0044	0.0691	0.0205	0.0113	0.0113	0.0691
202	0.0336	0.0238	0.0238	0.1452	0.0304	0.0044	0.0044	0.0044	0.0691	0.0205	0.0113	0.0113	0.0691
301	0.0004	0.0003	0.0003	0.0016	0.0003	0.0001	0.0001	0.0000	0.0008	0.0002	0.0001	0.0001	0.0008
302	0.0014	0.0027	0.0027	0.0086	0.0019	0.0080	0.0080	0.0080	0.0297	0.0034	0.0077	0.0077	0.0297
401	0.0010	0.0005	0.0005	0.0043	0.0007	0.0027	0.0027	0.0027	0.0536	0.0059	0.0023	0.0023	0.0536
402	0.0134	0.0110	0.0110	0.0363	0.0060	0.0194	0.0194	0.0194	0.0078	0.0128	0.0461	0.0461	0.0078
403	0.0134	0.0110	0.0110	0.0363	0.0060	0.0194	0.0194	0.0194	0.0078	0.0128	0.0461	0.0461	0.0078
404	0.0014	0.0027	0.0027	0.0086	0.0019	0.0080	0.0080	0.0028	0.0297	0.0034	0.0077	0.0077	0.0297

Notes:

1) See the code number in Appendix 1 for the sector name.
2) Coefficients in the table show the share of output produced by row sector that is supplied to the column sector or the share of input used by column sector that is supplied by row sector. For example, the coefficient 0.0336 for row 201 and column 101 means that sector 201 (wholesale) supplies 3.36% of its output to sector 101 (food). The same coefficient also means that sector 101 (food) uses 3.36% of input from sector 201 (textile).
3) Sector 102 (textile) and 103 (garment) have the same coefficients because the original input-output table considered these two sectors as only one sector (textile and garment). Sector 201 (wholesale) and 202 (retail) which are categorized as trade in the original input-output table also has the same coefficients. Sector 402 (transport) and 403 (IT) are grouped together as transportation and telecommunication in original input-output table. Therefore, they are assumed to have the same coefficients. There are no coefficients for sector 302 (tour services) in the original input-output table. Therefore, it takes the coefficients from sector 404 (other services). Sector 101 (food), 105 (plastic and rubber), 109 (other manufacturing), 301 (hotel and restaurant), 401 (construction) have their own coefficients.

Source: Oum (2008)

Figure 1 Analytical Framework