FDI SPILL-OVERS, ABSORPTIVE CAPACITY AND DOMESTIC FIRMS' TECHNICAL EFFICIENCY IN VIETNAMESE WEARING APPAREL INDUSTRY

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Abstract

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This study empirically examines relationship between FDI spill-overs and technical efficiency of domestic firms and role of the absorptive capacity of domestic firms. Data on Vietnamese Annual Enterprises Survey are exploited to build a firm-level panel data on the Vietnamese wearing apparel industry from 2009 to 2013. By applying stochastic production frontier model, this paper shows that there are positive vertical spill-over effects but no horizontal effects. Moreover, this study finds the negative impact of the absorptive capacity of domestic firms on benefits reaped from FDI externalities.

Keywords: FDI spill-over effects, absorptive capacity, technical efficiency, Vietnam

INTRODUCTION

FDI inflows are widely recognized as potential benefit of recipient countries in terms of capital raising, job creation, national budget contribution etc. However, economists and policy-makers are growingly concerning about indirect benefits including technological and managerial diffusion. FDI externalities are divided into horizontal and vertical spill-over effects and a large amount of empirical studies attempt to provide evidences of the relationship between FDI spill-over effects and host countries' merits. However, results are ambiguous. Some studies find positive effect of FDI spill-overs (Haddad & Harrison 1993; Suyanto et al. 2012; Javorcik 2004) while some show reverse findings (Aitken & Harrison 1999; Le & Pomfret 2008). To some extent, however it is a consensus that the effect of FDI spill-overs on host countries varies, depending on absorptive capacity of recipients (Bodman & Le 2013; Tang & Zhang 2015; Blomström & Sjöholm 1999; Liu *et al.* 2016). Absorptive capacity is firstly defined by Cohen and Levinthal in 1989 and exploited in the consecutive studies. Most of papers find the significant impact of absorptive capacity in the link between FDI spill-overs and domestic firms' performance (Blalock 2002; Girma 2005; Anwar & Nguyen 2010). However, proxies for absorptive capacity across these papers are heterogonous and there is a wide range of absorptive capacity measurement such as R&D expenditures and intensity, human capital or technology gap (Girma 2005; Blalock 2002; Ferragina & Mazzotta 2014).

Having seen various benefits of FDI, many developing countries including Vietnam, want to attract as much FDI flows as possible into their countries. Particularly, Vietnam conducted Doi Moi (Reform) transforming the economy from centrally planned one to market oriented one from 1986. Coupled with this, Vietnam has offered various incentives and established many economic zones to attract FDI from developed countries. As a result, FDI inflows into Vietnam have increased considerably and contributed significantly to economic growth. It is becoming more important when Vietnam actively takes part in some regional

and international economic associations. Recently, Vietnam commits to Trans-pacific partnership[1] with another 12 countries that not only generates promising chances but also big challenges. Domestic sectors have no way but improving their capabilities by taking full advantages of knowledge and technology diffusion from foreigners, or the former could be dominated by the latter via competition. Therefore, it is necessary to examine current state of absorptive capacity of domestic firms and theirs subsequent impact in Vietnam.

Hence, this paper enriches literature by examining relationship between FDI spillovers and performance of domestic sectors. In which, the latter is represented by technical efficiency. Moreover, it is focused on the case of Vietnam and takes a step further by analysing a single 3-digit industry (not 2 digit industries as many previous studies): the wearing apparel industry. This is one of the best exporting industries of Vietnam[2] and it is oriented to be the main exporting industry to 2030 (The Minister of Vietnam Ministry of Industry and Trade, 2014). The second contribution is that the paper uses another measurement of the absorptive capacity of domestic firms. Absorptive capacity is identified as firm-specific factors and measured by the gap between technical efficiency of domestic firms and FDI firms in the same industry. Basically, this paper aims to figure out the relationship between FDI spill-over effects and technical efficiency of domestic firms and how absorptive capacity could influence this relationship in the Vietnam wearing apparel industry.

The remainder of the paper is organized as follow. Section 2 briefly introduces the background on firm's absorptive capacity, FDI spill-over effects and provides empirical review on this research area. Then, section 3 explains methodology and empirical model used to test this relationship in case of Vietnam. It is followed by results section and conclusion is the final one.

Literature review

There are substantial studies on firm's absorptive capacity, providing various perspectives on this research area. However, all of them base on the root concept of Cohen and Levithal. These authors initially consider absorptive capacity at firm level as the ability to "identify, assimilate and exploit knowledge from the environment"

(Cohen & Levinthal 1989, p.569). This is a basis for further argument that absorptive capacity is the firm's ability to identify value of external knowledge before assimilating and applying them into commercial ends (Cohen & Levinthal 1990). Then, Cohen & Levinthal (1994) supplement the argument that absorptive capacity is not only about external knowledge recognition and exploitation but also the ability to predict future knowledge. In general, the definition of Cohen and Levinthal about absorptive capacity at firm level includes three important factors: the ability to recognize and assess external knowledge, the ability to assimilate what the firm recognized and the ability to apply external knowledge into commercial ends.

After Cohen and Lethinval, many authors expand or reify the firm's absorptive capacity (E.G. Zahra & George 2002; Lane et al. 2006) but to some extent, there is a consensus that absorptive capacity is firm's competitive advantage. Lane et al. (2006) review a huge amount of studies on this issue, concluding that there are 07 themes of absorptive capacity: external knowledge, organizational structure, organizational scope, organizational learning, inter-organizational learning and innovation. Therefore, it is possible to state that firm's absorptive capacity could depend on external factors such as type of external knowledge but majorly depend on firm specific factors. Amongst 07 themes, there are largest quantity of studies paying attention on the theme of inter-organizational learning and innovation. Within this theme, the role of partnership is appreciated. Firm absorptive capacity could be enhanced if this firm cooperate with good partners and then, they learn from knowledge similarity or knowledge dissimilarity (Lane & Lubatkin 1998; Ahuja & Katila 2001). Conversely, several authors believe that in some cases, inter-organizational relationship could hamper firm's absorptive capacity. Van de Ven & Polley (1992)concerns that international difference and dishonest behaviour could impede learning process while Lei & Hitt (1995) caution that over-reliance on external knowledge could gradually reduce firm's absorptive capacity.

Regarding to inter-organizational learning and innovation theme, many empirical studies are conducted to examine relationship between foreign direct investment (FDI) firms and domestic firms, based on assumption that external knowledge

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1 Trans-pacific Partnership is an agreement amongst 12 countries including Australia, Brunei Darussalam, Canada, Chile, Japan, Malaysia, Mexico, New Zealand, Peru, Singapore, United States and Vietnam. The agreement aims at setting up standard of global trade with five key features: comprehensive market access; regional approach to commitments; addressing new trade challenges; inclusive trade and platform for regional integration. More details about transpacific partnership found at https://ustr.gov/about-us/policy-offices/press-office/press-releases/2015/october/summary-trans-pacific-partnership

2 According to World Bank, six strategic export commodities are electronic components, footwear, apparel and textiles, seafood, coffee and rice (*Efficient Logistics: A Key to Vietnam's Competitiveness*, 2014, p. 12). This paper bases on Vietnam industrial classification to split apparel and textiles into wearing apparel and textiles and then only focuses on the former.

is generated by spill-over effects of foreign firms and domestic firms are expected to benefit from these externalities. FDI spill-over effects are categorized into horizontal (intra-industry) and vertical ones (inter-industry). There are four channels of horizontal effect including imitation, labour turnover, competition and exports and two linkages of vertical effect: forward and backward (Gorg & Greenway 2004). FDI performance could bring positive or negative spill-over effects to host countries.

Empirical studies on relationship between FDI and domestic firms vary. Some find positive impact of FDI generated spill-overs while some find reverse results. In terms of positive relationship, Haddad & Harrison (1993) employ production function approach on Morocco manufacturing firms, indicating that domestic firms in sectors with higher level of FDI presence are more efficient than ones in other sectors. Branstetter (2006) confirms that FDI is a conduit of knowledge diffusion in both forward and backward linkages in the US. Similarly, Keller & Yeaple (2009) also show that FDI spill-overs in the US manufacturing industries from 1987 to 1996 are significant and impact in the high-tech industries is strongest. Javorcik (2004) examines effect of FDI spill-over effects to Lithuanian manufacturing firms in the period 1996-2000. The result favours positive impact of backward linkage on domestic firms' productivity but finds no horizontal or forward linkage effects from FDI firms. Moreover, domestic firms are benefited more from joint venture projects than fully owned foreign projects. Liu (2008) figures out that within Chinese manufacturing sector from 1995 to 1999, FDI generates positive backward and forward linkage on domestic firms' productivity and the most vital channel is backward linkage. Le (2005) studies FDI spill-over effects on productivity growth on Vietnamese manufacturing industries in the period 1995-2002 and finds positive horizontal effect from FDI sectors. In contrast, some papers prove insignificant or negative relationship. For example, Germidis (1977) is unable to find positive spill-over effects from foreign firms to domestic firms across 12 developing countries (cited by Liu, 2008). Aitken & Harrison (1999) conduct research on Venezuela from 1986 to 1989 and conclude that presence of foreign firms create negative impact on productivity of domestic firms in the same industry (intra-industry). Le & Pomfret (2008) examine relationship between FDI spill-overs and domestic productivity (TFP) in Vietnamese firms in the period 2000-2006 and find positive vertical linkage but negative horizontal effect. Generally, whether foreign firms could generate positive spill-over effects to domestic sectors differs amongst nations and nations. It is subject to absorptive capacity of host countries and domestic organizations (Bodman & Le 2013; Ferragina & Mazzotta 2014; Sanchez-Sellero et al. 2014; Tang & Zhang 2015;

Blomström & Sjöholm 1999). Therefore, absorptive capacity needs taking into consideration.

In fact, examining absorptive capacity factor in the relationship between FDI spill-overs and domestic firms is not a new idea. It is possible to consider Cohen and Levinthal as one of the first authors studying firm's absorptive capacity (Cohen & Levinthal 1989, 1990, 1994). They appreciate the role of R&D activity in building firm's absorptive capacity. Consequently, there are varieties of study using R&D-related variable as a proxy for absorptive capacity at firm level such as R&D intensity or patents. Blalock (2002) studies technology adoption of Indonesia manufacturing firms from 1988 to 1996. Absorptive capacity in this study is proxied by R&D expenditures and the author distinguishes between firms' absorptive capacity and human capital, technology gap. The main conclusion is that firms with higher absorptive capacity and greater level of human capital could gain more significantly than other firms and the more technology gap between domestic firms and FDI is, the more benefit the former gain. Girma (2005) believes that impact of FDI on growth depends on absorptive capacity which is proved by empirical evidence on the UK manufacturing sector between 1989 and 1999. Applying threshold model, Girma (2005) shows existence of nonlinear threshold effect. It means there is a minimum level of absorptive capacity and above which FDI spill-overs could be positive and conversely, below which FDI externalities are insignificant. In case of Canadian manufacturing industries 1973-1977, Wang (2010) points out strong and significant effect of FDI-created spill-overs on total factor productivity of Canadian firms in terms of forward and backward linkages. Wang also examines the role of absorptive capacity, considering it as stocks of R&D. Consequently, these positive effects will be increased if industry's absorptive capacity is enhanced. Anwar & Nguyen (2010) take advantage of panel data of Vietnamese manufacturing industries 1995-2005 to identify impact of FDI spill-over effects on industrial growth. The conclusion is that FDI generates only positive backward linkage and this impact will be facilitated by the stock of human capital. Ferragina & Mazzotta (2014) exploit a database of Italian firms from 2002 to 2010 to test FDI spill-over effects on firm survival, arguing that technology gap and technology intensity of the industry affect impact of FDI externalities on firm survival. Sanchez-Sellero et al. (2014) declare that absorptive capacity is essential to gain from FDI spill-over effects and define absorptive capacity as many factors such as: R&D expenditure, intensity, outcomes; organizational structure, human capital, market concentration and business sophistication.

Apparently, literature is rich about impact of FDI spill-over effects on domestic firms in terms of productivity but there are few papers investigate impact of FDI externalities on domestic firms'

technical efficiency and the role of the firm's absorptive capacity within this relationship. The paper focuses on effect of FDI in Vietnam – one of the most FDI-attracting countries in the world, and takes a further step by examining this relationship in the 3-digit industry instead of 2 digit industry as in the previous studies. Vietnam has faced great opportunities from Trans-pacific Partnership commitment recently. However, it is also a huge pressure from foreign competitors on domestic firms. If the domestic sectors are unable to quickly learn and gradually compete with FDI firms, Vietnamese market is concerned to be dominated by foreign sectors. Hence, the paper examines relationship between FDI spill-overs and domestic technical efficiency in the wearing apparel industry – which is one of the best exporting industries of Vietnam and has a big amount of FDI firms operating within. It is expected that domestic firms could gain from intra-industry and inter-industry externalities. Then, the role of absorptive capacity of domestic firms is examined. In this paper, absorptive capacity is considered as firm specific factors that are integrated into stochastic production function of firms. It is to some extend approved by Khan (2013) when the author asserts that firms in developing countries are likely to lack of sufficient technological capacities and organizational capacities. Accordingly, they are unable to apply new production techniques to produce competitive outcomes. Recall that the firms' technical efficiency will indicate quality of inputs (given technological level) and its management (Farrell 1957). Hence, the gap among level of domestic technical efficiency and average level of FDI ones will be the gap of firm specific factors that could present for absorptive capacity of firm. Consequently, level of absorptive capacity of domestic firms in this industry could be measured and how it affects to the relationship between FDI spill-overs and domestic technical efficiency will be identified.

MATERIALS AND METHODS

Model Battese & Coelli 1992 and Model Battese & Coelli 1995

The paper will firstly measure technical efficiency level of all firms in Vietnamese wearing apparel before calculating absorptive capacity of domestic firms by measuring gap between technical efficiency of domestic firms and average level of technical efficiency of FDI firms. Model of Battese & Coelli 1992 will be applied to calculate absorptive capacity and then impact of FDI spill-overs on technical efficiency of domestic firms will be examined by exploiting the model of Battese & Coelli 1995.

Battese & Coelli consider technical efficiency of a specific unit as a ratio between its real production (given level of inputs) and potential production in case it makes use of its inputs in the most efficient way (Battese & Coelli 1992).

The model for N cross-sectional firms in T period is defined by:

$$Y_{it} = f(x_{it}; \beta) \exp(V_{it} - U_{it}) \quad t = 1, \ldots T, \; n = 1 \ldots N \quad (1)$$

Where Y_{it} is the output of firm i in the time t; x_{it} are inputs of firm i to produce output Y; $f(x_{it}; \beta)$ is production function of firm i in the time t and β is estimated unknown parameter; V_{it} presents for a random shock error and assumed to be i.d.d with distribution N(0, σ_v^2).

Model of Battese & Coelli (1992) – BC92

is a time variant model for unbalanced panel data where U_{it} is technical efficiency term and distributed i.d.d with non-negative truncation of N(μ_t, $\sigma_{\square}^2$). in this model is clarified by:

$$U_{it} = \eta_{it} U_i = \left\{ \exp\left[-\eta(t - T) \right] \right\} U_i \quad (2)$$

Where η is an unknown parameter needs estimating. The formula implies that U_{it} is decrease if $\eta < 0$, constant if $\eta = 0$ and increase if $\eta > 0$. In other words, technical efficiency of firm i decreases, remains unchanged or increases over period of time T if $\eta < 0$, $\eta = 0$ and $\eta > 0$ respectively.

Then, technical efficiency of firms in the time t is:

$$TEt \equiv E[\exp(-\eta t Ui)]$$

Note that the model will be transformed into the time invariant model if $\eta_t = 1$.

Model of Battese & Coelli (1995) – BC95

Unlike to BC92 model, in BC95 model, U_{jt} depends not only on time factor but also a set of other independent variables z_{jt} over time. Then, U_{jt} is assumed to be i.d.d and truncated (at zero) distribution N ($z_{jt}\delta, \sigma_{\square}^2$), where δ is set of unknown parameters need estimating within the model. This model will be reduced to the model of Battese & Coelii 1992 if the first variable in a set of independent variables equals to one and the other variables equal to zero. U_{jt} now is defined by:

$$U_{jt} = z_{jt}\delta + W_{jt}$$

Where W_{jt} is random variable and distributed by truncation of normal distribution N(0,$\sigma_{\square}^2$). It is truncated at value of $-z_{jt}\delta$. Consequently, technical efficiency will be estimated by:

$$TE_j \equiv \exp(-z_{jt}\delta - W_{jt})$$

The above-mentioned models are resolved by applying maximum likelihood and variances parameters of likelihood function could be described as follow:

$$\sigma_s^2 \equiv \sigma_v^2 + \sigma_{\square}^2$$

$$\gamma \equiv \sigma^2 / \sigma_s^2$$

The study applies model BC92 for all type of firms in the wearing apparel sector to estimate technical efficiency. Then, gap between technical efficiency level of domestic firms and FDI firms will be represented for absorptive capacity of domestic firms. Afterward, model BC95 is used to examine impact of FDI spill-overs and absorptive capacity on technical efficiency of domestic firms.

Model specification

Assume that there are only two inputs: labour (L) and capital (K) to produce output (Y), the BC92 and BC95 model are presented in the Cobb-Douglas form respectively:

$$\ln Y_{it} = \beta_0 + \beta_1 \ln Y_{jt} + \beta_2 \ln K_{it} + \beta_3 year_{it} + V_{it} - U_{it}$$
$$U_{it} = \left\{ \exp\left[-\eta(t-T) \right] \right\} U_i \tag{I'}$$

$$\ln Y_{jt} = \beta_0 + \beta_1 \ln L_{jt} + \beta_2 \ln K_{jt} + \beta_3 year_{jt} + V_{jt} - U_{jt}$$
$$U_{jt} = \delta_0 + \delta_1 back_t + \delta_2 for_t + \delta_3 hor_t + \delta_4 year_{jt} + w_{jt} \tag{II'}$$

Or they could be in the Trans-log form:

$$\ln Y_{it} = \beta_0 + \beta_1 \ln L_{it} + \beta_2 \ln K_{it} + \beta_3 \ln L_{it}^2 + \beta_4 \ln K_{it}^2 +$$
$$+ \beta_5 \ln L_{it} * \ln K_{it} + \beta_6 year_{it} + V_{it} - U_{it}$$
$$U_{it} = \left\{ \exp\left[-\eta(t-T) \right] \right\} U_i \tag{I}$$

$$\ln Y_{jt} = \beta_0 + \beta_1 \ln L_{jt} + \beta_2 \ln K_{jt} + \beta_3 \ln L_{jt}^2 + \beta_4 \ln K_{jt}^2 +$$
$$+ \beta_5 \ln L_{jt} * \ln K_{jt} + \beta_6 year_{jt} + V_{jt} - U_{jt}$$
$$U_{jt} = \delta_0 + \delta_1 back_t + \delta_2 for_t + \delta_3 hor_t + \delta_4 year_{jt} + w_{jt} \tag{II}$$

In the (I) and (I') equations, Y_{it} is output of firm i in the time t, L_{it} and K_{it} are number of worker and capital used by firm i to produce output, $year_{it}$ presents for Hicks neutral technological progress from time to time, V_{it} and U_{it} are defined as stated above.

Model specification tests include functional form test, half normal distribution test, time invariant test and technical inefficiency test. The testing hypotheses described in the Tab. I as follow:

I: *Specification tests for Model BC92*

Hypotheses	
H₀: Cobb-Douglas is valid	$\beta_3 = \beta_4 = \beta_5 = 0$
H₀: U_i is half-normal distribution	$\mu_{\square} = 0$
H₀: U_i is time invariant	$\eta = 0$
H₀: No technical inefficiency	$\gamma = \eta = \mu_{\square} = 0$

In the equation (II) and (II'), Y_{jt} is output of domestic firm j in time t; L_{jt} and K_{jt} are number of workers and capital used by domestic firm j in time t to produce Y; $year_t$ in the equation of technical inefficiency accounts for linear change of

inefficiency term over time. Specification tests for BC95 model include a test for existence of δ_0; a test for existence of technical inefficiency and a test for significance of a set of z variables (Tab. II).

II: *Specification tests for model BC95*

Hypotheses	
H₀: No δ_0	$\delta_0 = 0$
H₀: No technical inefficiency	$\gamma = \delta_0 = \delta_1 = \delta_2 = \delta_3 = \delta_4 = 0$
H₀: No significance of z set	$\delta_{1\check{c}} = \delta_2 = \delta_3 = \delta_4 = 0 = 0$

Additionally, $back_t$, for_t and hor_t are FDI backward linkage, forward linkage and horizontal effect respectively which are constructed by method of Javorcik *et al.* (Javorcik 2004).

hor_t is FDI horizontal effect measuring presence of FDI firms in the wearing apparel in time t and is calculated by the formula:

$$hor_t = \Sigma y_{jt} / Y_t$$

Where y_{jt} is output or labour of FDI firm in the Vietnamese wearing apparel sector; Y_t is gross output or total labour of all firms in the same sector. This study uses labour to calculate FDI horizontal effect (similar to Aitken & Harrison 1999)

$back_t$ proxies for participation of FDI firms in other sectors of Vietnamese manufacturing sector using products from the wearing apparel sector as production input. $back_t$ is measures by:

$$back_t = \sum_{k \neq j} a_{jk} \times hor_t$$

Where a_{jk} is proportion of the wearing apparel output consumed by sector k to produce output of sector k. These coefficients are taken from Input Output Tab. 2010 of Vietnam General Statistics Office.

hor_t proxies for presence of FDI firms in other sectors of Vietnamese manufacturing sector supplying inputs to the wearing apparel sector and it is defined by

$$for_t = \sum_{m \neq j} b_{jm} \times hor_t$$

Where b_{jm} is proportion of output of sector m to be used as input of the wearing apparel sector and they are picked up from Input Output Tab. 2010 of Vietnam General Statistics Office.

Data

Vietnam General Statistics Office conducts the Annual Enterprises survey every year from 2000 which comprise key information of firms such as net turnover, number of worker, labour wage, fixed capital, firm ownership, and firm's economic activities. A panel data set is created by combining annual data from 2009 to 2013.

Y_{it}, L_{it}, K_{it} are proxied by net turnover of firm i in the time t, total number of worker at the beginning of time t and value of fixed assets (after minus depreciation) used by firm i to produce output in the time *t*. Monetary variables are adjusted by provincial consumer price index to make a comparable database. Database is also clean by ignoring firms with negative value of net turnover, fixed assets and zero number of workers. Outliers are also deleted. Additionally, all variables are converted into logarithm form. Note that it is an unbalanced panel data set, only firms appear at least three times consecutively from 2009 to 2013 are kept. There are 3,217 firms and the total number of observation is 13,299 in the period 2009–2013. Variable description is summarized in the Tab. III.

III: *Variables summary*

Variables	Mean	Standard deviation	Min	Max
lnY	7.662	2.657	0.000	15.406
lnL	3.576	1.652	0.693	9.013
lnK	6.266	2.552	0.000	13.640
Hor	0.568	0.012	0.554	0.585
Back	0.202	0.008	0.191	0.213
For	0.398	0.035	0.341	0.426

Note: all monetary variables are adjusted by provincial consumer index.

All variables are processed by STATA 14 and estimation is conducted by FRONTIER 4.1[3].

RESULTS AND DISCUSSION

Firstly, the study employs model BC92 to calculate technical efficiency of firms in the wearing apparel sector before creating absorptive capacity of domestic firms. Secondly, impact of FDI spill-overs on technical efficiency of domestic firms is examined by using model BC95. It couples with testing the role of absorptive capacity, which has already defined, in this relationship.

FDI absorptive capacity of domestic firms

This study used model BC92 to estimate technical efficiency of the wearing apparel sector of Vietnam from 2009 to 2013. As mentioned above, tests for model specification result as follow:

IV: *Test results*

H_0	Log likelihood	Test statistics	Critical value	Decision
$\beta_3 = \beta_4 = \beta_5 = 0$	–23500	36	7.81	Reject H_0
$\mu = 0$	–25543	4122	5.99	Reject H_0
$\eta = 0$	–23531	98	5.99	Reject H_0
$\gamma = \eta = \mu = 0$	–25307	3650	11.07	Reject H_0

Note: critical values are taken from Chi square distribution table

They are obtained by applying the generalized likelihood ratio test which is specified as LR = –2 [log{likelihood(Ho)}-log{likelihood(H1)}] (Tab. IV). The first null hypothesis indicates that production function is formed as Cobb-Douglas function and it is totally rejected. Alternatively, the translog production function should be used. The second null hypothesis specifies that technical inefficiency term is half-normal distribution and the result rejects it at 5 % of significance and then, technical efficiency component is truncated normal distribution. The third null hypothesis implies that this model is time invariant with $\eta = 0$, which is strongly rejected as well. Finally, the null hypothesis that technical inefficiency does not exist in the production function of the wearing apparel sector is also rejected. Consequently, the specified model should be Model (I). FRONTIER 4.1 is used and estimated results are showed in the Tab. V:

V: *Regression result*

	Model 1		
	coefficient	std.-error	t-ratio
Constant	4.270***	0.106	40.300
lnL	1.130***	0.038	29.900
lnK	–0.007	0.018	–0.391
lnL*lnL	–0.034***	0.006	–5.290
lnK*lnK	0.005**	0.002	2.480
lnL*lnK	0.008	0.006	1.360
t	0.248***	0.011	22.300
sigma-square	17.500	0.928	18.900
gamma	0.919	0.005	169.000
mu	–8.030	0.505	–15.900
eta	–0.091	0.008	–11.200
Log likelihood	–23500		
Obs.	13,299		

Note: ***,**,* are statistically significant at 1 %,5 % and 10 %.

Note that estimation of lnK is –0.007 does not imply that capital have a negative impact on output. The model is formed as the Trans-log production

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3   FRONTIER 4.1 was created by Tim Coelli which could be downloaded at http://www.uq.edu.au/economics/cepa/frontier.php

function and it is necessary to examine marginal effect of inputs which also depends on coefficient of LnK*lnK and LnL*lnK. More specifically, marginal effect of labour and capital on net turnover of firms in the wearing apparel calculates by:

$$MP_L = \partial LnY / \partial LnL = \beta_1 + 2 \times \beta_3 LnL + \beta_5 LnK = 0.937$$

$$MP_K = \partial LnY / \partial LnK = \beta_2 + 2 \times \beta_4 LnK + \beta_5 LnL = 0.085$$

Vietnamese wearing apparel sector seems to be labour intensive, not capital intensive. 1 % increase in number of worker could lead to 0.937 % increase in output; meanwhile 1 % increase in fixed asset only leads to 0.085 % increase in the final output.

VI: *Average technical efficiency of all firms*

| year	Mean	Std. Dev.	Freq.
2009	0.510	0.215	1,933
2010	0.470	0.224	2,523
2011	0.435	0.224	3,217
2012	0.412	0.223	3,003
2013	0.400	0.216	2,623

Establishment of the Trans-log production function is a base to estimate firms' technical efficiency (Tab. VI). It is noteworthy that mean value of technical efficiency decreases over year by about 10 %. The study takes a further step by examining the gap between domestic firms and average technical efficiency of FDI firms within this sector to proxy for absorptive capacity of domestic firms. Recall the based definition considering *"technical efficiency of a given firm as the ratio of its mean production (in original way), given its realized firm effect, to the corresponding mean production if the firm effect was zero"* (Battese & Coelli, 1988, p. 389). Difference among firms' technical efficiency originates in firm effect. Then, the gap in technical efficiency between domestic firms and FDI firms could be a good proxy for absorptive capacity and absorptive capacity of domestic firms is defined by:

$$AC_{kt} = (TE_{kt} - averageFDI_t)/averageFDI_t$$

Where AC_{kt} is absorptive capacity of domestic firm k in the time t and $averageFDI_t$ is average value of technical efficiency of FDI firms in time t. If technical efficiency of domestic firm equals to $averageFDI_t$, there is no gap and AC will equal to 0. It could be the base point. From this point, the higher value and smaller value indicate higher and lower absorptive capacity of domestic firms.

Absorptive capacity of domestic firms (Fig. 1) changed from 2009 to 2013. Interestingly, number of extreme-low absorptive capacity firms has increased, leading to lower domestic capacity. More specifically, average value of absorptive capacity decreased from about –0.15 in 2009 to about –0.20 in 2013. These figures imply that Vietnamese firms in this sector are not comparatively improving their absorptive capacity over years. Conversely, domestic firms tend to be left behind by FDI firms.
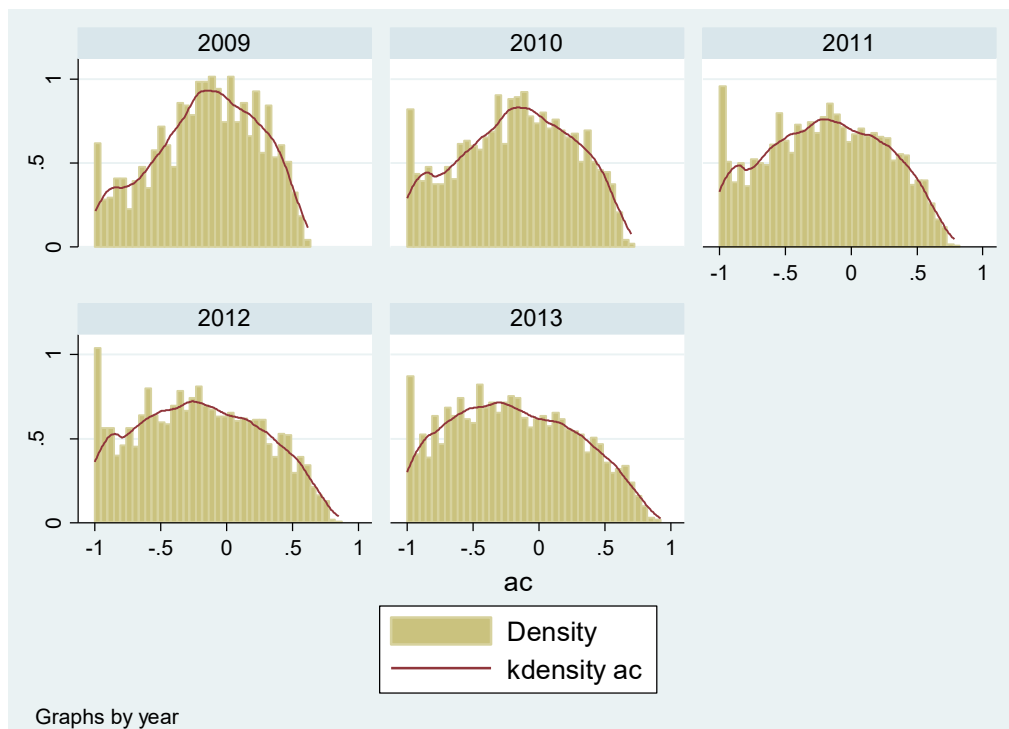
1: *Density of domestic absorptive capacity*

The role of domestic absorptive capacity in the link between FDI spill-overs and domestics technical efficiency

The study further examines impact of FDI absorptive capacity on FDI spill-overs to domestic firms by applying the BC95 model with technical inefficiency function. FDI spill-overs are represented by horizontal effect (Hor), forward linkage (For) and backward linkage (Back). Before estimating, model specification tests are conducted (Tab. VII). The first null hypothesis means the constant term in the technical inefficiency function is not valid. And the result strongly accepts it. Then, the second null hypothesis indicates no technical inefficiency and it is strongly rejected. Finally, the third null hypothesis implies FDI spill-overs have no effect on firm's technical efficiency and the test outcome approves the alternative hypothesis.

After conducting tests, impact of FDI spill-overs on technical inefficiency is examined first. Maximum likelihood estimates are obtained by using program FRONTIER 4.1.

Notably, the negative sign of coefficients in the technical inefficiency function implies that these variables have negative impacts on technical inefficiency. In other words, they have positive effects on technical efficiency of firms. Therefore, FDI spill-overs variables are expected to be statistically negatively significant.

However, the model 2 shows that only backward and forward linkages are statistically significant. It means that FDI firms in other industries could bring positive affect to efficiency of the domestic firms in the wearing apparel sector. This is equivalent to Anwar & Nguyen (2010) and Le & Pomfret (2008) with positive backward linkage in the Vietnamese manufacturing sector. However, these previous studies are unable to find positive forward linkage which is resulted in this study. It is understandable because these previous studies focus on manufacturing sector as a whole (2-digit industry) while this study focuses only on the wearing apparel industry (3-digit industry).In addition, the coefficients of backward and forward linkages are –1.493 and –1.520 respectively. The number of –1.493 reveals that 1 % increase in proportion of wearing apparel's output supplying to FDI firms in other sector will lead to 1.493 % increase in technical efficiency of domestic firms. Similarly, the number of –1.520 implies that 1 % increase in proportion

VII: *Test results*

H₀	Log likelihood	Test statistics	Critical value	Decision
$\delta_0 = 0$	–19677	2	3.84	Accept
$\gamma = \delta_0 = \delta_1 = \delta_2 = \delta_3 = \delta_4 = 0$	–21055	2757	11.07	Reject
$\delta_1 = \delta_2 = \delta_3 = \delta_4 = 0$	–20284	1216	9.48	Reject

Note: critical values are taken from Chi square distribution table

VIII: *Regression results*

	Model 2			Model 3		
	Coefficient	SE	T-ratio	Coefficient	SE	T-ratio
Constant	4.630***	0.092	50.229	5.549***	0.074	75.261
lnL	0.997***	0.036	27.854	0.737***	0.030	24.464
lnK	0.053***	0.02	2.72	0.010	0.016	0.623
lnL*lnL	–0.0029	0.007	–0.42	0.011*	0.006	1.790
lnK*lnK	0.0142***	0.002	6.044	0.013***	0.002	6.345
lnL*lnK	–0.021***	0.007	–3.193	–0.011**	0.006	–1.979
t	0.1274***	0.012	11.01	0.098***	0.0098	9.944
Back	–1.493**	0.664	–2.25	1.424***	0.438	3.254
For	–1.520***	0.162	–9.358	–0.592***	0.072	–8.255
Hor	–0.1229	0.171	–0.717	–0.176	0.113	–1.552
Back*ac	---	---	---	1.462***	0.585	2.498
For*ac	---	---	---	–0.643***	0.097	–6.655
Hor*ac	---	---	---	–0.252*	0.1495	–1.685
t	4.4403***	0.375	11.851	–0.083	0.054	–1.548
sigma-square	114.935	8.896	12.92	4.061	0.108	37.633
gamma	0.993	0.001	1362.019	0.856	0.005	159.248
Log likelihood	–19676.3			–16023.3		
Obs.	10,654	10,654				

Note: ***,**,* are statistically significant at 1 %,5 % and 10 %

of FDI firms' output in other sector using by the wearing domestic firms will lead to 1.520 % increase in technical efficiency.

The coefficient of horizontal effect term is negative but statistically insignificant. Because it is labour horizontal effect, then, it is possible to conclude that presence of FDI firms in the wearing apparel is unlikely to create labour turnover effect on domestic firms. It is the fact that FDI firms in this sector hire low-skilled domestic workers. Additionally, FDI firms only use low-skilled workers in some specific stages of production chain so that they are unable to apply and transfer their skills anywhere.

In addition, the coefficient of t is positively correlated with technical inefficiency showing that production efficiency of domestic firms decrease over years which is equivalent to prior result of low domestic absorptive capacity. Consequently, interaction terms between FDI spill-overs and domestic absorptive capacity are established to study theirs impact on domestic efficiency.

These interaction terms are statistically significant which specifies that absorptive capacity have impact on production efficiency via FDI spill-over effects (The model 3). However, the insignificant coefficient of horizontal effect is consistent with the model 2 asserting that no FDI horizontal effect in this sector. Impact of forward and backward linkages with presence of absorptive capacity need considering coefficients of interaction terms Back*ac and For*ac. Marginal effect of backward linkage and forward linkage equal to 1.148 and –0.471 respectively[4]. In other words, presence of absorptive capacity decreases level of FDI forward linkage positive effect on domestic efficiency from 1.520 to 0.471. Even worse, positive effect from backward linkage turns to negative effect with intervention of absorptive capacity. Hence, interesting remark is that FDI absorptive capacity of domestic firms in the Vietnamese wearing apparel negatively affects relationship between FDI spill-overs and theirs technical efficiency (Tab. VIII).

CONCLUSION

FDI is expected to create knowledge and technology spill-overs to host nations; however, impact of FDI spill-overs on host countries depends on absorptive capacity of domestic sectors. This paper examines this relationship in Vietnamese wearing apparel industry in the period 2009–2013. There are positive forward and backward linkages (inter-industry) of FDI. It implies that FDI firms in other industries generate positive impact on domestic firms in the wearing apparel industry. However, appearance of FDI firms within the wearing apparel industry is unlikely to bring significant horizontal effect to domestic firms in the same industry. Horizontal effect in this paper is measured by number of worker of FDI firms over total number of worker within the industry. Then, it is possible to state that there is no labour turnover effect in the wearing apparel industry of Vietnam.

In addition, the role absorptive capacity of domestic firms in the wearing apparel industry is inspected. In this paper, absorptive capacity is considered as firm-specific character and integrated into stochastic production function. Hence, absorptive capacity of the domestic firm is defined as gap between its technical efficiency and average technical efficiency level of FDI firms in this industry. Consequently, absorptive capacity of domestic firms in the wearing apparel is declining over times then, negatively affects externalities from FDI to technical efficiency of domestic firms.

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4   Marginal effect of backward linkage = 1.4239 + 1.4623*(–.0188) and Marginal effect of forward linkage = –0.592 + (–0.642)*(–0.188) where –0.188 is mean value of absorptive capacity.

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