The threshold of absorptive capacity: the case of Vietnamese manufacturing firms.

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Abstract

The paper empirically examines the impact of foreign direct investment spillovers on the performance of Vietnamese manufacturing firms and the role of absorptive capacity in this linkage from 2007 to 2015 in Vietnam. Importantly, it is expected that the thresholds of absorptive capacity of the domestic firms exists and the benefits which local firms enjoy can vary subject to the thresholds. This paper applies a threshold fixed effect model with a panel data in Vietnam to show several findings. Firstly, the domestic firms can benefit from spillovers via the horizontal channel and backward linkage. Secondly, absorptive capacity is a vital factor to link horizontal spillovers to the local firms. Finally, the paper finds that there are thresholds of absorptive capacity in the case of Vietnam.

Keywords: Absorptive capacity, FDI spillovers, Threshold

JEL classification: D24, F21

1. Introduction

It is well-documented that foreign direct investment (FDI) can generate benefits for host countries at the firm level via spillover effects (Blomström & Sjöholm, 1999; Jaffe, Trajtenberg, & Henderson, 1993; Javorcik, 2004; Kokko, Tansini, & Zejan, 1996). The benefits can occur via three main channels including horizontal channel, forward and/or backward linkage. However, domestic firms can only enjoy positive externalities if they have a good absorptive capacity. It implies that the local firms need to have some certain levels of absorptive capacity to gain the benefits from FDI spillovers (Cohen & Levinthal, 1994; Girma, 2005; Lane & Lubatkin, 1998; Zahra & George, 2002). Otherwise, local market can be dominated by the foreign firms. Generally, absorptive capacity is a prerequisite for the development of domestic firms. The root definition came from Cohen & Levinthal (1990) that absorptive capacity is "the ability of a firm to recognize the value of new , external information, assimilate it and apply it to commercial ends" (Cohen & Levinthal, 1990, p. 1). Moreover, the influence of absorptive capacity on the link from the spillovers to domestic firms might not be a linear function and then thresholds of absorptive capacity can exist (Girma, 2005). It indicates that the local firms may enjoy different levels of benefits from FDI firms subject to their absorptive capacity. Even in some circumstances, the FDI spillover can have a negative impact on the performance of domestic firms.

There are substantial studies on the mediating role of absorptive capacity in the link from FDI spillovers to the performance of domestic firms, but the measurement of absorptive capacity is not consistent. Some authors used R&D to present for absorptive capacity (Behera, 2015; Tsai, 2001), while some used technology gap (Flôres, Fontoura, & Guerra Santos, 2007; Jabbour & Mucchielli, 2007) or human capital (Martinkenaite & Breunig, 2015). The main reason for the existence of various proxies is that different authors might want to look at different aspects of absorptive capacity. More specifically, some studies focus on the within-firm aspect (Fosfuri & Tribo, 2008; Martinkenaite & Breunig, 2015; Szulanski, 1996) while another look at the inter-firm aspect (Dyer & Singh, 1998; Lane & Lubatkin, 1998). However, the author of this paper argues that absorptive capacity should include both of them. Then, in this paper, the within-firm aspect is proxied by the persistent efficiency and the inter-firm aspect is concerned by calculating the gap in persistent efficiency between a domestic firm and the best firms in the same industry. The reason why persistent efficiency is used is that this efficiency is persistent and unlikely to change over time unless there are changes in management performance of firms or big changes in industrial policy (based on Vu, 2018).

Although absorptive capacity is not a new concept, there are only few studies in Vietnam on this topic. Instead, there are various papers on spillover effects of foreign direct investment and its impact of the economy (Chuc, Simpson, Saal, Anh, & Pham, 2008; Q. H. Le & Pomfret, 2011; Thang, Pham, & Barnes, 2016; T. B. Vu, Gangnes, & Noy, 2008). Only some papers directly examine the impact of absorptive capacity (Anwar & Nguyen, 2010; H. D. Vu, 2018; H. D. Vu & Le, 2017). However, within the author's knowledge, no studies in Vietnam have tested the threshold effect of absorptive capacity. Therefore, the paper attempts to assess the role of absorptive capacity in case of Vietnam manufacturing from 2007 to 2015 before testing if any thresholds of absorptive capacity exist. This period covers some major changes and shocks of Vietnam economy. Firstly, Vietnam has officially become a member of WTO in 2007 and then it has been a promising land for foreign investors. Unfortunately, the whole world, including Vietnam suffered badly from a financial crisis in 2008 and 2009, which demotivated investors to come to Vietnam. Then, after few years of recovering, the Vietnam economy has started growing until 2015. Therefore, the period from 2007 to 2015 can picture clearly economic changes of Vietnam.

Vietnam is a transition economy where the average GDP growth rate is more than 5% from 2009 (in 2017, the GDP growth of Vietnam is 7.07%). It couples with relatively low inflation rates of 3% to 4% has made Vietnam a good destination of investors. According to UNCTAD

(2019), Vietnam is on the top 20 host economies for FDI inflows in the world. Remarkably, Vietnam stands at the 6th place on the list of developing and transition economies. It implies that Vietnam has been one of the most attractive destinations for foreign investors due to sizable market and relatively cheap labor price. Therefore, FDI should be one important drive for the development of Vietnam. However, if the host country cannot take advantage of FDI, the local market can be dominated by foreigners. In the case study in Vietnam, H. D. Vu & Do (2018) show that Vietnamese firms are unlikely to take part in the production chain of foreign investors and they are lagging behind further and further. In fact, this can be the same problem for other developing countries and this is a reason why the author of this paper states that FDI absorptive capacity is essential not only for Vietnam but also for other developing countries.

The paper is organized as follows. The next part briefly reviews the existing papers on this topic and then develops research hypotheses. Then, in the methodology part, the construction of absorptive capacity, FDI spillovers and the econometric techniques are described. It is followed by the results and discussion part which shows findings of the study. Finally, the main conclusions are included in the last part.

2. Literature review and hypotheses

Spillovers can happen within industry and/or between industries. Regarding within industries, Javorcik (2004) argues that spillovers occur when the presence of multinational corporations (MNCs) has a positive influence on the performance of domestic firms. It may take place in three types: competition, labor turnover or learning by doing. The domestic firms can boost their efficiency by duplicating technologies or production methods (learning by doing/demonstration) or by hiring the well-trained workers of foreign firms (labor turnover). Additionally, the presence of MNCs with better productivity can put high pressure on the domestic ones which forces them to self-develop, otherwise they can be kicked out automatically (competition).

In terms of between industries spillovers, there are forward and backward linkage. The backward linkage refers to the relationship between MNCs and their local providers. The foreign firms are motivated to transfer directly knowledge or new technology to their suppliers because they can benefit when purchasing and using better-quality intermediating goods from the local firms. Moreover, higher quality and time-delivery requirements from MNCs may force the domestic firms to improve their performance to compete with other local suppliers. Differently, the forward linkage manifests when the domestic firms use final products of the

foreign firms as production inputs. Obviously, the productivity of the former can be increased due to high quality of intermediate goods provided by the latter (Javorcik, 2004).

Theoretically, FDI spillovers can be a good source for the development of domestic sector especially in the developing and transition countries. It is possible to find empirical evidences for this argument from existing studies. More specifically, Javorcik (2004) finds a positive impact from backward linkages on Lithuanian firms. Similarly, Blomström & Sjöholm (1999) show that the local firms in Indonesia benefit from FDI spillovers regardless of the degree of foreign ownership. Cheung & Lin (2004) make use of Chinese panel data from 1995 to 2000 to show the existence of demonstration effect of FDI. Liu (2008) agrees that there is an evidence of FDI spillovers in China, but the author claimed that this effect only occurred in the long-run and even in the short-run it could turn out to be negative externalities. In the case of Vietnam, FDI can generate positive spillover effects to domestic sector through vertical backward linkages (Anwar & Nguyen, 2010; Q. H. Le & Pomfret, 2011), competition and demonstration effects (Chuc et al., 2008) or wage spillovers (H. Q. Le, 2008). Therefore, the paper attempts to test the positive impacts of spillover effects on the Vietnamese firms.

H1: Spillover effects have positive impact on the performance of domestic firms in Vietnam.

However, the presence of MNCs does not automatically bring positive effects to domestic firms. The local firms can benefit or not depending on their absorptive capacity (Chen, Kokko, & Tingvall, 2011; Crespo & Fontoura, 2007; Girma, 2005; Girma, Gorg, & Pisu, 2008; Kokko et al., 1996). The term "absorptive capacity" has become popular after the research of Cohen & Levinthal (Cohen & Levinthal, 1989, 1994, 1990). Basically, the authors define absorptive capacity of firms as capability to recognize and learn external knowledge and then apply them into practice. Successively, substantial studies base on the root concept to develop and examine absorptive capacity in different scopes. Interestingly, due to the ambiguity of the concept, there are several measurements of absorptive capacity. While majority of papers proxied absorptive capacity by R&D expenditure (Behera, 2015; Cohen & Levinthal, 1989, 1994, 1990; Marcin, 2008), some used technology gap (Anwar & Nguyen, 2010), technical efficiency gap (H. D. Vu & Le, 2017), total frontier productivity gap (Ferragina & Mazzotta, 2014; Girma, 2005) or human capital and infrastructure (Bodman & Le, 2013; Kinoshita & Lu, 2006; Tang & Zhang, 2016). Regardless of what proxies were used, most authors agree that the link from FDI spillovers to domestic firms is subject to absorptive capacity. To some extent, the mediating role of absorptive capacity has been examined in Vietnam by Chuc et al., 2008 and H. D. Vu & Le, 2017. These authors state that absorptive capacity could boost the positive externalities

from FDI in Vietnam. Therefore, it is worth testing the role of absorptive capacity in the case of Vietnam

H2: Absorptive capacity can affect the benefit from FDI spillovers to the domestic firms in Vietnam

Nevertheless, if absorptive capacity of domestic ones is low, they will be unlikely to benefit from FDI spillovers. Kokko, Tansini, and Zejan (1996) prove that in Uruguay, the positive externalities from FDI only occur when the technology gap between FDI firms and domestic firms is moderate. Similarly, Girma, Greenaway, and Wakelin (2001) investigate the situation in the UK and conclude that domestic firms with low-skilled workers benefit less from foreign firms. Therefore, Girma (2005) argues that impacts of FDI on domestic firms could be positive or negative subject to the level of absorptive capacity. It implies that the technology diffusion could be non-linear and there could be some thresholds of absorptive capacity. In the case Vietnam, no studies have examined the thresholds of absorptive capacity. Most papers only show that absorptive capacity is important but none of them show the level of absorptive capacity. Consequently, this paper attempts to figure out which level of absorptive capacity the domestic firms should have in order to gain benefits from FDI spillovers.

H3: There is a threshold of FDI absorptive capacity of domestic firms in Vietnam.

Generally, literature review has provided empirical evidence that the role of absorptive capacity is important. In developing countries including Vietnam where the gap between foreign investors and domestic firms is big, the absorptive capacity is becoming essential. If the local firms are unable to earn benefits from FDI, the market might be totally taking over by the foreign counterparts. Therefore, it is necessary to examine the impact of FDI absorptive capacity in Vietnam.

3. Methodology and data

3.1. Methodology

For estimating purpose, the log-linear production function (Aitken & Harrison, 1999; Konings, 2001) of the domestic firms is applied (the Equation 1). The main purpose of the regression is to estimate the effect of FDI spillover effects on the performance of domestic firms and then to examine the role of absorptive capacity in this link.

$$y_{ijt} = \alpha + \alpha_i + \beta_1 k_{ijt} + \beta_2 l_{ijt} + \beta_3 spill_{jt} + \beta_4 spill_{jt} * AC_{ijt} + \beta_5 X_{ijt} + \varepsilon_{ijt} \qquad (1)$$

Where i is firm i, j is sector j and t is time t. *Y* is productivity of domestic firm, *K* is fixed capital of domestic firm and *L* is total labor of domestic firm. *Spill* is FDI spillovers include three measurements: horizontal effect (*Horizontal)*, forward linkage (*Forward*) and backward linkage (*Backward*). The interaction terms are created to examine the mediating role of absorptive capacity (AC) in the link from FDI to domestic firms. *X* is the set of other control variables including *concentration index, human capital* and *institutions* and *size* of firms. *Y, K* and L are in logarithm transformation. Constructions of absorptive capacity and spillovers and description of other control variables are specified later.

The hypothesis 1 (H1) and 2 (H2) can be solved from estimation results by using fixed effect model with panel data. And the hypothesis 3 (H3) is tested by applying the threshold regression method (Girma, 2005) as follow:

$$y_{ijt} = \alpha + \alpha_i + \beta_1 k_{ijt} + \beta_2 l_{ijt} + \beta_3 spill_{jt} + \theta_1 spill_{jt}\, I(AC_{ijt} < \gamma_1) + \theta_2 spill_{jt}\, I(AC_{ijt} \geq \gamma_1) + \beta_5 X_{ijt} + \varepsilon_{ijt} \quad (2)$$

Where $I\,(\cdot)$ is the indicator function and AC is absorptive capacity. Note that it could be one or two thresholds and the number of thresholds can be tested. It implies that there might exist γ_2 such that $\gamma_1 \leq AC_{ijt} < \gamma_2$.

The paper bases on the estimation method of Hansen which is used widely (Girma, 2005; Wang, 2015). The equation (2) could be simplified as follow:

$$y_{ijt} = \alpha + \alpha_i + \beta_1 k_{ijt} + \beta_2 l_{ijt} + \beta_3 spill_{jt} + \theta spill_{jt}\, I(AC_{ijt}, \gamma_1) + \beta_5 X_{ijt} + \varepsilon_{ijt} \quad (3)$$

$\hat{\beta}(\gamma_1)$ and $\hat{\theta}(\gamma_1)$ can be estimated by OLS and then the residual sum square is $S_1(\gamma_1)$. Then, estimator of γ_1 must meet the requirement:

$$\hat{\gamma}_1 = arg \min_{\gamma} S_1(\gamma_1) \quad (4)$$

The most important step is to identify if the model should be non-linear or linear. The first test is single-threshold model versus linear model. The testing hypothesis is:

$$H_0: \theta_1 = \theta_2$$

$$H_1: \theta_1 \neq \theta_2$$

If $\theta_1 = \theta_2$, the threshold model shrinks into linear model. The F statistic is:

$$F_0 = \frac{S_0 - S_1}{\hat{\sigma}^2} \quad (5)$$

Where S_0 is residual sum square of the linear model and S_1 is residual sum square of threshold model. However, under H0, it is unable to identify $\gamma_1$and consequently F_0 is not standard normal distribution. Therefore, the significance of threshold model is test by using Hansen's construction of P-value from bootstrap that is asymptotically valid (Hansen, 1996). The bootstrap procedure is as follow:

Step 1: Regress the threshold model under the H_1 and then create the residual $\hat{\varepsilon}_{ijt}^*$

Step 2: Draw with replacement of $\hat{\varepsilon}_{ijt}^*$ and get the new residual $\hat{\mu}_{ijt}^*$

Step 3: Create new model as follow:

$$y_{ijt}^* = \alpha + \alpha_i + \beta_1 k_{ijt} + \beta_2 l_{ijt} + \beta_3 spill_{jt} + \theta spill_{jt}\, I(AC_{ijt}, \gamma_1) + \beta_5 x_{ijt} + \hat{\mu}_{ijt}^* \quad (6)$$

Note that β and θ are different to the previous equation.

Step 4: Regress the model under null hypothesis and alternative hypothesis and compute F statistics

Step 5: Repeat the last four steps B times and get the probability of F $>$ F_0 in the bootstrap number B.

If the result approves the existence of threshold model over linear model, it is necessary to form the confidence interval of $\hat{\gamma}_1$ with the null hypothesis is:

$$H_0: \gamma_1 = \gamma_0$$

If $\gamma_1 = \gamma_0$, it is easy to just divide the database and then run normal linear regression. if it is not, then the threshold is valid. This is tested by likelihood ratio test:

$$LR(\gamma) = \frac{S_1(\gamma_1) - S_1(\hat{\gamma}_1)}{\hat{\sigma}^2} \quad (7)$$

Given that α can be 0.1 or 0.05, the critical value equals:

$$c(\alpha) = -2\log(1 - \sqrt{1 - \alpha}) \quad (8)$$

IF $LR(\gamma) > c(\alpha)$, the null hypothesis is rejected.

Spillover variables

The paper bases on the methodology of Javorcik (2004) to calculate spillover effects of FDI. There are three spillover variables: *Forward, Backward* and *Horizontal*.

$$Horizontal_{jt} = \frac{\sum_{i \in j} Foreign\ share_{it} * A_{it}}{\sum_{i \in j} A_{it}} \quad (9)$$

A_{it} can be revenue of firm i in the industry j or total labor of firm i in the industry j. Therefore, horizontal represents for the appearance of FDI in the industry j. This paper uses total revenue to calculate the horizontal effect.

$$Backward_{jt} = \sum_{k \neq j} a_{jk} * Horizontal_{jt} \quad (10)$$

a_{jk} is the proprtion of industry j's ouput consumed by industry k. Note that $k \neq j$. This coefficient is collected from the Input-Output table of Vietnam in 2012. It is assumed that this coefficient does not change from 2007 to 2015.

$$Forward_{jt} = \sum_{m \neq j} b_{jm} * \frac{\sum_{i \in m} y_{ijt} - e_{ijt}}{Y_{jt} - E_{jt}} \quad (11)$$

where b_{jm} is the proportion of industry m's output consumed by industry j to produce final outputs. Once again, this coefficient is taken from the Input-Output table 2012. e_{ijt} is exports of foreing firm i in the indusry j at time t and E_{jt} is total exports of industry j at time t.

Bases on the methodology of Chuc et al. (2008), e_{ijt} is assumed to be linear correlation with the equity share. Hence, it is approxiated as follow:

$$\sum_{i} e_{ijt} = \frac{\sum_{i} ka_{ijt}}{KA_{jt}} * E_{jt} \quad (12)$$

where ka_{ijt} is fixed capital of foreign firm i in the industry j at time t and KA_{jt} is total equity of industry j. E_{jt} can be taken directly from the Input-Output table 2012. Note that, using only one input-output table for many years cannot be a good idea and can be strong. However, the

I-O table in Vietnam is not available for every year. Therefore, the paper has to base on this strong assumption.

Absorptive capacity of the domestic firms

Absorptive capacity of a domestic firm is constructed by calculating the gap in persistent efficiency between this domestic firm and FDI firms in the same industry. The persistent efficiency is one component of technical efficiency. In fact, some authors (Girma, 2005; H. D. Vu & Le, 2017) used the gap in technical efficiency or total factor productivity between local and foreign firms to proxy absorptive capacity. However, the paper takes a step further by decomposing the technical efficiency of a firm into four components and claims that the gap in persistent efficiency could be a good proxy for the domestic firm's absorptive capacity.

Classically, it is possible to estimate technical efficiency of firm based on following equation:

$$y_{it} = f(x_{it}; \beta) + \epsilon_{it}\ , \tag{13}$$

$$\epsilon_{it} = v_{it} - u_i, \qquad u_i \geq 0, i = 1, \ldots\ldots, N\ \&\ t = 1, \ldots\ldots, T \tag{14}$$

where u_i is technical inefficiency which is time-invariant of firm i and v_{it} can be fixed or random error term.

Now, based on the approach of Kumbhakar, Lien, & Hardaker (2014), ϵ_{it} is decomposed into four parts:

$$\epsilon_{it} = \mu_i + v_{it} - \rho_i - u_{it} \tag{15}$$

where μ_i presents for latent heterogeneity which assumes to be normal distribution with variance of δ_μ^2. Then, ρ_i is persistent inefficiency and it is i.i.d $N^+(0, \delta_\rho^2)$. This part is the key one to calculate absorptive capacity of the domestic firms. v_{it} and u_{it} are random shock and time invariant inefficiency in short-run with distribution $N(0, \delta_v^2)$ and $N^+(0, \delta_u^2)$ respectively.

$f(x_{it}; \beta)$ is the technology function of firm i with x_{it} is inputs (labor and capital) to produce the final product. y_{it} is productivity of firm which is measured by logarithm of value of added of this firm. Consequently, the regression is rearranged as follow (S. C. Kumbhakar, Wang, & Horncastle, 2015):

$$y_{it} = \theta_0^* + f(x_{it}; \beta) + \theta_i + \varepsilon_{it} \tag{16}$$

Where:

$$\theta_0^* = \theta_0 - E(\rho_i) - E(u_{it}) \tag{17}$$

$$\theta_i = \mu_i - \rho_i + E(\rho_i) \quad (18)$$

$$\varepsilon_{it} = v_{it} - u_{it} + E(u_{it}) \quad (19)$$

θ_i and ε_{it} are assumed normal distribution with variance of δ^2

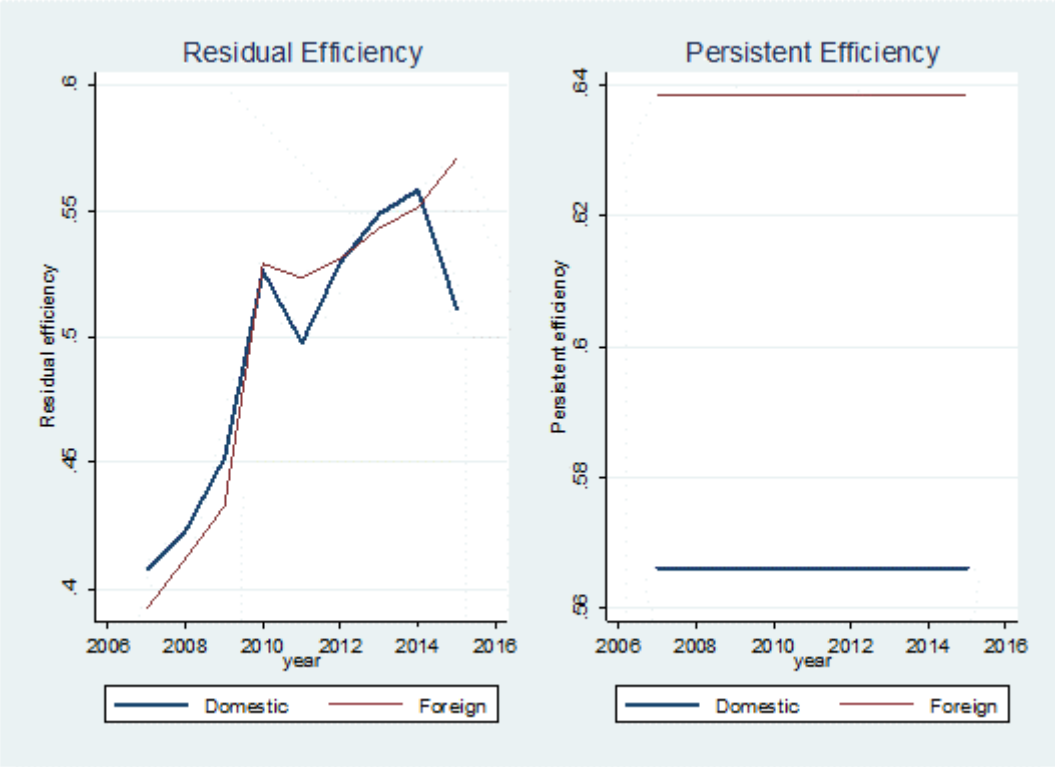
$\hat{\beta}$ in the equation 16 can be estimated by applying fixed effect model with panel data. After getting $\hat{\beta}$, the $\widehat{\theta_i}$ *and* $\widehat{\varepsilon_{it}}$ can be predicted as the residual of regression. Then, based on the distribution assumption of $v_{it} \sim N(0,\ \delta_v^2)$ and $\widehat{\varepsilon_{it}}$, the residual technical inefficiency $\widehat{u_{it}}$ can be predicted from the equation (19). Finally, the persistent inefficiency $\widehat{\rho_i}$ can be estimated from the equation (18) and distribution assumption of μ_i and ρ_i. And persistent efficiency (PE) simply equals to exp(-$\widehat{\rho_i}$).

Finally, the absorptive capacity is proxied by following index:

$$AC_{ijt} = \frac{DPE_{ijt}}{\overline{FPE_j}} \times 100 \quad (20)$$

AC_{ijt} represents for absorptive capacity of the domestic firm i in the industry j in time t and DPE_{ijt} is persistent efficiency of the domestic firm i in industry j in time t. $\overline{FPE_j}$ is the mean value of persistent efficiency of foreign firms in the sector j over years. Although persistent efficiency do not change over years, but the mean value of persistent efficiency of foreign firms could change due to the change in ownership of firms. In case there are no changes in ownership, AC can be unchanged. For example, in 2010 one firm is owned by local owners but then in 2011 it can be transferred to foreign owners. Therefore, the value of AC can be slightly change over years. That's is a reason why there is time index for AC.

The reason why the paper chooses the gap in persistent efficiency is that this efficiency is persistent and unlikely to change over time unless there are a change in management performance of firm or a big change in industrial policy (S. C. Kumbhakar et al., 2015). It implies that it is internal factor and every firm desire to keep the persistent inefficiency at lowest level. Reversely, residual technical efficiency only occurs in the short-run and might not repeat next year. It might happen due to some unexpected events and it cannot present for the absorptive capacity of domestic firms. In fact, the Figure (1) shows that the gap in the residual efficiency between domestic and foreign group is not significant over years while this in persistent efficiency is obvious. Hence, this gap can be a good explanation for efficiency differences amongst local and foreign firms and then can be a base for absorptive capacity of the domestic firms relative to foreign counterparts.



Source: Author

Figure 1: Residual and Persistent efficiency of the domestic and foreign firms

3.2. Data

By using the threshold regression model, it is necessary to have a strongly balanced panel data. Note that the panel data is created based on the cross-section data from 2007 to 2015 of the Annual Enterprises Survey. The database includes basic information of firms including operating industries, output, total labor, fixed capital and wage of workers. Only repeated firms in the period 2007-2015 are kept in the panel data. Therefore, from 2007 to 2015, there are 19,971 observations including repeated 1803 domestic firms and 416 foreign firms (details can be found in the Annex). There are 21 sectors in the Vietnamese manufacturing.

According to General Statistic Office of Vietnam, 53% of FDI inflows come to the manufacturing sectors[2]. Moreover, the number of employment in this sector consists of 17.9% of total number of employment. More importantly, the manufacturing sector have the largest GDP proportion in Vietnam in 2018 which comprises 18.32% of total GDP share. Hence, the author has selected the manufacturing sector in Vietnam to test the above-mentioned

[2] https://www.gso.gov.vn/SLTKE/pxweb/en/04.%20Investment/-/E04.15.px/table/tableViewLayout1/?rxid=5a7f4db4-634a-4023-a3dd-c018a7cf951d

hypotheses. In the recent Annual Enterprises Survey 2015, the percentage of manufacturing sector is 15% and the output of this sector consists of 40% of total output of surveyed sectors.

In the equation (13), x_{it} includes logarithm of total labor and fixed asset of firm i in time t. Firm i can be domestic firm or foreign firm. and y_{it} is logarithm of gross value added of this firm i in the time t. The values of these variables are taken from the Annual Enterprises Survey from 2007 to 2015. The value added is calculated by authors from the Annual Enterprises Survey. Note that productivity can be measured differently but this paper uses value added because this is the most expected outcome of domestic firms when cooperating with FDI firms. H. D. Vu & Do (2018) point out that majority of value added in the automobile and electronic industry (two main sub sectors of the manufacturing sector) in Vietnam have been created by foreign sectors. This situation could hamper the economy if FDI firms decide to leave the country. Additionally, adding value to its goods and services is a good way to differentiate one firm to another. It also helps cut the cost and brings benefits to firms in the long run. Therefore, value added is essential in this case. In fact, there are many papers use gross value added to proxy for productivity of firms (Ferragina & Mazzotta, 2014; Girma et al., 2001; W. S. Liu, Agbola, & Dzator, 2016), hence value added is an appropriate proxy for productivity of firms.

In the equation (2), y_{jit}, k_{jit}, l_{jit} are logarithm of value added, fixed assets and total labor of firm i in the industry j in time t. However, i can be the domestic firm only. Additionally, $spill_{jt}$ comprises of $Horizontal_{jt}$, $Backward_{jt}$, $Forward_{jt}$ which are described above. AC_{ijt} is absorptive capacity of the domestic firm i. Finally, X_{jit} is a set of other control variables *including concentration index, human capital, institutions* and *size of firms*. *Concentration index* is a Herfindhal index of two-digit industry concentration which is log-transformed. *Human capital* is proxied by wage level assuming that higher skilled labor can receive higher wage, therefore, if a firm pay higher wage per cap, it can have better human capital. It is constructed by the ratio between wage level of individual and the highest wage level in the same industry. It is also log-transformed. Firms are categorized into three groups by size based on the revenue. Finally, *institutions* is a provincial variable which is collected from PCI index in Vietnam. This index allows us to compare the institutions environment among provinces in Vietnam[3]. The description for all variables can be seen in the Table 1.

Table 1: Variables summary

Variables	Unit	Observation	Mean	SD	Min	Max

[3] For further detail, please look at http://eng.pcivietnam.org/

Value added	Mill. VND	19,971	58582.52	307724.6	0.782693	1.35E+07
Fixed capital	Mill. VND	19,971	30791.61	239103.6	2.123894	9349001
Total labor	Person	19,971	251.791	1735.624	1	85206
Absorptive capacity	%	16,227[4]	86.4653	19.62142	12.67586	138.9956
Backward	%	19,971	16.68085	20.08489	0.047045	99.52123
Horizontal	%	19,971	44.2987	17.74592	7.055851	99.11738
Forward	%	19,971	15.49803	9.155855	1.661027	30.80219
Institutions	index	19,971	59.78421	3.946957	44.17397	71.7572
Income per person	Mill. VND	19,971	33.98939	26.6631	6.967742	1418.519
HHI	index	19,971	0.068414	0.07126	0.017474	0.454318

(i) In the regression, value added, fixed capital, total labor and income per person are in the logarithm form.

Source: Author's calculation from Vietnam Annual Enterprises from 2007 to 2015

The Harris–Tzavalis for unit root test is conducted to test the stationary of the database because the time period is relatively small to the sample size. The results show that the database is stationary (Annex E).

4. Results and discussion

Absorptive capacity and FDI spillovers

Firstly, the study provides a general view on the correlation between absorptive capacity and FDI spillovers by calculating the mean value of them by sector. From the equation (16) and (20), the *AC* is calculated and its mean by sector can be seen in the Table 2[5]. The firms in the manufacture of pharmaceuticals, medicinal (code 21) have the best absorptive capacity and follows are the firms in the manufacture of textiles (code 13), the manufacture electrical equipment, the manufacture of chemicals and chemical products and the manufacture of other non-metallic mineral products (code 27,20 and 23). In contrast, the manufacture of paper and paper products (17), the manufacture of motor vehicles; trailers and semitrailers (29), wood and products of wood (16) and the manufacture of beverages (11) stand at the last positions. Interestingly, based on the classification of Eurostat, apart from the industry code 13, other top industries are the medium and high technology ones while the bottom industries are the low

[4] Only domestic firms have FDI absorptive capacity

[5] The value of AC is calculated based on the results from the Equation 13 (Annex B)

technology ones (except for the industry 29)[6]. It signals that in Vietnam, absorptive capacity of the high-tech firms is better than this of the low-tech firms.

Table 2: Mean *AC* of domestic firms by industry

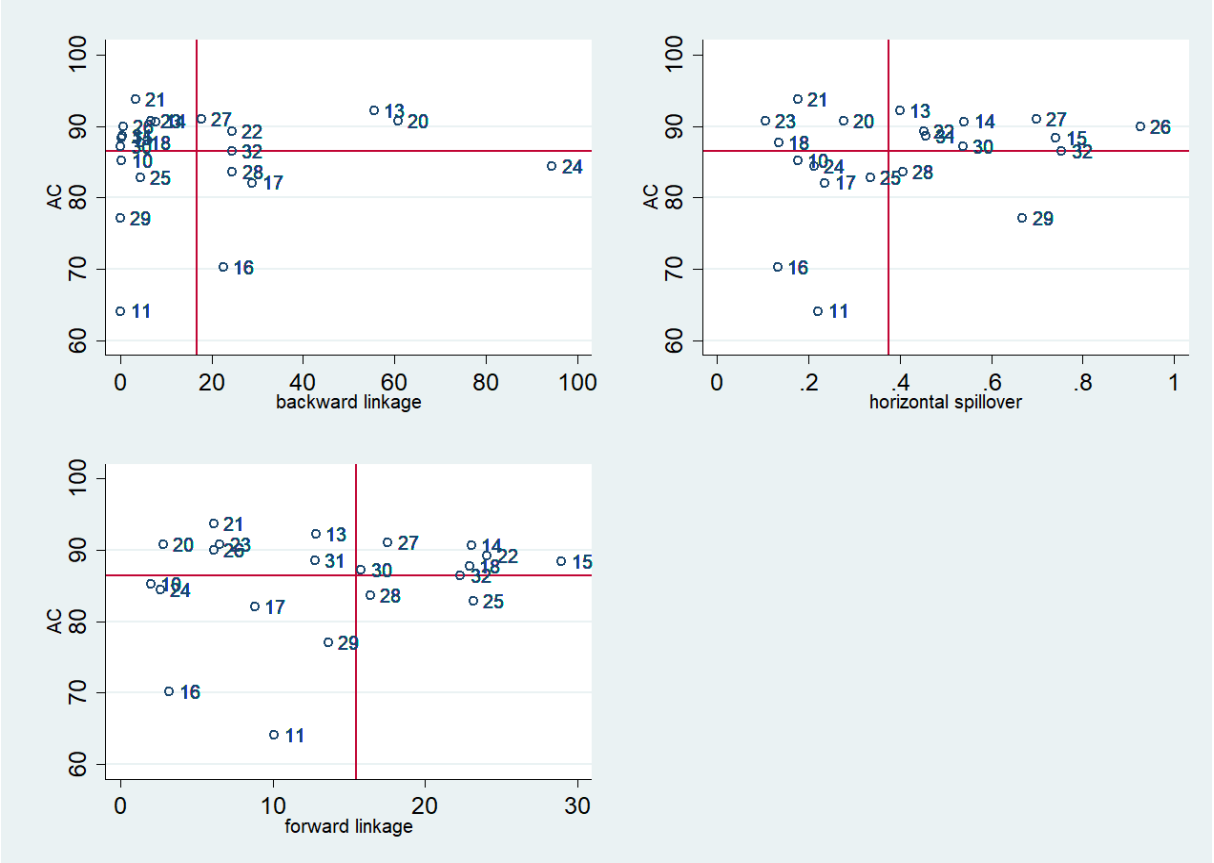
Sector Code	Name of sector	Mean value of *DACM*	Rank
21	Manufacture of pharmaceuticals, medicinal	93.7123	1
13	Manufacture of textiles	92.2075	2
27	Manufacture of electrical equipment	91.0416	3
20	Manufacture of chemicals and chemical products	90.7931	4
23	Manufacture of other non-metallic mineral products	90.7284	5
14	Manufacture of wearing apparel	90.6713	6
26	Manufacture of computer, electronic and optical	89.9898	7
22	Manufacture of rubber and plastics products	89.2223	8
31	Manufacture of furniture	88.5929	9
15	Manufacture of leather and related products	88.3803	10
18	Printing and reproduction of recorded media	87.7484	11
30	Manufacture of other transport equipment	87.1532	12
32	Other manufacturing	86.4603	13
10	Manufacture of food products	85.2312	14
24	Manufacture of basic metals	84.3943	15
28	Manufacture of machinery and equipment n.e.c	83.5907	16
25	Manufacture of fabricated metal products, except	82.7983	17
17	Manufacture of paper and paper products	82.0869	18
29	Manufacture of motor vehicles; trailers and semitrailers	77.0939	19
16	Manufacture of wood and products of wood	70.2062	20
11	Manufacture of beverages	64.1253	21

Source: Author

Next, the study also examines the correlation between the absorptive capacity of domestic firms and FDI spillover effects by using Pearson correlation. It finds that absorptive capacity has significant and positive correlations with *horizontal, backward and forward* (Annex A). Moreover, it is interesting to capture both absorptive capacity and FDI spillover at the same time. The Figure 2 shows all sectors with relevant mean of absorptive capacity and FDI spillovers. The sectors which locate in the top right corner of one graph have good absorptive capacity and better FDI spillover. From the top left graph in the Figure 2 we can see that most of the sectors in the top right corner are medium-high technology ones. It implies that firms in the medium-high technology industries which have good absorptive capacity could enjoy more benefits when producing inputs for FDI firms. Interestingly, the situation is different for the forward linkage channel (in the bottom left graph of the Figure 2). Majority of the top-right-

[6] Eurostat classification can be found here: http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:High-tech_classification_of_manufacturing_industries

corner sectors are medium-low and low technology ones. It indicates that firms with good absorptive capacity in these industries can be better off when purchasing and using production inputs from FDI firms. This current state is understandable in Vietnam where FDI firms usually have a higher level of technology than domestic firms. Therefore, only firms in the medium-high technology industries are capable to provide the FDI firms with decent inputs and then enjoy the positive externalities (backward linkage). Reversely, firms with lower level technology can use inputs produced by the FDI firms to better their production chains (forward linkage). Additionally, the situation is mixed for horizontal effect (in the top right graph of the Figure 2). This information can be important to identify the key industries for the development of Vietnam in the future. However, the graph in unlikely to show us any causal relationship therefore it needs further evidences from running regressions.



Source: Author

Figure 2: Absorptive capacity and spillovers by sector

Regression results

The hypothesis 1 and hypothesis 2 are examined by exploring the regression results of the model in the Equation (1). Firstly, the model is run without interaction terms between FDI

spillovers and absorptive capacity to examine the main effect of FDI spillovers on the domestic firms' performance (the Model 1). Then, the mediating role of absorptive capacity is tested by adding the interaction terms (the Model 2).

The regression results from the first column of Table 3 shows that apart from labor and physical capital, human capital, institutions and industry concentration have positive effects on the performance of domestic firms. More specifically, 1% increase in *human capital* may lead to 0.1667 % increase in the added value created by the domestic firms. Not surprisingly, *institutions* (proxied by PCI index) is an important factor when 1% increase in the PCI index will boost 1.3164 % of the performance of local firms. Additionally, the positive impact of *industry concentration* (lnHHI) is also approved when 1% rise in HHI causes 0.2354% improvement for firms. All three coefficients are statistically significant at 1% level.

Essentially, although the Model 1 detects the positive influences of the three types of spillovers, only horizontal effect and backward linkage are significant statistically. The positive and significant of *Horizontal* coefficient implies that in Vietnam the appearance of foreign firms brings a positive impact to the domestic firms in the same industry. Note that the horizontal effect here is calculate based on total revenue, it indicates that domestic firms have improved its capability via competition with FDI firms and learning-by-doing process (equivalent to Chuc et al., 2008). Moreover, while the backward linkage from FDI to the local enterprises is found, the forward linkage seems not exist. It is reasonable in Vietnam. Generally, the Vietnamese firms are relatively small and less productive than foreign firms. Therefore, they can only be a provider of FDI ones and during this process they must improve themselves to meet the requirements (backward linkage) (it is relevant to the results of Anwar & Nguyen, 2010). Note that the coefficient of AC is positive but not statistically significant, and it implies that absorptive capacity does not directly affect the performance of the domestic firms. It is explainable because this is FDI absorptive capacity and it could not directly bring impacts to the domestic firms. Therefore, the model 2 examines the role of AC in the relationship with spillover effects.

The second column of the Table 3 displays the regression results after adding the interaction terms between FDI spillovers and *AC*. Interestingly, the statistically significance of the variable *AC* now implies that the absorptive capacity of the domestic firms only have a positive impact on their performance conditional on spillover effects. Additionally, the significance of *Horizontal* and *Horizontal*AC* show that absorptive capacity can be a catalyst to improve the effect of the horizontal effect from FDI on the performance of the domestic firms. The negative

sign of *Horizontal* does not mean the negative impact of horizontal effect. It is necessary to take the value of AC into consideration. From the Table 1, the mean value of *AC* is 84.4653, then the impact of horizontal effect on the performance of the domestic firms is 0.0004*84.4653 – 0.0183 = 0.0155 in average. It can interpret that the domestic firms can enjoy the benefits from FDI firms in the same industry if they have some certain levels of absorptive capacity. Specifically, one percent goes up in horizontal effect leads to 0.0155% arise in value added of domestic firms, subject to their absorptive capacity. Unfortunately, it seems that absorptive capacity cannot boost the influence of backward linkage and forward linkage when the coefficient of *Backward*AC and Forward*AC* are not statistically significant. Note that this result is not equivalent to the previous study of Anwar & Nguyen (2010). The study found the positive effect of absorptive capacity on backward linkage. However, the authors proxied absorptive capacity by human capital which is a single index and that could be a reason for a difference in regression results.

Table 3: Regression results

LnY	Model 1	Model 2	Model 3
Ln(Labor)	0.5802***	0.5779***	0.5777***
	(0.0382)	(0.0194)	(0.0365)
Ln(Capital)	0.1776***	0.1765***	0.1752***
	(0.0150)	(0.0103)	(0.0152)
Ln(Human capital)	0.1667***	0.1676***	0.1688***
	(0.0157)	(0.0143)	(0.0155)
Ln(HHI)	0.2354***	0.2447***	0.2628***
	(0.0691)	(0.0663)	(0.0695)
size	0.0532	0.0595	0.0426
	(0.1226)	(0.0427)	(0.1194)
Ln(Institutions)	1.3164***	1.3121***	1.3003***
	(0.1083)	(0.1331)	(0.1074)
AC	0.0868	0.0896*	0.1078+
	(0.0686)	(0.0363)	(0.0636)
Horizontal	0.0124***	-0.0183**	
	(0.0025)	(0.0070)	
Backward	0.0179***	0.0146+	0.0187***
	(0.0037)	(0.0085)	(0.0037)
Forward	0.0064	-0.0112	0.0046
	(0.0056)	(0.0190)	(0.0055)
Horizontal*AC		0.0004***	
		(0.0001)	
Backward*AC		0.0001	
		(0.0001)	
Forward*AC		0.0002	

		(0.0002)	
Horizontal			-0.0283
$(AC < \gamma_1)$			(0.0215)
Horizontal			-0.0719+
$(\gamma_1 < AC < \gamma_2)$			(0.0412)
Horizontal			0.0152***
$(AC > \gamma_2)$			(0.0024)
Constant	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes
Observation	16227	16227	16227
R_square	0.7464	0.7302	0.6918
Sigma_u	0.9239	1.3174	1.6904
Sigma_e	1.0417	1.0408	1.0370
F-statistics	35.2519	65.6158	35.4171

(i) +Significant at 10% level, *significant at 5% level, **significant at 1% level, ***significant at 0.1% level

(ii) Heteroskedasticity and within-firm serial correlation robust standard errors in the parenthesis

Source: Author

Up to now, the Hypothesis 1 and Hypothesis 2 are tested, and it is possible to argue that FDI spillovers have positive effects on the productivity of local firms and absorptive capacity plays an intermediating role in this relationship. However, the impacts of FDI spillovers depends on values of absorptive capacity and it is necessity to test if it is linear or non-linear on absorptive capacity. This is a novelty value of the paper because up to now, no studies point out which level of absorptive capacity the domestic firms should have in order to earn benefits from FDI. The null hypothesis of linear model is rejected in the Table 4, therefore there must be some thresholds of the absorptive capacity. The threshold effect test in the Table 4 confirms that there are two thresholds in this case.

Table 4: Threshold effect test

Testing hypothesis	MSE	F stat	Prob	10% Critical	5% Critical	1% Critical
H_0: Linear Model H_1: Threshold model	0.9557	126.58	0.0000	15.6240	26.9498	46.3767
H_0: Single threshold H_1: Double threshold	0.9543	23.64	0.0400	17.9137	22.4791	47.1101
H_0: Double threshold H_1: Triple threshold	0.9538	7.85	0.8033	27.3350	34.4394	60.3100

Source: Author

Table 5: Threshold values

	Threshold	Lower	Upper
First threshold (γ_1)	53.6269	52.7456	60.0667
Second threshold (γ_2)	57.3146	56.2225	58.1892

Source: Author

The threshold regression is shown the third column of the Table 3. We can easily see that the impact of *Horizontal* varies depending on the value of absorptive capacity. The threshold divides the value of *DACM* into three quantiles. The first one is the lowest values of *AC* (*AC*<γ_1) while the third quantile includes firms with the highest value of absorptive capacity (*AC*>γ_2). It is obvious to see that a firm with absorptive capacity which is larger than γ_2 can receive a positive horizontal effect from FDI. It can interpret that an 1% increase in horizontal effect of the firms which have good absorptive capacity leads to an 0.0152% increase in their value added. However, if a firm has its absorptive capacity which is below γ_2 but over γ_1 can suffer from the presence of the foreign counterparts. Lastly, firms in the first quantile seems not to be affected by the horizontal effect when the coefficient is not statistically significant. Generally, the operation of FDI firms might create externalities on domestic firms. It can be positive if the domestic firms have good absorptive capacity (their AC> γ_2), otherwise, the externalities can be negative ($\gamma_1 < AC < \gamma_2$). Note that, if a firm falls below the threshold γ_2, the negative impact is -0.0719 which is bigger than the positive impact of 0.0152 if a firm has its AC over γ_2. It means that if a firm does not have a sufficient level of absorptive capacity, it is likely that it could be lagged behind further when FDI firms appear in the same industry. However, there are only 1208 observations which have their absorptive capacity below γ_2 and it indicates that most of the Vietnamese firms in the manufacturing industry can benefit from competing and cooperating with FDI firms in the same industry.

The hypothesis 1 and hypothesis 2 are comparable with existing studies. Unfortunately, there are no studies on the threshold of absorptive capacity in Vietnam, hence it is unable to make a comparison with this paper. However, this is also a contribution of the paper when showing the specific levels of absorptive capacity.

5. Conclusion

The paper examines the impact of FDI spillover effects on Vietnamese firms in the manufacturing firms and the influence of firm-level absorptive capacity on the link from spillovers to Vietnamese manufacturing firms in the period 2007-2015. The absorptive capacity in this paper is defined as the gap in persistent efficiency between domestic firms and FDI firms. Moreover, it is expected that there are thresholds of absorptive capacity of the domestic firms so that the impact of FDI spillovers might vary. Therefore, the paper applies a fixed effect model and a fixed effect threshold model for panel data and finds several findings. Firstly, backward linkage and horizontal effect have positive impacts on the productivity of domestic

firms. Secondly, absorptive capacity of domestic firms does not directly influence their performance, but it plays an intermediating role to boost the positive effects from horizontal effect. However, the paper cannot find the impact of absorptive capacity on the domestic firms via backward linkage. Finally, the paper finds double thresholds of absorptive capacity of the Vietnamese firms. Given the estimated *AC*, firms with better absorptive capacity may enjoy the benefit while firms with lower absorptive capacity may suffer from negative effects of the horizontal effect.

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ANNEX

Annex A: Pearson correlation among AC and FDI spillovers

	Horizontal	Backward	Forward
AC	0.0848*	0.0851*	0.0530*

* Statically significant at 1% level

Source: Author

Annex B: Results from fixed effect regression to calculate DACM

LnY	Equation 13
Ln(Total Labour)	0.5634***
	(0.0438)
Ln(capital)	0.1758***
	(0.0163)
Industry dummy	Yes
Constant	Yes
Obs	19,971
R-Square	0.6667
Sigma_u	0.9161
Sigma_e	1.081
F-statistic	17.21

(i) ***Statistically significant at 1% level

(ii) Heteroskedasticity and within-firm serial correlation robust standard error are given in the parenthesis

Source: Author

Annex C: Number of observations by ownership

Sector	Name	Domestic Firms	Foreign Firms
10	Manufacture of food products	2,169	270
11	Manufacture of beverages	400	36
13	Manufacture of textiles	895	196
14	Manufacture of wearing apparel	1,593	732
15	Manufacture of leather and related products	531	245
16	Manufacture of wood and products of wood	502	68
17	Manufacture of paper and paper products	841	149
18	Printing and reproduction of recorded media	1,226	38
20	Manufacture of chemicals and chemical products	907	105
21	Manufacture of pharmaceuticals, medicinal	255	18
22	Manufacture of rubber and plastics products	2,172	503
23	Manufacture of other non-metallic mineral products	569	99
24	Manufacture of basic metals	268	36
25	Manufacture of fabricated metal products, except	1,664	517
26	Manufacture of computer, electronic and optical	168	124
27	Manufacture of electrical equipment	480	168
28	Manufacture of machinery and equipment n.e.c	516	30
29	Manufacture of motor vehicles; trailers and semitrailers	120	65
30	Manufacture of other transport equipment	94	72
31	Manufacture of furniture	589	102
32	Other manufacturing	268	171

Source: Author

Annex D: Correlations of variables

	LnY	LnL	LnK	Ln(HC)	Ln(PCI)	Ln(HHI)	Size	AC	Forward	Backward	Horizontal
LnY	1										
LnL	0.776199	1									
LnK	0.738875	0.733814	1								
Ln(HC)	0.241912	0.190135	0.177317	1							
Ln(PCI)	0.046358	-0.0418	-0.00934	0.114803	1						
Ln(HHI)	0.032122	0.00751	0.005231	0.27391	0.030889	1					
Size	0.580711	0.765958	0.559552	0.161695	-0.02649	-0.00068	1				
AC	0.718558	0.549758	0.536214	0.242255	0.033922	-0.07004	0.381815	1			
Forward	0.002913	0.04876	-0.06245	0.061823	0.108712	-0.14395	0.05743	0.06536	1		
Backward	0.042953	-0.06972	0.040067	0.08911	0.036641	0.187351	-0.10058	0.058669	-0.21616	1	
Horizontal	0.145634	0.192975	0.038278	0.164591	0.121388	0.330805	0.161012	0.0685	0.270514	0.067451	1

Source: Author

Annex E: Stationary Test

	Statistic	Z	P-value	Decision
LnY	0.0994	-93.7591	0.000	Stationary
LnL	0.4747	-35.1747	0.000	Stationary
LnK	0.1936	-79.0497	0.000	Stationary
Ln(HC)	-0.0274	-1.1e+02	0.000	Stationary
Ln(PCI)	-0.1313	-1.3e+02	0.000	Stationary
Ln(HHI)	0.3905	-48.3239	0.000	Stationary
Size	0.4720	-35.5932	0.000	Stationary
AC	0.0000	-98.5045	0.000	Stationary
Forward	0.3438	-55.6146	0.000	Stationary
Backward	0.3332	-57.2651	0.000	Stationary
Horizontal	0.3461	-55.2429	0.000	Stationary