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# FDI Horizontal and Vertical Effects on Local Firm Technical Efficiency

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## Abstract

Differencing from previous studies on foreign direct investment (FDI) spillovers to domestic enterprises which mainly focus on productivity, in this paper we take a different perspective by analysing the impacts of FDI to technical efficiency of domestic firms. The paper goes beyond the current literature to shed some light on the spillover effects of FDI to technical efficiency of small and medium enterprises in a developing country. By exploiting a firm-level panel dataset and using SFA models following Battese and Coelli (1995), the paper is able to analyse horizontal spillovers through imitation and competition and labour mobility as well as vertical spillovers through backward and forward linkages on technical efficiency. The paper contributes to the understanding of potential effects on foreign invested enterprises on domestic economy in general and local enterprises performance in particular. Thus it importantly assists policy making by the government of developing countries, where FDI is believed to create technical spillovers on domestic enterprises.

**Keywords:** *Technical Efficiency, Foreign Direct Investment, Spillovers*

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## I. INTRODUCTION

Many developing countries look to foreign direct investment (FDI) as a resource for improving and expanding their small and inexperienced domestic enterprise sector. It was mentioned by Blomstrom and Kokko (2003, pp. 2) as follows:

> "On the expectation that foreign MNCs will raise employment, exports, or tax revenue, or that some of the knowledge brought by the foreign companies may spill over to the host country's domestic firms, governments across the world have lowered various entry barriers and opened up new sectors to foreign investment."

The benefits from foreign investment to domestic economies have long been studied. The standard theory of international trade saw investment abroad by private enterprises as arbitrating capital. Under this view, FDI will reduce the gap between marginal product of capital and of labour (Blomstrom and Kokko, 1997). This gap is caused by the lack of capital in the many developing countries.

Moreover, multinational corporations (MNCs) bring new technology and management skills which during their operation will spillover to domestic enterprises. In the context of hard competition from FDI sector, domestic enterprises experience intensified "creative destruction", which refines them to become more efficient. Spillovers from FDI sector to local enterprise sector are also realized by labour mobility, in which labours equipped with advanced technical and managerial skills move from foreign firms to domestic firms. Moreover, foreign invested firms play the role of examples, and domestic firms imitate their advanced skills and techniques for production improvement.

Apart from the aforementioned horizontal (intraindustry) effects, foreign firms as players in the domestic economy also create vertical (interindustry) externalities. Being buyers in the domestic markets, foreign firms can contribute to technological improvement of their local suppliers by offering technical assistance and supports. They require higher quality products from local suppliers, which also result in technology improvement by local

firms. As suppliers, they can provide training and other types of technical supports to customers, building sophisticated demand of domestic buyers.

This paper exploits a firm-level panel dataset to examine both horizontal (intraindustry) and vertical (interindustry) spillovers of FDI on technical efficiency of domestic enterprises in a developing country. Using two-step SFA following Battese and Coelli (1995) and estimation strategy following Javorcik (2004), the paper is able to capture imitation and competition effects of FDI on technical efficiency of domestic firms by analysing horizontal output spillovers. The study also captures labour mobility effects on technical efficiency by examining horizontal employment spillovers. At the same time, vertical effects in both backward and forward linkages will also be examined in the paper. The next section will briefly describe theoretical framework of FDI spillover effects. Section 3 summaries empirical researches on FDI spillovers. In section 4 the methodological approach and estimation strategy will be described. Section 5 follows by describing model specification and data. The next section discusses the empirical analysis. Section 6 concludes the paper.

## II. AN OVERVIEW OF FDI SPILLOVERS

Positive spillover effects are expected by the host countries when they decide to open their markets to foreign investors. There are spillover effects of FDI when "the entry or presence of MNC affiliates lead to productivity or efficiency benefits in the host country's local firms, and the MNCs are not able to internalize the full value of these benefits" (Blomstrom and Kokko 1998). There are different points of view on the causes of spillovers from FDI. From industrial organization theory, advanced technology brought into the host country by MNCs that allow them to compete successfully on the domestic markets. Equilibrium in the domestic markets is broken by the presence of MNCs and the local firms are forces to take action to protect their benefits. These changes are believed as the cause of several types of spillovers of FDI (Blomstrom and Kokko 1998).

From a more general point of views, channels of impacts from FDI to domestic enterprises include learning-by-doing, learning-by-watching, movement of labour from MNCs to domestic enterprises, and competition. Researchers have long seen learning-by-doing and learning-by-watching as the main channel for technical change and

productivity growth. At the presence of FDI, domestic firms can learn from the operation, action and techniques of foreign invested enterprises. By imitating foreign firms, domestic enterprises can reduce the cost of own-learning experience, and acquire of more effective techniques, which result in their operation performance (Wang and Blomstrom 1992). Learning-by-watching can also happen in exporting activities where domestic enterprises imitate MNCs in exporting. In collaboration with MNCs, domestic enterprises can participate in distribution networks, learn about the consumers' demand and legal regulations to penetrate the export markets (Görg and Greenaway 2004).

Another important channel of FDI spillovers is the mobility of skilled workers. MNCs with more advanced technology often have to invest in training of local workers. These workers may later establish their own business or are employed by domestic enterprises (Fosfuri, Motta et al. 2001). This may cause the indirect spillovers from FDI to domestic enterprises. To avoid the losses of intangible assets of labour skills and knowledge, MNCs may have to pay higher compensation for their workers. This prevents the direct spillovers happen but indirect spillovers start since local economy is benefited from higher income of MNCs' local workers. Worry to diffuse technology to competitors is also the reason MNCs may prefer exporting to investment (Andrea, Massimo et al. 2001). Some researchers assert the importance of labour mobility in spreading positive effects from FDI. Andrea, Massimo et al. (2001) insist that mobility of workers is the only way superior technology of MNCs can be transferred to domestic enterprises.

Intensified competition in the domestic markets caused by the presence of foreign investment firms, and improvements in productivity and efficiency of local enterprises in coping with this competition is also seen as a form of FDI spillovers. With more advanced technology MNCs force domestic enterprises to upgrade their technology, reform their management practices and improve their performance. Adoption of new technology by local enterprises and higher efficiency in association with the presence of MNCs is the topic of this paper.

The aspects of spillovers describe impacts of foreign invested enterprises on local enterprises mainly under the view of intraindustry effects. However, FDI spillovers are not limited in the very industry where foreign invested enterprises operate. There are spillovers from MNCs to local enterprises in other industries of the economy. These are

called interindustry or vertical spillovers. On the one hand, as customers of local enterprises for intermediate inputs, MNCs can provide technical supports and assistance to their local suppliers, so their demand for high-quality inputs could be satisfied. On the other hand, as suppliers in the domestic economy, MNCs can offer their local customers, enterprises and households with training and different types of technical supports. Thus, it creates more sophisticated demand of local customers – a pressure for improvement of products manufactured by local producers.[1]

While the above discussion focuses on the positive spillovers of FDI, the existence of foreign invested enterprises in the local markets can create negative impacts on local enterprises. Particularly, in the presence of the so-called "market stealing effects" foreign invested enterprises take an increasing market share from domestic players. The loss of market share also results in problem of not obtaining the most productive scale size of domestic enterprises, therefore the efficiency of local enterprises may be further reduced. Moreover, foreign invested enterprises can attract high-quality workers from domestic enterprises, leaving local enterprises with lower quality workers or suffer higher labour costs (Anh, Thang et al. 2008).

## III. PREVIOUS STUDIES

Given the importance and interesting story of the role of FDI in economic development and productivity/efficiency improvement of local enterprises, there have been increasing researches on spillovers of FDI. The first attempt is to analyse the FDI spillovers in developed country is studies by Caves for Australia (1974), Globerman for Canada (1979). While Blomstrom and Persson (1983) is among the first author to discuss about the FDI spillovers in developing country, particularly Mexican manufacturing industry. More recent studies on FDI spillovers in developed countries include Dimelis, Louri et al. (2002) for Greece, Camilla (2004) for Poland, Frances and Ali (2005) for Ireland, Flores, Fontoura et al. (2007) for Portugal. Developing economies also receive increasing attention from researchers and recent studies on FDI spillovers on developing countries include Zhiqiang (2002) for China, Archanun (2006) for Thailand, Anh, Thang et al.

[1] See Anh, N. N, N. Thang, et. al (2008) for a discussion on the classification of the channels of FDI spillovers.

(2008) for Vietnam. Comprehensive surveys of studies on FDI spillovers could be found in Görg and Greenaway (2004), and Alfaro and Rodriguez-Clare (2004).

The empirical results from these researches, however, are contradictory. Positive spillover effects could be found in researches by Caves (1974), Blomstrom (1986), Blomstrom and Sjoholm (1999), Chuang and Lin (1999). While Aitken and Harrison (1999), Aslanoglu (2000), Djankov and Hoekman (2000), Kokko, Zejan et al. (2001) found that FDI have negative spillover effects to the host countries.

The contradiction in research findings on spillover effects of FDI to the host economies and enterprises is explained by several reasons. The widely accepted explanation is that the technology gap between MNCs and domestic enterprises prevent domestic enterprises from learning and imitating operational experiences of MNCs. Domestic enterprises simply cannot absorb technology brought in by MNCs. This implies that positive spillover effects of FDI are more likely found in advanced industries or in developed countries (Anh, Thang et al. 2008). Therefore it is not surprising in the literature survey by Görg and Greenaway (2004) on spillovers of FDI, among 5 studies using firm-level panel report significant positive spillover effects, there are only one from developing country.

It is also possible that the “market stealing effects” of MNCs are much higher than the positive spillovers from their presence in the domestic markets. As mentioned in the previous section that “market stealing effects” of MNCs can push domestic enterprises far away from their most productive scale sizes. Inefficiency effects dominate the positive spillovers from MNCs, causing a negative spillover effects from FDI to domestic enterprises.

Anh, Thang et al. (2008) point out other two methodological defects that may cause the failure in finding spillover effects from FDI. Firstly, there are differences in estimation strategy and aggregation level of data for analysis. Survey by Görg and Greenaway (2004) shows that, among 45 studies surveyed, 14 use industry level data. When it is more available for analysis, industry level data prevent researchers from differentiating horizontal and vertical spillovers of FDI, which may be quite different from each other. There are also 16 studies using cross-section data for analysis. This type of data not only

prevents researchers analysing lagged effects of FDI to domestic enterprises, but also it usually leads to a higher estimation of spillover effects (Gorg and Strobl 2001). It is consistent with the survey by Görg and Greenaway (2004) where among 19 studies find significant positive spillover effects, 14 use either cross-section data at industry level, or use cross-section of firm level data without controlling for the endogeneity of FDI presence (Anh, Thang et al. 2008).

Secondly, most of studies delve into intra-industry (horizontal) spillovers. On the survey by Görg and Greenaway (2004), among 45 studies mentioned, only 5 studies consider the vertical spillovers of FDI. When arguments are that vertical spillovers may be more important than horizontal spillovers, this fact shows a gap to be filled in literature of FDI spillovers.

The literature on spillovers of FDI also point out a weakness when most of studies on spillovers of FDI to host countries' enterprises regress the labor productivity or TFP of domestic firms on a range of independent variables, including proxies for the FDI penetration in the same industry (Görg and Greenaway 2004). Although theory suggests that FDI spillovers, if ever exist, would improve the level of productivity or efficiency of local firms, almost all previous studies have only examined the effects of FDI on either labour productivities or total factor of productvities. The impacts of FDI on technology progress and efficiency of domestic enterprises are mentioned elsewhere in the literature (Sinha, 1993 and Driffield and Munday, 2001), there is paucity in empirical studies on this aspect of FDI spillovers.

One reason for the lack of empirical studies on FDI spillovers on technical efficiency is the subtle difference between productivity and technical efficiency concepts. Productivity and technical efficiency are two related concepts, but should be differentiated. Thanassoulis (2001, pp.24) defines that "technical (input) efficiency of a Decision Making Unit (DMU) is the maximum proportion any one of its contracted input levels is of the observed level of that input". Technical efficiency measures the capacity of a DMU in transforming input(s) into output(s). This definition of technical efficiency follows the definition of Pareto-Koopman on technical efficiency. In other words, technical efficiency is the distance between the quantity of input and output that is used and produced by a production unit and the best possible frontier created by a group of

production units in the same industry. Understanding this way, “the measures of technical efficiency are more accurate than those of productivity in the sense that they involve a comparison with the most efficiency frontier, and for that they can complete those of productivity” (Daraio and Simar, 2007, pp. 14). We therefore follow this view to analyse the impact of FDI on local enterprises, which differ other studies in the main stream research on FDI spillovers on domestic enterprises.

To the knowledge of the authors of this paper, there are only two papers that analyse the FDI spillovers on technical efficiency of domestic enterprises. Sinha (1993) may be the first paper to examine the impacts of FDI on technical efficiency of local enterprises. In this paper, Sinha (1993) find positive and significant impacts of foreign participation on technical efficiency. However, the research suffers from some crucial issues. Sinha (1993) uses COLS which includes random noise on the estimation of technical efficiency. Furthermore, foreign participation is proxied by the dummy variable of equity share, which is seen as having the present of foreign investors only if the share is larger than 20% of the total equity. This proxy has its own problem, since equity participation do not reflects the operation side of the business. The performance of a company with foreign capital is influenced more by the knowledge and technology brought in by foreign investors and the present of foreign employees. Therefore, the share of foreign equity does not reflect the level of influence created by foreign participation. A more serious issue that is not taken into account of the study is the endogeneity of foreign participation. Foreign investors tend to invest into potential companies and/or companies. Therefore, estimation of the impact of FDI on technical efficiency of local manufacturing companies based on capital penetration could be biased.

The second paper is Driffield and Munday (2001) for United Kingdom. Driffield and Munday (2001) expect that foreign invested enterprises in an industry are connected to improvements of domestic enterprises technical efficiency. They use industry level data from UK manufacturing industries, assuming a homogenous production function across industries, to estimate the influence of foreign investment on domestic sector technical efficiency. In their study, Driffield and Munday (2001) analyse only horizontal effects, in which FDI penetration is proxied by percentages of FDI value added in the industry. By using the one-step estimation framework of Battese and Coelli (1995), they found that both FDI and regional concentration (their interested independent variables) are

significant and serve to improve technical efficiency of analysed industries. The estimation framework enables Driffield and Munday (2001) to overcome weaknesses of the study on FDI impacts over technical efficiency by Sinha (1993), namely inclusion of random noise in technical efficiency, and biased estimation in two-step technical efficiency effect analysis. However, this paper suffers from several limiations. First, this paper used industry level data which may lead to aggregation bias. Görg and Greenaway (2004) in their review paper suggest that firm level data should be used. Second, the paper only focused on the intra-industry spillovers, ignoring inter-industry spillover through the vertical linkages.

## IV. METHODOLOGICAL APPROACH AND ESTIMATION STRATEGY

The purpose of this empirical study is to examine the spillovers from foreign investment on technical efficiency of manufacturing small and medium size enterprises, both horizontally and vertically, in the context of the developing economy of Vietnam. This is enabled by using a panel firm level data, combining with industry level data on backward and forward linkages of FDI as discussed in following section. The estimation of technical efficiency involves the stochastic frontier analysis (SFA) method, which is invented simultaneously by Aigner, Lovell, and Schmidt (1977) and Meeusen and Van Den Broeck (1977). The method is based on the observation that real production outputs of firms can only be on or under the optimal production frontier. There are possibly two reasons explaining why firms do not obtain their optimal outputs in the real world data. Firstly, there may be error in the measurement of the production output caused in the data collecting process, or other random factors can negatively influence the outcome of production process. Secondly, there is associated technical inefficiency in production of firms. It is the technical inefficiency that we want to estimate to reflect performance of firms.

A stochastic production frontier model can be written as:

$$\ln y_i = \beta_0 + \sum_n \beta_n \ln x_{ni} + v_i - u_i \qquad (1)$$

Where $y_i$ is the scalar output of producer $i$; $x_i$ is a vector of $n$ inputs used by producer $i$, $v_i$ is the two-sided noise component of the error term, while $u_i$ is the nonnegative technical inefficiency component of the error term.

The above model is equal with the following model:

$$y_i = \exp\left(\beta_0 + \sum_n \beta_n \ln x_{ni} + v_i - u_i\right) \qquad (2)$$

Or

$$y_i = \exp\left(\beta_0 + \sum_n \beta_n \ln x_{ni}\right) \cdot \exp(v_i) \cdot \exp(-u_i) \qquad (3)$$

Where $\exp\left(\beta_0 + \sum_n \beta_n \ln x_{ni}\right)$ is called the deterministic component, $\exp(v_i)$ noise component, and $\exp(-u_i)$ inefficiency component of the frontier model. Technical efficiency of producers is the ratio between the real outputs and the optimal outputs they could be obtained without any inefficiency in production process. Therefore, technical efficiency of producer *i* is (see Kumbhakar and Lovell (2000) for a comprehensive presentation on the model):

$$\begin{aligned} TE_i &= \frac{y_i}{\exp\left(\beta_0 + \sum_n \beta_n \ln x_{ni} + v_i\right)} \\ &= \frac{\exp\left(\beta_0 + \sum_n \beta_n \ln x_{ni}\right) \cdot \exp(v_i) \cdot \exp(-u_i)}{\exp\left(\beta_0 + \sum_n \beta_n \ln x_{ni}\right) \cdot \exp(v_i)} \\ &= \exp(-u_i) \end{aligned} \qquad (4)$$

To analyse the impact of external factors to technical efficiency, many researchers use the two-steps approach. In this approach, after technical efficiency levels are estimated, they will become dependent variable and explained by external factors in the role of explaining variables. However, in their important paper Wang and Schmidt (2002) pointed out that two-steps approach to explaining efficiency scores is biased due to two reasons. There may be omitted variables that are not included in explaining the efficiency scores, and the problem of non-constant variances. Wang and Schmidt (2002, pp. 144) conclude that "These biases are substantial enough that we would recommend against using two step procedures in any circumstances we can envision".

In this paper, we employ Battese and Coelli (1995) model, which is one-step procedure in nature, assuming that environmental factors affect technical efficiency but not the shape of production. In this model explaining variables for efficiency scores are incorporated directly into the technical inefficiency estimation. For panel data the Battese and Coelli model of stochastic frontier production function is as follows:

$$\ln y_{it} = \beta_0 + \sum_n \beta_{nt} \ln x_{nit} + v_{it} - u_{it} \qquad (5)$$

And the technical inefficiency effect in the stochastic frontier model could be specified in the following equation:

$$u_{it} = z_{it}\delta + w_{it} \qquad (6)$$

In which *t* is the time index, $w_{it}$ is the random variable which has truncation normal distribution with zero mean and $\delta^2$ variance, and other denotations are mentioned above. $z_{it}$ is a (1 * m) vector of explanatory variables associated with technical inefficiency of production.

## V. Model Specification and Data

Within the outlined framework, to examine the relationship between FDI and technical efficiency of SMEs in same industry or other industry, we combine Javorcik (2004) approach in specifying and estimating a Cobb-Douglas production function. The empirical frontier model can be presented as follows:

$$\ln Y_{ijt} = \alpha + \beta_1 \ln K_{ijt} + \beta_2 \ln L_{ijt} + \beta_3 Year_{it} + v_{ijt} - u_{ijt} \qquad (7)$$

$Y_{ijt}$ is the total revenues of firm *i* operating in sector *j* at time *t*. $K_{ijt}$ is total assets of firm *i* at time *t* in sector *j*, which is determined at the end of the year. $L_{ijt}$ is the measure of labour, defined as the total permanent employees including the management at the end of the year. The variable *Year* indicates the year of observation. This variable enters the production frontier model to capture Hicks neutral technological progress over the year.

The appropriate specification to explore the spillover effects of FDI on technical efficiency is as follows:

$$u_{ijt} = \delta_0 + \delta_1 Horizontal_{jt} + \delta_2 Forward_{jt} + \delta_3 Backward_{jt} + \delta_4 Year_{it} + w_{jt} \qquad (8)$$

Where *Horizontal*, *Backward* and *Forward* are used as proxies for the horizontal and vertical effects of FDI on local enterprises as used by Javorcik (2004); $w_{jt}$ is the random variable, defined by the truncation of the normal distribution with zero and variance $\sigma^2$ as in Battese and Coelli (1995). In the inefficiency effect model, variable *Year* is to account for the linear change of inefficiency effect over year.

$Horizontal_{jt}$ is to measure the presence of foreign firms in sector *j* at time *t*, and defined as follows:

$$Horizontal_{jt} = \frac{\sum y_{ijt}}{Y_{jt}} \qquad (9)$$

where:

$y_{ijt}$ output or labor of foreign invested firm *i* of the sector *j* at time *t*

$Y_{jt}$ total gross output or labor of the sector *j* at time *t*.

$Horizontal_{jt}$ captures the participation of foreign invested firms in the sector and is usually is calculated based on the output share of foreign invested firm within the sector at a specific time. In this model, we take the advantage of our data to include both measures of the presence of foreign invested firms in a particular sector, namely the horizontal output measure of FDI presence and the horizontal employment measure of FDI presence. By including the horizontal employment measure of FDI presence in several models together with the horizontal output measure of FDI presence, we hope to disentangle the effect of labour mobility from other spillover effects such as the competition effect or the demonstration effect.

Following Javorcik (2004), $Backward_{jt}$ as proxy for the foreign presence in the industries that are being supplied by sector j, is defined as:

$$Backward_{jt} = \sum_{k \text{ if } k \neq j} a_{jk} Horizontal_{kt} \qquad (10)$$

where $a_{jk}$ is the proportion of sector *j*'s output supplied to sector *k*, taken directly from input-output table.

$Forward_{jt}$ is defined as

$$Forward_{jt} = \sum_{m \text{ if } m \neq j} b_{jm} \frac{\sum_{i \text{ for all i} \in m} y_{ijt} - e_{ijt}}{Y_{jt} - E_{jt}} \qquad (11)$$

where $b_{jm}$ is the share of inputs that firms in sector *j* purchase from sector *m* in the total inputs used by sector *j*; eijt is goods that are produced by foreign invested firm *i* in sector *j* at time *t* for exports; $E_{jt}$ is total gross exports of sector j. It is directly taken from IO table. The rest ratio is the share of outputs sold in the domestic markets by foreign invested firms in the total outputs of sector *m* supplying to domestic markets. Since IO table does not allow us to calculate the value of foreign firm's exports $e_{ijt}$, we assume that proportion of foreign export within sector is linear correlation with the equity share of foreign firms. Hence approximation is as follows:

$$\sum_{\forall i \in j} e_{ijt} = \frac{\sum_{\forall i \in j} k_{ijt}}{K_{jt}} E_{jt} \qquad (12)$$

where $k_{ijt}$ is capital stock of foreign firm *i* of sector *j* at time *t* and $K_{jt}$ is total sectoral capital stock of sector *j* at time *t*.

To compare with previous studies on spillovers of FDI on local enterprises, we also analyse the impact of FDI on productivity of local enterprises by using the following model. As in the stochastic production frontier model, the model is based on a Cobb-Douglas production function.

$$\begin{aligned} \ln Y_{ijt} = {} & \alpha + \beta_1 \ln K_{ijt} + \beta_2 \ln L_{ijt} + \beta_3 Horizontal_{jt} \\ & + \beta_4 Forward_{jt} + \beta_4 Backward_{jt} + \beta_5 Year_{it} + v_{ijt} \end{aligned} \qquad (13)$$

To analyse horizontal and vertical spillover effects of FDI on local small and medium enterprises, we use the data set from the productivity and the investment climate enterprise survey by the World Bank[2]. The ultimate aim of this firm level survey is to understand the investment climate in Vietnam. The information gathered from the survey, however, is comprehensive covering different performance aspects of the manufacturing firms in Vietnam. The survey was conducted in 2005 with more than 1000 manufacturing

[2] The data set can be accessed freely at http://www.enterprisesurveys.org

firms in its sample. Information from the labor relations and productivity sections of the survey helps to establish a three-year, from 2002 to 2004, panel data for the analysis of this paper. As for proxies of FDI horizontal and vertical spillovers, our estimation is based on the 2000 IO table of Vietnam. Monetary variables from the survey are adjusted by price indexes to ensure the comparable of the series over time. The summary statistics of variables used in models for analysis is presented in the following table.

**Table 1. Summary Statistics**

| Variables | Mean | Standard Deviation | Max | Min |
|---|---|---|---|---|
| Y* | 18241.98 | 35565.13 | 421903.9 | 70.99567 |
| K* | 11461.01 | 20441.31 | 205841.2 | 67.89098 |
| L | 87.81353 | 74.25842 | 296 | 2 |
| Horizontal (output) | 0.404953 | 0.170993 | 0.83786 | 0.01785 |
| Horizontal (labour) | 0.433177 | 0.16838 | 0.82398 | 0.03264 |
| Forward | 0.072763 | 0.031504 | 0.13673 | 0.01635 |
| Backward | 0.135027 | 0.097577 | 0.36093 | 0.0021 |

*Note: * Volumes in 2000 constant prices, unit: millions Vietnamese dong (VND)*

The dataset covers 17 different manufacturing sectors. Their production characteristics are summarised in the following table.

## Table 2. Production characteristics of manufacturing industries (average)

| Industries | Labour productivity | Capital-output ratio | Output-input ratio | Capital per labour ratio |
|---|---|---|---|---|
| Food and Beverages | 335.7685 | 0.918236 | 1.794889 | 159.99 |
| Textiles | 170.5068 | 1.411679 | 2.821702 | 159.0336 |
| Apparel | 59.44185 | 1.672364 | 5.167264 | 68.52187 |
| Leather products | 93.62501 | 1.782059 | 1.545945 | 110.249 |
| Wood & wooden products, including furniture | 128.8606 | 1.015474 | 1.795426 | 82.28804 |
| Paper | 250.6627 | 0.882188 | 1.85277 | 189.2248 |
| Chemical and chemical products | 324.9443 | 0.664143 | 1.710409 | 151.5739 |
| Rubber & plastic products | 255.2152 | 1.10032 | 1.572661 | 192.7068 |
| Non-metallic mineral products | 48.96769 | 1.288802 | 3.696792 | 52.12628 |
| Basic metal | 266.9853 | 0.91677 | 1.514644 | 177.7361 |
| Metal products | 313.3947 | 0.873483 | 1.725998 | 156.3569 |
| Machinery & equipments | 312.8387 | 1.159691 | 1.744752 | 238.0645 |
| Electrical machinery | 178.7457 | 1.097237 | 1.703733 | 140.142 |
| Electronics | 213.0501 | 1.082811 | 1.827696 | 179.7985 |
| Construction materials | 176.2042 | 1.298421 | 2.436093 | 142.5564 |
| Vehicles and other transport equipment | 347.4241 | 1.282636 | 1.413998 | 253.7244 |
| Other | 114.545 | 1.166143 | 2.015724 | 108.2042 |
| **Total** | **231.1236** | **1.055538** | **1.986988** | **148.6767** |

The table shows that it is most expensive to create a job in automobile, transportation vehicles and machinery manufacturing industries. The two industries where job creation is cheapest are apparel and non-metallic mineral products industries. One job created in these industries costs only one fifth of the job created in automobile, transportation vehicles manufacturing industry. However, this capital intensive industry is also the one which has highest labor productivity. It is followed by the food and beverage industry as the second highest labour productivity industry. The two labour intensive industries of apparel and non-metallic mineral production are non-surprisingly the industries with lowest labour productivity. Capital productivity is highest in chemical and metal products manufacturing industry and lowest in apparel and leather products manufacturing industries.

## VI. ESTIMATION RESULTS AND DISCUSSION

Results of the estimations are presented in the table 3 and 4. The OLS regressions on the impacts of FDI on productivity show that the direction of horizontal and vertical impacts of FDI on domestic manufacturing enterprises productivity and technical efficiency are relatively consistent. As in the technical efficiency impact analysis below, we cannot find labour mobility effects from FDI enterprises to domestic manufacturing enterprises. In contrast, the sign of the coefficient means that FDI has negative impacts on domestic enterprises by attracting high quality labour from them. We also find negative technical spillovers from foreign invested enterprises to their local suppliers in the upstream sector. However, all horizontal and vertical impacts of FDI on local enterprises productivity are not significant as being discovered in the technical efficiency impact analysis.

In stochastic frontier models, production functions are established where firms' output is the dependent variable and its variation is explained by the mix of labour and capital as explanatory variables. In all models, we use sector dummy variables to capture the differences in production by enterprises in different industries. The results of the estimations show that, all the main independent variables are very significant. Except the time variable which shows that there is no significant technological change in the observed periods of time.

**Table 3. OLS regression of the impact of FDI on productivity of local enterprises**

| | MODEL 1 | MODEL 2 | MODEL 3 |
|---|---|---|---|
| Constant | 1.4784***<br>(0.1967) | 1.4457***<br>(0.1988) | 1.4361***<br>(0.2029) |
| Capital | 0.5959***<br>(0.0182) | 0.5959***<br>(0.0182) | 0.59591***<br>(0.0182) |
| Labour | 0.4640***<br>(0.0246) | 0.4639***<br>(0.0246) | 0.4638***<br>(0.0246) |
| Horizontal (Output) | -0.2604<br>(0.3112) | -- | 0.1335<br>(0.55896) |
| Horizontal (Labour) | -- | -0.4344<br>(0.3720) | -0.5670<br>(0.6684) |
| Forward | 1.0049<br>(1.8412) | 2.26897<br>(2.2434) | 2.5956<br>(2.6282) |
| Backward | -0.1530<br>(0.7964) | -0.2417<br>(0.7801) | -0.2974<br>(0.8145) |
| Year | 0.0467<br>(0.0648) | 0.0514<br>(0.0643) | 0.0493<br>(0.0649) |
| Sector dummies | Yes | Yes | Yes |
| **Number of observation** | **1995** | **1995** | **1995** |
| **R-squared** | **.703** | **.703** | **.703** |

*Notes: ***, **, * denote significance level at 1%, 5%, and 10% respectively.*

Since we are interested in the spillover effects of FDI to technical efficiency of local enterprises, coefficients in the inefficiency effect models are in our focus. Signs of coefficients in these inefficiency effect models are consistent. They reveal the fact that FDI does not always create positive spillovers to technical efficiency of local small and medium size enterprises. We found mixed impacts of horizontal spillovers. There is signal of competition and demonstration effects where local enterprises are forced to improve their performance by efficiently mixing their production factors to compete with foreign invested firms present in the domestic markets. The estimated coefficient of horizontal output measure of presence of foreign invested enterprises is negatively correlated to inefficiency of local enterprises. It is statistically significant in the last model where all measures of FDI presence are considered simultaneously.

In contrast, at the same time the expected labour mobility effects are not present in the relationship between foreign invested and local manufacturing enterprises. The estimated coefficient of horizontal employment measure of FDI presence in the industry is positively correlated to inefficiency of local enterprises. In other words, it is negative externality channel from FDI to technical efficiency of local small and medium size

manufacturing enterprises. At this stage of development, skilled labours from foreign invested enterprises do not move to domestic enterprises as expected by labour mobility theory of FDI spillovers. FDI sector instead is absorbing high quality workers and directly competing with local enterprises for this important production factor.

**Table 4. Maximum Likelihood Estimates (MLE)**

| **Stochastic Frontier Model** | | | |
|---|---|---|---|
| ***Variables in natural logs*** | ***MODEL 1*** | ***MODEL 2*** | ***MODEL 3*** |
| Constant | 3.5994***<br>(0.1053) | 3.5871***<br>(0.1052) | 3.5736***<br>(0.1050) |
| Capital | 0.5240***<br>(0.0137) | 0.5252***<br>(0.0137) | 0.5251***<br>(0.0138) |
| Labour | 0.4471***<br>(0.0180) | 0.4466***<br>(0.0180) | 0.4458***<br>(0.0181) |
| Year | -0.0221<br>(0.0197) | -0.0218<br>(0.0197) | -0.0220<br>(0.0196) |
| Sector Dummies | Yes | Yes | Yes |
| $\lambda$ | 5.6823***<br>(0.0102) | 5.6655***<br>(0.0102) | 5.7353***<br>(0.0102) |
| $\sigma_u$ | 1.9044***<br>(0.3925) | 1.8986***<br>(0.3893) | 1.9211***<br>(0.4047) |
| **Inefficiency Effects Model** | | | |
| Horizontal (Output) | -0.0232<br>(0.0781) | -- | -0.2420*<br>(0.1471) |
| Horizontal (Labour) | -- | 0.0693<br>(0.1003) | 0.3139*<br>(0.1882) |
| Forward | -0.3606<br>(0.5086) | -0.6289<br>(0.5633) | -1.1793*<br>(0.6849) |
| Backward | 0.0995<br>(0.1820) | 0.0908<br>(0.1821) | 0.1553<br>(0.1873) |
| Year | -0.0613***<br>(0.0237) | -0.0665***<br>(0.0238) | -0.0629***<br>(0.0240) |
| **Number of observation** | **1995 (3 years)** | **1995 (3 years)** | **1995 (3 years)** |
| **Log likelihood function** | **-1706.891** | **-1706.700** | **-1705.507** |

*Notes: ***, **, * denote significance level at 1%, 5%, and 10% respectively. Models estimated by LIMDEP 9.0. All inefficiency effect models include constants.*

The negative and statistically significant coefficient of *Year* variable suggests that production efficiency of local enterprise tend to increase over the observed years. The improvement trend of technical efficiency is significant in all estimated models. However, it is not the most important factors account for the improvement of technical efficiency of local enterprises.

We find the contradictory results for interindustry spillovers to local enterprises' efficiency from FDI sector. A positive coefficient of *Backward* variable is found in all specifications, which provide an evidence of negative technical spillovers from foreign invested enterprises to their local suppliers in the upstream sector. It may reveal the fact that foreign invested enterprises exploit the advantages of rich natural resources of Vietnam, and buy from local suppliers mainly raw materials, which is usually produced by utilising labour intensive technology. However, the estimated coefficient of *Backward* is not statistically significant.

Local manufacturing enterprises, however, enjoy substantial positive spillovers from FDI to their technical efficiency by gaining access to intermediate inputs provided by foreign invested enterprises. This is concluded at the presence of negative estimated coefficient of *Forward* variable. Advanced technology and management knowledge of FDI sector enable them to provide domestic enterprises with new, improved and/or less costly intermediate inputs. Accessing to these production resources help local enterprises reduce their production inefficiency as show by the estimated coefficient in all specification.

## VII. CONCLUSION

Since the launch of economic innovation (*Doimoi*) in 1986, Vietnam has opened to trade and FDI flows. There are praises to the contribution of FDI to the rapid growth of Vietnamese economy in the past decade. This paper, however, look at the potential contribution of FDI in a different angle. Using the data from the productivity and the investment climate enterprise survey by the World Bank in 2005 and Vietnam IO table in 2000, the paper delves into the analysis of vertical and horizontal spillovers of FDI to technical efficiency of local manufacturing enterprises. With a panel data from 2002 to 2004 we investigate all possible channels of spillovers from FDI to local enterprises' performance. Taking advantage of the data, we also analyse the labour mobility effects of foreign invested enterprises to local enterprises in the same industry.

Findings of the analysis are important to policy making in developing countries, where FDI is seen an important device to improve and expand the small and inexperienced domestic enterprise sector. In terms of horizontal spillovers, we do not find the expected theoretical labour mobility effects of the technical efficiency from foreign invested

enterprises to domestic enterprises.  However, we find that competition and demonstration effects are present in the relationship between foreign invested and local manufacturing enterprises. Therefore the presence of FDI in terms of output measure reduces production inefficiency of domestic enterprises.

There is weak evidence about the negative effects of FDI sector to technical efficiency of their local suppliers in upstream sector. However, there is consistent evidence of the fact that by gaining access to new, improved and/or less costly intermediate inputs provided by foreign invested enterprises, local manufacturing enterprises' production efficiency is improved. There is also the trend that production efficiency of local manufacturing enterprise increase over the year.

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