How Will the Origin of FDI Affect Domestic Firms' TFP?-Evidence from Vietnam

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Abstract:

Technology spillover from foreign direct investment is thought to be a powerful vehicle for economic growth. This study examines how the origin of foreign investors affects the degree of horizontal and vertical technology spillovers, using firm-level panel data from Vietnam in 2002-2011. First, we examine if the investment from different continents might have different impacts on domestic firms' productivity. Second, given the fact that the sourcing pattern of multinational firms is likely to be affected by preferential trade arrangements or investment agreements, especially in transitional economy like Vietnam, e.g. the tariff rates on imported goods into Vietnam are totally different between ASEAN (Association of South-East Asian Nations) and non-ASEAN countries, we would like to see how this factor impacts the spillover.

The empirical analysis produces evidence consistent with our hypothesis: preferential treaties in general, promote spillover from multinational firms, while local procurement is the most important channel to incur vertical spillover. The results show a positive association between the presence of Asian firms in downstream sectors and the productivity of Vietnamese firms in the supplying industries, and no significant relationship in the case of European and North American affiliates. Within Asian area, we find foreign direct investment (FDI) from East Asian firms excluding Japan and South Korea tend to have the most vertical spillover impact on increasing Vietnamese suppliers' productivity. It coincides with the fact that multinational firms whose origins are these two countries tend to not to source locally. In the horizontal way, FDI from ASEAN, East Asian and European firms all shows negative impact, indicating that FDI from these firms tends to drive Vietnamese counterparts away. Also, we find that firm size and location also affect the extent of spillover.

JEL classification: D22, F14, F21, F23, O33

Keywords: FDI, spillover, Total factor productivity, Vietnam

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1. Introduction

Recent empirical studies using firm-level data have investigated the mechanism as to how foreign direct investment (FDI) incurs technology spillover to domestic firms through both horizontal and vertical linkages (e.g. Blomstrom and Kokko, 1998; Görg and Greenaway, 2004). Meanwhile there have been a number of studies to investigate how the origin of FDI might have heterogeneous influence on domestic firms' productivity, most of which try to examine the impact from empirical perspectives. The targeting home countries of investigation consist of the EU (Javorcik and Spatareanu, 2011; Ayyagari and Kosova, 2010; Monastiriotis and Alegria, 2011), the US (Chen, 2011) and China (Ito et al., 2012; Kamal, 2014). They all show that the origin of foreign investors does lead to different spillover effect while the signs of the effect vary.

This paper investigates the technology spillover effect of FDI on firms in Vietnam while paying attention to its varying effect across the origins of investors. Studies that examined the technology spillover effect of FDI on firms in newly emerging economies have been limited. Compared to China, Vietnam has been positioned as a new investment target in Asia. Its FDI inflow keeps rising in recent years and the development is undergoing a transitional period towards a market-driven economy. Foreign investors crowd into Vietnam in pursuit of cheap labor and huge business margin. Although there are several studies which examined the technology spillover effect of FDI in Vietnam (Thuy (2007); Nguyen (2008); Anwar and Nguyen (2013)), this paper is the first one to investigate the variation of the technology spillover effect of FDI from the perspective of the origins of investors. It also differs from the existing literature in that it tries to verify the potential new channel—sourcing pattern, through which the backward vertical spillover is likely to occur.

With their close partnership with Vietnam and their notable penetration in the Vietnamese economy, FDI from East Asian countries are expected to affect more local firms' performance than that from Europe and other regions. As shown in Figure 1, seven of the ten largest investor countries of FDI in Vietnam are in East Asia, namely Taiwan, South Korea, Singapore, Japan, Hong Kong, Malaysia and Thailand.¹ Furthermore, there may be a significant difference in FDI spillover even among those major investor countries as they are thought to vary in relationship with Vietnam in terms of investment treaties, and trade agreements which can affect sourcing patterns of investors. Thus, an analysis of FDI spillover with meaningful disaggregation of FDI's origins is needed to understand the systematic tendencies in FDI spillover.

Egger and Pfaffermayr (2004), Rosendorff and Shin (2012) demonstrated bilateral investment treaties (BIT) s' positive impact on promoting FDI in general. The firms from BIT-signed countries with Vietnam will enjoy more benefits such as protection from expropriation, free transfer of means and plenty other resources. As a consequence, these firms will have more incentive to increase investment in Vietnam. Since more investment indicates foreign investors' deeper interaction with domestic partners because more local resource and labor shall be involved, we assume that the firms from BIT-signed countries will affect domestic firms in a different way from those from non-BIT-signed countries.

Foreign firms' sourcing patterns also can affect spillover. Saggi (2002) indicates that in developin g countries, suppliers of intermediate goods are more likely to benefit because foreign firms transfer zero defect procedure and production audits to domestic suppliers, thus increasing the productivity of

¹ In the figure, the FDI is calculated as the total accumulated capital of effective FDI projects in Vietnam.

the latter. However, such backward spillover might only occur when there is sufficient interaction between local suppliers and foreign end users, which is to be verified in this paper. Even though East Asian firms are found to invest the most, we can observe the diversity in the way how firms from different countries apply resources. Japanese firms, for instance, tend to insist on using the suppliers from their own country because Vietnamese suppliers usually cannot meet their requirements on quality, cost and delivery (QCD). While Chinese investors tend to choose local suppliers to minimize costs. The frequency of corporation with local firms will affect the degree of the knowledge that local firms can learn from their foreign investors (Rodriguez-Clare, 1996; Markusen and Venables, 1999). Therefore, we also examine the effect of sourcing pattern on FDI spillover by disaggregating origin countries in consideration of relative easiness to procure inputs between domestic procurement and import. This criteria leads us to focus on ASEAN as the most important trade arrangement to Vietnam. According to the ASEAN FDI database 2006 of the ASEAN Secretariat, the total intra-ASEAN inward FDI to the manufacturing sector has been stably increasing since 1999. However, due to the relatively low tariff rates for members under the Common Effective Preferential Tariff (CEPT) scheme, ASEAN countries have the option not to source inside Vietnam because the intermediate inputs required for production such as parts are cheap to be imported from their home countries due to the preferential tariff. This might potentially reduce the local sourcing for ASEAN investors. For this reason, we make an individual group for only ASEAN investors.

Our study replies on a firm-level panel dataset build based on the Vietnam's Enterprise Survey data during the period 2000-2011. We firstly examine how the geographical characteristics of foreign investors influences domestic firms' total factor productivity (TFP) as a measure of firms' technological level, and group their source countries into Asian, European and American ones. Then, we group source countries according to BITs in which Vietnam is a member since the spillover effect of the investor's source countries is expected to be affected by the bilateral or plurilateral relationships (Javorcik and Spatareanu, 2011) between Vietnam and other countries due to tax exemption or reduction incentives. Finally, we group the investors by their sourcing patterns² and examine if the variation of spillover exists.

The results suggest that FDI from Asian firms most pominently incur spillover to domestic suppliers in Vietnam. Within Asian area, East Asian firms excluding Japanese and Korean ones contribute more to vertical spillover impact. The result also provides strong evidence that sourcing pattern is the most important channel to induce vertical technology spillover while horizontal FDI negatively affect the producitvity of domestic competitors.

This paper is organized as follows. Section 2 describes the situation of FDI in Vietnam. Section 3 summarizes the previous literature concerning the spillover effect of FDI. Section 4 describes the dataand estimation strategy. Section 5 presents the results, and examines the robustness. Section 6 concludes.

² In our paper, sourcing pattern specifically refers to the pattern of suppliers' procurement of the inputs in terms of domestic or foreign sources.



Figure 1 The cumulative amount of registered FDI in Vietnam by country at the end of 2012 (USD)

Source: Vietnam Industrial Investment Report (VIIR) 2012 of Vietnam Ministry of Planning and Investment

2. Background

Vietnam experienced a remarkable economic growth due mainly to two major events – the adoption of a major economic reform called *Doi Moi* in 1986, and the accession to the World Trade Organization (WTO) in 2006. A high rate of growth around 7% has been observed from the late 1990s to the late 2000s, and this period is characterized as the period of a rapid growth in inward FDI to Vietnam. Vietnam has become one of the most attractive destinations for FDI in the world during the last decade primaliry due to its cheaper labor among East Asian countries. China had been the world most popular destination for FDI for a long time, but the emerging South-East Asian countries have become attractive destinations since the 2000s. Vietnam has been one of the most successful countries in the region in attracting FDI from countries worldwide both because of its substantially low wages and because of the success in *Doi Moi* to liberalize trade and investment. In the case of the apparel industry, for example, the wages of Vietnam were approximately half those in China (the Wall Street Journal, May 1st, 2013). Also, Samsung is shifting their production base to Vietnam in order to maintain profit margins by saving labor cost as growth in sales of high-end handsets has slowed down according to Bloomberg report in December 2013 (Lee and Folkmanis, 2013).

FDI has recently accounted for an increasingly large part of investment in Vietnam. The share of implemented FDI in Vietnam's GDP rose from 0.3% in 2000 to 1.2% in 2007 (GSO Vietnam). The number of FDI projects in 2007 was five times as many as in 2000 and the total implemented capital of these projects had increased nearly four times, amounting to around USD 80 billion (Figure 2). Meanwhile according to the recent "Vietnam Industrial Investment Report 2011" (hereafter referred as VIIR), the sectoral composition of FDI is mainly concentrated in manufacturing and real estate. At the end of 2011, these two sectors accounted for around 67 and 77 % of total FDI projects and registered capital, respectively. Also, FDI has been highly concentrated in a limited number of cities, namely, Ho Chi Minh City, Hanoi, Dong Nai, Baria-Vung Tau, and Binh Duong. They cover nearly 60 % of all the FDI inflows at the national level.

Figure 2 Number of FDI projects and implemented FDI (Bill. Dongs) in Vietnam



Source: GSO Vietnam

The amount of FDI does not only matter to spillover, but the way how foreign firms how foreign investors source their intermediate inputs also is expected to affect the pattern of technological spillover. For example, even though ASEAN investors are assumed to invest more in Vietnam than other non-ASEAN investors, the former can also import the intermediate inputs from their home countries directly. Thus ASEAN investors' interaction with local suppliers might not be as strong as that of the non-ASEAN investors. We would like to take into account foreign investors' sourcing pattern when investigating the degree of spillover.

3. Literature Review

In our paper we aim at investigating the mechanism of how difference in origins of foreign investors affects the productivity of domestic firms in Vietnam. Firstly we will review the studies that generally elaborate on how FDI promotes spillover through both horizontal and vertical channels. Then we pay a particular attention to the case of Vietnam, followed by the investigation in the relationship between the origin of country and heterogeneous spillover effects. Finally we will review some factors, such as preferential agreement, that might affect the spillover incurred by firms from different origins of countries.

3.1 FDI's spillover

3.1.1 The mechanism of technology spillover through FDI

The results regarding the FDI's impact in the horizontal way are mixed due to counteracting demonstration effect and crowding out effect. Liu (2008) proposed a model to explain the former. He extended Ehrlich et al.'s (1994) model of firm productivity gap to demonstrate the mechanism through which FDI causes positive technology spillover. He argued that the dominance of foreign investors in terms of technology promotes domestic firms to increase their productivity, and empirically demonstrated that the productivity gain to domestic firms is positively correlated with technology gap³. Empirical evidence provided in Blomstrom and Wang (1992), Markusen and Venables (1999), and Glass and Saggi (2002a) generally support Liu (2008)'s theory. The local partners in developing

³ See Liu (2008) for the detailed proof.

countries have an incentive to absorb the technology of foreign affiliates with superior technology through trainings provided by the foreign affiliates or learning by imitation in order to compete with their rivals. It happens when the competition is intense and domestic firms have to use their resources in a more efficient way or adopt new technology (Blomstrom and Kokko, 1998).

On the other hand, competitors in the same industry can also cause "crowding-out" effect (Caves, 1996; Sleuwaegen and Backer, 2003), and this may result in a lower average productivity of the industry. The protection of intellectual property and higher wage paid by foreign affiliates force domestic firms to increase operation cost, thereby, driving local firms out of the market. If the crowding-out effect offsets the demonstration effect, the net impact of FDI may become negative. This explains why previous empirical studies on this topic had ambiguous results (Aiken and Harrison, 1999; Haskel et al., 2007; Monastiriotis and Alegria, 2011).

In contrast to horizontal spillover, foreign affiliates also incur vertical spillover when they deal with both the local suppliers and domestic buyers. This kind of spillover takes place more frequently through (i) direct knowledge transfer from multinational firms to local suppliers; (ii) stricter requirements for product quality and on-time delivery by multinational firms (Javorcik, 2004). Thus in this paper we would like to pay attention to the influence that foreign customers have on local suppliers (or backward vertical spillover) only.

3.1.2 The heterogeneity of the spillover effects across origins of FDI

Despite the large literature that concentrates on the presence of FDI and technology spillover, there have been only few studies to investigate the relationship between the origin of FDI and its spillover impact from theoretical point of view, to our best knowledge. Evidence relies solely on empirical studies.

Monastiriotis and Alegria (2011) focused on European firms' investment in Bulgaria, but only in the case of horizontal spillover. Their finding was that, compared to Greek FDI's strong spillover, other European firms' impact are fairly small. Ayyagari and Kosova (2010) found horizontal spillovers in Czech Republic are driven by FDI from EU firms, but not from non-EU firms. They provided the insight of why spillover does not exist in manufacturing industry; manufacturing firms tend to protect their knowledge more than in the service sector. Although the impact in manufacturing and services might be different, the opposite effects will simply cancel out when the full sample is used.

Javorcik and Spatareanu (2011) used firm-level panel data from Romania to examine whether the origin of foreign investors affects the degree of vertical spillovers from FDI. They found that the distance between the host and the source economy positively affects the share of intermediates sourced locally by multinationals. They also found that the sourcing pattern is likely to be affected by preferential trade agreements. In their paper, FDI from American firms are found to have more backward spillover effect on domestic firm in Romania than that from European firms.

Chen (2011) evaluated the casual relationship between the source of FDI origin and performance of target firms in the US. She divided foreign investors by OECD and non-OECD, finding that FDI from OECD firms cause target firms to gain more labor productivity after M&A. The same endeavor has been made by Vega et al. (2011), Ito et al. (2012) and Kamal (2014). They all found OECD-acquired firms to present more spillover effect, in terms of TFP growth.

3. 2 Spillover on domestic firms' productivity in Vietnam

In the macro level, Thuy (2007) used industry level data from 1995 to 2002 in Vietnam to examine if FDI's linkage with domestic firms has a positive impact on the latter's labor productivity. Since the Vietnamese Enterprise Survey became available, there has been an increasing number of studies on the analysis of spillover impact from the micro level. Nguyen (2008) examined both FDI's horizontal and vertical spillover effect on total factor productivity (TFP) in several regions in Vietnam. He found a positive effect for both horizontal and vertical spillover for Vietnamese manufacturing industries, but that the effect varies across regions and types of firms. Anwar and Nguyen (2013) supported his claim by testing FDI's spillover effect in eight regions of Vietnam. They found a strong positive impact of FDI on TFP through backward linkages in some regions but a negative impact in other regions.

3.3 Sourcing pattern, preferential agreement and spillover

Nguyen and Xing (2008) shed light on the fact that investors from Asian countries, such as Japan and Singapore tend to consider Vietnam as their production base for their export, for the purpose of reducing production costs. They argued that free trade agreement (FTA) might enhance inward FDI because tariff exemption encourages foreign investors to shift their production activities to Vietnam and export back to the home countries (or export directly to other countries). Examples can be found that after Vietnam signed FTA with Japan, the US and ASEAN countries, the FDI flow into Vietnam from these areas all increased. We follow their approach to separate samples according to agreement-based groupings. Since we are interested in how the origin of each individual country matters, in practice we will also use bilateral preferential agreement as the criterion.

4. Data and Estimation Strategy

4.1 Data

This paper uses a panel dataset constructed from the Vietnam Enterprise Survey at firm level. The data set covers the period 2002-2011. The Vietnam Enterprise Survey were collected annually by the General Statistics Office (GSO) of Vietnam for all the industrial sectors as of March 1st of each year. The general objectives of this survey are: (i) to collect the business information needed to compile national accounts; (ii) to gather up-to-date information on the business registration; and (iii) to develop the statistical database of enterprises. This panel dataset covers ten years, from 2002 to 2011, in which Vietnam experienced two major economic changes, namely WTO accession and the global economic crisis. The majority of the firms in the dataset can be found in the list of Vietnam Standard Industrial Classification (VSIC) code⁴, including all 22 manufacturing sectors out of 42 in total. Profiles of firms concerning ownership, labor, capital stock, turnover, assets, FDI, wage, materials inputs and other information are provided⁵. In the estimation, we measure capital and labor by fixed asset and total labor at the end of year t. Output and capital are deflated using annual GDP⁶. Above that, the GSO surveyed all multinational enterprises (MNEs), which are defined as firms that have foreign capital.⁷ An advantage of this dataset is that the country which represents the ownership of the firm, is also reported. Each firm is given a unique "enterprise code", and it is used together with province code to identify firms and construct the panel dataset.

⁴ We use the first 2-digits indicated in VSICcode2007 and VSICcode1993 to identify industries. For simplicity we aggregate some sectors. See Appendix-1 for details.

⁵ Census is taken for firms with more than 10 employees (over 20 employees in 2010 and 2011).

⁶ Producer Price Index in the sector level is a preferred deflator but such data are not available for Vietnam.

⁷ The sampling methods varied for private firms across years.

The number of observations of each year is presented in Table 2. ⁸ The incomplete information about export and import, missing data for materials, and inconformity of units among different years, lead to a reduction in observations that can be used in the analysis. We eliminate the missing observations in calculating firm's productivity, and delete outliers⁹. In the end, we are left with 1,272,058 observations.

Variable	Mean	S.D.	Ν
material	3.746	2.346	553993
labor	2.385	1.287	1367707
output	6.382	2.238	1318029
capital	5.182	1.936	1197153
investment	5.223	1.928	472853

Table 1. Summary statistics for the variables used for the production function estimation

Note: All variables are in the form of logarithm-

Table 2. The number of foreign firms by continent (samples used for estimation)

Year	Asia	Europe	North America
2002	1687	278	71
2003	1611	208	56
2004	2379	327	109
2005	2707	394	138
2006	2662	336	116
2007	3703	449	179
2008	4134	528	210
2009	4751	623	246
2010	4974	662	265
2011	5739	734	322

Source: Annual Enterprise Survey, GSO Vienam.

4.2 Estimation of firm productivity

TFP has been most commonly used measure of the effect of FDI spillover on firm's performance in the literature (see, for example, Haskel et al. 2007; Javorcik 2004). Although there are many ways to estimate TFP, we choose two alternative approaches that are suitable to our data situation, namely a stochastic frontier estimation, and Levingsohn and Petrin's (2003) firm-level productivity estimation. The former has advantage of isolating statistical noise from genuine productivity whereas the latter has advantage of incorporating explicitly the correlation between unobservable productivity shocks and input levels.

⁸ We only count the one with the largest share. If Japan's share of investment is the largest, we consider the firm to be a Japanese-invested firm.

⁹ Firms in the top and bottom one percentile of all firm-specific output and input variables (in the means of annual growth) were deleted from the sample. Also the top and bottom 1% of output/capital and output/labor are excluded.

Let us begin by the traditional econometric approach to estimate TFP to illustrate the advantages of our approaches. The production function under Cobb-Douglas technology is written as:

$$\ln Y_{it} = \alpha + \beta_k \ln K_{it} + \beta_l \ln L_{it} + \varepsilon_{it} \quad , \quad (1)$$

where Y_{it} stands for firm i's net revenue in year t. *K* and *L* represent capital and labor respectively,. ε_{it} is the unobserved error term. Once this model is estimated using ordinary least squares (OLS), TFP is calculated by normalizing the exponential transformation of the residual¹⁰. The well-known drawback of this approach is its inability to isolate genuine productivity from statistical noise.

The stochastic frontier analysis overcomes this drawback by including two error components representing both (the inverse) technical efficiency and statistical noise. According to Aigner et al. (1977), Kumbhakar and Lovell (2000), the model is specified as:

$$\ln Y_{it} = \beta_0 + \sum_n \beta_n \ln x_{ni} + v_i - u_i \quad , \quad (2)$$

where x_{ni} is a vector of inputs. v_i is the noise component and u_i is the nonnegative technical inefficiency component. Here, technical efficiency derived by inverting technical inefficiency estimate is the measure of TFP. A half normal, exponential and Gamma distributions are often assumed on u_i to ensure non-negativity of productivity estimates whereas a full normal distribution is assumed on v_i as is common for random noise. The conditions for the error components for the normal-half normal model are:

(i)
$$v_i \sim iid N(0, \sigma_v^2)$$

(ii)
$$u_i \sim iid N^+(0,\sigma_u^2)$$

(iii) v_i and u_i are distributed independently of each other, and of the regressors

This model is estimated by a maximum likelihood estimation. Once estimates of u_i are obtained from the residual of the model, the technical efficiency of the firm can be obtained by:

$$TE_i = \exp\{-u_i\}$$
(3)

where u_i is $E(u_i | \varepsilon_i)^{11}$. Alternative distributional assumptions on u_i can be accommodated simply by replacing (ii).

The concern about the bias caused by correlation between unobservable productivity shocks and input levels motivates us to use a line of structural approaches that can handle the endogeneity of input selection, proposed originally by Olley and Pakes (1996) and improved by the later studies such as Levinsohn and Petrin (2003). The Olley and Pakes assume that labor is the only (freely) variable input,

¹¹
$$E(u_i | \varepsilon_i) = \mu_{*i} + \sigma_* \left[\frac{\phi(-\mu_{*i} / \sigma_*)}{1 - \Phi(-\mu_{*i} / \sigma_*)} \right] = \sigma_* \left[\frac{\phi(\varepsilon_i \lambda / \sigma)}{1 - \Phi(\varepsilon_i \lambda / \sigma)} - \left(\frac{\varepsilon_i \lambda}{\sigma} \right) \right], \ \sigma \text{ and } \lambda \text{ are } \sigma_u$$

¹⁰ The intercept is usually corrected make the estimated TFP to fall within the appropriate range.

and σ_{v} ; ϕ and Φ are density and cumulative density functions respectively.

and thus is likely to be affected by productivity shocks. Levinsohn and Petrin add greater flexibility to Olley and Pakes model by assuming an intermediate input to a variable input as well while both assume that capital is a state or quasi-fixed variable. Consider the following econometric specification:

$$\ln Y_{it} = \alpha_i + \beta_k \ln K_{it} + \beta_l \ln L_{it} + \beta_m \ln M_{it} + \overline{\omega}_{it} + \varepsilon_{it} \quad , \qquad (4)$$

where K_{it} , and L_{it} denote capital and labor, respectively, and M_{it} denotes intermediate input such as materials. The term ω_{it} represents the productivity that is assumed to be observable to the firm. Levinsohn and Petrin use the intermediate input to invert ω_{it} , thus reducing endogeneous bias, in comparison to OLS estimation.¹²

We employ both the stochastic frontier analysis and the structural approaches because each has advantages and weaknesses in different aspects. The former is robust against the effect of statistical noise, but is not suited to handle the input-productivity correlation. On the other hand, the latter is robust against the input-productivity correlation, but is likely to be influenced by statistical noise. Furthermore, the latter is data demanding as it requires data on intermediate input and lagged input variables.

Particularly, the lack of data on intermediate input is a critical constraint to us when we estimate the Levinsohn and Petrin model. We do not have a direct measure of intermediate input, however, we use "work-in-process" as a proxy variable for intermediate input. "Work-in-process" is an appropriate proxy because products which are uncompleted in the previous period are to be brought into the production line in the current period and to be completed. Also, it has to be noted that we interpolate input variables to avoid losing too many observations due to the use of the lagged inputs in the Levinsohn and Petrin model. These caveats are thought to reduce reliability of our estimation using this structural approach. Thus, we rather use this model for robustness check for the stochastic frontier analysis. As discussed later, both estimation are reasonably similar, and therefore, we claim that the stochastic frontier analysis yields fairly reliable result.

4.3 Estimating the spillover effect

Now we proceed to the methodology to estimate the effect of FDI on the estimated TFP. We use a standard panel regression where TFP is regressed on measures of the influence of FDI and other covariates. Our FDI spillover variables are build based on the influence of FDI within the same industry and downstream industries. The former captures the horizontal spillover effect, and the latter captures the backward vertical spillover. The origins of FDI are also distinguished in the FDI spillover variables. The estimation model becomes.

$$\ln TFP_{ijt} = \alpha_i + \beta_1 Horizontal_{jt-1} + \beta_2 Vertical _Asia_{jt-1} + \beta_3 Vertical _Europe_{jt-1}$$

+
$$\beta_4$$
Vertical_NorthAmerica_{it-1} + β_5 Herfindal_{it-1} + $\beta_i X_{it}$ + η_t + u_{ijt} . (5)

 $lnTFP_{ijt}$ is the logarithm of TFP of firm *i*, in sector *j* at time *t*. *Horizontal_{jt}* is defined as the share of sector *j*'s output produced by foreign firms at time t^{13} . *Vertical_Origin* is the measures of foreign presence in the downstream industries. These variables are constructed by adopting the formula developed by Javorcik and Spatareanu (2011), which are an origin-differentiated version of the

¹² Olley and Pakes use "investment" to invert ω_{it} .

¹³ In practice, we use horizontal index categorized by continent as well, but there is no statistically significant difference between the aggregated and disaggregated ones.

variables proposed by Javorcik and Spatareanu (2004). Since there might be time lag for spillover to occur, we use one-year lag of each variable as independent variables. As covariates X_{it} , we include Herfindahl index. Time dummies are included to control for time specific shock η_t . The fixed effect model is used to control for the firm-industry pair effect α_{ij} by assuming that $u_{ijt} = \alpha_{ij} + \varepsilon_{ijt}$.

The variable Vertical_Origin is defined as:

$$Vertical_Origin_{jt} = \sum_{k \neq j} \alpha_{jkt} Horizontal_Origin_{kt}$$
(6)

where *Horizontal_Origin* is defined as the share of the output produced by foreign firms within sector k in year t, and a_{jkt} is the coefficients representing proportion of sector j's output used by sector k in year t^{14} . The coefficients are taken from Vietnamese Input-Output Table (IO Table) 2007.

For the industry classification, we follow that of the IO Table 2007 because we need to explore the industry linkage to construct vertical spillover variables. Because the Enterprise Survey follows VSICcode industry classification, however, we had to match the industries in the dataset with those used in the IO Table. In the end, our industry categories reduced from 138 to 42 (see the detailed category in Appendix 1). Furthermore, the VSICcode system changed from VSICcode1993 to VSICcode2007 in year 2007, and therefore, the industry codes used in prior to 2007 are converted in accordance with VSICcode2007 by using 1993-2007 concordance table¹⁵.

As indicated in Javorcik and Spatareanu (2011), because of the advantage in technology, foreign buyers usually require high-quality inputs, thus imposing pressure on their upstream local suppliers. Accordingly it is more reasonable to observe the spillover incurred backwardly to the suppliers. In the following sections, we only focus on backward linkage and use *Backward_Vertical_Origin_{jt}* to represent vertical spillover from sector *j* to sector *k*. It is used to capture the potential interaction between foreign firms in *j* and local suppliers in *k*. This index was firstly developed by Schoors and van der Tol (2001). In the baseline estimation, we include *Vertical_Continent* (Asia, Europe and NorthAmerica) first, and use different grouping method to investigate other topics of interest. All specifications are estimated using "cluster" in the industry level.

4.4 Grouping of origin countries of foreign investors

4.4.1 Baseline grouping—continent

The categorization in this paper is based on the geographic location of the firms. Our baseline model adopts the grouping of origin countries of foreign investors according to Javorcik and Spatareanu (2011): namely, Asian, European and North American firms¹⁶. These regions account for 90% of the countries of origins of foreign investors in our sample.

4.4.2 Alternative grouping

Bilateral investment treaty (BIT) blocs

Egger and Pfaffermayr (2004) and Rosendorff and Shin (2012) demonstrated BITs' positive impact on promoting FDI in general. Rosendorff and Shin (2012) pointed out that it is especially the case for the countries that need an institutional improvement most. Although the political partnership between Vietnam and its foreign investors is beyond the scope of discussion in this paper, most of the previous studies reach a consensus that BITs lead to greater FDI inflows. Thus, we examine the effect

¹⁴ When we calculate α_{jkt} , sector j's output sold for final consumption was excluded.

¹⁵ The table is made based on the content description of the sector.

¹⁶ Though firms with multiple investors are rarely the case in Vietnam, we delete these observations for simplicity.

of BITs by applying an alternative grouping in terms of BITs to the vertical spillover variables¹⁷. We group countries depending on whether they have signed BITs with Vietnam during our period of estimation according to the criteria of the United Nations Conference on Trade and Development.

Alternative grouping—FTA-based grouping

As we mentioned previously that sourcing pattern of foreign firms is also likely to be affected by preferential trade agreements. Because of the existence of the AFTA within ASEAN, we expect that the firms based in the member countries that are benefiting from this agreement have different way to procure their resources from that of the investors from outside ASEAN. Because ASEAN firms have higher average productivity than their Vietnamese counterparts do¹⁸, upon entering the market, they tend to be huge rivals to Vietnamese domestic firms. Thus, we expect the horizontal spillover effect from FDI from ASEAN firms to be negative.

Consideration of Japan and Korea

Japan and Korea are the two most important business partners of Vietnam among the Vietnam's BIT partners after year 2000. These countries have close ties with Vietnam, and are the largest investors in recent years. By the end of 2010, as far as investment amount is concerned Japan was amongst the top four in Vietnam as the origin, with the other three being Taiwan, Korea and Singapore (MPI, 2011).

Nevertheless, Japanese manufacturers' procurement ratio in Vietnam is quite low, compared to the other ASEAN countries. According to Japan External Trade Organization (JETRO), the local procurement ratio of Japanese manufacturing firms in 2004 was 47.9% in Thailand, 45.0% in Malaysia, 38.3% in Indonesia, and 28.3% in the Philippines, while this number was 22.6% in Vietnam (JETRO 2005). As Mori (Vietnam Development Forum 2006, Chapter 4) argues, most Japanese investors in Vietnam do not have sufficient information on where productive Vietnamese suppliers are located. Even though the localization rate has been rising in recent years, the locally procured products are still limited to low-value parts. In contrast, investment from Korean firms in the first quarter has surpassed Japan in June 2014, and accounted for 22.9% of the entire investment amount in Vietnam¹⁹. Samsung and LG electronics are the main driving force of this investment surge. However, Samsung Vietnam still prefers Korean suppliers to local firms because "the quality of local parts is below the standard"²⁰. The localization rate was 16% in Vietnam during 2012 compared to 40% in China.

While we witness Japanese and Korean firms' large investment in Vietnam, it is not certain whether it can still cause a significant spillover effect when less interaction with local suppliers is involved. Thus, it is worthwhile to examine a grouping that isolate Japan and Korea from the Asian country group: Japan&Korean, non-JK Asian, Europe and North America.

http://tuoitrenews.vn/business/11689/samsung-vietnam-uses-korean-suppliers-as-local-firms-below-standard

¹⁷ In fact, BITs might indirectly affect the sourcing pattern as well. For example, some Canadian BITs prescribe mandatory sourcing from local suppliers. See "Agreement Between the Government of Canada and The Government of The Republic of Trinidad and Tobago For the Reciprocal Promotion and Protection of Investments", Article 2.

 ¹⁸ ASEAN firms' average TFP is 0.64 whereas that for Vietnam firms is 0.58, when we calculated TFP using stochastic frontier method. The result is similar when we apply Levinsohn and Petrin method.
 ¹⁹ Quoted from BusinessKorea, 20 June, 2014.

http://www.businesskorea.co.kr/article/5112/largest-investor-south-korea-becomes-biggest-investor-vietnam-beating-japan

²⁰ Tuoitrenews, July 24th., 2013.

5. Estimation Results

5.1 Total factor productivity

We rely mainly on the stochastic frontier analysis in the estimation of TFP due to its modest data requirement. We then examine its robustness by comparing it with the alternative methods, primarily, Levinsohn and Petrin (LP) structural approach. We also estimate the production function by the OLS and fixed effects model to derive TFP for the comparison purpose. We include "intermediate input" (proxied by "work-in-process") in the OLS, the fixed effect model (FE), and the stochastic frontier models (SF) as well. TFP scores from OLS and FE are normalized to follow the range from 0 to 1. The parameter estimates of the production function for each model are presented in Table 3, and the summary statistics for TFP scores is presented in Table 4. Although there are moderate differences between the parameters of alternative models, relative magnitude between the coefficients of capital and labor can be said to be reasonably similar. On the other hand, the coefficients for the intermediate input are substantially different across the models, most importantly, between the full SF and LP models. The low correlation between SF and OLS/FE implies the disadvantage of OLS/FE estimation of mixing the random noise with genuine TFP.

This concern about the robustness of parameter estimates leads us to examine robustness by directly comparing the TFP scores across models. Table 4-2 shows the pair-wise correlation between TFP scores under alternative models. The moderate correlation between TFP scores under LP and two SF models motivates us to examine TFP scores in terms of ranking. Table 4-3 shows that the rank-based correlations between any of the two SF models and LP are nearly one. This justifies the use of SF based TFP scores in the subsequent analysis of FDI spillover although we should examine robustness of the results between SF and LP.

	1				
	(1)	(2)	(3)	(4)	(5)
MODEL	OLS	FE	SF	LP	SF
VARIABLES	log y	log y	log y	log y	log y
log k	0.105***	0.217***	0.297***	0.183***	0.257***
	(0.00257)	(0.00168)	(0.00155)	(0.00466)	(0.000902)
log l	0.611***	0.707***	0.635***	0.645***	0.677***
	(0.00434)	(0.00241)	(0.00213)	(0.00281)	(0.00137)
log m	0.00135	-0.0187***	-0.0415***	0.0645***	
	(0.00178)	(0.00116)	(0.00106)	(0.00861)	
Observations	513,913	513,913	513,913	513,913	1,272,074
R-squared	0.120	0.117			
Wald Test P value			0.000	0.000	0.000

 Table 3
 Production function parameters

Standard errors in parentheses, calculated with cluster option.

*** p<0.01, ** p<0.05, * p<0.1

Table 4a. Summary	statistics	for various	TFP scores
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TFP scores	Ν	mean	sd	max	min
FE	513913	0.003	0.008	1	0
OLS	513913	0.001	0.004	1	0

SF with intermediate input	513913	0.513	0.165	0.810	0.008
SF without intermediate input	1272074	0.577	0.119	0.787	0.043
LP	513913	0.028	0.046	1	0

Table 4b. Correlation of TFP scores

	FE	OLS	SF with	SF without	LP
			intermediate	intermediate	
			input	input	
FE	1				
OLS	0.929	1			
SF with intermediate input	0.065	0.047	1		
SF without intermediate input	0.045	0.034	0.988	1	
LP	0.007	0.017	0.573	0.553	1

Table 4c. Correlation of TFP Rank

	OLS with FE	OLS without FE	SF with	SF without	LP
			intermediate input	intermediate input	
FE	1				
OLS	0.993	1			
SF with intermediate input	-0.018	-0.021	1		
SF without intermediate input	-0.054	-0.053	0.996	1	
LP	-0.026	-0.018	0.986	0.993	1

5.2 Baseline estimation result

The baseline results for FDI spillover based on Equation (5) are shown in Table 5. Columns 1-5 show the results when we use stochastic frontier TFP while 6-10 show the ones when LP TFP is applied²¹.-We observe the negative and significant signs for *Horizontal_Asia* throughout models, and this indicates the presence of a strong replacement effect by FDI from Asia region. This result is consistent with Caves (1996) and Blomstrom et al. (2000) which found a tendency of MNCs to "crowd out" local firms in the same industry in developing countries. *Horizontal_Europe* and *Horizontal_NorthAmerica* however, are not robustly significant²². This phenomenon might be due to the fact that Asian firms have relatively closer technology to domestic firms than European or North American firms do. Thus Asian firms pose a greater threat to the local competitors. The result also implies that, if Vietnamese firms are to compete with foreign firms in the same industry, a greater effort of product diversification or product differentiation through greater R&D would be necessary.

Vertical spillover²³ from FDI from Asia region, *Vertical_Asia*, always has a positive sign and in most cases it is significant²⁴. This supports our expectation that higher penetration of Asian FDI does have positive spillover on Vietnamese suppliers. Concerning FDI from European and North American firms, however, no consistent results have been found. This indicates that the potential technology gap only might not necessarily lead to spillover.

²¹ We will adopt the same approach to report the results using both SF and LP TFP in the rest of the analysis.

²² Alhough *Horizontal_Europe* is negative and significant when LP TFP is applied. This is consistent with the results in the later sections.

²³ In the following context of the paper, vertical spillover only refers to backward spillover brought to upstream suppliers.

²⁴ We obtain similar results when we limit the samples to domestic firms.

Tuble 5. Result of I DI spillovel w	itii regioni oused groupings (ot	(senne)
Dependent Variable: Ln_TFP (SF)	(1)	(2)
Herfindal	-0.0967***	-0.0976***
	(0.0295)	(0.0295)
Horizontal_total	-0.0299***	
	(0.00983)	
Vertical_total	0.0228*	
	(0.0119)	
Vertical_Asia		0.0353**
		(0.0170)
Vertical_Europe		-0.0416
		(0.100)
Vertical_NorthAmerica		-0.291
		(0.549)
Horizontal_Asia		-0.0370***
		(0.00881)
Horizontal_Europe		-0.0205
		(0.0187)
Horizontal_NorthAmerica		-0.0153
		(0.0598)
Observations	1,272,058	1,272,058
R-squared	0.052	0.052
Number of id	569,507	569,507

Table 5. Result of FDI spillover with region-based groupings (baseline)

All control variables are in the form of one period lag.

Robust standard errors in parentheses, calculated with cluster option.

*** p<0.01, ** p<0.05, * p<0.1

Year dummy is included; firm-specific characteristics are controlled (fixed effect).

5.3 Result for alternative groupings

Table 6 indicates that a greater vertical spillover on domestic suppliers seems to be generated by investors from BIT-signed countries whereas the direction of the effect is mixed in the case of the non-BIT investors. These unstable results for the non-BIT investors may be explained by greater investment barriers for investors without BITs. On the other hand, the significantly negative sign of ,horizontal spillover shows that investors with BITs tend to suppress the development of their domestic competitors in the same industry.

	i with Bill cubtu Brouping.		
Dependent Variable: Ln_TFP	(1)	(2)	
Herfindal	-0.120***	-0.123***	
	(0.0337)	(0.0336)	
Horizontal_total	-0.0305***		
	(0.00983)		

Table 6. Result of FDI spillover with BIT-based groupings

Vertical_BIT	0.0354**	0.0348**
	(0.0153)	(0.0149)
Vertical_non-BIT	-0.0150***	-0.0148***
	(0.00490)	(0.00488)
Horizontal_BIT		-0.0413***
		(0.00844)
Observations	1,272,058	1,272,058
R-squared	0.052	0.053
Number of id	569,503	569,503

All control variables are in the form of one period lag.

Robust standard errors in parentheses, calculated with cluster option.

*** p<0.01, ** p<0.05, * p<0.1

Year dummy is included; firm-specific characteristics are controlled (fixed effect).

Dependent Variable: Ln_TFP (SF)	(1)	(2)	(3)	(4)
Herfindal	-0.0549***	-0.0538***	-0.0659*	-0.0650*
	(0.0199)	(0.0195)	(0.0389)	(0.0393)
Horizontal_total	-0.0308***		-0.0312***	
	(0.00982)		(0.00993)	
Vertical_Europe	-0.0424	-0.0343	-0.0361	-0.0257
	(0.0978)	(0.0979)	(0.0986)	(0.0969)
Vertical_NorthAmerica	-0.363	-0.180	-0.376	-0.241
	(0.543)	(0.546)	(0.546)	(0.539)
Vertical_JK	0.0258	0.0299	0.0193	0.0287
	(0.0244)	(0.0221)	(0.0221)	(0.0200)
Vertical_non-JK_Asia	0.0562***	0.0479**		
	(0.0214)	(0.0209)		
Vertical_ASEAN			-0.0370	-0.0210
			(0.0433)	(0.0419)
Vertical_other Asia			0.133***	0.106**
			(0.0450)	(0.0412)
Horizontal_Europe		-0.0262*		-0.0236
		(0.0146)		(0.0149)
Horizontal_NorthAmerica		0.0107		0.0277
		(0.0582)		(0.0611)
Horizontal_JK		0.00329		-0.00395
		(0.00917)		(0.00928)
Horizontal_non-JK_Asia		-0.0788***		
		(0.0151)		
Horizontal_ASEAN				-0.116***
				(0.0272)

Table 7. Result of FDI spillover with region-based groupings (alternative)

Horizontal_other Asia				-0.0518***
				(0.0139)
Observations	1,272,058	1,272,058	1,272,058	1,272,058
R-squared	0.052	0.053	0.053	0.054
Number of id	569,505	569,505	569,507	569,507

All control variables are in the form of one period lag.

Robust standard errors in parentheses, calculated with cluster option.

*** p<0.01, ** p<0.05, * p<0.1

Year dummy is included; firm-specific characteristics are controlled (fixed effect).

Columns (1) and (2) in Table 7 show the result for grouping with Japan&Korea firms and non-JK Asian firms, thus demonstrating how spillover effect differs among different degrees of interaction with local suppliers. They support our prior expectation that Japanese and Korean firms do not have any vertical spillover effect. Asian investors excluding these two countries remain to show positive spillover impact in the vertical way. At the same time, *Horizontal_nonJK_Asia* always has negative sign, implying that they are suppressing Vietnamese firms in the same industry. Using this specification, we find that FDI from European investors are also having a "crowding out" effect although it is not the case for North American investors.

Columns (3) and (4) in Table 7 show the different spillover effect when we take into account both FTA and foreign investors' interaction with local suppliers. *Vertical_other Asia* (Backward) is always positive and significant, which indicates that the FDI from Asian firms incurs positive spillover on Vietnamese firms' productivity, and it is mainly caused by East Asian firms except Japanese and Korean ones. A possible explanation would be that investors from countries such as Taiwan, Hong Kong and China have more advanced technology than Vietnamese firms. Furthermore, these firms have more incentive to source locally because of the imposed tariff on imported parts from outside ASEAN. In comparison, the inactive sourcing of Japanese and Korean firms in local area prevents their technology from being spread to the domestic suppliers.

On the other hand, horizontal indicators always show negative signs except for *Horizontal_NorthAmerica*. Among them, *Horizontal_ASEAN* and *Horizontal_otherAsia* are significant in all cases. This provides strong evidence that foreign firms' entry in the same industry appears to prevent domestic competitors from increasing their productivity.

5.4 Robustness Check

5.4.1 Higher foreign share cutoff

As indicated by Javorcik and Spatareanu (2011), small ownership share gives foreign investors little power to take control of the firm and lowers the possibility of technology spillover led by foreign shareholders. Since in our baseline estimation, foreign firms are defined as the ones with foreign share regardless of the percentage, we would like to check the robustness of the results in the previous sections by increasing the cut-off value. We decide to use 50% foreign equity share as the cut-off value to conduct the examination²⁵. As shown in the 1st Column of Table 8, this attempt does not change our qualitative prediction.

 $^{^{25}}$ When we use 10% foreign equity share as the cut-off, there are only 51 firms out of 42,142 foreign firms in total (over ten years), while nearly 80% of the pool are wholy-foreign-invested firms (33,000).

Table 8. Robustness check

	(1)	(2)	(3)	(4)	(5)
	50% cutoff	Location	Firm	Size	Heterogeneity
Dependent Variable: Ln_TFP(SF)			<10 person	>10&<50	=
Herfindal	-0.0940**	-0.0955***	-0.0528	-0.00844	0.00457
	(0.0427)	(0.0337)	(0.0510)	(0.0418)	(0.0196)
Vertical_Asia	0.0353**	0.0417**	0.0671***	0.0189***	0.0484**
	(0.0167)	(0.0206)	(0.0225)	(0.00719)	(0.0243)
Vertical_Europe	0.0264	-0.0413	-0.155	-0.0426	0.0793
	(0.0837)	(0.101)	(0.157)	(0.0455)	(0.147)
Vertical_NorthAmerica	-0.400	-0.375	-0.131	-0.514*	-0.0925
	(0.478)	(0.511)	(0.827)	(0.297)	(0.623)
Vertical_TFP					-0.348***
					(0.0930)
Horizontal_Asia	-0.0350***	-0.0449***	-0.0672***	-0.0131***	-0.0561***
	(0.00816)	(0.00783)	(0.0124)	(0.00409)	(0.0116)
Horizontal_Europe	-0.00251	-0.0208	-0.00349	-0.0223**	-0.00473
	(0.0247)	(0.0193)	(0.0222)	(0.00877)	(0.0192)
Horizontal_NorthAmerica	-0.0482	-0.00611	-0.0552	-0.0132	0.0381
	(0.0644)	(0.0699)	(0.0814)	(0.0359)	(0.0702)
Observations	1,272,058	339,800	720,748	374,874	1,166,855
R-squared	0.052	0.048	0.115	0.019	0.060
Number of id	569,506	141,553	396,548	189,884	579,298

All control variables are in the form of one period lag.

Robust standard errors in parentheses, calculated with cluster option.

*** p<0.01, ** p<0.05, * p<0.1

Year dummy is included; firm-specific characteristics are controlled (fixed effect).

5.4.2 Location effect

Due to the geographical inequality in economic growth inside Vietnam, we are motivated to investigate how foreign firms in different regions have distinctive impact on domestic firms' TFP. The centrally administered provinces in Vietnam can be roughly divided into 6 major social-economic districts: Red River Delta, Midlands and Northern Mountainous Areas, Northern and Coastal Central Regions, Central Highlands, Southeastern Area, and Mekong Delta.

Thus we divide the full sample by region and see if there is any variation among different groups. We try to identify the location of each firm by "province" code²⁶. Column (2) in Table 8 shows the result for Red River Delta analysis. The significant and positive sign of *Vertical_Asia* (Backward) shows that FDI from Asian firms have more impact on promoting the productivity of the domestic firms. Considering the fact that Red River Delta is the most economically-developed region in Vietnam, we can infer that FDI from Asian firms are more likely to incur spillover in the areas where economic development is more active and prosperous.

²⁶ There was a reform on the provinces of Vietnam in 2004, when some provinces were merged to others and the codes were changed accordingly. We will only focus on the firms using the new province code.

5.4.3 Firm size effect

We further investigate if the size of the domestic firms affects the way they receive FDI spillover. To do this, we divide all domestic firms into three groups: small (<10 persons), medium (10~50 persons) and large (50~ persons) firms. Then we conduct the same estimation as in Equation (5) based on the samples in each group. Shown in Columns (3) and (4) of Table 8, Asian investors incur positive vertical spillover to their domestic suppliers when domestic firms are of small and medium size. While this impact is not found when only large firms are concerned²⁷. This implies that spillover from FDI from Asian firms is more possible in relatively small-scaled firms because such firms are flexible in absorbing new technology and staff from outside. By contrast, it will take time for large firms to adapt themselves to different technology system. On the other hand, *Horizontal_Asia* is negatively significant for small firms, while both *Horizontal_Asia* and *Horizontal_Europe* are playing negative roles for medium firms. We don't get any consistent results for large firms.

5.4.4 Controlling for heterogeneity of foreign firms

One might argue that our previous findings are caused by the idiosyncratic characteristics of different foreign investors. MNCs from different countries usually will have different productivities (Appendix 1). The variation might become the factor to affect degree of spillover because firms with more sophisticated technology will require more refined inputs from their local suppliers. On the other hand, if the TFP of foreign firms is far superior to that of domestic suppliers, it is difficult for domestic firms to catch up and most likely that the presence of FDI will not bring any spillover effect to the upstream suppliers.

To verify whether foreign firms' TFP heterogeneity matters, Following Javorcik and Spatareanu (2011), we generate a new control variable *Vertical_TFP*²⁸. The estimation result is presented in Column (5) of Table 8. *Vertical_TFP* is always negative and significant. This indicates that the more sophisticated foreign firms in downstream sectors are, the more difficult these firms are able to transfer knowledge to their local suppliers. Meanwhile adding this term does not change our previous conclusion.

6 Conclusions

By far the spillover impact of FDI has been widely investigated. In this paper, we examine how the origin of foreign investors affects the degree of horizontal and vertical technology spillovers, using firm-level panel data from Vietnam in 2002-2011. In general, FDI does not bring horizontal spillover to domestic firms, which is in contrast to Nguyen (2008). However, in the vertical way, FDI is positive and significant, conditional on the region. This finding is in accordance with Anwar and Nguyen (2013).

Deviating from the previous studies, we examine if the investment from different continents might have different impacts on domestic firms' productivity. We first group the origins of multinational firms according to geographical regions into East Asia, Europe and North America. Second, given the fact that the sourcing pattern of multinational firms is likely to be affected by preferential trade arrangements or investment agreements, we examine alternative groupings which incorporate

²⁷ We do not report the results because of space constraint. The result is available upon request.

²⁸ Please see their original paper for more details.

preferential trade arrangement and investment arrangements. To be specific, we subdivide Asian countries according to the ASEAN membership, BITs and sourcing tradition.

The empirical results provide solid evidence of Asian firms' positive spillover in Vietnam, and we show that this spillover is mainly generated through the channel of local sourcing. In general, a positive relationship is observed between the presence of Asian firms in downstream sectors and the productivity increase of Vietnamese firms in the supplying sectors. And no robust result is found when European or North American firms are supplied by Vietnamese firms. Furthermore, we find that FDI from Japanese and Korean firms do not induce positive spillover to domestic suppliers despite their large investment in Vietnam. In contrast, firms in the rest of East Asia are the most likely to induce spillover to the local suppliers because of their closer interaction. In the horizontal perspective, the ASEAN, East Asian and European firms all exhibit a negative productivity effect, implying that they tend to restrain the productivity growth of Vietnamese firms in the same industry. Apart from the above, we conduct robustness check by investigating the factors of higher foreign share cutoff value, the size of domestic firms, location and foreign firms' heterogeneity. The Asian vertical variable is robust across all specifications while horizontal variables present consistent results as in the previous analysis.

Thus, our finding support the view that, in addition to preferential investment agreement, interaction with local firms through sourcing is likely to be the most decisive channel to incur vertical spillover. Since Japanese or Korean investors' reluctance to local procurement prevents Vietnam from grasping potential benefit from high-tech FDIs, the government should provide multinational firms with better investment environment, for example, by providing information on local supplies. At the same time, the Vietnamese government should foster Vietnamese firms to improve their technology level and to devote to product upgrading to catch up with foreign investors.

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Continent	Variable	Mean	St. deviation	N
Asia	TFP_OLS	0.015	0.024	14667
	TFP_SF	0.600	0.095	34347
	TFP_LP	0.032	0.049	14667
	net turnover	149697.300	1025113.000	34347
	invest total	23201.910	124191.900	21402
	labor	4.600	1.591	34347
	output	8.998	1.985	34347
	capital	8.062	2.244	34347
	investment	6.788	2.271	16254
Europe	TFP_OLS	0.014	0.018	1412
	TFP_SF	0.624	0.091	4539
	TFP_LP	0.039	0.054	1412
	net turnover	198516.300	1102810.000	4539
	invest total	33042.240	217019.700	2923
	labor	4.223	1.611	4539
	output	8.925	2.218	4539
	capital	7.358	2.685	4539
	investment	6.394	2.513	2281
North America	TFP_OLS	0.011	0.013	486
	TFP_SF	0.608	0.098	1712
	TFP_LP	0.038	0.055	486
	net turnover	100671.800	311122.700	1712
	invest total	14796.780	66136.600	1070
	labor	4.142	1.482	1712
	output	8.618	2.067	1712
	capital	7.218	2.466	1712
	investment	6.231	2.319	810

Appendix 1 Statistical Summary by Continent

*output, capital and investment amount are deflated by GDP deflator.

Appendix 2 Two-sample t test on coefficient of spillover variables by continent

Spillover variable	Europe & North America	Asia & Europe	Asia & North America
Vertical Asia	Different	Different	Different
Vertical Europe	Different	Different	Different
Vertical North American	Different	Different	Not Different
Horizontal total	Different	Different	Different

*For all results with "different" conclusion, p<0.01

Variable	Mean	St. Deviation	Obs		
Vertical_Asia	0.169	0.092	1369286		
Vertical_Europe	0.044	0.018	1369286		
Vertical_NorthAmerica	0.007	0.004	1369286		
Vertical_ASEAN	0.039	0.023	1369286		
Vertical_EastAsia	0.073	0.043	1369286		
Vertical_Japan	0.054	0.042	1369286		
Vertical_NonJa_Asia	0.115	0.060	1369286		
Herfindal	1.591	0.231	1369267		
Horizontal_total	0.144	0.178	1369267		
Horizontal_Asia	0.103	0.143	1369267		
Horizontal_Europe	0.029	0.065	1369267		
Horizontal_NorthAmerica	0.005	0.009	1369267		
Horizontal_ASEAN	0.029	0.044	1369267		
Horizontal_EastAsia	0.049	0.093	1369267		
Horizontal_Japan	0.024	0.057	1369267		
Horizontal_NonJapan_Asia	0.079	0.114	1369267		

Appendix 3 Statistical Summary spillover variables

No.	sector name
1	agriculture
2	mining
3	food
4	beverage
5	tobacco
6	textile
7	apparel
8	leather product
9	wood product
10	paper product
11	printing
12	coke product
13	chemical product
14	medicine
15	rubber and plastic
16	non-metallic product
17	metal
18	electronics
19	electrical equipment
20	machinery
21	vehicle
22	transport equipment
23	furniture
24	other manufacturing
25	repair and installation
26	electricity and water
27	construction
28	wholesale and retail
29	transportation
30	accommodation and restaurant
31	information
32	finance
33	real estate
34	professional activity
35	support service
36	communist party
37	education
38	hospital and social work
39	art and entertain
40	lottery
41	other service
42	household service

	A	ppendix 4	Industry	Classification
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