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Thang, T.T., Pham, T.S.H. orcid.org/0000-0002-0764-9182 and Barnes, B.R. (2016) Spatial Spillover Effects from Foreign Direct Investment in Vietnam. The Journal of Development Studies, 52 (10). pp. 1431-1445. ISSN 0022-0388

https://doi.org/10.1080/00220388.2016.1166205

Spatial Spillover Effects from Foreign Direct Investment in Vietnam

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To cite this paper: Thang, T.T., Pham, T.S.H. and Barnes, B.R., 2016. Spatial spillover effects from foreign direct investment in Vietnam. The Journal of Development Studies, 52(10), pp.1431-1445

Abstract

This paper investigates the role of inter-firm interaction and geographical proximity in the determination of productivity spillover effects from foreign to domestic firms. We developed an estimation approach using the Spatial Durbin model and applied this to a firm-level dataset from Vietnam from 2000-2005. We found that productivity spillovers diminished when the distance between foreign and local firms increase and that interactions among local firms amplify the spillovers. Within short distances, the presence of foreign firms creates positive backward, negative forward and horizontal spillovers. Based on the findings, several implications are extracted regarding promotion policy for FDI in developing countries.

JEL: F210, O330

Keywords: Foreign Direct Investment, Spatial Spillover Effect, Geographical Proximity, Social Interaction.

1. Introduction

Governments in developing countries compete to attract foreign investors by offering different fiscal incentives in the expectation of improving productivity through technology that spills over from foreign direct investment (FDI) to domestic firms. At the sub-national level, local governments have employed different investment strategies in a bid to obtain greater FDI. Whether or not the expenditure spent on attracting FDI pays off depends in part on the existence and magnitude of positive spillovers from such FDI. Empirical studies on the evidence surrounding FDI spillover effects have not reached a consensus. Further research is therefore needed to identify the conditions that determine this effect.

In a study on the impact of tax havens on non-tax haven countries in terms of FDI inflow, Blanco and Rogers (2014) found evidence of positive spillovers from tax haven FDI countries to nearby developing countries, but not to nearby developed countries. This finding triggers the question of the role of geographic proximity in determining spillover effects within a country. Geographic proximity may generate agglomeration and has an interaction effect. On this relationship, the agglomeration effect, as illustrated in the regional development literature, has influence on productivity among clustered firms. The interaction effect, as outlined in the social interaction literature, generates positive impact on productivity.

Most empirical studies on the spillovers of FDI have tended to omit the role of geographic distance. Moreover, most used a classical production model which measures the productivity of a local firm against the presence of foreign firms, and therefore fails to capture any interaction effect among local firms. Empirical research on spillovers which fails

to capture the interaction effect among local firms will provide biased results due to model misspecification.

This paper investigates the role of geographical proximity and social interaction in determining spillovers of FDI. We develop an estimation model based on the Spatial Durbin model (SDM) and run the model using firm-level panel data from Vietnam. This country constitutes a highly relevant setting, particularly with regards to examining such interaction among local firms.

2. Literature Review

2.1. Geographical proximity and spillover

The role of geographical proximity in knowledge and technological spillovers has been popularly recognized in the regional development literature. In their theoretical work, Martin and Ottaviano (1999), Lucas (2001), Baldwin and Martin (2004), and Audretsch and Feldman (2004) combined endogenous growth theory and endogenous location model to examine the influence of spillovers on growth. They showed that firm location matters for growth and that spillovers are stronger within certain distances. More specifically, they expressed that knowledge or technological spillovers which occur through a variety of mechanisms, such as skill acquisition, competition and production linkages are more likely to materialize and be more effective when firms are located in close proximity.

A critical effect of geographic proximity lies in the concept of clusters (Porter, 2000). Driffield and Girma (2003) and Driffield (2006) argued that cluster give rise to agglomeration externalities because of specialized local markets for labour and intermediate goods. Physical proximity may also aid the process of inter-firm knowledge spillovers, for example making causal communication less costly. The role of geographical proximity has also gained attention in the FDI literature. Baltagi, Egger & Pfaffermayr (2007) and

Blonigen, Davies, Waddell & Naughton (2007) discovered that spatial interdependence has a significant effect on the distribution of FDI between neighbouring countries. Blonigen et al. (2007) indicated that spatial econometrics can provide useful techniques that can be applied to multiple countries as well as regions within a given country to account for spatial interdependence.

The role of geographical proximity in spillover effects in a host country has been somewhat under researched. Some initial attempts have been made to detect the regional aspect of the spillovers (Aitken, Hanson & Harrison, 1997; Driffield, 2006; Girma & Wakelin, 2007; Sajarattanochote & Poon, 2009). Nevertheless, apart from Driffield (2006), these studies used a conventional approach built on the assumption of interdependency among spatial observations to examine spillovers of FDI. They incorporated the spatial factor by decomposing foreign presence into inter and intra-regional foreign presences. Therefore, they are unable to deal with the spatial pattern and in particular the nature of spatial dependence among local firms.

Driffield (2006) published the first study which incorporated the spatial pattern in the study on FDI spillover. The results suggest that contradictory findings in previous studies on the FDI spillover effect were due to the failure in capturing spatial dependency. This justifies using an estimation model which enables the detection of spatial dependence among firms in examination of the FDI spillover effect.

2.2. Social interaction and spillovers

Social interaction refers to particular forms of externalities, in which the actions of a reference group, typically an individual's family, neighbours, friends or peers, affect an individual's preferences (Scheinkman, 2002). Key theoretical discussion on this issue can be found in Topa (1997), Manski (2000), Jackson (2009) and Easley and Kleinberg (2010). They

suggested three specific forms of social interaction; namely constraint interaction, expectation interaction and preference interaction which jointly have a positive impact on productivity.

Empirically, social interaction has been documented in a number of studies from different economics strands. In the economic growth and technological transfer literature, Antonelli and Scellato (2013) found that the productivity of a firm is significantly affected by localized social interaction, both in terms of spillovers and creative reaction. From econometrics perspective, the social interaction of agents suggests a need to change empirical model specifications (Ertur & Koch, 2007; Easley & Kleinberg, 2010). Despite theoretical development and empirical evidence about the impact of social interaction on knowledge and technology spillovers, no study has captured a firms' social interaction while measuring productivity spillovers of FDI.

2.3. Limitations of conventional estimation of the spillover effect of FDI

A conventional approach to examine productivity spillovers is based on a model such as:

$$Y = FDI\beta_{fdi} + Z\beta_z + \varepsilon \qquad \textbf{(1)}$$

In (1), *Y* denotes productivity (or output) of local firms; *FDI* denotes foreign presence, *Z* denotes the firm, sector or region's characteristics. The statistical significance of the estimated coefficient$\hat{\beta}_{fdi}$ is considered as evidence of productivity spillovers from FDI firms.

The traditional approach denoted in **(1)** does not enable a detection of the effect arising from the type of geographical distribution of economic activities. The distribution itself can uniquely create a productivity effect in the form of agglomeration economies as well as the externalities generated by the social interaction (Parr, 2002). Therefore, non-consideration of

the effects of geographical distribution among firms may generate bias due to variable omission.

To make it clearer, Figure 1 illustrates the relationship of firms in the context of measuring spatial spillovers. The presence of a foreign firm is assumed to generate productivity improvement of three surrounding local firms D_1, D_2, D_3. Productivity improvement in a local firm, for example D_3, arising from the presence of foreign firm F, may exert some influence on the productivity of other local firms (such as D_2 and D_1) through the social interactions. The productivity improvement in firm D_1 and D_2, in turn, has some feedback effects on the productivity of firm D_3. Thus, firm D_3 can obtain two types of effect: one directly from foreign firms and another induced from interaction with D_2 and D_1. By not taking into account either the distance or interaction, studies employing the above mentioned conventional approach have omitted an important productivity determinant and have not fully measured the spillover effects of foreign firms**.**

Insert Figure 1

2.4. FDI in Vietnam

Vietnam's recent experience in attracting FDI and achieving rapid economic growth has generated considerable research. Most studies focused on examining the determinants of FDI (Pham, 2002; N. Nguyen & T. Nguyen, 2007; Vu, Le & Vo, 2007). Others investigated the contribution of FDI to job creation, poverty reduction and economic growth (Pham, 2003; CIEM, 2004). Few studies on spillover effects in Vietnam include Nguyen et al. (2006), Tran (2011), and Anwar & Nguyen (2014). Although Esiyok and Ugur (2015) did not examine the spillover effect, their work on locational determinants of FDI flows in Vietnam took spatial interdependence between provinces into account and found that the distribution of FDI

between Vietnamese provinces is subject to agglomeration effects, suggesting a need to apply spatial econometric model to obtain unbiased estimates spillover effects in Vietnam.

3. Estimation Approach

3.1. Model Specification

To capture the role of geographical proximity and firm interaction when measuring FDI productivity spillovers, we utilized an estimation approach based on spatial econometrics. Our empirical model is constructed from the general model for the estimation of FDI productivity spillovers, in combination with the model of spatial econometrics. The spatial spillovers of FDI for a representative firm in sector *j* and province *r* at time *t* is presented as follows:

$$Y_{jrt} = g(Y_{\_jrt}, X_{jrt}, \beta, \rho) + \varepsilon_{jrt} \qquad \textbf{(2)}$$

In which Y_{jrt} is productivity of that firm; Y_{jrt} is the productivity of all other firms except the firm in the province *r;* X_{jrt} is a set of exogenous variables for the province *r* including FDI, sector and provincial characteristics; β, ρ are parameters to be estimated and ε_{jrt} is the error term of the model (assumed *identical independent distribution*, *iid*). The model implies that productivity of a representative firm is a function *g(.)* of such factors as the sector and provincial characteristics which firms belong to and the productivity of representative firms in all other regions and sectors. This interactive function is well-known as the best-response function in game theory.

This study focuses on the sector-province level for two reasons: information on geographical distance is only available between provinces; and even when between firm's distance data is available, an estimation with firm-level distance is not feasible in spatial

analysis given the limitations in algorithm procedures and computing capacity of available software packages.

The estimation model is specified based on the Spatial Durbin model (SDM). SDM enables an in-depth investigation and visualization of productivity spillovers over the space (Autant-Bernard and LeSage, 2011). In addition, it helps to distinguish both intra-regional and inter-regional effects as well as the effect from the interaction among local firms. In principle, SDM captures the property of both spatial lag and spatial error by including the spatial lags of both dependent and independent variables in the right hand side of the model.

In the matrix form, our empirical model to be estimated can be written as follows:

$$Y = \rho \mathrm{W}Y + FDI\,\beta_{fdi} + X\beta_{x} + \mathrm{W}FDI_{fdis} + \mathrm{W}X\beta_{dx} + \mu + \varepsilon \qquad \textbf{(3)}$$

W is the weighting matrix, FDI is foreign presence; X is a vector of all other exogenous variables; μ is the unobservable time fixed effect that is assumed to be correlated with the exogenous variables in the model, ε is the error that is assumed *iid.*

For a given province *r* the term ρWY denotes the spatial effect of other provinces in the space, resulting from the interaction of local firms between provinces. Also, ρWY is endogenous by the construction of the model. Foreign presence is also possibly endogenous because one can argue that foreign firms may invest more into sector and provinces with high productivity. In this paper, the endogeneity of the former is managed by the estimation method, while that of the later is attenuated by using the time lag. Specifically, our dependent variable, is measured by the productivity of a single representative firm not the productivity of a sector, while our independent variable is measured by FDI flows into a sector and a province. We used time lag (one year lag) of this variable instead of using an alternative method like spatial GMM because the results produced by GMM are very sensitive and unstable.

The spatial weighted matrix $W_{(NJTxNJT)}$ captures the spatial relationship among units in the space. In the spatial panel data model, this matrix is the block-diagonal matrix of time *t* of which each diagonal element is the spatial weighting matrix of cross-section units (off-diagonal elements=0). Cross-section units are Kronecker products of industrial sector matrix $J_{(8x8)}$ which includes eight sectors and geographical distance matrix which are either neighbouring matrix $N_{(61x61)}$ ($n_{ij}=1$ if province *i* and *j* have the same border and $n_{ij}=0$ otherwise) or inverse distance matrix ($n_{ij}=1/d_{ij}^2$ of which d_{ij} is the distance (km) between the main town of province *i* and *j;* $n_{ij}=0$ if *i=j).* Eight sectors are aggregated from the IO table (see data section). This aggregation is a reasonable approach to reduce the complexity associated with the large dimensions of the weighting matrix. The distance *d* between any pair of provinces is measured based on the distance between the two main towns of the provinces.

The dependent variable (*Y*) is the total factor productivity (TFP) of a representative firm in a given sector of each province. This variable is aggregated (with weighted) from firm-level productivity which is estimated and predicted by using the Petrin-Levinson method (Levinson and Petrin, 2003). So, for a given time *t*, the productivity of the representative firm in province *r* and sector *j* is as follows, in which l_{irj} is the employment of firm *i* in sector *j* and province *r*.

$$Y_{jr} = \sum_i TFP_{ijr} w_{ijr}; w_{ijr} = \frac{l_{ijr}}{\sum_i l_{ijr}} \qquad \textbf{(4)}$$

Following Aitken and Harrison (1999), the foreign presence (*FDI*) in this model includes three variables reflecting horizontal (H_{jr}), backward (B_{jr}) and forward spillovers (F_{jr}). For a given representative firm in province *r* and sector *j*, three annual foreign presence variables are calculated as follows:

$$H_{jr} = \frac{\sum_i S_j L_{ijr}}{\sum_i L_{ijr}}; \qquad B_{jr} = \sum_{s \neq j}^{J} \delta_s * H_{jr}; \qquad F_{jr} = \sum_{s \neq j}^{J} \propto_s * H_{jr}$$

S_j denotes the share of fixed capital of FDI firms in the sector j, L_{ijr} is labor force of foreign firm i in sector j; α_s and δ_s are coefficients of the Vietnam input-output table for 2002. So, the variable for horizontal foreign presence is measured as the capital share weighted by employment share of foreign firms in a sector; B_{jr} and F_{jr} represent backward and forward spillovers which are computed as the foreign presence in all downstream sectors and upstream sectors respectively.

Other exogenous variables in the model include two groups: agglomeration index and regional specifics. The agglomeration index is included in this model to justify the impact of concentration and diversity which is believed to affect the rate of technological change and, therefore, the productivity in the region. Many empirical studies (Driffield, 2006; Beeson, 1987) suggested that the productivity effect of concentration arises from the specialized local market for labour and intermediate goods, while diversity can have effect through the availability of complementariness and choice. In this model, two agglomeration indexes are used: (1) *CONCENT*, calculated as the total output of province r per km^2, denoting economic density; (2) *DIVER* denotes diversification, $DIVER_r = \sum_j (q_{ij})^2$ in which q_{jr} is a relative weight of output from sector j in the province r, j is the number of sectors in the province;

Regional characteristics are a set of different variables including: (3) *URBAN* - measured as the ratio of urban population of each province and included in the model to control for industrialization in each province. In Vietnam, industrialization and urbanization are closely related since the majority of industrial activities are concentrated in urban areas and suburban areas; (4) *LQUALITY* is the labour quality of each province, measured as the ratio of skilled to unskilled labour. It proxies the human capital of each province; (5) *PCI* or

provincial competitiveness index is the composed measurement of the competitiveness of the province. This index is calculated from a survey of the provincial competitiveness in Vietnam (Malesky, 2005). In general, *PCI* reflects the institutional environment for business activities in each province.

3.2. The data

Data was extracted from Vietnam's annual Enterprise Census, which was collected by the General Statistic Office of Vietnam (GSO). Vietnam is a country with a unique shape (long and thin) and has provincial authorities that have been competing to attract foreign investors. FDI in Vietnam is unevenly distributed. For example, eight provinces in two economic centres in the North and the South tended to receive the vast majority of total inward FDI (Nguyen et al. 2006). Moreover, Vietnam is a country with a collectivist culture and where social interactions have significant influence on business activities. Given the conditions, Vietnam offers a good empirical setting for the spatial analysis of FDI spillover effects.

The country has managed to attract a large inflow of FDI during the last two decades by liberalising policies. Remarkably, during the period from 2000 to 2005, Vietnam was either the second or third largest recipient of total FDI in South East Asia, surpassing China (see Figure 1 in Esiyok & Ugur, 2015). Only data from 2000-2005 was used as this marked the peak time for provinces giving incentives to foreign investors. During this period, local governments in 32 of Vietnam's 64 provinces were reported to provide extra legal incentives to foreign investors, creating a clash between central and local governments and huge competition between provinces (Vu et al. 2007). In a further effort to liberalise FDI policies and to provide an equal treatment to foreign and domestic investors, a unified Law of Investment was introduced in 2006 (Esiyok & Ugur, 2015). Since 2006, no more exclusive incentives were allocated to foreign investors.

The number of firms in this census increased from 27,000 in 2000 to over 67,000 in 2005. The number of provinces increased from 61 in 2000 to 64 in 2005. The census contained information on firm performance, fixed assets, employment, production costs, and so forth. Firms can be classified by sectors, locations (provinces) and ownership. Although information on locations of firms was available, it was not detailed enough to enable a measurement of distance between individual firms but it was possible to measure distance between provinces.

Data was aggregated into eight industrial sectors, including: (1) agriculture and mining;(2) food processing; (3) chemical and materials;(4) machinery, automobile and vehicles; (5) construction, gas and electricity supplies;(6) commerce, hotel, restaurant and maintenance services; (7) transport, telecom and finance; (8) and other services. A reason for not using more disaggregated sectors was the limitation in spatial estimation procedures. Thus, the panel data had a total of 2440 observations (5 years x 61 provinces x 8 sectors).

Information on the provincial competitiveness index (PCI) was extracted from (Malesky, 2005). Information on labour quality for each industrial sector by province was extracted from annual Labour and Employment Survey of Vietnam GSO data was also used for the provincial urbanization ratio. The descriptive statistics used in the model are presented in Table 1 and the correlation matrix appears in Table 2. The VIFs suggest that multicollinearity does not appear to be a problem with this data (Hair et al. 2006).

Insert Tables 1 and 2

4. Results and Discussions

4.1. Spatial Estimation

Before estimating the model, the spatial interdependency of productivity was checked using two indicators: the global Moran's *I* and Geary's *c*. They were recorded at 0.308 and 0.297

respectively; and were statistically significant ($p < 0.01$), showing a moderate spatial dependency of productivity among provinces. We also calculated local Moran's *I* using a first-order contiguous weighting matrix. The results revealed that Ha Noi and Ho Chi Minh city had relatively high productivity and such high productivity was inter-dependent with neighbour provinces ($p < 0.05$). Similar productivity inter-dependency was found for some provinces in the northern mountainous areas where productivity was low.

After exploring the spatial dependency of productivity, the empirical model was estimated using different methods. Firstly, the model was estimated with OLS (column 1 in Table 3). The estimated coefficients may be biased due to the endogeneity in the model. The results for spatial fixed effect and random effect for SDM are presented in Column 2 (SDM1) and Column 3 (SDM2) of Table 3. These methods were introduced by Beer and Riedl (2012) and are partly based on the spatial method for panel data developed by Elhorst (2003). It also takes into account the procedure to deal with both time and spatial heterogeneity. We used the m-file in the MATLAB library for SDM, which was developed based on Beer and Riedl (2012). Both the fixed effect and random effect for spatial estimation were based on the ML estimation. The estimated coefficients in SDM1 and SDM2 were more or less similar. However, the correlations between the variances of the unobservable random factors and the error term are significant (*theta* = 0.8206 with *t-value* of 26.3). Therefore the spatial random effect (SDM2) is a preferable specification and all further calculations and interpretation will be made using SDM2.

Insert Table 3

A critical point to note from all specifications is the significance of the spatial correlation ρ. Value of ρ ranges from 0.39 (for SEM) to 0.63 (for SDM1), suggesting a

modest correlation of spatial units and more importantly all of them are significant. Hence, the presence of interaction among local firms in the model was justified.

To check the robustness and in order to trace the influence of distance, the SDM model was estimated with different ordering levels from the contiguous matrix. The first order contiguous matrix (W1) reflects neighbourhood relationships between any spatial units of which off-diagonal elements have value 1 if two provinces share a border, and 0 otherwise. Similarly, the second order matrix which is formed as W2=W1*W1 captures relationships of neighbours and neighbour of neighbours and so on. Table 4 presents the estimations for SDM with four ordering levels. In general, the estimated coefficients are consistent and robust in alternative estimations; the signs are similar although the absolute values differ (due to the difference in the weighting matrix).

Insert Table 4

With regards to the existence of the spillover effects, the coefficients of FDI variables and their spatial lag (the variables with the prefix "D_" in Table 3) would signal evidence of negative horizontal spillovers; positive vertical backward spillovers and negative vertical forward spillovers from intra-region FDI and inter-regional FDI if a model was employed without a spatial factor. However, in a spatial model, any interpretation cannot be so straight forward; the coefficients only partially reflect the first round effect and do not account for the interaction, which are accumulated to local firms (addressed in Section 4.4.)

4.2. Spatial Multipliers

Spatial econometric models, which have non-linear property, use global multipliers instead of estimated coefficients to reflect the global or accumulative effects that a spatial unit receives from surrounding units. The multipliers of a given exogenous variable are actually the total

differential of the model with respect to that variable in the model. The method proposed in Le Sage & Pace (2009) and Franzese & Hays (2007) is applied as follows:

$$S_{FDI} = (I_n - \rho \mathrm{W})^{-1}(I_n \beta_{fdi} + \mathrm{W}\beta_{dfdi}) \qquad \textbf{(5)}$$

The matrix S_{FDI} is driven by differentiating the SMD model with respect to the FDI variables. The column ith of the matrix reflects the effect of FDI in province *i* to productivity of local firms in all other provinces r$\neq$ i or $(\frac{\partial y_r}{\partial x_i})$

Because the number of provinces is large, we constrain the calculation into multipliers of FDI in three provinces of interest, where inward FDI is mostly concentrated in the North (Ha Noi), in the centre (Da Nang) and in the south (Ho Chi Minh city).

Insert Figures 2 and 3

Figures 2 and 3 jointly show that the spatial spillovers from all three locations decay quickly corresponding to the distance from foreign firms. For example, for an approximate distance over 150 km, the effect of, both positive backward and negative horizontal spillovers are likely to decline six times (from 0.6 to 0.1).

In addition, whether it is the horizontal or backward effect, the speed of the effect decaying in Da Nang is substantially different from those in Ha Noi and Ho Chi Minh. Such dispersion can be explained by the difference in the number and the concentration of neighbouring provinces surrounding those cities. As illustrated in the map, in comparison with Da Nang, Ha Noi and Ho Chi Minh have borders with a much larger number of provinces which also have a high density of firms and FDI inflow. These findings confirm the significance of geographic proximity to spillover assessment. The limitation of spillovers

over distance is consistent with empirical studies which use non-spatial econometric methods (Girma & Wakelin, 2007; Halpern & Muraközy, 2007).

4.3. The intra and inter-regional effect

To further examine the role of distance in spillovers, we measure inter and intra-regional spillovers. In the multiplier matrix, intra-regional spillovers refer to the own derivative ($\frac{\partial y_i}{\partial x_i}$) while the inter-regional effect measures the average effect of FDI firms from all other provinces, to the productivity of a local firm in province *i* (y_i), that is the average of row-sum cross-derivatives ($\sum_j \frac{\partial y_i}{\partial x_{j \neq i}}$).

The results are presented in Table 5 with the 61 provinces classified into two groups, the provinces with high firm density (High) and low firm density (Low), to gauge the effect of the density of both local and FDI firms. Regions with a high density of FDI firms also have a high density of local firms.

Insert Table 5

On average, we found that FDI firms in downstream sectors induce the positive effect to local firms' productivity (backward spillovers), whereas local firms suffer negative effects from FDI in the same sector (horizontal spillovers) and in the upstream sector (forward spillovers). The finding of positive backward spillovers is consistent with many other studies in this area. The meta-analysis of data from 47 countries by Havaranek and Irsova (2011) provides robust evidence consistent with knowledge transfer from foreign investors to local firms in supplier sectors (backward spillovers). This is explained by the scale effect, learning-

by-doing, tougher standard requirements and technical support from foreign firms dealing with their local suppliers.

However, in contrast with previous studies, our results show that the magnitude of the effect is subject to geographic distance. The intra-regional effects are much greater than the inter-regional effects. On average, for backward spillovers, given 10% increase in the foreign share downstream sector for a province, the productivity of a local firm in upstream sectors in that province increases by 0.48%, while it is only 0.014% for inter-regional spillovers. This finding is consistent with the empirical setting, because Vietnam is a developing country where infrastructure is not well developed FDI firms tend to use local suppliers in the same region to save logistic time and cost. Therefore there are more backward linkages between local suppliers and FDI firms in the same region than in different regions.

Distance again matters in our findings of vertical forward and horizontal spillover effects. The inter-regional forward and inter-regional horizontal spillovers are negligible, while intra regional forward and intra-regional horizontal spillovers are observed to be 27 and 34 times higher respectively. The findings relating to the intra-regional effect are similar to those in Driffield (2006). Driffield (2006) found no evidence of an inter-regional effect, whereas for Vietnam the inter-regional effect has much smaller magnitude than the intra-regional effect, demonstrating the role of geographical distance.

A further point worthy of discussion is the inverse sign of the intra-regional and inter-regional effect in forward and horizontal spillovers. Similar to Aitken and Harrision (1999), we found a market stealing, or negative competition effect. However, it was only for intra-regional horizontal spillovers; meanwhile, distant foreign firms and inter-regional horizontal FDI had positive effects. This finding suggests that a market stealing effect is more locally severe. This finding is consistent with the fact described in Nguyen et al. (2006) that many

FDI firms in Vietnam are small in size and many of them compete with Vietnamese firms at local levels.

The negative effect of intra-regional forward spillovers seems contrary to the production linkage literature (for example, that local firms who buy inputs from foreign firms benefit from better quality input and on-time delivery). A possible explanation for this finding is that intermediate inputs produced by foreign firms may not be easily harmonized local firms in downstream sectors. The lack of harmonization possibly harms productivity in local firms. Moreover, foreign presence in upstream sectors cause tough competition in upstream sectors, kicking out many local suppliers, and also harming local firms in downstream sectors who can only afford to buy from local suppliers. So in general, FDI presence in upstream sectors may harm local firms. However, negative forward spillovers only matters in short or intra-regional distances. Meanwhile, distant foreign firms or inter-regional forward FDI seem to have positive effects. Explanation for this is similar to the above discussion on intra-regional and inter-regional horizontal spillovers.

Our findings of forward and horizontal spillovers provide more insights than previous studies. In the meta-analysis of data from 47 countries, Havaranek and Irsova (2011) found positive forward spillovers in many studies. We also found that forward spillovers can be positive or negative. Positive forward spillovers happen if local firms are located far from foreign firms, in different provinces. Forward spillovers will be negative if local firms are in the same region with foreign firms. While meta-analysis of data from 47 countries by Havaranek and Irsova (2011) found no effect on firms in the same sector, we found that horizontal spillovers can be negative or positive depending on the distance between domestic and foreign firms.

4.4. The Interaction Effect

To estimate the interaction effect, we take intra-regional effects minus the first round effect which is $\hat{\beta}_{fdi}$ in our SMD models. $\hat{\beta}_{fdi}$ is the effect of the foreign firms in province *i* to a local firm located in that province. This only explains the first round effect. The intra-regional effect ($\frac{\partial y_i}{\partial x_i}$) is the sum of the first round effect from FDI and the feedback effect to the local firm in province *i* accumulated through the interaction with other firms. Thus, the difference between intra-regional effects and the first round effect will be the interaction effect. They are average calculations for all regions as well as high and low density regions. The results are presented in Table 5. We use the coefficients $\hat{\beta}_{fdi}$ in SDM2 because SDM2 proved to be the better estimation model.

The results reveal a large contribution of the interaction effect to the intra-regional effect of FDI. On average, the interaction contributes 61.9% (0.0297/0.0480) of the intra-regional effect of backward spillovers. Local firms in upstream sectors obtain spillovers from their foreign buyers and also from interacting with other local firms who also work as suppliers for FDI firms. The interaction among local firms in upstream sectors magnifies the intra-regional effect of backward spillovers.

The results reveal positive interaction effects in horizontal spillovers. On average, interaction among firms helps to reduce any severe effect caused by FDI presence in the same sector by 21.4% (0.003/0.014). The interaction effect in high density regions (0.004) is twice that of low density regions (0.002). The results are consistent with the literature on the agglomeration effects. The findings of the interaction effects associated with forward linkages need to be interpreted separately between high and low density regions, rather than interpreting it from the average figures. In high density regions, the interaction effect among

local firms in downstream sectors are positive (0.0309) which help to reduce the negative effect caused by FDI presence in upstream sectors in the region (-0.017). This result is a contribution from agglomeration effect. In a region with dense economic activity, interactions among firms are more intensive than those in less populated regions.

In sparsely populated regions, the positive agglomeration effect is very negligible, while local firms may face tougher competition for affordable inputs. This is because local suppliers who supply at an affordable price may be kicked out by foreign presence in upstream sectors. Therefore, overall, in a region with sparse economic activity, interaction among local firms may harm productivity. This finding is in line with Propris & Driffield (2006) who find firms in clusters gain significantly from FDI in their region even though there are no such spillovers. Although local firms in clusters suffer from increased competition caused by foreign firms, any loss in productivity is more than offset by the beneficial effects of FDI. Overall, local firms in clusters gain significantly from inward investment, while firms outside clusters tend not to.

5. Conclusion

In this paper we draw on recent developments in spatial econometrics to develop a novel estimation approach based on the SDM to investigate the role of spatial dependence and interaction. We estimate the productivity of a representative local firm in a given province conditionally on: (i) the foreign presence in the sector in that province, (ii) the foreign presence in neighbouring provinces, and (iii) the interaction among all local firms.

The combination of the estimated coefficients with the spatial weighting matrix allows us to compute the global multiplier matrix that reflects intra-and inter-regional effects, and the interaction effect. Consistent with previous studies, we found positive backward spillovers. In contrast to other studies, forward and horizontal spillovers were found to be

positive or negative under different conditions. Positive forward spillovers can happen only if local firms are located far from foreign firms; if local firms are in the same region with foreign firms, forward spillover is negative. While Havaranek and Irsova (2011) identified no effect on firms in the same sector, we found horizontal spillovers can be negative or positive conditional on the distance between domestic and foreign firms.

Our results confirm the role of physical proximity in FDI as spillovers decay quickly with increasing distance between foreign and local firms. Intra-regional spillovers are much greater than inter-regional spillovers. Within short distances, foreign firm presence creates positive spillovers for local firms in supplier sectors (backward spillovers), but negative effect on firms in customer sectors (forward spillovers) and negative effect on firms in the same sector (horizontal spillovers). Interestingly, the presence of foreign firms in neighbouring provinces generates all the positive effects regardless of backward, forward and horizontal spillovers, although these effects are negligible and will be almost zero if local firms are located far from FDI firms. These findings are consistent with Driffield (2006) in showing that externalities from FDI are localized. Social interaction positively influences the productivity spillover effects; interaction among local firms enhances the positive effect of FDI downstream presence (backward spillovers) and helps to reduce severe negative effects caused by FDI presence in the same sector (horizontal spillovers) or in upstream sectors (forward spillovers).

The limitations relate to the computation capacity and availability of information. Although there is some theoretical discussion relating to the time dimension in spatial estimation (Anselin and Florax, 1995; Lee and Yu, 2010), algorithms to include this dimension have not been incorporated in common software packages. We therefore employ SDM, with an assumption that there was no time dynamic effect in this model. Given data limitations, distances between provinces rather than between individual firms were used and

data of upstream and downstream sectors were aggregated into eight industrial sectors rather than more disaggregated sectors. These limitations could be addressed in future studies, in particular accounting for firm proximity and inter-firm interaction.

This paper contributes to the literature in several different ways. The results support the proposition that geographical distance and social interactions significantly influence spillover effects of FDI. The findings demonstrate that the econometric treatment of issues such as agglomeration, contiguity and spatial dependence significantly change the conclusions regarding local and national spillovers from FDI. More specifically, we propose that geographical distance and social interaction are mechanisms which transform the signs and magnitudes of backward, forward and horizontal spillover effects.

Methodologically, the study has demonstrated that estimations of spillover effects are sensitive to the assumptions on spatial dependency, agglomeration effects and differences in location characteristics. This suggests that the estimation of spillovers or productivity growth generated by FDI that do not allow for such effects must be treated with caution. We have further developed an estimation approach based on spatial econometrics which enable us to capture the effect of spatial dependency, the agglomeration effect and location characteristics when examining spillovers from inward FDI. The method employed went further to estimate *global multipliers* which reflect the global or accumulative effect that a spatial unit received from surrounding units. This enabled us to separate the interaction effect and direct effect, and thereby measure the importance of interaction among local firms in the spillovers.

Our paper provides practical implications for FDI promotion policies in developing countries. In order to promote productivity spillovers from foreign to local firms, FDI promotion policies should be tailored to conditions which influence on the sign and magnitude of the spillover effects. It is vital to consider geographical, social and economic conditions as well as the industrial structure of different regions within a country when

designing FDI policy to promote economic development in different regions and the country as a whole.

From our findings of positive backward spillovers, we suggest that a developing country should attract more foreign firms to enter its downstream sector. Tougher standards of input and technical support for local suppliers may lead to the establishment and development of local upstream producers and, consequently, to the development of the entire industry.

Our finding that intra-region spillovers are higher than inter-region backward spillovers suggests that in order to maximize positive backward spillovers, foreign firms should be attracted to the same areas where many domestic suppliers are located. On the other side, local firms should be promoted to locate not very far from foreign firms to gain the positive spillovers

With respect to the negative intra-region but positive inter-region forward spillovers finding, we recommend that foreign firms in upstream sectors should be attracted to the region which are far from locations of local firms in downstream sectors. From our findings that social interaction amplifies the spillovers, we recommend that FDI policies should consider clustering local firms. FDI firms ought to be located in an area with a high density of local firms. To reduce the negative effects caused by FDI, we also suggest that FDI firms should not be motivated to locate in regions with a low density of local firms in the same or downstream sectors.

References

Aitken, J.B. & Harrison, A. E. (1999). Do Domestic Firms Benefit from Direct Foreign Investment? Evidence from Venezuela. *Economic Review*, 89, 605-168

Aitken, J.B., Hanson, G.H & Harrison A. E. (1997). Spillovers, Foreign Investment, and Export Behavior. *Journal of International Economics,* 43, 103–132.

Anselin, L. & Florax, R. J. G. M. (1995). *New Directions in Spatial Econometrics*, Springer, Berlin, Germany.

Antonelli, C. & Scellato, G. (2013).Complexity and innovation: social interactions and firm level total factor productivity. *Journal of Evolutionary Economics*, 23 (1), 77-96.

Anwar, S. & Nguyen, P.L.(2014). Is foreign direct investment productive: A case study of the regions in Vietnam. *Journal of Business Research*, 67, 1376-1387.

Audretsch, D. & Feldman, M.P. (2004). Knowledge Spillovers and the Geography of Innovation. In V. Henderson and J. Thisse (Eds.), *Handbook of Urban and Regional Economics: Cities and Geography* (2713-2739). Elsevier.

Autant-Bernard, C. & LeSage, J. P. (2011). Quantifying Knowledge Spillovers using Spatial Econometric Models. *Journal of Regional Science,*51 (3), 471–496.

Baltagi, B. H., Egger, P. & Pfaffermayr, M.(2007). Estimating Models of Complex FDI: Are there Third-Country Effects?. *Journal of Econometrics*, 140 (1), 260–281.

Baldwin, R. & Martin, P. (2004). Agglomeration and Regional Growth. In V. Henderson and J.Thisse (Eds.), *Handbook of Regional and Urban Economics: Cities and Geography* (2671-2712). Elsevier

Beeson, P. E. (1987). Total Factor Productivity Growth and Agglomeration Economies in Manufacturing, 1959-73. *Journal of Regional Science*, 27, 183-99.

Beer, C. & Riedl, A. (2012). Modelling Spatial Externalities in Panel Data: The Spatial

Durbin model revisited. *Papers in Regional Science*, 91(2), 299–318.

Blanco, L. & Rogers, C. (2014). Are Tax Havens Good Neighbours? FDI Spillovers and Developing Countries. *The Journal of Development Studies*, 50(4), 530-540

Blonigen, B. A., Davies, R. B., Waddell, G. R & Naughton, H. T. (2007). FDI in Space: Spatial Autoregressive Relationships in Foreign Direct Investment. *European Economic Review*, 51 (5), 1303-1325.

Driffield, N.L.(2006). On The Search For Spillovers From Foreign Direct Investment With Spatial Dependency. *Regional Studies*, 40(1),107-119

Driffield, N. L. & Girma, S. (2003). Regional Foreign Direct Investment and Wage Spillovers: Plant Level Evidence from the UK Electronics Industry. *Oxford Bulletin of Economics and Statistics*, 65(4), 453-474.

Easley, D. & Kleinberg, J. (2010). *Networks, Crowds, and Markets: Reasoning about a Highly Connected World*. Cambridge University Press.

Elhorst, J. P.(2003). Specification and Estimation of Spatial Panel Data Models. *International Regional Science Review,* 26(3), 244-268.

Ertur, C. & Koch, W. (2007). Growth, Technological Interdependence and Spatial Externalities: Theory and Evidence. *Journal of Applied Econometrics,* 22(6), 1033-1062.

Esiyok, B. & Ugur, M.(2015). A Spatial Regression Approach to FDI in Vietnam to FDI in Vietnam. *The Singaporean Economics Review*. DOI: 10.1142/S0217590815501155

Galeotti, E.(2009). Do Domestic Firms Benefit from Geographical Proximity with Foreign Investors? Evidence from the Privatization of the Czech Glass Industry. *AUCO Czech Economic Review*, 3, 26-47.

Girma, S. & Wakelin, K.(2007). Local Productivity Spillovers From Foreign Direct Investment In The U.K. Electronics Industry. *Regional Science And Urban Economics,* 37, 399–412

Hair, F.J., Black, C.W., Babin, J.B., Anderson, F.R. & Tatham, L.R. (2006), *Multivariate Data Analysis*, 6th Edition, Pearson Prentice Hall.

Halpern, L. & Muraközy, B.(2007). Does distance matter in spillover? *Economic of Transition,* 15(4), 781-805.

Jackson, M. O.(2009). *Economic Network*. Princeton University Press.

Lee, L. F. & Yu, J. (2010). Esimation of Spacial Panels, Foundations and Trends in Econometrics, 4(1/2), 1-164.

LeSage, J. P. & Pace, R.K.(2009). *Introduction to spatial econometrics.*Chapman and Hall/CRC Press, Taylor & Francis Group.

Lucas, R. E. B.(2001).The effects of proximity and transportation on developing country population migration. *Journal of Economic Geography,* 1(3), 323-339.

Malesky, E.(2005). Vietnam competitiveness index, project document, Final Report. *Vietnam Competitiveness Initiative Policy Paper No4.*

Manski, C. F.(2000). Economic Analysis Of Social Interactions. *Journal of Economic Perspectives*, 14(3), 115–136.

Martin, P. & Ottaviano, G.I.P.(1999). Growing Locations: Industry Location in a Model of Endogenous Growth. *European Economic Review,* 43 (2), 281–302

Meyer, K.E & Sinani, E.(2009). When and where does foreign direct investment generate positive spillovers? A meta-analysis. *Journal of International Business Studies*, 40, 1075–1094

Nguyen, A., Nguyen, T., Vu, H. & Nguyen, H (2006). *Effects of Foreign Direct Investment to Economic Growth in Vietnam.* Technical Publishing House, Vietnam

Nguyen, N.A. and Nguyen, T. (2007). Foreign Direct Investment in Vietnam: An Overview and Analysis the Determinants of Spatial Distribution Across Provinces. *MPRA Paper No.921.*

Parr, J. B.(2002). Agglomeration economies: Ambiguities and confusions. *Environment and*

Planning, 34,717-731.

Pham, H.M. (2002). Regional Economic Development and Foreign Direct Investment Flows in Vietnam in1988-1998. *Journal of the Asia Pacific Economy*, 7 (2), 182–202.

Pham, H.M.(2003). The Economic Impact of FDI Flows on Vietnam, *Asian Studies Review*, 27, 81-98.

Porter, M. E.(2000). Location, Competition, and Economic Development: Local Clusters in a Global Economy. *Economic Development Quarterly,*14(1), 15- 34.

Propris, L.D. & Driffield, Nigel. (2006).The importance of clusters for spillovers from foreign direct investment andtechnology sourcing. *Cambridge Journal of Economics*, 30, 277–291.

Sajarattanochote, S. & Poon, J.P.H.(2009). Multinationals, Geographical Spillovers, and Regional Development in Thailand. *Regional studies,* 43(3), 479-494.

Scheinkman, José A.(2002).Social Interactions. In *S.*Ourlauf and L. E. Blume (Eds.), *The New Palgrave Dictionary of Economic* (231-255). MacMillan.

Topa, G.(1997). Social interaction, local spillovers and unemployment. *Review of Economic Studies,* 68(2), 261-295

Tran, T.T.(2011). Productivity Spillover of Foreign Direct Investment, what if productivity is no longer a black box? *The South East Asian Journal of Management*, 5 (1), 1-16.

Vu, T.T.A., Le, T.V. & Vo, T.T. (2007). Provincial Extralegal Investment Incentives in the Context of Decentralisation in Viet Nam: Mutually Beneficial or a Race to the Bottom? *Fulbright Economics Teaching Program, Policy Research Paper*.