DEPOCEN

Working Paper Series No. 2013/12

Spatial Spillovers of Foreign Direct Investment: The Case of Vietnam

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Length of the article: 8,487 including figures, tables and references

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Abstract

In an effort to unlock the black box of mixed empirical evidence for productivity spillovers from foreign direct investment in host countries, this paper, using the case of Vietnam, examined the role of geographical proximity and inter firm interaction in determining productivity spillovers of FDI. The spatial productivity model specified based on the empirical spillovers literature and spatial econometric model. This paper confirms negative effect of horizontal spillovers. The distance and interaction are confirmed to be two determinants of the significance of spillover effects. The paper finds the positive backward and negative forward spillovers. Indirect effect (or the inter-regional spillovers) is found about twice to four times higher than the direct effect (or the intra-regional spillovers) but such kind of indirect effect is quickly attenuated for a certain distance. The paper also finds the evidence of the effect arising from the social interaction among local firms in productivity spillovers. The testing results suggest that local firm's productivity is substantially driven by the agglomeration effect and the presence of inter- and intra-regional FDI.

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1. INTRODUCTION

Empirical studies on productivity spillovers reveal the contradictory or mixed evidence of the positive spillover effect from foreign direct investment (FDI) to domestic owned firms. In an effort to explain the mixed evidence of the spillovers by examining the "black box" of productivity, this paper aims at further investigating evidence of spillovers in association with geographical distance.

Theoretical arguments point out four major channels for spillovers namely skill acquisition, technological imitation, competition and production linkages (Gorg and Greenaway, 2004). The effectiveness of these channels in spillover transmission appears to be subject to the proximity or the distance among firms (Jaffe *et al.*, 1993). For skill acquisition effect, this type of tactic and practical knowledge is transferred more effectively via face-to-face communication. Personal relationship and face-to-face communication are limited among employees and managers of firms which are located far from each other. This, therefore, narrows the possibility of knowledge to be transferred. Regarding to technological imitation, the closer the distance between foreign firms and domestic firms, the more potential is for imitation because the close distance reduces the cost of imitation and increases the opportunities to duplicate the technologies (Autant-Bernard, 2001). A similar potential can be seen with the spillovers taken through production linkages. For competition effect, interaction among geographically proximate competitors develops a more dynamic competitive situation. Moreover, psychological factors such as prestige and pride stimulate companies to compete actively and to become more innovative (Porter,1990).

Apart from investigating the matter of geographical distance, this paper tries to examine address the interaction of local firms while estimating spillovers. The interaction among domestic owned firms has yet been fully documented in the framework of productivity spillovers so far. While focusing on the technology diffusion from foreign firms to local firms, researchers conventionally employ production function to estimate the growth or productivity change of domestic owned firms with an implicit assumption that economic agents or firms are independent from each other. By considering economic units as independent and autonomous agents, economists seem to ignore the interaction among economic agents. The effect of agglomeration and social interaction, therefore, is omitted. An important point to note is that when interacting in the market firms do not only involve market interaction but also social interaction (*i.e.* the interaction in constraints, expectation and the preference). Therefore, this issue should be taken into account when one investigate firm's profit maximization (Manski, 2000)

Some recent studies (Jordaan, 2008; Girma and Wakelin, 2007; Smazynska, 2002) initially mention the regional aspect of spillovers in their research, but none of them deal with the spatial pattern, particularly the spatial dependence nature among domestic owned firms. Current studies limitedly focus on the variable FDI, and try to disaggregate this variable as detailed as possible to capture the horizontal, vertical and regional foreign presence. Such a specification possesses some weaknesses. When a strong assumption of independency among spatial observations is imposed, the conventional estimation of spillovers may be biased. In addition, there is no room for incorporating the factor of firm's proximity in the model, therefore, limiting the findings.

This research tries to overcome such problems in the specification to measure spillovers. In other words, it examines how the distances between foreign firms and local firms (and among local firms) affect spillovers. It does not rely on the independency assumption on the firms but models it and measures how the interdependency and interaction amplify the productivity spillovers.

In this research, the data from Vietnam- a transition country was employed. Vietnam has a unique geographical shape (long and narrow), the narrowest place is 45 km while the length is over 3000 km; by that the distance matters more. FDI started flowing into Vietnam in 1988 and has become significant since 1996. Like in other countries, FDI inflow in Vietnam is unequally located. Though being observed in all 61 provinces, the flow clusters into some provinces (eight provinces received more than 75% total FDI inflow (Tue Anh *et al.*, 2006)). Likewise, local firms are also clustered. Most of manufacturing activities are focused in two economic centers in the North and the South. With the above mentioned characteristics, Vietnam offers good empirical setting for the research.

This paper is structured into five sections. After the introduction, the paper proceeds with Section 2 summarizes theoretical and empirical arguments relating to the relationship between proximity, agglomeration, firm interaction and the productivity spillovers. Section 3 presents the method and data used in this research. The estimation results and discussion are in Section 4. The last section provides conclusion remarks.

2. LITERATURE REVIEW

2.1. Geographical proximity, agglomeration and spillovers

Spatial externality is discussed in various strands including regional growth, urban economics, innovation economics etc. However, theoretical studies on the spatial dimension of productivity spillovers from FDI are spare (Smeets R., 2009), most studies do not distinct foreign firms from domestic owned firms when they attempt to examine the impact from one firm to others. However, all of them emphasize the importance of proximity to the extent of the effect. Martin and Ottavinano (1996) and Baldwin *et al.* (2001) combine the endogenous growth theory (known as Romerian-type endogenous growth model) and endogenous location model to examine the influence of spillovers (not necessary from FDI) to growth. They show that firm's location matter for growth and the spillovers are stronger within a certain distance. Such statement then is confirmed in Audresch and Feldman (2004), Jaffe et al., (2000), Lucas, (2001) for the case of patent citation and knowledge spillovers.

For demonstration effect, Jordaan (2008) argue that knowledge, in contrast to information, is vague. It is difficult to codify and often only serendipitously recognized. As a result, geographic proximity becomes factor for knowledge to be transmitted since face-to-face communication and other kinds of personal interaction are important in this process.

Similarly, the spillover through skilled labor turnover is subjected to proximity as well (Scott, 1988). If FDI firms and domestic firms are located far away, the likelihood that domestic workers substitute working for a foreign firm by for a domestic firm is lower than the case they locate in proximity. On the other side, labor mobility can accelerate regional productivity through two ways: first, the interaction between new comers and incumbent labors boosts up the knowledge transfer not only from the new comers to the incumbents but also in a inverse direction, leading to the increase in human capital; second, the mobility fosters the matching process whereby employers are able to find out more jobs matched with their working skills, therefore increase the efficiency and overall productivity (Thulin, 2009). So, the proximity is not only stimulates the labor mobility but also leverage the effect caused by the labor movement.

Regarding to inter-firm linkages, besides the low transportation cost advantage, a conventional expectation is that proximity between firms enhances inter-firms linkages. Pointed out by Dunning (1993), one reason why FDI firm finds it difficult to use local suppliers is that it takes time and effort to identify suppliers and develop relationship; geographical proximity between them, therefore, facilitates the identification and creation of such business relationships.

Theoretical studies on localized innovation process (Storper, 1995; Edquist and Mckelvey, 2000; Porter, 2000) have added a spatial dimension to competition. As such, it seems to be a paradox to emphasize the importance of location in the era of global competition where firms can obtain their immobile inputs by their network. However, the intensity and quality of competition is enhanced by the proximity of competitors. The interplay among geographically proximate competitors operating under the same cultural conditions, speaking the same language and so on, develops a much more dynamic competitive situation. Furthermore psychological factors such as prestige and pride stimulate firms to compete more actively and become more innovative. Thus, the pressures provided by competition include spatial dimensions rather than the purely market structure. So, it can infer that the spillovers effect from competition (either negative or positive effect) must be in a larger extent if firm locate closer.

A more critical effect of proximity lie in the concept of cluster that defined as a geographic concentration of related firms e.g. the suppliers, processing factories, logistic services and related industries.

Empirical studies for the spatial spillovers of FDI is rare, although there have been some attempts to approach to this issue. Aitken *et al.* (1997) conduct an empirical assessment of the importance of geographical concentration for the existence of demonstration affect from FDI in the form of market access. They conclude that the more geographical concentration or the closer the distance between firms, the more opportunities for domestic firms to obtain knowledge spillovers.

A more direct and comprehensive examination for this question is found in Halpern and Murakozy (2007). In this research positive horizontal spillover is found for domestic firms close to the foreign firms (less than 50 km) but not for those who are in a certain far distance and there is no evidence of spillovers as a whole. Their study underlines the importance of local nature of knowledge for attempts to measure spillovers. In contrast, Galeotti (2009) finds that the geographical proximity has a negative effect to the productivity of local firms and the significant negative effect of agglomeration of foreign investment. His result is contrast with what is found in Mullen and Martin (2007) for the agglomeration of nine sectors in state data of US.

Regarding the spillovers from vertical linkages, Sajarattanochote and Poon (2009) finds the effect is profound only for simple technical transfer, suggesting the low absorptive capability of Thai firms. A stronger evidence for spatial vertical effect is found for developed countries, for example UK (Twomey and Tomkins, 1998), Republic of Ireland (Gorg and Ruane, 2000) and Netherlands (Van Soest et al, 2006).

2.2. Social Interaction of firms and spillovers

Theoretical economic models of interacting agents and social interaction diverge from the traditional approach in which economic agents are assumed to be autonomous agents. Social interaction models emphasize that the interaction among the agents leads to collective behavior and aggregate patterns. Those models have recently received considerable attention while explaining social phenomena such as peer effects, neighborhood effects, network effects etc. In a comprehensive review, Manski (2000) summaries three specific forms of social interaction namely constraint interactions, expectation interaction and preference interaction. All of them are believed correspondingly affects to the performance/outcome of economic agents.

Many empirical evidences are found for social interaction in various research strands but not yet for productivity spillovers of FDI. Green et al. (1998) apply spatial lag model to study social interaction in crime; Shee (2000) examines the demand interaction in conjunction with distance; more studies are found in economic growth and technological transmission and spillovers (Asselin et al, 1996; Autant-Bernard et al, 1997, 2001; Ertur and Koch, 2007).

In econometrics sense, the social interaction of agents in the space leads to a possible change in specifications of the estimating empirical models that we are discussing below:

2.2. Limitation of traditional estimation for spatial spillovers

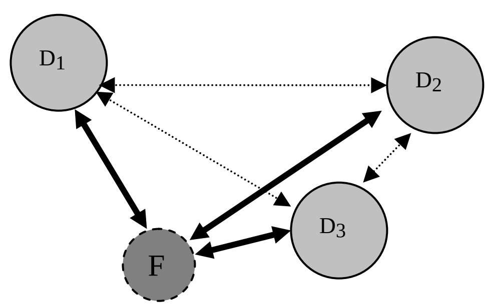
Regarding estimation method, a conventional approach to examine the productivity spillovers is to estimate the econometric model below:

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

in which Y denotes for productivity (or output if estimate the production) of domestic firms; FDI denotes for the foreign presence, either from intra-industry or inter-industries; Z denotes for firm's and sector/region's characteristics. The significance of estimated coefficients β_{fdi} is believed the indicator for productivity spillovers from foreign investments.

This traditional approach can be exposed to criticism from the geographic point of view for not considering the effect arising from the type of geographical distribution of economic activities. The distribution itself can uniquely create productivity effect in the form of agglomeration economies as well the externalities generated by the social interaction (Parr, 2002). Therefore, non-consideration of effects of geographical distribution of industries may generate bias due to variable omissions.

To make it clearer about the limitation of traditional approach, the figure below illustrates the relationship of firms in the context of measuring spillovers. The presence of foreign firms results in the productivity improvement of three domestic firms D_1, D_2, D_3 surrounding. Firstly, a conventional approach as presented through the model (1) ignores the importance of the distances from foreign firm F to local firms Ds, the proximity should have play a role in spillovers from F to Ds. Secondly, it only focuses on the direct effect from foreign firms (denoted by the dash line) and ignoring the effect from the interaction of local firms (the dot line). Productivity improvement in a local firm, for instance $D_{3,}$ arising from the presence of foreign firm F, can have some influences on the productivity of other local firms i.e. D_2 and D_1. The productivity improvement in firm D_1 and $D_{2,}$ in turn, have some effects to the productivity of firm D_3. So, firm D_3 can receive two effects: one from foreign firms and another induced from interaction with D_2 and D_1. By ignoring such induced effect, recent studies obviously have omitted an important productivity determinant as well as not fully measured the spillover effect of foreign firms**.**



3. ESTIMATION METHOD, MODEL SPECIFICATION AND DATA

3.1. Empirical model specification

In this research, we investigate the spillovers at regionally aggregated level (province). There are two reasons for doing so. First, information of the firm location is only available at province level. Lacking information on distance among firms within a province does not allow us to look further the interaction of within region firms. Second, even when such data is available the estimation at micro-level is rare in spatial approach because of limitation in recent algorithm procedures. For our dataset with over 25 thousand firms for five years leads to extreme difficulties in processing with a squired matrix having the size of over 100 thousand column and row. So we resort to construct the model for aggregated sectoral-provincial data.

Our empirical model for spillovers is constructed from the general model for estimate productivity spillovers of FDI in combination with the framework of spatial econometrics model as discussed above. The general model takes the form:

$$y_{it} = g(y_{Jt}, x_{it}, \beta, \rho) + \varepsilon_{it}$$

of which y_{it} is an observation on the dependant variable (productivity) at location *i*, *i*=1….n and time *t*; g(.) is the function of $y_{j\#i}$, and x_{it} that are exogenous variables including variables FDI, sectoral and regional characteristics; β, ρ are parameter to be estimated. This interactive function is well-known as the best-response function in game theory.

The empirical model is constructed from reviewing literature on geography of innovation and knowledge spillovers. The spatial Durbin model (SDM) that recently has been gained more popularity in economics is applied. For this type of spatial model, one can refer to Autant-Bernard and LeSage (2009) where they theoretically construct the spatial knowledge spillovers model from a non-spatial model, then come up with an important conclusion that SDM is the most relevant model for examining spillovers. In principle, SDM captures the property of both spatial lag model and spatial error model. SDM has spatial lag of both dependant and independent variables in the right hand side of the model. Our SDM model for testing spillover of FDI has the form as follows:

$$y = \rho W\mathrm{y} + FDI\,\beta_{\mathrm{fdi}} + X\,\beta_{x} + W\mathrm{FDI}\beta_{fdis} + W\mathrm{X}\beta_{dx} + \mu + \varepsilon$$

Of which, y is productivity; W is weighting matrix (discussed below), FDI is a set of vectors including: HORISON, FORWARD and BACKWARD that are respectively the foreign presence within a sector, from forward sectors and from backward sectors. X are vector of other exogenous variables that will be discussed below. μ is unobservable time fixed effect of the model that is assumed correlated with the exogenous variables in the mode, ε is the error that is assumed *iid*

Construction of variables

Dependant variable Y in our model is TFP of a representative firm in a given sector of each province. We compute micro-based sectoral-province TFP from firm-level productivity. In order to estimate it, the production function (translog form) is estimated using Petrin and Levinson approach to take into account endogeneity and selection problem. The panel data from enterprise census with over 27000 firms and five years (2001-2005) is used for predicting the productivity (see section data for details of the survey)

Having predicted firm level TFP, the sectoral-provincial TFP is computed by weighted averaging method of which the weight is employment share of each firm in a sector. As such TFP of sector *j* in province *r* at each subsequent year is computed as

$TFP_{jr} = \sum_{i} TFP_{ijr} w_{ijr}$; $w_{ijr} = \dfrac{l_{ijr}}{\sum_{i} l_{ijr}}$, of which l_{irj} is the employment of firm *i* in sector *j* and province *r*.

We aggregated two-digit ISIC into 8 industrial sectors for each province, including: agriculture-mining, food processing, chemistry-materials, machine- automobile-vehicles, construction-gas-electricity supplies, commerce-hotel-restaurant- maintaining, transport-telecom-finance, and other services. This sectoral classification is substantially aggregating, however, it is most consistent with the major industrial classification issued by Vietnam (10 sectors). An important reason for not using more disaggregating sectoral classification is the limitation in spatial estimation procedures. We end up with the panel data with 2440 observations (5 years, 61 provinces and 8 sectors).

Variables foreign presence

The proxy for foreign presence has been still in debate in spillovers literature. Some studies (Kokko, 1998; Fredrick, 2001) use the employment share of foreign firms in total employment of a sector as a proxy since they emphasize the labor turnover as an important channel for spillovers. Some others use capital share or revenue share as they relate spillovers with demonstration and competition effects. We combine both employment and capital share to proxy for foreign presence in this research. This approach is consistent with the Aitken and Harrision (1999) and Driffied (2001). So, the foreign presence in a sector j of a given province at time *t* is computed as physical capital share weighted by employment share of the sector.

$$Horizontal_{jt} = \frac{\sum_i S\_capital_{ijt} * Employment_{ijt}}{\sum_i Employment_{ijt}}$$

$$Forward_{jt} = \sum_{s=1}^{J} \alpha_{st} * Horizontal_{jt}, \quad \text{s} \neq \text{j}$$

$$Backward_{jt} = \sum_{s=1}^{S} \delta_{st} * Horizontal_{jt}, \quad \text{s} \neq \text{j}$$

Given α_{st} and δ_{st} are coefficients of IO table and its transposed table respectively, the forward and backward foreign presence, which are defined as the foreign presence from backward and forward sectors, are computed as the horizontal foreign presence weighted by the forward and backward linkage among sectors.

Weighting matrix: Spatial weighted matrix $W_{(NTxNT)}$ captures the spatial relationship among units in the space. Unlike the matrix form discussed in previous cross-sectional case, the weighting matrix in spatial panel data model is block-diagonal matrix of time *t* with each diagonal element is the spatial weighting matrix of cross-section units.

We construct two type of matrix for our research:

(1) neighborhood matrix: off-diagonal elements have value 1 if two province are neighbor, 0 otherwise

(2) Geographical distance matrix: off-diagonal elements are the distance decay function between two provinces. In principle, the decay function, as it is named, reflects the decreasing effect in accordance with the distance from a space unit to others

Other exogenous variables

Other exogenous variables in the model includes two groups: agglomeration index effect and regional specifics, of which the earlier contains different agglomeration index while the later captures the regional characteristics that are supposed to affect the performance of firms.

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 2001, Beeson 1987, Adsera, 2000; Deckle, 2002) suggest that productivity effect of concentration arises from the specialized local market for labor and intermediate goods, while diversity can have effect through the availability of complementariness and choice. In this model, different agglomeration index are introduced, including:

- Diversity index (with respect to capital): $D_r = \sum_j (q_{jr})^2$ in which q_{jr} is relative weight of output from sector j in the province *r, j* is number of sector in the province.

- Concentration index: C_r=computed as total output of province *r* per squared km.

Region characteristics are a set of different variables including: (1) *urban* that is measured as the ratio of urban population of each province. It is included into the model to control for industrialization in each province. In Vietnam the industrialization and urbanization is closely related since much more industrial activities concentrate in urban areas and suburban areas; (2) *lquality* is the labor quality of each province that is measured as the ratio of skilled labor and unskilled labor. It proxies the human capital of each province and is expected to explain the productivity of such province; (3) PCI or provincial competitiveness index is the comprehensive index of each province. This index is calculated from a survey on the provincial competitiveness in Vietnam. In general, PCI reflects the institutional environment for business activities in each province (see data section for further details).

3.2. Data

This research uses micro firm level data and aggregated data from different sources. The data was extracted from the enterprise census to compute various variables in this model. The census was conducted by GSO (General Statistics Office of Vietnam). It contains information on firm's performance, stock capital, employment, production costs etc. Number of firm in this survey varies from 27 thousands in 2000 to over 67 thousands in 2005. The firms can be classified into different categories, for example, by location (61 provinces), by 4-digit VSIC, by ownership (foreign, domestic private owned firms and state owned enterprises). Although information on the location of firms is available, it is not as such detailed to enable a measurement of the distance between any individual firms but only the distance of firm between different provinces.

Capital stock and value added of firm was deflated by production price index provided by GSO. This information is used for computing agglomeration index, foreign presence. The foreign presence (horizontal, forward, backward) are computed in combination with the latest IO table of Vietnam (IO-2000).

The IO table originally has 112 rows was aggregated to 8 rows. Reasons for not using more disaggregating is to reduce the dimension weighting matrix in spatial model, making it easier to compute. Current spatial estimation approach do not allows us to use very large matrix size, particularly with spatial ML method. We end up with 2440 observation (61 provinces x 5 years x 8 sectors).

Information on provincial competitiveness index (PCI) was extracted from Malesky (2005). That is an aggregated index, measuring and assessing the standard of economic governance in all provinces in Vietnam. The index was computed based on the survey of 6700 enterprises over the country with a set of qualitative questions. In principle, PCI contains ten sub-index, including: (1) entry cost, measured as time consuming, (2) land access and security of tenure; (3) transparency and access to information; (4) time costs and regulatory compliance; (5) informal charges, (6) SOE bias-competition environment, (7) proactivity of provincial leadership, (8) private sector development services, (9) labor and training, (10) legal institution. PCI was firstly computed in 2005, reflecting the institutional environment of each province that not only affecting the entry of new firms but business performance incumbent in each province. We included this indicator in our model to capture the local institution in each province.

Information for labor quality of each sector by provinces is computing from labor and employment survey of Vietnam. The survey is conducted by GSO annually. That is the ratio of skilled labor per total labor force in each sector and province.

4. RESULTS AND DISCUSSION

4.1. Spatial estimation

Micro-based regional productivity (TFP) is estimated from firm panel data. We applied the approach in Cingano and Schivardi (2003) where the firm level data was employed to estimate the productivity of individual domestic owned firm. The aggregated sectoral-provincial productivity, then, is constructed by using employment weight.

The testing results show that productivity is not equally distributed across provinces. The map below shows that although there are some exception, productivity (averaged over time and industrial sectors) is found higher in three regions including: (1) Hanoi and surrounding provinces in the North, (2) Hochiminh city and its surrounding provinces in the South, (3) Danang city and its surrounding provinces in the Central areas. On average, productivity in those provinces is three time higher than provinces those have lowest productivity level. In combination with the maps on FDI distribution, density of domestic owned firms and the agglomeration index distribution, our results show the intensive and dynamic economic activities in these three areas. Higher productivity firms (or sectors) are likely concentrated, however, it is noted that there is not an immediate change in the pattern of productivity from the very high to very low for neighboring provinces in those areas. The fact initially suggests the inter-dependency of productivity-the issue that we are investigating.

Before going further to estimation of the model, it is necessary to check for the spatial dependency of productivity. This procedure in spatial approach is somehow similar to the checking of stationary in time-series domain. Two measures were employed including Moran’s I, Geary’s c (see Auselin, 2005 for the details). They are recorded at 0.308 and 0.297 respectively and both of them are significant at 1% showing a moderate spatial association of productivity among provinces.

It is, however, noted that the global Moran’s I is an aggregated index (Ausellin, 2005) which limitedly suggest that the nul-hypothesis of the absence of spatial pattern against the variety of alternatives, for instance spatial autocorrelation, mis-specification or the instability of the spatial distribution can be rejected. To have deeper look into the spatial structure, we used first-order contagious weighting matrix (standardize) to compute local Moran’s I and local Geary’s c. Differing from the global Moran’s I where it ignores the potential instability of each local units, local Moran’s I and Geary’s c, provides more details on the clustering of each province. The indicator reflects how similar (if it is positive) or dissimilar (if it is negative) a province is to its neighboring provinces. The results for the local Moran’s I is presented in Appendix 1. We found the significance and positive of local Moran’s I for two group of provinces surrounding two economic centers of Vietnam including Hanoi and Hochiminh city. The results suggest that there is correlated (at 5% of significance) of productivity of Hanoi and surrounding areas as well as among Hochiminh city and their surrounding provinces. The similar pattern of productivity is also found for almost all provinces in the North mountainous areas. However, it is for low productivity level as it can be seen from the productivity map.

Having explored the spatial dependency, we estimated my empirical model by using different methods. Firstly, the model was estimated with OLS (column 1 in table 1). As it was analyzed in previous section, OLS estimators in spatial model may produce bias due to the endogeneity and simultaneity of dependence lag variables introduced into the model. In the test against OLS estimation that is presented in subsequence columns LM-test and Robust-LM test for both spatial lag and spatial error all confirm that one can suffer bias when using OLS (LM=13.81 and its robust LM=7.19).

We estimated spatial lag (SAR) and spatial error models (SEM) that are supposed to be nested model of SDM. The results (column 2 and 3 in table 1) suggest that dependency may be existed both in the lag of dependent variable and the error term that suggest the combination of both kind of model.

Values in parenthesis are t-values

The result by spatial fixed effect estimation, particularly applied for SDM is presented in column (4) of table 1. This method is introduced by Beer and Riedl (2010) which partly based on the spatial method for panel data developed by Eldhost (2003). This estimation approach takes into account the autoregressive AR(1) process of error term (the time dimension) and heterokedasticity of cross-section units.

In addition, we also estimate the results of the model using random effect (column 5 of table 1). It should recall that both fixed effect and random effect for spatial estimation are based on the ML estimation, although Elhorst (2001) shows that spatial fixed effect could be obtained by demeaning all variables and estimated by OLS. However, such approach suffer from incident parameter problems whereby the number of parameter increasing in accordance with the increasing in spatial unit numbers.

A critical point to note from all spatial estimations is the significance of the spatial correlation, denoted by ρ in the estimation equations. Value of ρ ranges from 0.31 for spatial error model to 0.63 for SDM. This suggests a modest correlation of spatial units and the significance of interaction among local firms.

Estimation results in Table 1 show that most controlled variables have expected sign. Variable *Lquality*, which denotes for labor quality, is positive and significant, however, only for OLS estimation. The coefficients of *PCI* that represents for institutional and business environment improvement indicates that provinces those have better business conditions can facilitate productivity. A similar result is observed for urbanization, the coefficient of the variable *Urban* is positive and significant at 1% in all estimations.

Regarding the relationship between the region concentration and the productivity of firms, the results indicate that there is agglomeration effect for the firms those are operating in densely and large provinces. The coefficient of variable *Concentration* is positive and significant at 1%.

Regarding to local diversity, as it is the sum of squired output share of each sector in a province, the lower the value of this Hirschman type index the higher the diversification is. Given the arguments that diversification can boost up the growth or productivity through the expansion of complementariness or the choice for the firms (Adsera, 2000), the coefficient of variable *Diversity* is negative and that is expected sign, however it is not statistically significant. So it can be concluded that in the sense of productivity improvement, specialization but not diversity in our research making the firms are better off. This result is consistent with Deckle (2002) for Japan where he confirms that there is positive effect to TFP from concentration but not diversity of the sectors in a region.

For purpose of robustness checking and tracking the influences of distance, the SDM model, then, is estimated using spatial fixed effect method with different weighting matrix. I replace the distance matrix by contageous matrix at different order. The first order matrix (W1) reflects the neighborhood relationship between any spatial units of which off-diagnal elements have value 1 if two provinces have the same border, 0 otherwise. Similarly, the order 2 matrix that can be seen as W2=W1*W1 captures the relationship of neighbors and neighbor of neighbor, so on and so forth.

Table 2 presents the fixed effect estimation for SDM with contagious weighting matrix. Subsequently, columns W1-W4 present the results of the model with matrix ordering from first order to fourth order. In general, it is found that the estimated coefficients are consistent and robust in almost all estimations. The signs for coefficients are consistent to the case of distance matrix, although the absolute values are somehow different. However, that result is natural because of different meaning of weighting matrix as already mentioned in previous section.

Regarding to the most important hypothesis on the spillover effect of foreign direct investment posed in this paper, preliminarily, the coefficients of FDI variables indicate that there is evidence of negative horizontal spillovers from within-region (province) foreign direct investment. For vertical effect, it shows only the positive effect from intra-regional backward spillovers. Inter-regional foreign presence indicates positive horizontal spillovers while vertical effects have the same sign with intra-region. The interpretation of spatial models, however, is not so straightforward. The coefficients in the models are only partial reflect the direct effect but does not count for the interaction and therefore the accumulative effects from different spatial units. We move to more insight about those effects in the next section.

4.2. Spatial Multipliers

Unlike conventional econometrics, global multipliers, not coefficients, are more important for spatial estimation because it reflects the global or the accumulative effect that a firm received from the interaction with others. In addition, we interested in the spatial pattern of the effect or how the effect from a given firms change over the distance. In other words, we interested in the effect from FDI in a given province *i* to surrounding provinces *j*, or $\frac{\partial y_{jk}}{\partial x_{ik}}$; taking into account the interaction among those provinces

In order to compute global multipliers or counterfactual effect we employed the medthod suggested in Le Sage (2009) and Hay (2007).

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

The matrix S_{fdi} is driven by differentiating SMD model with respect to variable *FDI*. The column i^{th} of the matrix reflects the effect of variable FDI (for example backward FDI) in location *i* to productivity of local firms in all other locations. We tries to compute this global multiplier effect for three important locations those are most FDI densely provinces including Hanoi (in the North), Danang (in the Centre Coastal Region) and Hochiminh city (in the South). Both plotting and mapping the effect were employed to visualize this kind of spillovers.

Both the maps and plot show that the spatial spillovers from a certain location decline quickly. For example the graph shows that for approximately distance over 150 km the effect of both positive backward FDI and negative horizontal are likely reduced by six times from 0.6 to 0.1.

The diminishing spillovers over distance as described can be explained by the fact that the spillover channels are subject to the distance. For example, labor skilled turnover may be limited.

For the context of Vietnam, although the movement of labor has been observed for long since the economic reform and there has been no constraint for labor moving so far, skilled labors concentrated in three economic centers and move within such areas where economics activities are clustered. So it can be said that the clustering of economic boost up the productivity improvement within clustered areas but limit the spillover. Similarly, perhaps the spillovers through imitation and production linkages are also limited. This makes both inter-sectoral and intra-sectoral spillovers limited.

A notable point is that not only positive backward spillovers are limited, negative horizontal spillovers also seems to be limited in accordance with proximity. Given the fact that negative horizontal spillovers caused by the market stealing effect (Aitken and Harrision, 1999), the finding in this case suggests that such kind of competition effect may also be limited locally. The reasons for that need a further research.

This finding raises an importance of distance to the spillover measurements. The limitation of spillovers over distance is consistent with some empirical studies those use non-spatial econometrics approach, for example Girma and Wagelin (2001) where they conclude that positive spillovers from MNEs are limited to local firm in the region; foreign firms those locate outside the location of domestic firms appear to have no impact on domestic productivity. It also is consistent with Halpern and Muraközy (2007) when they used weighted distance FDI presence and found that the positive of horizontal spillovers dropped sharply for the distance of 100km between two firms.

Direct Effect, Indirect effect, Total effect

From the spatial multiplier matrix computed in previous section, the direct effect is reflected by the diagonal elements while the indirect effects are the row sum of off-diagonal elements. Obliviously, total effect is the sum of both direct and indirect effect.

We computed the direct, indirect and total effect for three interested variables, including backward, forward and horizontal FDI. In addition, we split the sample into two groups: firm-densely provinces and otherwise as we would like to examine how the different is direct and indirect as well as total effect occurring in those regions. The results are presented in table 3

A point to emphasize here is indirect effects have absolute value surpassing direct effect. The figure is more profound in regions where local firms are dense. For example, for backward effect, indirect effect is 2.8 times higher indirect effect. The figures are 3.7 and 2.7 respectively for forward and horizontal effects. Such difference is less clear for regions those have less firm density. The computed difference is only at 1.17 to 1.42 times.

Possible explanation for this finding is the contribution of agglomeration effect, for clustered regions where economic activities are dense the interaction among firms more intensive than non-cluster region, labor movement among firms may be faster, imitation effect also more intensive, more opportunity for a local firm to observe and imitate technology.

Another interesting point is the inverse sign of direct and indirect effect. It is noted that the sign of direct effect is consistent with the sign of coefficients obtained from the estimation function. For example, horizontal FDI in a given region/province has negative effect implies the fact that local firms those are within a province with FDI firms suffer negative effect which is named as market stealing effect (Aitken and Harrison, 1999) while distant local firms may have positive effect. The invert direction of the effect arising to distant local firm and near local firms once more confirm the importance of distance when measuring spillovers effect. This evidence once more raises a demand for further study the local nature of market stealing effect.

5. CONCLUSION

In an effort to unlock the black box of mixed empirical evidence for productivity spillovers from foreign direct investment in host countries, this paper, using the case of Vietnam, examined the role of geographical proximity and inter firm interaction in determining productivity spillovers of FDI.

The spatial productivity model specified based on the empirical spillovers literature and spatial econometric model. By that productivity of a local firm is conditional on the foreign presence within the region and from neighboring regions as well as the presence of other local firm surrounding. The estimated coefficients from the model in combination with the spatial weighting matrix allows me to compute the within region effect, inter-region effect and the induced interaction effect as well.

This research confirms negative effect of horizontal spillovers. It also found the positive backward and negative forward spillovers. Indirect effect (or the inter-regional spillovers) is found about twice to four times higher than the direct effect (or the intra-regional spillovers). However, such kind of indirect effect is quickly attenuated for a certain distance. In addition, the research also finds the evidence of the effect arising from the social interaction among local firms in productivity spillovers.

The paper points out that indirect channel of productivity spillovers and the interaction of local firms should not be ignored. The mixed evidence found in much of literature in spillovers, particularly the negative horizontal effect may be caused by the lack of sufficient consideration of the effect of FDI in surrounding regions. Local firms may suffer negative effect from FDI nearby (intra-regional) but may gain positive effect from FDI firms in far distance (inter-regional).

This research contributes to literature by two folds. In academic sense, it is the first one applying spatial econometrics to measure the productivity spillover effect of FDI. By using spatial approach, a strong assumption on the independence of local firms is no longer held; the interaction of domestic owned firm are modeled, the externality from such interaction is hypothesized to contribute to the productivity. The testing results suggest that local firm's productivity is substantially driven by the agglomeration effect and the presence of inter- and intra-regional FDI. This research confirms that distance and interaction are two determinants of the significance of spillover effects.

For policy implication, the spatial pattern of spillovers is one of important points for policy makers to consider an appropriate policy in attracting FDI. The result confirms that for a given short distance (around 150 km), the inter-regional spillovers are significant; however, it is soon diminished. That result suggests that to promote the spillovers there is a need for tailoring policies for different regions, for example the policies for remote regions and urban-dense regions. It also emphasizes that cost-benefit consideration for FDI promotion policy is very important. The policies issued by local governments to compete with other regions to attract more FDI sometime are not necessary, particularly for small provinces within the densely economic regions. However, for some remote regions this kind of policy is essential because of the limitation in spatial spillovers.

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Table 1: Main Estimation Results

	SMD (OLS)	*SEM*	*SAR*	*SMD 1*	*SMD 2*
	(1)	(2)	(3)	(4)	(5)
Backward	0.0224**	0.0199**	0.0179**	0.0139	0.0183*
	(2.459)	(2.312)	(2.013)	(1.485)	(1.924)
Forward	-0.0194**	-0.0223***	-0.0212**	-0.0192**	-0.0139
	(-2.269)	(-2.746)	(-2.552)	(-2.219)	(-1.558)
Horizon	-0.0178***	-0.0133**	-0.0129**	-0.0099	-0.017**
	(-2.767)	(-2.114)	(-2.03)	(-1.506)	(-2.502)
D_backward	0.016			0.0288**	0.0208
	(1.277)			(2.227)	(1.573)
D_forward	-0.009			-0.0528***	-0.0388***
	(-0.606)			(-3.241)	(-2.595)
D_horizon	-0.0178			0.0366**	0.0256*
	(-1.454)			(2.426)	(1.957)
Lquality	0.0371	0.029	0.03	0.031	-0.002
	(1.506)	(1.178)	(1.213)	(1.215)	(-0.08)
PCI	0.0563	0.1647**	0.1674**	0.167**	0.1012**
	(1.493)	(2.437)	(2.446)	(2.369)	(2.361)
Urban	0.1582***	0.1053***	0.1087***	0.1118***	0.1672***
	(8.777)	(5.1)	(5.18)	(5.132)	(8.145)
Diversity	-0.0104	-0.0016	-0.0026	-0.004	-0.0199
	(-0.463)	(-0.079)	(-0.12)	(-0.177)	(-0.798)
Concentration	0.0225**	0.0434***	0.0416***	0.0379***	0.0155
	(2.251)	(4.085)	(3.878)	(3.434)	(1.366)
D_Lquality	0.1012***			0.0115	-0.0981***
	(3.903)			(0.316)	(-3.601)
D_PCI	-0.0503			-0.0393	-0.0254
	(-0.871)			(-0.422)	(-0.439)
D_Urban	-0.0756***			0.0062	0.0287
	(-2.627)			(0.15)	(0.981)
D_Diversity	0.0278			-0.0145	-0.0176
	(1.436)			(-0.446)	(-0.909)
D_Concentration	0.0012			0.0102	0.0218
	(0.065)			(0.404)	(1.146)
Rho		0.393***	0.45**	0.6348***	0.5217***
		(3.404)	(2.356)	(31.226)	(25.974)
Teta					0.8206***
					(26.235)
LM test spatial lag		3.00*	1.98	13.81***	104.85***
Robust LM		0.08	0.05	7.19***	2041.85***

LM test spatial error	6.41**	3.54*	45.96***	10.26***
Robust LM	3.49*	1.52	39.34***	1947.26***

,,*** are significant at 10%, 5% and 1% respectively*

Table 2: SMD with contagious weighting matrix

Variables	***W1***	***W2***	***W3***	***W4***
Backward	0.0171*	0.0175*	0.0184**	0.0192**
	(1.847)	(1.864)	(1.987)	(2.089)
Forward	-0.0179**	-0.0197**	-0.02**	-0.0204**
	(-2.11)	(-2.287)	(-2.346)	(-2.401)
Horizon	-0.0146**	-0.0152**	-0.015**	-0.0146**
	(-2.264)	(-2.312)	(-2.297)	(-2.241)
D_backward	0.0022**	0.0014**	0.0009	0.000
	(1.994)	(2.243)	(1.428)	(0.025)
D_forward	-0.0024**	-0.0008	-0.0004	0.0004
	(-2.115)	(-1.251)	(-0.664)	(0.648)
D_horizon	0.000	-0.001***	-0.0007**	-0.0005
	(0.04)	(-2.843)	(-2.472)	(-1.62)
Rho	0.7981***	0.5972***	0.3976***	0.3998***
	(3.366)	(5.198)	(4.455)	(3.393)

Note: Only interested variables are presented to keep space
,,*** are significant at 10%, 5% and 1% respectively*
Values in parenthesis are t-values

Table 3: Direct and indirect of productivity effect

	Average			*max*		*Min*	
	Cluster	Not	Average	Cluster	Not	Cluster	Not
Backward							
Total	0.168	-0.008	0.137	0.460	0.064	-0.390	-0.352
Direct	0.044	0.051	0.048	0.059	0.075	0.004	0.012
Indirect	0.124	-0.060	0.089	0.301	0.012	-0.394	-0.364
Forward							
Total	0.045	0.009	0.026	0.202	0.182	-0.040	-0.027
Direct	-0.017	-0.021	-0.019	0.003	-0.001	-0.025	-0.033
Indirect	0.063	0.030	0.045	0.199	0.184	-0.015	-0.006
Horizontal							
Total	0.024	0.003	0.012	0.114	0.103	-0.025	-0.018
Direct	-0.013	-0.015	-0.014	-0.001	-0.003	-0.017	-0.022
Indirect	0.036	0.017	0.026	0.115	0.106	-0.009	-0.003

Note: "Cluster" includes provinces those have high local firm density
The values were averaged over time for the period 2000-2005