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Does Proximity to Foreign Invested Firms Stimulate Productivity Growth of Domestic Firms? Firm-level Evidence from Vietnam*

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Abstract

Inward foreign direct investment (FDI) is regarded as a key engine of industrial growth and technological progress, especially in emerging markets. Regarding the relevance of geographic proximity between foreign and domestic firms for FDI spillover effects, there is yet little clear evidence, owing to a lack of precise location specific firm-level data. This paper presents the so far spatially most detailed analysis of FDI spillover effects by geo-referencing the census of Vietnamese enterprises for the period 2005 to 2010, allowing us to measure the changing presence of foreign invested firms around each domestic firm. We apply a first-differenced two-stage-least-squares estimator to identify spillover effects from proximate FDI exposure on TFP growth of domestic manufacturing firms. We find positive and significant within-industry (horizontal) spillover effects within radii of 2 to 10 km, that decay beyond. Importantly, in particular small and medium enterprises (SMEs) gain from foreign firms in their vicinity. Furthermore, vertical spillovers through forward and backward linkages to other manufacturing firms are localized, while vertical spillovers from foreign firms in the service sector are less geographically restricted.

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1 Introduction

Foreign direct investment (FDI) is seen as an important driver of technological progress in particular in developing countries. Foreign investment spillovers may foster technological change and thus reduce the productivity gap between advanced multinational firms and incumbent establishments. As described by Javorcik (2004), positive FDI spillovers occur when advanced knowledge from foreign firms spills over to domestic firms that are then able to increase their productivity. The main channels of FDI spillovers are demonstration effects, labour mobility, and technology transfers through upstream and downstream linkages (see Javorcik, 2004, and Smeets, 2008). As foreign firms enter a developing country and bring superior technologies, local manufacturers start imitating foreign products and production processes. People working for foreign firms switch jobs and join local firms transferring valuable know-how on organisational structures. The domestic firms can thereby improve their productivity and competitiveness.

A claim often made is that geography matters for spillover effects as proximity between firms may intensify the spillover channels.[1] Yet, in the extensive FDI literature, there is little convincing evidence that proximity between foreign and domestic firms is indeed an important driver of knowledge spillovers.[2] At least since Marshall (1920) we are aware of the importance of localisation of industries, for which he identifies three sources: labor market pooling, intermediate inputs and technological spillovers. Krugman (1991) further elaborated that geography, hence localisation of industry, clearly matters and that spillovers are much a local phenomenon. Firms benefit from being near other firms. Porter (1990, 2011) points out the importance of geographic concentration in industry clusters. Proximity between firms may be crucial for foreign know-how to spill over to domestic firms in particular in developing countries like Vietnam, where the transportation system has not yet been well developed. Several studies, most in the agglomeration economies literature, show that spillovers indeed decay with increasing distance among firms, demonstrated e.g. by Rosenthal and Strange (2003), Orlando (2004), Greenstone, Hornbeck and Moretti (2010), and Lychagin et al. (2010).

In this paper we analyse the importance of spatial proximity between firms for foreign investment spillover effects in a case study of the Vietnamese manufacturing sector from 2005 to 2010. Vietnam presents a very interesting and suitable set-up due to two main reasons. First, in 2005, Vietnam enacted an important investment law which was a step-

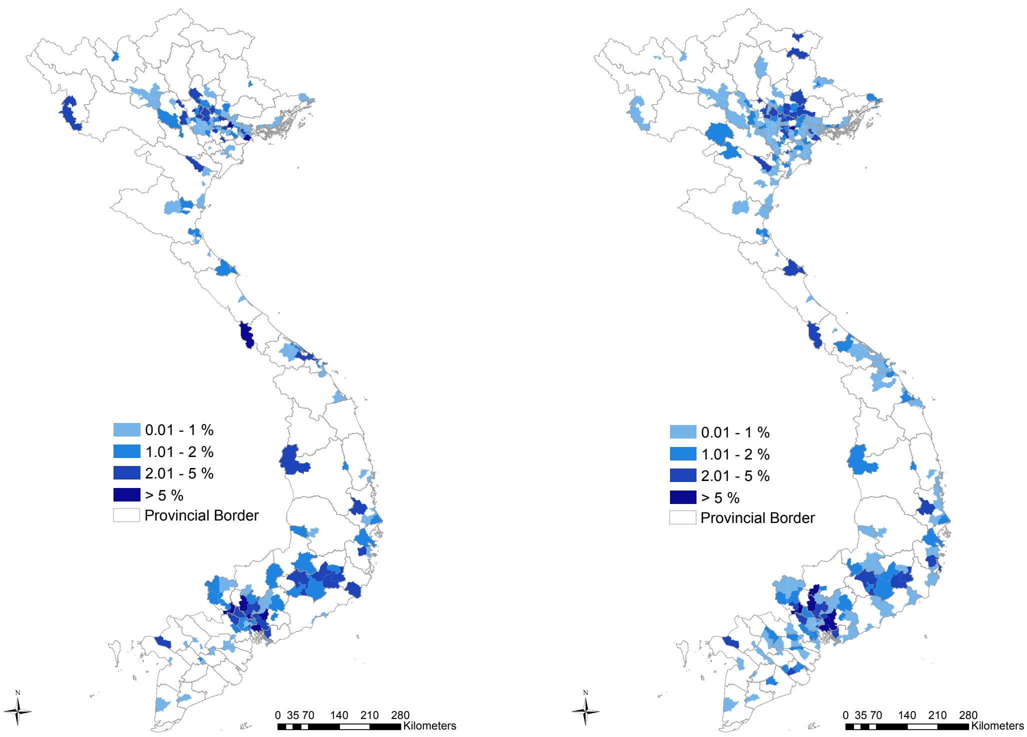
[1] For a discussion of proximity and spillover effects, see Audretsch and Feldman (2004).

[2] There are a few studies that focus on the relevance of distance for foreign investment spillovers. Aitken and Harrison (1999) analyse the presence of foreign invested firms in 220 districts in Venezuela, but find no evidence for localized spillovers. Halpern and Muraközy (2007) study the importance of spatial proximity for FDI spillovers employing a small sample of Hungarian firms and find that distance matters for horizontal spillover effects. Barrios et al. (2012) utilise an Irish plant survey with detailed information on firms' location to find a localized distance decay effect. Yet, the sample used comprises just 1790 firms. Specifically for the case of Vietnam, Thang, Pham and Barnes (2016) use a spatial econometric model to analyse FDI spillover effects. Yet, they use only the provinces as spatial units for their analyses and hence to not achieve the spatial detail we present in our study.

ping stone in the attraction of foreign investment. New decentralized investment policies facilitated the location for foreign firms in urban and rural areas. Second, a net inflow of more than 2000 partially or fully foreign owned firms to Vietnam provides essential variation of foreign investment across space. Figure 1 presents two maps to illustrate the change in the spatial distribution of foreign invested firms at the district level in 2005 and 2010.

Figure 1: Shares in Number of Foreign Invested Firms by District in Vietnam 2005 & 2010

(a) 2005 (b) 2010



Notes: Share of foreign invested firms per province is equal to the number of foreign invested firms in the province over the total number of firms. The maps are based on authors' calculations using the Vietnam Enterprise Survey 2005 & 2010. Administrative boundaries are based on Global Administrative Areas data (www.gadm.org). Several Vietnamese islands (e.g. Hoang Sa and Truong Sa) are not displayed due to the limitation of the GADM administrative boundaries data.

We are the first to geo-reference the census of Vietnamese firms to provide the as yet spatially most detailed analysis of foreign investment spillover effects. Knowing the location of all foreign and domestic firms allows us to answer the following research questions. First, are domestic firms able to increase their productivity by having foreign firms of the same industry in their close surroundings? In other words, we investigate localized horizontal foreign investment spillover effects. We propose that shorter distances between firms intensify the spillover channels. Second, how does foreign investment affect the small and medium business sector? Since small and medium enterprises (SMEs) represent the bulk of the economy in Vietnam, it is particularly important to study these firms. Third, are even unproductive firms able to absorb spillover effects and to what extent does the productivity gap between foreign and domestic firms matter? Finally, does spatial proximity also matter for spillovers through vertical linkages to the manufacturing and the service sector? To the best of our knowledge, we are the first to study the relevance of proximity for spillover effects from foreign invested service companies.

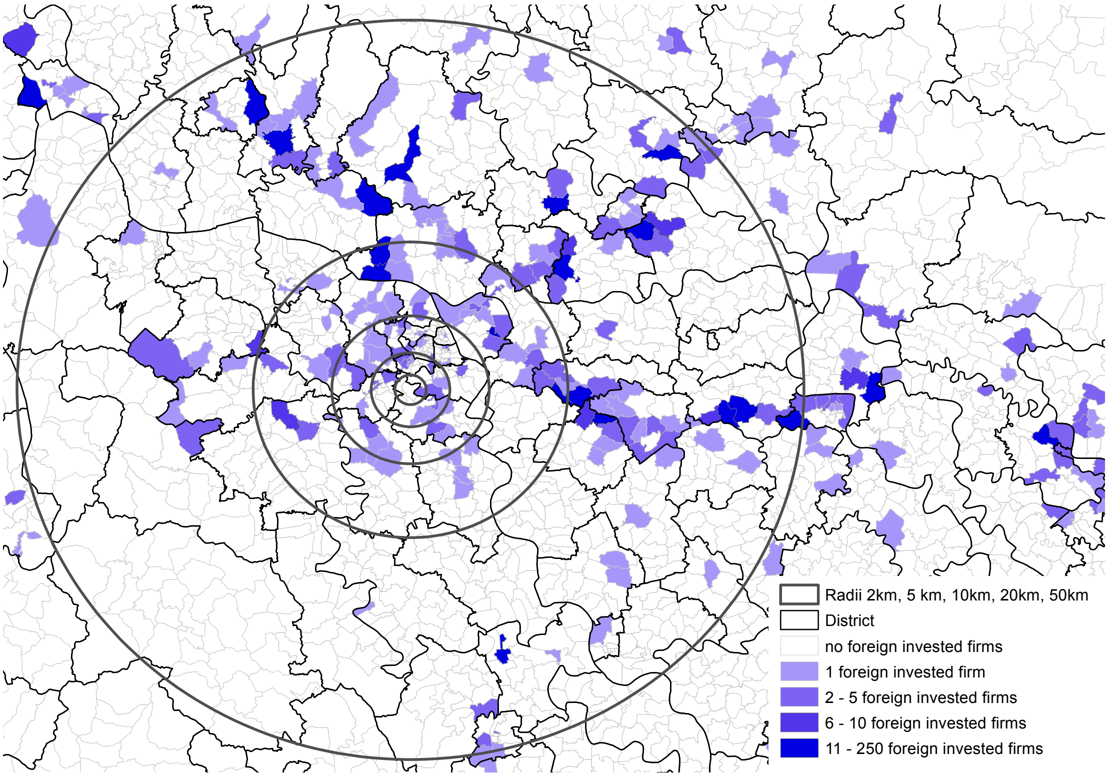
Our contributions to the literature are as follows. (i) We compile a unique micro-data set for Vietnam that combines geo-referenced firm-level data for foreign and domestic establishments with input-output data of the Vietnamese manufacturing and service sectors. Using Geographical Information System (GIS) tools, we are the first to precisely locate firms based on wards, the lowest administrative units in Vietnam. This allows us to measure the Euclidian distance between any two firms. This is the basis for the enhanced spatial accuracy of estimating localized FDI spillover effects. (ii) To improve the estimation of FDI spillovers compared to previous studies, we apply a dynamic model using a two-stage least square estimator introduced by Anderson and Hsiao (1981). Eventually, existing studies analyzing FDI spillovers such as Newman et al. (2015), Anwar and Nguyen (2010), and Halpern and Muraközy (2007) do not take the dynamic structure of TFP into account. (iii) We give the spatially most precise evidence on FDI spillover effects, which we show to be very localized within 10 kilometres. In contrast to many other studies (e.g. Lu, Tao and Zhu, 2017), we calculate a firm specific treatment variable that measures the exposure of local firms to foreign investment in their close vicinity. We provide not only evidence on localized foreign investment spillovers, yet also show that foreign investment creates a negative congestion effect. (iv) We provide the first evidence that localized FDI spillover effects are inclusive for small and medium business. (v) Finally, we further examine how distance between firms affects spillovers working through forward and backward linked manufacturing and service sector firms (vertical linkages).

Our data set includes over 67'000 manufacturing firms in Vietnam over the period 2005 to 2010. Since we know the location of all surveyed firms in Vietnam at ward-level, we are able to calculate how intensively each domestic establishment is exposed to foreign invested firms in its close proximity over time. Figure 3 resembles the main idea of our paper for the Hanoi metropolitan area. We virtually draw circles of various radii around each domestic firm and measure the presence of foreign firms within its surroundings.

Our empirical strategy to estimate localized spillover effects consists of two stages. The first stage computes total factor productivity for each firm based on the parameters estimated by an industry specific production function using the method introduced by Levinsohn and Petrin (2003) and Petrin, Poi and Levinsohn (2004).[3] The second stage causally identifies localized spillover effects from foreign invested firms on the local manufacturing firms using an estimation procedure first proposed by Anderson and Hsiao

[3]The method of Levinsohn and Petrin (2003) is an extension of the framework initiated by Olley and Pakes (1996). Olley and Pakes (1996) decompose the residuals of the production into unobserved firm level productivity and zero-mean measurement errors. They calculate the unobserved productivity of an individual firm by using parameters estimated from the industry's production function. Other researchers such as Halpern and Muraközy (2007), Van Beveren (2012), and De Loecker and Warzynski (2012) define the unobserved firm level productivity (Olley and Pakes, 1996) as the total factor productivity. For consistency of the terminology, we also refer to the firm-productivity as total factor productivity.

Figure 3: Circles with different radii and foreign invested firms in 2010 in the Hanoi area



Notes: The map shows a representative example of circles around a firm with radii of 2km, 5km, 10km, 20km, and 50km. For each ward the number of foreign invested firms is indicated. Calculations of firms are based on the Vietnam Enterprise Survey 2010.

(1981), and controlling for possible confounding factors that may both influence the location choice of foreign firms and domestic firm productivity. Our firm specific treatment variable measures the intensity of foreign investment around each domestic firm. In addition to absorbing the firm fixed effect by first differencing, we include industry fixed effects, and province-time fixed effects. Placebo tests confirm that our estimation strategy absorbs any selection of foreign firms into areas with higher domestic firm performance. We rigorously examine different aspects relevant to the FDI spillover literature, yet with specific focus on the spatial scope of spillover effects, looking at horizontal – within industry – and vertical linkages working through the supply chain.

Our results affirm that (i) horizontal FDI spillovers are localized. They are strongest between 2 and 10 kilometres, and attenuate rapidly across geographic space. (ii) We find positive spillover effects from foreign investments on the local small and medium enterprises (SMEs). The spillover effects are in fact largest for very small firms with up to 10 workers. (iii) With regard to vertical spillovers, domestic firms benefited from foreign suppliers in their close vicinity, but were negatively affected by foreign backward linkages. (iv) Finally, spillovers through vertical linkages to foreign service firms are less geographically restricted. These results may give profound implications for foreign investment facilitation and regional development policies not only in Vietnam but also in other developing countries.

The rest of the paper is organised as follows. Section 2 gives an overview of the existing literature on spillovers from foreign direct investment with a specific look at the studies that scrutinise the localisation of such effects. An overview over foreign investment in Vietnam is presented in section 3. Section 4 summarizes description of our novel data set. Section 5 briefly presents the two-steps of our estimation approach, and explains the identification strategy to estimate FDI spillover effects within the spatial framework. The estimation results are discussed subsequently. Section 6 concludes.

2 Related Literature

We present a short overview of the most related studies in two parts. The first part looks at the relevance of horizontal and vertical linkages, and the heterogeneity in effects. The second part sums up the contributions for the case of Vietnam.

2.1 Literature on FDI Spillovers

General results: A growing number of theoretical and empirical studies has shown that FDI is a crucial driver stimulating economic growth of the host country through the transfer of knowledge and technologies from advanced multinational enterprises (MNEs) to domestic firms.[4] As stated by Javorcik (2004), positive FDI spillovers happen when advanced knowledge from MNEs is transfered to domestic firms, and enhances productivity of domestic firms. Interestingly, literature shows results of negative and positive FDI spilloves as well as insinificant spillover effects on local economy. For example, Görg and Greenaway (2004) investigate results of 40 studies on FDI spillover effects, and draw general conclusions from the early literature. Their overall corollary is, first of all, that FDI is likely to be a key driver of economic growth by boosting capital formation and the quality of the capital stock in host countries. Multinational companies seem to bring best practice of technology and management with them. They deduce that absorptive capacity of domestic firms and geographical proximity to multinationals are important determinants of spillover effects from foreign invested to domestic firms. Governments are hoping to stimulate these external benefits of FDI by offering incentives to foreign companies, suggesting that policy improvements should target the general conditions for doing business instead of particular industries or firms.

Smeets (2008) summarises the literature by concluding that the evidence on the magnitude, direction, and even existence of knowledge spillovers from foreign direct investment is ambiguous. The author indicates three important channels of FDI spillovers, such as: demonstration effects (imitation of technologies and knowledge), labour mobility, and technology transfers. Yet, the literature seems to agree on missing evidence for spillovers

[4]See e.g. Lim (2001), Borensztein, De Gregorio and Lee (1998), and Carkovic and Levine (2002) for an account of FDI and economic growth; Girma, Greenaway and Wakelin (2001) and Blomstrom and Kokko (2003) on FDI spillovers.

working through forward linkages, i.e. when foreign firms supply goods to domestic firms.

Horizontal spillovers: There are two main arguments about horizontal spillovers which occur within an industry. On the one hand, firms of the same industry may benefit from each other through face-to-face contacts and imitation of products or processes. On the other hand, firms in the same industry compete with each other. Competitive pressure may lead to more efficient use and quicker adoption of technologies, but it may also drive up the average cost curve due to fewer sales. Using a panel of 4'000 Venezuelan plants between 1976 and 1989, Aitken and Harrison (1999) find that foreign equity participation increases productivity of recipient plants with less than 50 employees, suggesting that plants benefit from productive advantages of foreign owners. Crucially, they also find a negative impact of foreign ownership on wholly domestically owned firms in the same industry. These large significant negative effects are brought by competitive pressures. Overall they conclude that there is no clear evidence of the existence of technology spillovers from foreign firms to domestically owned firms. In contrast to this early influential enquiry, Abraham, Konings and Slootmaekers (2010) find positive intra-industry spillovers. Their results indicate that it was beneficial for total factor productivity of domestic firms when there was a certain presence of foreign competitors in analysis of more than 15'000 manufacturing firms in China from 2002 to 2004. Recently, Lu, Tao and Zhu (2017) also find a negative aggregate spillover effect due to increased competition and subsequent loss in the market share to more productive foreign firms that enter in the Chinese market. Nevertheless, their treatment of foreign investment is measured only at the sector level.

Vertical spillovers: Much attention has also been paid to the role of FDI spillovers to domestic firms through vertical linkages in the supply chain. Either a foreign firm supplies intermediate goods to a domestic firm or vice versa. A review of studies on the relevance of vertical linkages is conducted by Smeets (2008). Most studies find positive spillovers through backward linkages, but negative effects in the case of forward linkages. Javorcik (2004) analyses spillovers effects of FDI on productivity through backward and forward linkages using a firm level panel dataset from Lithuania. The author shows that spillovers are associated with projects that are shared between domestic and foreign firms, and not with fully foreign owned projects. Robust evidence for spillovers working through backward linkages is found, while intra-sectoral spillovers are absent in her study. Blalock and Gertler (2008) demonstrate the gain in productivity of Indonesian local suppliers through spillovers from foreign firms in downstream industries over the period of 1988 to 1996. In addition, the significance of inter-industry benefits to upstream domestic firms also seems to depend on the origin of the foreign investment in the downstream industry (Javorcik and Spatareanu, 2011). Lu, Tao and Zhu (2017) find that both forward and backward linkages provide positive spillover effects.

Geographical Proximity: Spatial proximity between economic agents was already studied by Marshall (1920) in terms of specialised clusters of inputs (e.g. labor, materials, services), and technology spillovers. Halpern and Muraközy (2007) specifically investigate geographical distance as a determinant of FDI spillovers. The novelty in their study is the link between the TFP level (estimated by Levinsohn and Petrin, 2003) and the FDI spillovers in light of the distance from foreign firms to domestic firms in Hungary (1996–2003). They confirm that distance indeed matters for horizontal spillovers and emphasise the local nature of those. In addition, the authors extend the vertical and horizontal linkages proposed by Javorcik (2004) by weighting these variables with a function of distance between a foreign invested firm and a domestic firm. Though, a drawback of Halpern and Muraközy's (2007) approach is the assumption on the functional form of the distance.[5] A priori, using a functional form assumption for the distance $f(d)$ to weight foreign firms, it is unclear whether the effect of a foreign firm which has low output but is close to a domestic firm is similar in magnitude to an other foreign firm with a large output but which is far away. Furthermore, they are neither able to control for agglomeration effects such as the size of the labor market in the vicinity of each firm. To improve the analysis of spatial effects, this paper does not use the functional form assumption, but provides a higher degree of accuracy of firms' locations. Despite finding a negative competition effect, Lu, Tao and Zhu (2017) find a positive agglomeration spillover effect for within-industry firms that locate in the same city, giving support to our results.[6]

In an investigation of spillovers from local and global R&D activities of domestic and foreign plants, Barrios et al. (2012) estimate distance decay effects by using the sample of Irish plant-level data from 1986 to 1996. Most relevant for our study, they also analyse local spillovers within circular areas around each plant. Considering all plants, they estimate significant local spillovers of R&D activity conducted in Ireland. Effects are strongest and significant within a radius of 10 km around a plant, but decay quickly beyond. Interestingly, domestic firms seem to benefit more from local R&D activities conducted by other domestic firms than those by foreign firms. In order to geo-reference firms, Barrios et al. (2012) use Irish district electoral divisions (DED) that have a mean size of 21 km^2. Compared to Barrios et al. (2012), our study employs a much larger data set and more precise firm's location. The Vietnamese wards that we use in the analysis have a weighted mean size 8.21 km^2 (weighted by share in number of firms in each ward).

2.2 Literature on FDI Spillover Effects for the Case of Vietnam

With a fast growing trend of foreign investment into Vietnam, extensive research has been conducted to study the role of FDI inflows for the local economy, whereof we specify the

[5]Halpern and Muraközy (2007) use a variety of functional form assumption to weight the horizontal and vertical linkages. Specifically, they use the following weighting functions of distance: $f_1(d) = 1/(1+d/100)$ (the linkage to a foreign firm that is 100 km away from the domestic firm, is weighted by 0.5); furthermore, they also use two other functions with more pronounced decay patterns: $f_2(d) = 1/(1+d/100)^2$ and $f_3(d) = 1/ln(1+d/100)$ as weighting functions.

[6]Further studies that analyze foreign investment spillover effects at the regional level are Bwalya (2006) and Xu and Sheng (2012).

most relevant works.[7]

Thang, Pham and Barnes (2016) are the first to use a spatial econometric model for the case of Vietnam to investigate the importance of proximity for spillovers. Although they employ a spatial econometric model, they merely use the provinces as geographic units of analysis. The spatial accuracy of provinces, therefore, is not as precise as using wards in our analysis. Thang, Pham and Barnes (2016) find inter-regional spillovers to be four times larger than intra-regional spillovers. Their empirical results indicate negative horizontal spillovers, positive backward and negative forward spillovers effects. Since their data set is limited to the period 2000 to 2005, the paper cannot draw implications for the important period after the first Investment Law (2005) was introduced in Vietnam.

Anwar and Nguyen (2014) analyse the performance of manufacturing firms in the eight regions of Vietnam affected by varying intensity of foreign investment.[8] By applying 2SLS estimations and using manufacturing firm-level data for the period 2000 to 2005, Anwar and Nguyen (2014) suggest that through backward linkages, positive FDI spillovers were only shown in four of eight regions (i.e. Red River Delta, South Central Coast, South East and Mekong Delta River).

Howard et al. (2014) investigate agglomeration effects of manufacturing clusters in Vietnam by using detailed information about the administrative units in the Vietnam Enterprise Survey (2002–2007).[9] The study finds strong evidence of significant agglomeration economies in Vietnam. Unlike many other studies, they do not find negative competition effects. Interestingly, foreign firms seem to benefit the most from firm clustering. While remarkably being one study that uses the ward (commune) as unit of analysis (other studies only analyse within province spillovers), they limit the analysis to clusters of firms within those communes, but not across. The spatial dimension of clusters (restricted to each ward) is hence captured in a non-continuous, thus very limited way. In contrast, we measure distances between wards and hence can model the whole agglomeration of firms to detect spillover effects to achieve a more thorough picture.

Newman et al. (2015) separate out productivity gains along the supply chain through direct transfers of knowledge and technology between linked firms. Importantly, they disentangle the spillovers through direct linkages, real technology transfers and other indirect effects. Their results confirm the importance of vertical linkages versus horizontal linkages with regard to spillover effects. More specifically, considering only direct linkages, they find that domestic firms experience positive productivity spillovers through their direct

[7]See e.g. Anwar (2011) for the analysis of FDI linkages and local firms' export activities. Another study for FDI in Vietnam (2001-2008) by Kokko and Thang (2014) indicate that the presence of foreign counterparts and foreign suppliers would increase the exit ratio of domestic firms.

[8]The government of Vietnam groups the provinces into eight large regions: Northwest, Northeast, Red River Delta, North Central Coast, South Central Coast, Central Highlands, Southeast, and Mekong River Delta.

[9]Their paper only considers the sample of firms in Vietnam (2002-2007) that includes registered firms with more than 30 employees. The data records information on firms in 4'325 wards (communes) and 631 districts in 2007.

linkages with upstream FDI suppliers of inputs. Nevertheless, the author did not look at spatial factors in FDI spillovers.

In short, existing studies do not analyse the spatial component of FDI spillover effects for the case of Vietnam with great geographic detail. Complementing the existing literature, this paper proposes a simple though intriguing approach to evaluate localized spillover effects. We use the information on firms' location to evaluate how foreign investment in the surrounding area of a domestic firm stimulates its total factor productivity growth.

3 Foreign Direct Investment in Vietnam

Since the *Doi Moi* (Renovation) in 1986, Vietnam's development policy has sought to promote high economic growth, macroeconomic stability and international integration (UNIDO, 2011; Nguyen et al., 2006). Since the introduction of a new Law on Foreign Investment in 1987 with amendments in 1990, 1992, 1996, 2000, Vietnam was constantly expediting foreign direct investment in order to strengthen capital formation and know-how transfer from more advanced economies through foreign firms.[10] In the earlier periods of opening up the country between 1988 and 2001, foreign investors were compelled to form joint-ventures with domestic firms, while after 2001 investments in the form of wholly foreign owned enterprises became more important (UNIDO, 2011). In 2005, the Law on Foreign Investment and the Law on Domestic Investment were unified into a new Law on Investment. The new Law balanced the rights and treatment between domestic and foreign investors, and simplified the registration procedures for new FDI projects and enterprises as well as allows more flexible types of foreign owned enterprises in Vietnam. In the meantime, Vietnamese government pursued strategies to attract FDI for export orientation (Ministry of Planning and Investment and General Statistics Office of Vietnam, 2011). Importantly, the 2005 Law on Investment and 2005 Law on Enterprises decentralised the control of investment license and business registration to provincial-level authorities.

Subsequently, in January 2007, Vietnam made another important step towards remarkable international economic integration by acceding the World Trade Organization (WTO) that brought a further push to foreign investment and eventually resulted in registered USD 198 billion in foreign capital in 2011 (UNIDO, 2011). Foreign direct investment is concentrated mostly in the manufacturing and real estate sectors, accounting for 77 percent of total registered capital in foreign invested projects in 2011 (UNIDO, 2011). Manufacturing alone accounts for 58 % of all projects. The share of exports carried out by foreign invested firms jumped from 47 % to 57.2 % in 2007, then slightly decreasing to 54.2 % in 2010 due to the uncovered of the global economy after the financial crisis in 2009.

From 2005 to 2010, Vietnam attracted almost 2000 foreign invested firms (net increase)

[10] For a detailed discussion see e.g. Nguyen et al. (2006).

Table 1: Description of Foreign Firms in Process Manufacturing Sectors, Vietnam (2005–2010)

Year	**Number**	**Δ (%)**	**Share of foreign invested firms (%)**		
			Total output	**Total labor**	**Total firms**
2005	2654	14.10	43.51	36.35	11.05
2006	3032	14.24	46.01	39.38	11.29
2007	3516	15.96	45.23	41.41	11.32
2008	3958	12.57	44.42	42.77	10.31
2009	4353	9.98	41.66	42.64	9.74
2010	4587	5.38	44.47	44.73	9.80

Notes: Authors' compilation using the data drawn from the Vietnamese Enterprise Survey (2004–2010). The column "Number" is the number of foreign invested firms. The column Δ(%) is the percentage change in number of FIEs. The column "Share" is the Share of FIEs in Total Manufacturing firms' Total out, Total labor, and Total number.

in the process manufacturing sectors. The international financial and economic crisis in 2007 and 2008 probably led many foreign companies to leave the country resulting in a very dynamic pattern of foreign investment during these years. Table 1 indicates that the increase in percent of number of foreign firms was 12.57% in 2008, then went down to merely 5.38% in 2010 while the number ranged from 14-16% in years before 2008.

Nevertheless, the crucial role of foreign invested firms in the process manufacturing sectors of Vietnam were still maintained with their significant shares in total output and in creating jobs (table 1). From 2005 to 2010, the output share of foreign firms was in the range of 41 to 46%, and hence rather stable over time. The number of workers employed by foreign manufacturers augmented from 36% in the year 2005 to almost 45% percent in the year 2010. This highlights the growing foreign presence in the labor market, where potential spillover channels are at play.

Figure 1 (already referred to in the introduction) presents two maps with the regional allocation of foreign invested firms in the years 2005 and 2010 at the district level. It gives a clear indication of the dispersion of foreign presence across provinces. While in the year 2005 most of the foreign firms were located in the economic core areas around Hanoi Capital and Ho Chi Minh City, foreign activity moved more into suburban and rural areas over time up to 2010. This change in the regional distribution is possibly due to the more favourable investment environment mentioned above, for instance, the simpler licensing process and the more decentralised authority control at provincial level. Figure B.1 in the appendix presents two similar maps using the share of revenue accruing to foreign firms in each district in the years 2005 and 2010. Figure B.3 in the appendix shows the same pattern for the labor force working for foreign invested firms.

4 Data

This section gives a brief overview of the Vietnamese firm level data used in this study, then explains in more details the process of geo-referencing firms using the smallest Vietnamese administrative units.[11]

4.1 Firm-level Data

To investigate the relevance of proximity for FDI spillovers in Vietnam, we use firm level data of process manufacturing industries in Vietnam drawn from the Vietnam Enterprise Survey for six consecutive years (2005–2010).[12] The survey is a rich firm level database reporting yearly information on the legally registered enterprises that were in operation on the 31st of December each year. The data provides information about the establishment year, the location (at province, district, and ward level), the revenue, the profit before taxes, the total cost, the total wages, the number of workers, and the value of net fixed assets of each firm. The information on foreign investment is a dummy variable that is 0 for firms with no foreign investment and 1 for firms that are partly or fully foreign invested. Every firm in the data features a unique identification number and is compiled in an unbalanced panel over six years.

In order to exploit the location specific information of firms in the survey to examine spillovers at the local level, the firm level data is merged with the ward level administrative boundary data retrieved from the Global Administrative Areas database (GADM)[13], and combined with the national input-output table of Vietnam (2007) assembled by the Vietnam General Statistics Office.[14] Industry codes in the firm level data are specified by the 2-digit and 4-digit Vietnamese Standard Industrial Classification 1993 (VSIC 1993)[15]. To merge the firm-level data with the input-output table, we convert the 4-digit VSIC 1993 in the firm-level data to the 2-digit industrial classifications of the input-output table using the concordance table provided by the GSO. After merging the firm-level data with the input-output table, only firms in industries considered in the input-output data are included. It is assumed that the cost coefficients in the input-output table do not change over the studied periods.[16] The resulting panel is unbalanced including 67'275 firms. Table B.1 in the appendix shows the number of firms in each industry.

[11] See Nguyen (2016) for a detailed description of the Vietnamese manufacturing firm-level dataset from 2000-2010. See also Ha and Kiyota (2014) and Newman et al. (2015) for the descriptions of similar datasets respectively in the time frames from 2000-2009 and from 2009-2012.

[12] The census is annually conducted by the Vietnam General Statistics Office (GSO; www.gso.gov.vn) since 2000 till the current year. The data is published at an aggregated level in the Statistical Yearbook of Vietnam. We restrict our analysis to the years 2005 to 2010 because the new Law on Investment was introduced in Vietnam in 2005. The data after 2010 is not available to us. We would like to thank Pham Hanh at the Middlesex University (UK) for sharing the raw data with us, and Doan Thi Thanh Ha and Doan Hung at the Foreign Trade University (Vietnam) for discussing and sharing related documents.

[13] GIS shapefiles of administrative boundaries for Vietnam are available at www.gadm.org.

[14] The input-output table is available at:
http://www.gso.gov.vn/default.aspx?tabid=512&idmid=5&ItemID=10752.

[15] VSIC 1993 is provided by the GSO, and is similar to the International Standard Industrial Classification (ISIC Rev.3) provided by the United Nations. We use only the sample of industries for which 2-digits industry classification ranges from 15 to 37.

[16] This assumption follows Javorcik (2004).

4.2 Information on Location of Firms

To the best of our knowledge, we are the first to geo-reference the lowest administrative unit of the Vietnamese governing system in the Vietnam Enterprise Survey.[17] Vietnam comprises more than 11'000 wards (communes). Since the Vietnam Enterprise Survey provides information on the province, the district, and the ward for each firm since 2005, we are able to geo-locate all of the 67'000 firms in our data set to their respective wards.[18]

The geographical scope of Vietnamese wards is remarkably small-scale. If we summarise the spatial dimensions of wards with at least one manufacturing firm domiciled, the median size is 7.94 km^2, while the mean size is 17.55 km^2 with a standard deviation of 34.78. Looking at the whole sample of firms and weighting the extent of wards by the number of firms based within, we receive a median size of just 3.99 km^2, and a mean of 8.21 km^2 with a standard deviation of 16.79. This is equal to a circle of radius 1.12 km^2. These numbers convey the geographic specifics at which we can perform the analysis and highlight the exceptionally small spatial scale used.

For each ward we determine the dyad wards within a certain radius and are thus able to calculate distances between firms with high accuracy.[19] This enables us to model the entire agglomeration of firms and to calculate industry specific statistics at various spatial dimensions for each firm in the data set.

5 Empirical Strategy and Results

Our empirical strategy consists of two steps that are prevalently applied in the literature (see e.g. Combes and Gobillon, 2015, Newman et al., 2015, Anwar and Nguyen, 2014, and Barrios et al., 2012). In the first step, we estimate a production function within each industry by applying the procedure proposed by Levinsohn and Petrin (2003) and Petrin, Poi and Levinsohn (2004). We then use the parameters estimated to impute firm level productivity (we refer to section A in the Appendix for a description of the estimation of firm level total factor productivity). In the second step, we use a first-difference two-stage least squares estimator introduced by Anderson and Hsiao (1981) to account for the

[17] In order to map the ward information in the Vietnam Enterprise Survey on the Global Administrative Areas boundary shapefiles, we used the geocode command in Stata and mapped the wards according to the information on province, district, and ward. We then manually checked all 11'043 wards in ArcGIS for the correct geolocation. The position of a ward is identified by its geographic centroid. For wards that were not located automatically by the geocode command, we extracted the coordinates by the use of Google Maps (http://maps.google.com).

[18] The survey data of manufacturing sectors records 5'662 unique codes of wards, 664 unique codes of districts, and 63 unique codes of provinces. These administrative units incorporate at least one observation, resulting in about 5'300 wards with no registered manufacturing firm in operation.

[19] Since we cannot determine the exact location of firms within wards, we assume that they are all located at the geographical centroid of each ward. For firm dyads within wards we determine a minimal distance below 2km. Some studies randomly allocate firms within an administrative unit (e.g. Barrios et al., 2012). We abstain from this procedure since Vietnamese wards are sufficiently small units, and due to limited computing power.

dynamic structure in TFP. We then estimate spillover effects with a pronounced focus on spatial proximity between domestic firms and their foreign counterparts.

5.1 Baseline Specification

Our baseline specification presents a causal estimation of the effect of foreign direct investment on total factor productivity growth of domestic firms in Vietnam. We presume that the influence of a foreign firm on a domestic firm is constraint to a geographic space around each local firm. We assess whether the change in presence of foreign invested firms within a specific perimeter of a domestic firm i in year t has a positive (or negative) spillover effect on the local firm's productivity. By varying the spatial extent of the radius around each firm – 2km, 5km, 10km, 20km, and 50km –, we investigate the intensity of spillovers with regard to geographical proximity. The inquiry of location specific spillovers effects restricted to a given radius around each firm i is similarly applied by e.g. Rosenthal and Strange (2008) on human capital spillovers in the US, Halpern and Muraközy (2007) on horizontal and vertical spillovers in Hungary, and Barrios et al. (2012) on R&D spillovers in Ireland.[20]

The most simple assessment of within industry FDI spillover effects on productivity of domestic firms is to estimate the following specification by ordinary least squares:

$$log(TFP_{ik,t}) \quad = \quad \alpha_i + \delta log(FDI^{RD}_{ik,t}) + \beta log(X^{RD}_{ik,t}) + \varphi HHI_{k,t} + \varepsilon_{ik,t} \tag{1}$$

where the dependent variable is the logarithm of $TFP_{ik,t}$ of domestic firm i in industry k at time t. The variable of interest is measuring the presence of foreign firms of the same industry k in a circle of radius RD around each domestic firm i, denominated $FDI^{RD}_{ik,t}$. We measure the presence of foreign invested firms either by the number or the total output of firms within a circle. In order to interpret the estimated coefficient as elasticity of foreign direct investment on a local firm's productivity, we use the logarithm of $FDI_{ik,t}$. a_i is a firm fixed effect. $X^{RD}_{ik,t}$ is a vector of time varying control variables in logarithms measured for each firm within a circle of radius RD. It includes the local presence of domestic firms in the same industry k, the presence of foreign firms in all other industries, and the presence of domestic firms in all other industries. We hence control for all possible agglomeration economies and spillovers that are not attributable to foreign firms of the same industry. Furthermore, it also contains a variable that measures the size of the labor market, summing up the number of employees within the circle of radius RD. $HHI_{k,t}$ is an indicator for the concentration of an industry, the Herfindahl-Hirschman Index. $\varepsilon_{ik,t}$ is a an error term.

[20]Classifications of radii by Barrios et al. (2012) are 10km, 20km, 50km, 100km, 200km, and 300 km, respectively. In our study, the maximum radius for which we present results is 50km. Due to the peculiar shape of Vietnam, the support of the data gets unreliable beyond 50km.

The above specification has one important caveat. According to Olley and Pakes (1996), total factor productivity follows the Markov rule: its current value depends on its past and hence forms an autocorrelation process. Therefore, a simple OLS estimation of the coefficients in the specification above omits one crucial variable, the lagged dependent variable (LDV) of total factor productivity.[21] In the existing literature on spillovers from foreign investment, this Markov process in total factor productivity is often ignored, as e.g. in Barrios et al. (2012) or Anwar and Nguyen (2014). Incorporating the LDV accounts for the AR(1) structure in the data generating process of dynamic total factor productivity at the firm level.

Including the LDV $log(TFP_{ik,t-1})$ in a panel fixed effect estimation with a short time dimension yields, however, a downward bias (Nickell, 1981). By construction, the LDV correlates with the error term. In order to solve this estimation issue, we propose two steps following Anderson and Hsiao (1981). First, we estimate the specification in first differences, which eliminates the unobserved firm fixed effect. Moreover we can get rid of the persistent characteristic of the log(TFP) and reduce the problem of serial correlation. Second, we use $ln(TFP_{ik,t-2})$ as an internal instrument for $\triangle ln(TFP_{ik,t-1})$ and estimate the specification by 2-stage-least-squares.[22] Obviously, the following conditions need to hold to consistently estimate this instrumental variable approach:

$$E[\triangle ln(TFP_{ik,t-1})|ln(TFP_{ik,t-2})] \neq 0 \tag{2}$$

and

$$E[\triangle \varepsilon_{ik,t}|ln(TFP_{ik,t-2})] = 0 \tag{3}$$

The enhanced specification in first differences, our baseline specification, hence is:

$$\begin{aligned} \triangle log(TFP_{ik,t}) \quad = \quad & \rho \triangle log(TFP_{ik,t-1}) + \delta \triangle log(FDI^{RD}_{ik,t}) \\ & + \beta \triangle log(X^{RD}_{ik,t}) + \varphi \triangle HHI_{k,t} \\ & + \triangle \eta_p \times \phi_t + \triangle \varepsilon_{ik,t} \end{aligned} \tag{4}$$

where we added province-time fixed effects. Industrial policy regulations are mostly determined at the national or provincial government level. By including province-time fixed effects $\eta_p \times \phi_t$, we take account of the regulatory environment that may change year on

[21] E.g. Khandelwal and Topalova (2011) also raise similar concerns when estimating the impact of trade liberalisation on firm productivity.

[22] Applying a GMM estimation and using additional lags as instruments would still increase efficiency. Our robustness checks show that results are very similar (to be done).

year, and regional business cycles. The province-time fixed effects also absorb general province specific annual shocks. Naturally, to obtain a consistent estimation in equation 4, the control variables from the equation also need to be orthogonal to the error term $\triangle\varepsilon_{ik,t}$.

Our identification assumption with regard to the main regressor of interest $\triangle log(FDI^{RD}_{ik,t})$ is that a single domestic firm is not decisive for the location choice of foreign invested firms. In other words, we assume that the yearly change of a single domestic firm's TFP is not affecting the change in foreign presence in the surrounding area of a firm. We argue that the problem of endogeneity is unlikely, since it is not possible for a foreign firm to observe the yearly change in a domestic firm's productivity (our dependent variable), and for that reason to select a specific location. More specifically, we assume that the change in productivity is only observed by the domestic firm itself but not by other firms. When making investment decisions, foreign firms can investigate the general conditions of the location. The location choice first of all depends on local production conditions such as the local labour market, access to transportation infrastructure, and proximity to forward and backward linked industries.

Since there is no possibility to run a random experiment by assigning location choices to foreign firms and see how it affects TFP of domestic incumbent firms, we need to determine the factors that are correlated with the location choice of foreign firms and at the same time influence TFP of the domestic firms. By including such possible confounding variables, we address these concerns. We control for the change in the presence of other domestic firms, foreign firms of all other industries, and the size of labor market. We are thus able to adjust our coefficient estimates for the attractiveness of a specific location for foreign investment. Furthermore, we present a placebo test in our baseline specification by including the lead of our variable measuring foreign investment within the close surrounding of domestic firms. If there was a selection problem in our specification, then change in productivity should already be higher before foreign firms enter the location, hence show up in the lead, the year before foreign investment takes place. An additional potential confounding factor could be the development of local infrastructure that may both attract foreign investment and improve a local firm's productivity. One may think of new roads or improved internet access that makes an area more attractive for investment. While the province-time fixed effect should absorb large scale changes in accessibility, changes in local infrastructure is hard to capture. In order to dispel such concerns, we provide a variant of the basic specification using ward-time fixed effects.

5.2 Baseline Results

In this section we present a series of results focusing on within industry spillovers. We then disentangle the heterogeneity in effects according to firm size, productivity levels and the productivity gap of local firms to foreign firms. Spillover effects working through the supply chain, called vertical linkages, are discussed in a separate section 5.6. A series of robustness checks confirm the main results.

Table 2 presents our baseline estimations, by building up step by step our preferred specification. In these first series of regressions we consistently use the number of foreign firms in the vicinity of a domestic firm as underlying measure for our main explanatory variable. To construct it, we simply count the number of foreign firms of the same industry as the domestic firm within a circle of radius RD. Since we are estimating our specification in log differences, we can interpret this variable as a growth rate in the presence of foreign firms within a certain area. We are convinced that the number of firms, while not containing any information on the size of firms, is a good indicator of the presence of foreign firms, because it is a rather neutral measure. A priori, one does not really know whether a few large firms convey more spillovers than a large number of small firms.

Panel A presents an ordinary least squares regression of the log of total factor productivity of domestic firms on the log of the number of foreign invested firms in the same industry in first differences, leaving aside any controls. Two important points are revealed. First, these raw results – while by first differencing is corrected for the unobserved firm fixed effect – show that there is a significant positive correlation between TFP growth of domestic firms and the change in the presence of foreign firms in the close surroundings of these domestic firms. Second, the relationship is strongest for circles with radii of 2 to 10 kilometres, and there seems also to be a clear decaying pattern of spillovers with increasing distance beyond 5 kilometres.

In panel B we add the control variables, accounting for agglomeration forces and factors influencing the location choice of foreign firms. The estimated coefficients slightly decrease in size, while keeping the decaying pattern and their significance. Panel C instruments the lagged dependent variable by the internal instrument $ln(TFP_{ik,t-2})$. Estimated using a two-stage-least-squares procedure it corresponds to the Anderson-Hsiao estimator (Anderson and Hsiao, 1981) and is our preferred specification.[23] The estimated coefficients are, again, highly significant and still show the pattern of strong within industry localized spillover effects, and the weakening of spillovers beyond 5 to 10 kilometres. The coefficients are only significantly different from zero up to a circle with a radius 20 kilometres. The estimated spillover effect within a circle of 5 kilometres is substantial at almost 0.3 percentage points higher growth in TFP by an additional percent in the number of foreign firms.

Panel C additionally presents the results for the four most relevant control variables. Remarkably, foreign invested firms other than those of the same industry do not have positive impact on the local economy. In contrast, having more foreign firms close by

[23] Adding further lags as instruments for the lagged dependent variable in differences in a GMM framework would increase efficiency. However, due to the unbalanced structure of our data, adding further lags results in losing numerous observations. Since our first stage estimation confirms the strength of the instrument, we stick with the simple version with only one lag. We checked the results using GMM, but the loss in observations due to using additional lags is actually worse than the increase in efficiency. Results are available on request.

Table 2: Number of FDI Firms and TFP Growth of Domestic Firms, Baseline Results

Dep. Var.: $\triangle Log(TFP_{ik,t})$	Circle Radius				
	2km	5km	10km	20km	50km
	(1)	(2)	(3)	(4)	(5)
Panel A: Ordinary Least Squares without controls					
$\triangle$ Log No. of FDI firms within industry	0.276*	0.296**	0.267*	0.234*	0.188^{+}
	(0.106)	(0.100)	(0.102)	(0.101)	(0.098)
R^2	0.07	0.08	0.08	0.08	0.07
Observations	88150	88150	88150	88150	88150
Panel B: Ordinary Least Squares with controls					
$\triangle$ Log No. of FDI firms within industry	0.246**	0.273**	0.247**	0.217*	0.165^{+}
	(0.089)	(0.085)	(0.087)	(0.090)	(0.086)
R^2	0.07	0.08	0.08	0.08	0.07
Observations	88150	88150	88150	88150	88150
Panel C: 2SLS, Instrumented Lagged Dependent Variable					
$\triangle$ Log No. of FDI firms within industry	0.248*	0.297**	0.287*	0.215^{+}	0.154
	(0.101)	(0.101)	(0.108)	(0.108)	(0.100)
$\triangle$ Log No. of FDI firms in other industries	−0.101**	−0.079*	−0.032	−0.041	−0.072*
	(0.031)	(0.036)	(0.036)	(0.031)	(0.032)
$\triangle$ Log No. of dom. firms within industry	0.037	0.002	−0.018	−0.005	−0.003
	(0.051)	(0.052)	(0.060)	(0.076)	(0.101)
$\triangle$ Log No. of dom. firms in other industries	0.000	0.026	0.013	0.042	0.041
	(0.021)	(0.019)	(0.027)	(0.037)	(0.044)
$\triangle Log(TFP_{i,t-1})$	0.531***	0.523***	0.523***	0.529***	0.533***
	(0.035)	(0.036)	(0.037)	(0.037)	(0.037)
Observations	52461	52461	52461	52461	52461
First Stage F-statistic	965.82	916.38	879.93	891.04	903.15
Panel D: Placebo Test, Lead of Change in Foreign Firms					
Lead $\triangle$ Log No. of FDI firms	0.003	0.002	−0.011	0.002	0.024
	(0.024)	(0.030)	(0.027)	(0.024)	(0.022)
$\triangle Log(TFP_{i,t-1})$	0.443***	0.442***	0.441***	0.442***	0.443***
	(0.055)	(0.055)	(0.055)	(0.055)	(0.055)
Observations	31162	31162	31162	31162	31162
First Stage F-statistic	474.91	473.66	470.79	470.97	473.01
Time FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Province-Time FE	Yes	Yes	Yes	Yes	Yes

Notes: Dependent Variable is annual TFP growth, defined as $log(TFP_{ik,t}) - log(TFP_{ik,t-1})$. Our main explanatory variable is $\triangle$ *Log No. of FDI firms*, defined as the annual change of the log of number of foreign invested firms within a circle of radius RD. Estimations include a lagged dependent variable $\triangle log(TFP_{i,t-1})$ that is instrumented with its lagged value in levels $log(TFP_{ik,t-2})$. The control variables (Panels B, C, and D) are measured for each firm within a circle of radius RD over time, and calculated as annual change in logarithms. They include the number of domestic firms in the same industry k, the number of foreign firms in all other manufacturing industries, the number of domestic firms in all other manufacturing industries, and the labor force (total number of workers) of all manufacturing industries. Further included is the annual change of the Herfindahl-Index at the industry level. All estimations include time fixed effects, province-time fixed effects, and industry fixed effects. Huber-White standard errors in parentheses are clustered at the industry level. + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$ *** $p < 0.001$.

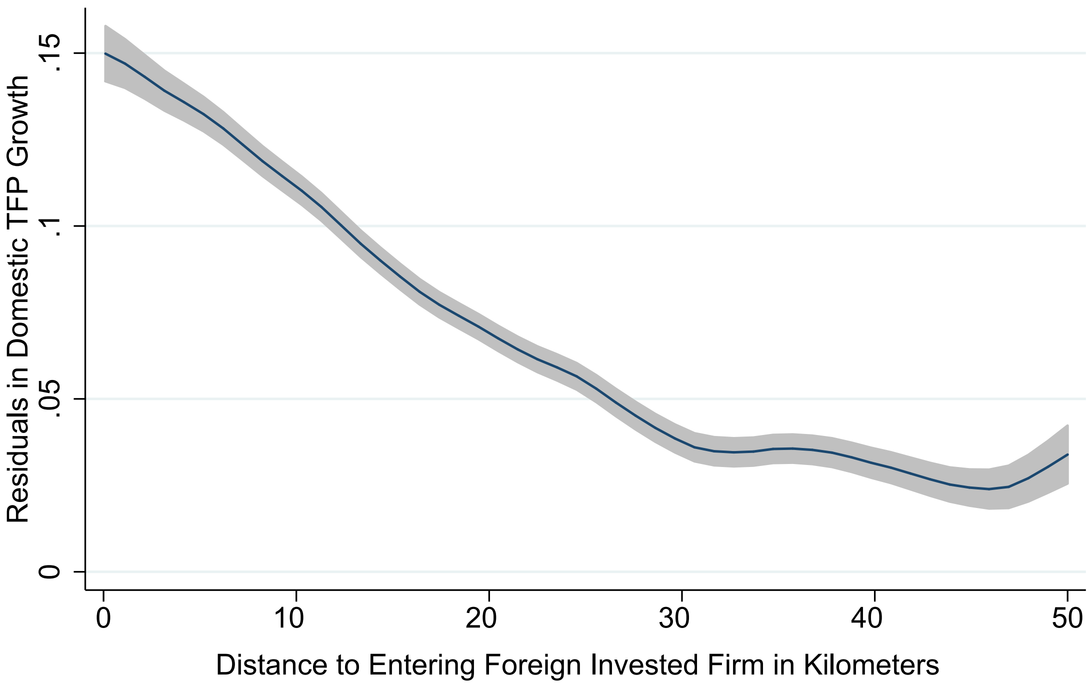
does have a significantly negative impact on TFP growth of domestic firms, indicating a congestion effect. Yet this congestion effect is much smaller and more than compensated by the positive effect of within industry foreign investment. This interesting results proposes that foreign firms absorb resources when settling into an area. In case the foreign firm is from a different industry there are no positive spillovers and only the negative impact on domestic firms' TFP remains. Other domestic firms do not show spillover effects, both within and across industries. Although we should be able to detect agglomeration spillovers, this restrictive estimation seems to absorb them.

The lagged dependent variable $\triangle Log(TFP_{i,t-1})$ is strongly affecting current TFP growth, supporting our concern of a dynamic autocorrelation process in our dependent variable. The high value of the first stage F-test suggests that the internal instrument is working well.

Panel D presents a placebo test. Instead of the contemporaneous value of FDI, its lead $\triangle log(NOF\ TFP_{ik,t+1})$ is included as main regressor. There seems to be no selection problem in the sense that foreign firms move to places where TFP growth of domestic firms is high in the previous year. This placebo test affirms our well specified estimation procedure.

To illustrate the pattern of spillover effects, Figure 4 depicts a local polynomial regression of the residual in TFP growth of domestic firms on their distance to entering foreign invested firms. The residual is based on a regression of TFP growth on industry fixed effects and interaction between province-by-time dummies in order to account for the location specific factors that influence TFP growth. The figure impressively depicts the spillover effects that attenuate with increasing distance. It resembles our baseline results in Table 2. The decay in spillovers is very regular and approaches zero at larger distances beyond 30 kilometres.

Figure 4: Entering Foreign Invested Firms and Domestic TFP Growth



Notes: The figure presents a kernel-weighted local polynomial regression of domestic firm level TFP growth on the distance to entering foreign invested firms. In gray is a 95% level confidence band. Each observation in the regression is a domestic firm–foreign firm dyad. The residual is based on a regression of TFP growth on industry fixed effects, and province-time fixed effects. The local polynomial uses an Epanechnikov kernel of degree 0, a bandwidth of 2.96, and pilot bandwidth for calculating the standard errors of 4.44.

Table 3 presents the exactly same series of regressions, though using total revenue of foreign firms as the underlying measurement of foreign direct investment. The overall pattern in the results is highly similar. However, estimated spillover effects are weaker and limited to a circle size of radius 5 kilometres. A one percent increase in the change of presence of foreign firms measured by their revenue within a 5 kilometre radius translates into an increase in TFP growth of 0.015 percentage points.

Drawing a preliminary conclusion from our main results, horizontal (within industry) spillover effects of foreign direct invested firms are a distinctly local phenomenon. They only occur within a limited spatial scope and quickly fade out beyond 10 kilometres. Entry of foreign firms may both lead to negative competitive pressures and positive spillover effects (Javorcik, 2004). Competitive pressures may substantiate a market stealing effect as described by Aitken and Harrison (1999). Yet, our results indicate that the positive gains of foreign entry through positive spillovers are offsetting the negative market stealing effects. This might be due to the fact that foreign invested firms, while producing in the same industry classification as domestic firms, likely export most of their products to foreign markets because of their global marketing strategies and advanced technologies (i.e. they produce for different markets). This is consistent with the theoretical arguments by Melitz (2003) that only firms with a size and productivity above a certain threshold are in fact able to export. Accordingly, our descriptive statistics of foreign and domestic TFP levels have shown that on average, foreign invested firms are larger in size and reach higher TFP levels than their domestic counterparts (see Table A.2 and Figure A.1). In addition, a statistical report at an aggregate level indicates that foreign firms in Vietnam export more than the domestic firms.[24] Outputs produced by domestic firms likely target local customers because of their better understanding domestic demand and markets. Only firm-level trade data could yield further insights in this regard. Overall, the lack of studies that do find significant horizontal spillovers (e.g. Newman et al., 2015, on Vietnam), is likely a result of missing spatial data at a sufficiently small scale.

5.3 Does Domestic Firm Size Matter for Spillover Effects?

In this subsection we provide more evidence on the heterogeneity of effects with respect to firm size of local establishments. Table 4 presents the results with regard to size of domestic firms measured by the number of workers. The regressions are also based on our baseline specification in first differences and instrumenting the lagged dependent variable. The whole sample of domestic firms is divided into three brackets according to the definition of firm size by the Vietnamese Statistical Office: micro firms with up to 10 workers, small firms have between 10 and 200 workers, and medium and large firms have more than 200 workers.[25]

Remarkably, micro firms seem to especially benefit from the presence of foreign firms

[24] See report by the Vietnam Trade Promotion Agency on April 3rd, 2015, available at `http://www.vietrade.gov.vn/en/`.

[25] Spillover effects for medium and large firms are jointly estimated since the sample becomes small.

Table 3: Total Revenue of FDI Firms and TFP Growth of Domestic Firms, Baseline Results

Dep. Var.: $\triangle Log(TFP_{ik,t})$	Circle Radius				
	2km	5km	10km	20km	50km
	(1)	(2)	(3)	(4)	(5)
Panel A: Ordinary Least Squares without controls					
$\triangle$ Log Tot. Rev. of FDI firms within industry	0.018^{*}	0.020^{**}	0.014^{+}	0.009	0.002
	(0.008)	(0.007)	(0.008)	(0.010)	(0.009)
R^2	0.06	0.06	0.06	0.06	0.06
Observations	88150	88150	88150	88150	88150
Panel B: Ordinary Least Squares with controls					
$\triangle$ Log Tot. Rev. of FDI firms within industry	0.017^{*}	0.019^{**}	0.012	0.008	0.003
	(0.008)	(0.006)	(0.008)	(0.009)	(0.008)
R^2	0.07	0.07	0.07	0.06	0.06
Observations	88150	88150	88150	88150	88150
Panel C: 2SLS, Instrumented Lagged Dependent Variable					
$\triangle$ Log Tot. Rev. of FDI firms within industry	0.015^{+}	0.017^{*}	0.012	0.004	0.001
	(0.008)	(0.007)	(0.009)	(0.010)	(0.008)
$\triangle$ Log Tot. Rev. of FDI firms in other industries	-0.007^{**}	-0.003	0.002	-0.006^{+}	-0.008^{**}
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
$\triangle$ Log Tot. Rev. of dom. firms within industry	-0.004	-0.005	0.000	-0.002	-0.023
	(0.004)	(0.007)	(0.010)	(0.013)	(0.024)
$\triangle$ Log Tot. Rev. of dom. firms in other industries	-0.004	-0.002	-0.001	0.004	0.024
	(0.004)	(0.004)	(0.005)	(0.008)	(0.021)
$\triangle Log(TFP_{i,t-1})$	0.536^{***}	0.535^{***}	0.537^{***}	0.538^{***}	0.537^{***}
	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)
Observations	52461	52461	52461	52461	52461
First Stage F-statistic	992.34	985.62	984.51	992.89	1005.53
Panel D: Placebo Test, Lead of Change in Foreign Firms					
Lead $\triangle$ Log Tot. Rev. of FDI firms within industry	0.002	0.005^{+}	0.003	0.000	0.004
	(0.002)	(0.003)	(0.003)	(0.004)	(0.004)
$\triangle Log(TFP_{i,t-1})$	0.444^{***}	0.444^{***}	0.444^{***}	0.444^{***}	0.443^{***}
	(0.055)	(0.055)	(0.055)	(0.055)	(0.055)
Observations	31162	31162	31162	31162	31162
First Stage F-statistic	476.74	476.47	475.40	474.97	477.90
Time FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Province time FE	Yes	Yes	Yes	Yes	Yes

Notes: Dependent Variable is annual TFP growth, defined as $log(TFP_{ik,t}) - log(TFP_{ik,t-1})$. Our main explanatory variable is $\triangle$ *Log Tot. Rev. of FDI firms*, defined as the annual change of the log of the total revenue of foreign invested firms within a circle of radius RD . Estimations include a lagged dependent variable $\triangle log(TFP_{i,t-1})$ that is instrumented with its lagged value in levels $log(TFP_{ik,t-2})$. The control variables (Panels B, C, and D) are measured for each firm within a circle of radius RD over time, and calculated as annual change in logarithms. They include the sum of total revenue of all other domestic firms in the same industry k , the sum of total revenue of foreign firms in all other manufacturing industries, the sum of total revenue of domestic firms in all other manufacturing industries, and the labor force (total number of workers) of all manufacturing industries. Further included is the annual change of the Herfindahl-Index at the industry level. All estimations include year fixed effects, province-year fixed effects, and industry fixed effects. Huber-White standard errors in parentheses are clustered at the industry level. + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$ *** $p < 0.001$.

in close proximity: Firms with less than 10 employees exhibit the largest coefficients at 0.4 percentage points additional growth in TFP as they are exposed to an additional one percent of foreign firms within 5 kilometres (panel A). Again, one observes a distinct decay of spillovers beyond a 5 kilometre radius. In panel B, the effects are similar although somewhat smaller for firms with 11 to 200 workers employed. For this group of small firms, spillover effects are strongest within 10 kilometres, restricted to a circle radius of 20 kilometres, and they fade out with increasing distance.

The group of medium and large firms is the smallest bracket as there are about 6'000 such firms in our sample. Also for the medium and large firms, the pattern of spillover effects is localized, affirming the robustness in spillover pattern. The effects are slightly increasing up to 10 kilometres, and fading out thereafter. Yet, the effect is only significant within a distance of 5 kilometres, at the 10 percent level. The estimated size of the spillover effect appears to be smaller for these large firms than for the small firms.[26]

Table 4: Number of FDI firms and TFP growth of Domestic Firms, Heterogeneity in Firm Size

Dep. Var.: $\triangle Log(TFP_{ik,t})$	Circle Radius				
	2km	5km	10km	20km	50km
Panel A: Micro firms: Labor force up to 10 workers					
$\triangle$ Log No. of FDI firms within industry	0.386**	0.410**	0.374**	0.251+	0.165
	(0.139)	(0.127)	(0.134)	(0.141)	(0.133)
Observations	14071	14071	14071	14071	14071
First Stage F-statistic	580.33	586.14	556.05	545.06	524.58
Panel B: Small firms: Labor force 11-200 workers					
$\triangle$ Log No. of FDI firms within industry	0.198*	0.255*	0.262*	0.206+	0.147
	(0.097)	(0.099)	(0.102)	(0.105)	(0.104)
Observations	32362	32362	32362	32362	32362
First Stage F-statistic	1486.18	1408.13	1351.90	1356.09	1348.06
Panel C: Medium/large firms: Labor force more than 200 workers					
$\triangle$ Log No. of FDI firms within industry	0.155	0.193+	0.212	0.184	0.184
	(0.101)	(0.106)	(0.151)	(0.134)	(0.120)
Observations	6004	6004	6004	6004	6004
First Stage F-statistic	210.40	209.26	209.68	208.25	209.35
Controls	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
Province time FE	Yes	Yes	Yes	Yes	Yes

Notes: Dependent Variable is annual TFP growth, defined as $log(TFP\_ik, t) - log(TFP\_ik, t-1)$. Our main explanatory variable is $\triangle$ *Log No. of FDI firms within industry*, defined as the annual change of the log of number of foreign invested firms in the same industry within a circle of radius RD . Estimations include a lagged dependent variable $\triangle log(TFP\_i, t-1)$ that is instrumented with its lagged value in levels $log(TFP\_ik, t-2)$. The control variables are measured for each firm within a circle of radius RD over time, and calculated as annual change in logarithms. They include the local number of domestic firms in the same industry k , the number of foreign firms in all other manufacturing industries, the number of domestic firms in all other manufacturing industries, and the labor force (total number of workers) of all manufacturing industries. Further included is the annual change of the Herfindahl-Index at the industry level. All estimations include time fixed effects, province-time fixed effects, and industry fixed effects. Huber-White standard errors in parentheses are clustered at the industry level. + p<0.10, * p<0.05, ** p<0.01 *** p<0.001.

Overall, the analysis of spillover effects for different domestic firm sizes reveals that

[26] A direct comparison of effects is not possible based on these results since the table presents an separate estimation for each subsample.

micro and small firms appear to benefit from foreign investment even more than medium and large firms in relative terms. The within industry spillover effects are restricted to short distances, both for large and small firms.

5.4 Does Productivity Level of Domestic Firms Matter for Spillover Effects?

In this section we look at the heterogeneity in effects with respect to productivity levels of domestic firms within each industry. For each industry, we divide the sample of firms into three groups: below median productivity, third quartile of productivity, and fourth quartile of productivity.[27]

Table 5: Spillover Effects for Unproductive and Productive Domestic Firms, 2SLS estimation

Dep. Var.: $\triangle Log(TFP_{ik,t})$	Circle Radius				
	2km	5km	10km	20km	50km
Panel A: Unproductive Firms (below median productivity)					
$\triangle$ Log No. of FDI firms within industry	0.376^{**}	0.380^{**}	0.323^{**}	0.250^{*}	0.172^{+}
	(0.132)	(0.117)	(0.115)	(0.112)	(0.096)
Observations	23818	23818	23818	23818	23818
First Stage F-statistic	673.31	668.06	650.32	650.39	643.13
Panel B: Medium productive firms (third quartile)					
$\triangle$ Log No. of FDI firms within industry	0.216^{*}	0.291^{*}	0.348^{**}	0.265^{*}	0.224^{+}
	(0.098)	(0.110)	(0.124)	(0.120)	(0.113)
Observations	14232	14232	14232	14232	14232
First Stage F-statistic	498.40	493.79	499.14	497.48	503.31
Panel C: Productive firms (fourth quartile)					
$\triangle$ Log No. of FDI firms within industry	0.116	0.205^{+}	0.198	0.134	0.077
	(0.091)	(0.111)	(0.123)	(0.132)	(0.149)
Observations	14398	14398	14398	14398	14398
First Stage F-statistic	430.80	433.84	424.49	420.36	423.06
Controls	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
Province time FE	Yes	Yes	Yes	Yes	Yes

Notes: Dependent Variable is annual TFP growth, defined as $log(TFP_{ik,t}) - log(TFP_{ik,t-1})$. Our main explanatory variable is $\triangle$ *Log No. of FDI firms*, defined as the annual change of the log of number of foreign invested firms within a circle of radius RD. Estimations include a lagged dependent variable $\triangle log(TFP_{i,t-1})$ that is instrumented with its lagged value in levels $log(TFP_{ik,t-2})$. The control variables are measured for each firm within a circle of radius RD over time, and calculated as annual change in logarithms. They include the local number of domestic firms in the same industry k, the number of foreign firms in all other manufacturing industries, the number of domestic firms in all other manufacturing industries, and the labor force (total number of workers) of all manufacturing industries. Further included is the annual change of the Herfindahl-Index at the industry level. All estimations include year fixed effects, province-year fixed effects, and industry fixed effects. Huber-White standard errors in parentheses are clustered at the industry level. + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$ *** $p < 0.001$.

The results in Table 5 are astounding. Relatively unproductive firms within each industry seem to specifically benefit from the presence of foreign firms in their vicinity (panel A). Firms at the upper end of the productivity distribution, in contrast, show

[27] Instead of dividing the group into three equally large groups, we decided to separate the unproductive lower half of firms from the third and fourth quartile. It seems more interesting to have a more pronounced picture in the upper half of the productivity distribution.

less pronounced signs of spillover effects. Yet the pattern of decaying spillovers is still detectable (panel C). Domestic firms in the third quartile of the TFP distribution also experience large and significant spillover effects, which are yet somewhat smaller (panel B). These results indicate a convergence process in productivity levels between low and high productivity firms. Unproductive firms indeed seem to be able to absorb know-how from their foreign counterparts, but only if they are sufficiently close-by.[28]

While one would need to look at each industry individually to see if there is absolute convergence in productivity levels, we can still make some calculation at the average of each group of firms. A 10 percent increase in the presence of foreign firms would lead to an absolute growth of TFP of 604 for low productivity firms, 610 for medium productive firms, and 812 for the productive firms over a 5 year period. While, at first glance, these back of the envelope calculations do not point to a quick convergence of productivity levels, unproductive and medium productive firms may increase their productivity almost at the same rate. Furthermore, while the effects for the productive quartile of firms is large in absolute terms, the effects are only marginally significant.

5.5 Does Productivity Gap between Domestic and Foreign Firms Matter?

In this section, we specifically look at how the productivity level of foreign firms is affecting domestic firms' productivity of diverse productivity levels. Do domestic firms benefit more from foreign firms of similar productivity levels or from foreign firms of much higher productivity? To answer this question, we divide the sample into groups of firms according to their TFP level for each industry. We define three groups: below median (low productivity), third quartile (medium productivity), and fourth quartile (high productivity). Both domestic firms and foreign firms are divided under the same TFP distribution for each industry. Since we want to look at the productivity gap within a certain circle of radius RD, we cannot directly calculate a TFP gap to the foreign productivity leader since in many cases, there are no foreign firms within a certain radius at all. The objective of this analysis is to figure out whether the technology gap is important in determining the size of spillover effects.

We perform a series of our baseline regression while including only certain subsamples with specific TFP levels. Figure 5 depicts 3x3 graphs with combinations of TFP levels of foreign and domestic firms. The top row shows low productivity domestic firms, while the TFP level of foreign firms increases from left to right: lower half, third quartile, and fourth quartile. The middle row shows domestic firms with medium level (third quartile) TFP, while, again, varying the level of foreign firms' level of TFP. And logically, the third row shows high productivity domestic firms, with increasing levels of foreign firms' productivity level from left to right.

[28] A direct comparison of effects is not possible based on these results since the table presents an separate estimation for each subsample.

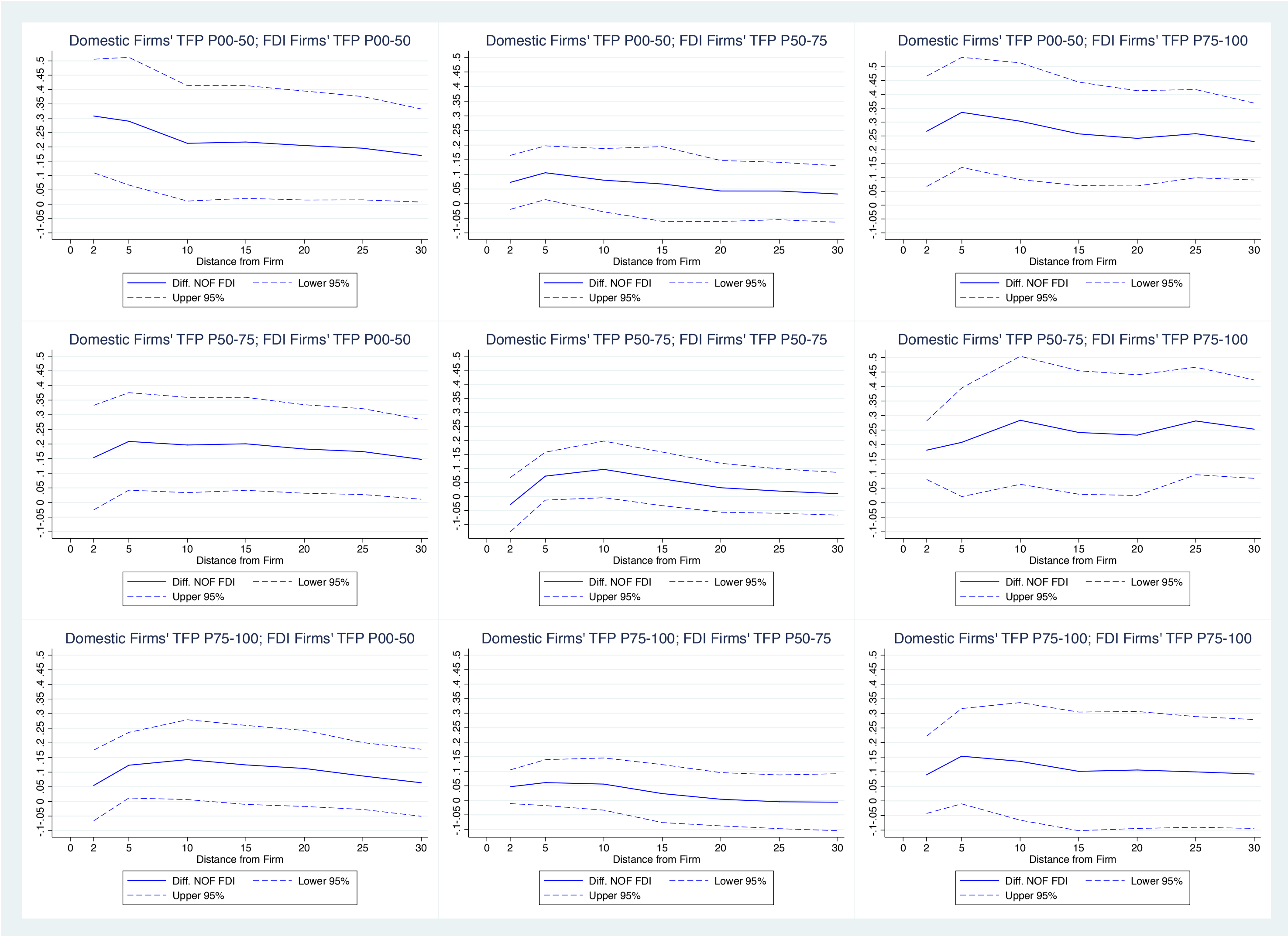


Figure 5: Varying Productivity of Foreign Firms Affecting Low and High Productivity Domestic Firms

Notes: The 9 graphs show our baseline regressions of growth in TFP on growth of number of foreign firms within a circle. Each graph shows a distinct combination of TFP levels of domestic and foreign firms. "Domestic firms' TFP P00-50" means the firm the estimation was based on a sample selection of domestic firms with TFP level below the median. TFP P50-75 is the third quartile of TFP levels, and P75-100 is the fourth quartile TFP level of all firms. Denotation for TFP levels of foreign firms is identical. The TFP quartiles are based on the whole sample of domestic and foreign firms.

Two results stand out. First, unproductive local firms (row 1) seem to benefit both from rather unproductive foreign firms, but also from very productive firms. Firms are able to learn both from other firms in the same industry that are similar in technology levels, but even more so from firms that are at a advanced technology level. The size in spillover effects is smallest for foreign firms with intermediate productivity levels (middle column). The patterns is similar for medium (row 2) and highly productive (row 3) domestic firms, although with reduced clarity. The productive domestic firms absorb the smallest spillover effects overall, and less significantly so. Second, and more importantly, a small productivity gap leads to a relatively lower learning ability of domestic firms, compared to a large productivity gap. A larger productivity gap between foreign and domestic firms within the same industry appears to facilitate the learning aptitude of domestic firms.

What is common to all combinations of productivity levels of domestic and foreign firms is the diminishing pattern of spillover effects with increasing distance. This, again, supports the robustness of the pattern in our baseline results. A further investigation of the productivity gap could reveal a more clear picture of effects, yet this is beyond the scope of this paper.

5.6 Are Spillover Effects in Vertical Linkages Localized?

Vertical linkages between foreign and domestic firms to upstream (forward linked) and downstream (backward linked) industries are another important channel through which spillover effects may work. With regard to FDI presence in vertical linkages, spillover effects have been extensively studied by various scholars (see e.g. Javorcik, 2004, Halpern and Muraközy, 2007, Anwar, 2011, and Newman et al., 2015). In the following, we assess the relevance of foreign presence in forward and backward linkages, yet in our established spatial framework, by adding these linkages to our baseline regression. Instead of just considering vertical linkages within an industry as done in most existing studies, we investigate vertical linkages to FDI firms in the vicinity of each domestic firms. Due to the decentralised structure of our data, we calculate the absolute value of deflated revenue produced by foreign firms in forward and backward linked industries instead of the output share (Javorcik, 2004) or value added share (Francois and Woerz, 2008). We enhance our baseline specification with the vertical forward and backward linkages as follows:

$$\begin{aligned}\triangle log(TFP_{ik,t}) \quad = \quad & \rho\triangle log(TFP_{ik,t-1}) + \delta\triangle log(FDI^{RD}_{ik,t}) \\ & +\kappa_1\triangle log(FWL\ Manu^{RD}_{i,fk,t}) + \kappa_2\triangle log(BWL\ Manu^{RD}_{i,kb,t}) \\ & +\kappa_3\triangle log(FWL\ Serv^{RD}_{i,fk,t}) + \kappa_4\triangle log(BWL\ Serv^{RD}_{i,kb,t}) \\ & +\lambda\triangle log(DOM\ Links^{RD}_{ik,t}) + \beta\triangle log(X^{RD}_{ik,t}) + \varphi\triangle HHI_{k,t} \\ & +\triangle\eta_p \times \phi_t + \triangle\varepsilon_{ik,t}\end{aligned} \tag{5}$$

where we construct the four variables measuring vertical linkages to foreign firms as follows. The first differenced vertical linkage to foreign invested manufacturing firms in forward linked industries is defined as

$$\triangle log(FWL\ Manu^{RD}_{i,fk,t}) = log(\sum_{j=1}^{N} \alpha_{fk} TR^{RD}_{jf,t}) - log(\sum_{j=1}^{N} \alpha_{fk} TR^{RD}_{jf,t-1}) \tag{6}$$

reflecting the annual change in the forward linked foreign manufacturing firms in industries f within a circle of radius RD around each domestic firm i. Each dyad foreign firm j's total revenue TR is weighted by α_{fk}, the coefficient measuring the forward link in the input-output table. α_{fk} measures the amount of goods supplied by forward linked industries f (upstream) to downstream industries k.[29]

The first differenced vertical linkage to foreign invested manufacturing firms in backward linked industries is defined as

$$\triangle log(BWL\ Manu^{RD}_{i,kb,t}) = log(\sum_{i=1}^{N} \beta_{kb} TR^{RD}_{jb,t}) - log(\sum_{i=1}^{N} \beta_{kb} TR^{RD}_{jb,t-1}) \tag{7}$$

where total revenue $TR_{jb,t}$ of each downstream foreign firms j is weighted by β_{kb}, measuring the amount of goods supplied by upstream industry k to downstream industry b.

The remaining two linkages to forward and backward linked service firms are calculated identically as:

$$\triangle log(FWL\ Serv^{RD}_{i,fk,t}) = log(\sum_{i=1}^{N} \alpha_{fk} TR^{RD}_{jf,t}) - log(\sum_{i=1}^{N} \alpha_{fk} TR^{RD}_{jf,t-1}) \tag{8}$$

$$\triangle log(BWL\ Serv^{RD}_{i,kb,t}) = log(\sum_{i=1}^{N} \beta_{kb} TR^{RD}_{jb,t}) - log(\sum_{i=1}^{N} \beta_{kb} TR^{RD}_{jb,t-1}) \tag{9}$$

Specification 5 also includes a set of control variables $\triangle log(DOM\ Links^{RD}_{ik,t})$, measuring the presence of forward and backward linked domestic firms. Identically as for the vertical links, we calculate these four types of vertical links for domestic firms.

Table 6 presents the results of our baseline specification, and includes four variables measuring the vertical linkages to forward and backward linked foreign firms, as described above. In general, spillover effects, whether positive or negative, seem to be much more

[29] The indices reflect three types of industries: k is the industry of domestic firm i itself. Industries f are forward linked industries (upstream), and industries b are backward linked industries. The index fk represents goods or services supplied by industry f to industry k; kb represents goods or services supplied by industry k to industry b. As mentioned before, we use the same definition of forward and backward linkages as Newman et al. (2015): forward linkages are upstream foreign suppliers; backward linkages are downstream foreign customers. This definition of forward and backward is implicitly referring to the perspective of the foreign firm.

locally restricted in the manufacturing sector compared to the service sector. The coefficients on the measures of linkages to foreign firms in manufacturing sectors are only significant within 10 kilometres. This result confirms the spatially bounded spillover effects among manufacturing industries and is robust for horizontal and vertical linkages. Besides, spillover effects from foreign service firms are quite stable across space and significant also across larger distances.

Our preferred 2SLS estimates are presented in Panel C in Table 6, including the horizontal linkages from our baseline regression and all control variables. Regarding vertical linkages from FDI manufacturers, our estimations show positive spillover effects from forward linked industries (i.e. foreign manufacturing firms are suppliers to domestic firms). The spillover effects are spatially restricted to within 10 kilometres. This finding is partly in line with the results of Newman et al., 2015 who also find positive spillovers from FDI forward linkages for Vietnamese manufacturing during the period 2006 to 2012 (the research period is comparable to ours), but only when they consider direct forward linkages of upstream foreign to downstream domestic producers.[30] The positive spillovers from upstream foreign firms may be explained by the know-how transfer through the products supplied to domestic downstream firms.

Spillover effects from backward linked foreign firms are negative (foreign manufacturing firms as customers of domestic firms). The foreign firms in downstream industries might have substantial bargaining power and drive down sale prices for domestic firms. As foreign firms in downstream sectors enter the market and choose locations close to the domestic firms, they also potentially absorb a lot of resources, as e.g high skilled employees join technologically more advanced foreign firms in downstream industries. This result is, however, in contrast to the literature: Thang, Pham and Barnes (2016), for instance, find positive backward and negative forward spillovers in their case study of FDI spillovers in the Vietnamese manufacturing sectors for the period 2000 to 2005. Our results are, however, not fully comparable to other studies as we analyse the vertical linkages in our spatial framework, where different mechanisms are supposedly at play.

Services that are supplied to domestic manufacturers by foreign firms reflect mode 3 and mode 4 trade in services (see Francois and Hoekman, 2010, for a more detailed description of mode 3 and mode 4 types of services). Interestingly, the results in Table 6 show that spillovers through vertical linkages of foreign service suppliers seem much less spatially constraint.[31] This can be explained by the support of internet and e-commerce to services industries so that services transactions can be implemented online easier than

[30]Newman et al. (2015) distinguish between direct and indirect vertical linkages. As they have information on direct supplier-customer relationships, they are able to measure direct links between firms, although for a much smaller sample. We construct the vertical linkages by the input-output table and cannot distinguish between direct and indirect linkages. As we look at vertical linkages in close proximity of domestic firms, the probability that a vertical linkage is actually a supplier-customer relationship is increasing, if we assume that closer firms are more likely to trade.

[31]Hilber and Voicu (2010) worked out that service agglomeration economies to be localized. In their study, Hilber and Voicu (2010) include both domestic and foreign service suppliers.

business transactions for commercial goods (for instance: e-banking services). In addition, there is often the mobility of experts from foreign services suppliers to the location of their customers (for instance: on-site services in auditing and business consulting).[32] Hence, the geographical distance does not really matter to foreign services supplied to domestic firms. Interestingly, our results record negative spillover effects from forward services linkages, and positive spillover effects for backward linked foreign services firms. Both effects do not provide evidence that spillover effects through vertical service linkages do fade out with increasing distance. This finding is not in line with results in the literature which indicates evidence of positive impacts from foreign service suppliers on the performance of downstream manufacturing in other countries (e.g. Francois and Hoekman, 2010). Nevertheless, done-to-date studies did not look at spatial components of the vertical spillover effects generated from services sector. We provide the first evidence for the less localized of FDI spillover effects from services on manufacturing industries in Vietnam.

Again, our results are not easily comparable to the results in the literature as we look specifically at the presence of foreign firms in vertical linkages within a certain area. The interpretation of our results is, therefore, different from most studies whici did not look at the geographical information at ward level. Most importantly, however, is the fact that the horizontal spillovers are stable and keep being significant after controlling for vertical linkages in panel C of Table 6. This supports the robustness of our results on the spatially restricted horizontal spillover effects of foreign direct investment.

[32]Foreign firms providing auditing services such as KPMG, Deloitte, Ernst & Young, and PWC have their head offices in central districts in Hanoi and Ho Chi Minh city, but still send their staff to nation-wide locations of their clients to provide on-site services.

Table 6: Vertical Linkages, Total Revenue (nom.) of FDI Firms and TFP Growth of Domestic Firms

Dep. Var.: $\triangle Log(TFP_{ik,t})$	Circle Radius				
	2km	5km	10km	20km	50km
	(1)	(2)	(3)	(4)	(5)
Panel A: Ordinary Least Squares without controls					
△ Log FWL Manufacturing	0.042***	0.057***	0.044**	0.017	0.007
	(0.009)	(0.014)	(0.015)	(0.016)	(0.020)
△ Log FWL Services	−0.082**	−0.100*	−0.116*	−0.120*	−0.103+
	(0.025)	(0.038)	(0.046)	(0.054)	(0.057)
△ Log BWL Manufacturing	−0.032***	−0.033*	−0.025	−0.006	0.003
	(0.009)	(0.013)	(0.016)	(0.020)	(0.027)
△ Log BWL Services	0.101***	0.137**	0.165**	0.163*	0.173*
	(0.029)	(0.047)	(0.060)	(0.066)	(0.072)
R^2	0.07	0.08	0.08	0.08	0.09
Observations	83907	86939	87809	88095	88150
Panel B: Ordinary Least Squares with Horizontal Linkage and Control Variables					
△ Log FWL Manufacturing	0.032***	0.045***	0.042**	0.017	0.022
	(0.008)	(0.012)	(0.013)	(0.016)	(0.018)
△ Log FWL Services	−0.053***	−0.064**	−0.081***	−0.080***	−0.073**
	(0.012)	(0.019)	(0.022)	(0.023)	(0.022)
△ Log BWL Manufacturing	−0.040***	−0.039**	−0.030*	−0.010	−0.012
	(0.009)	(0.012)	(0.014)	(0.015)	(0.019)
△ Log BWL Services	0.064***	0.089***	0.114***	0.110***	0.121***
	(0.015)	(0.024)	(0.029)	(0.028)	(0.027)
△ Log TR of FDI firms (horiz.)	0.013*	0.013**	0.005	0.003	0.000
	(0.006)	(0.005)	(0.005)	(0.008)	(0.008)
R^2	0.09	0.09	0.09	0.09	0.10
Observations	83907	86939	87809	88095	88150
Panel C: 2SLS, Vertical and Horizontal Linkages					
△ Log FWL Manufacturing	0.030**	0.045**	0.041**	0.022	0.036
	(0.009)	(0.014)	(0.015)	(0.020)	(0.025)
△ Log FWL Services	−0.061***	−0.077**	−0.094**	−0.077**	−0.078***
	(0.014)	(0.024)	(0.027)	(0.027)	(0.022)
△ Log BWL Manufacturing	−0.043***	−0.039**	−0.031*	−0.015	−0.020
	(0.011)	(0.013)	(0.015)	(0.015)	(0.021)
△ Log BWL Services	0.071***	0.106**	0.130***	0.102**	0.118***
	(0.017)	(0.031)	(0.036)	(0.033)	(0.029)
△ Log TR of FDI firms (horiz.)	0.013+	0.012*	0.005	−0.001	−0.001
	(0.007)	(0.006)	(0.006)	(0.009)	(0.009)
Observations	50059	51800	52273	52436	52461
First Stage F-statistic	1012.91	1016.88	1021.97	1064.57	1065.70
Time FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Province time FE	Yes	Yes	Yes	Yes	Yes

Notes: Dependent Variable is annual TFP growth, defined as $log(TFP_{ik,t}) - log(TFP_{ik,t-1})$. Our main explanatory variables are measuring the presence of foreign firms in forward and backward linked manufacturing and service sectors within a circle of radius RD around a domestic firm. The linkages are calculated as the weighted sum of total revenue of foreign firms in forward and backward linked industries within a circle of radius RD, and are calculated as annual changes in logarithms. The weights are α_{jk}, measuring the supply goods of forward linked industry j to industry k of the domestic firm i, and β_{kj} measuring the supply of goods of industry k of domestic firm i to backward linked industry j. Also included is the horizontal linkage $\triangle$*Log Tot. Rev. of FDI firms*, defined as the annual change of the log of the total revenue of foreign invested firms in industry k within a circle of radius RD. 2SLS estimations include a lagged dependent variable $\triangle log(TFP_{i,t-1})$ that is instrumented with its lagged value in levels $log(TFP_{ik,t-2})$. The control variables are measured for each firm within a circle of radius RD over time, and calculated as annual change in logarithms. They include the sum of total revenue of all other domestic firms in the same industry k, the sum of total revenue of foreign firms in all other manufacturing industries, the sum of total revenue of domestic firms in all other manufacturing industries, and the labor force (total number of workers) of all manufacturing industries. Further included is the annual change of the Herfindahl-Index at the industry level. All estimations include year fixed effects, province-year fixed effects, and industry fixed effects. Huber-White standard errors in parentheses are clustered at the industry level. + p<0.10, * p<0.05, ** p<0.01 *** p<0.001.

6 Conclusion

This paper investigates the spatial component of spillover effects of foreign direct investment on the productivity of domestic firms in Vietnam over the period 2005 to 2010. A unique data set with geo-referenced information on manufacturing and service companies allows us to be the first to conduct a spatially precise analysis of FDI spillover effects. Exploiting variation in the presence of foreign firms in the vicinity of local establishments, we contribute novel and interesting evidence of remarkably localized foreign investment spillover effects to the literature.

We find positive and significant highly localized horizontal spillover effects. Spillovers are strongest within distances of 2 to 10 kilometres, and fade out beyond. Our 2-stage least squares estimations, accounting for the dynamics in TFP, estimate elasticities of 0.25–0.4 in TFP growth with respect to changes in FDI presence in the surrounding of domestic firms. Placebo tests show that our results are not driven by reverse causality as the current TFP growth is not causally linked to the presence of foreign firms in the following year. Results are also similar both in the northern and southern regions of Vietnam, and when ward-time fixed effects are included. Importantly, the results indicate that spillover effects are largest for small and relatively unproductive firms. Estimated elasticities are larger and more significant for micro and small firms with a labour force up to 200 workers. These results give a concrete response to the ongoing concern that FDI spillovers might only benefit big firms. Most interestingly, our results show the first evidence that vertical spillovers from foreign manufacturing firms are localized while the spillovers from foreign services firms are not spatially constraint in Vietnam during 2005-2010.

Our results suggest that strategies should be considered to target foreign manufacturers to specific locations (such as remote areas) which may enhance the productivity of local manufacturers in less developed areas. At the same time, our results also suggest that a strong clustering of firms in the same industry is beneficial for productivity growth. Improvements of the transport system in a country with an underdeveloped infrastructure, such as Vietnam, may increase the intensity of interactions among domestic and foreign firms. This would then strengthen the spillovers created from foreign manufacturers through the three channels described (demonstration effects, labour mobility, and technology transfers). Since we find a negative effect on productivity of vertical linkages to upstream service firms, the competition in the service sector should be further improved to reduce the high cost burden on domestic manufacturers when using foreign services.

This study not only provides important implications for FDI facilitation policies to enhance TFP growth in Vietnam, but also yields interesting and relevant insights for other developing countries. Despite of significant contributions to the literature, this study still has limitations due to the lack of micro-data in inter-firm linkages, research and development expenditures, and import-export activities. Further research using more complete data could provide a deeper analysis and additional interesting results.

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A Total Factor Productivity Estimation Appendix

A.1 TFP Estimation Methodology

We compute the firm-level productivity from the estimation of parameters in industry specific production functions as proposed and documented by Levinsohn and Petrin (2003) and Petrin, Poi and Levinsohn (2004), which are extensions of the Olley and Pakes (1996) methodology. More technical details on the methodological framework are explained in the Appendix A.

One important problem with firm-level productivity estimation is data related. Missing or non-positive values of investment flow reported in or imputed from micro data is a prevalent challenge in manufacturing firm data (Levinsohn and Petrin, 2003). The issue of lumpy investments is simply due to the typical high fixed cost in manufacturing sectors (i.e. start-up expenditures for machines and infrastructure) and does not allow for the inversion of the investment demand as the function of unobserved productivity. Firms in these sectors tend to invest large amounts of capital for expensive fixed assets when starting their business, but then delay the investment in the next year while the capital stock continues to depreciate. A feasible solution is to use intermediate inputs (materials and services) instead, which are demanded yearly, and can be observed or calculated from the information available in our data (see the description in Table A.1). Modifying the model of Olley and Pakes (1996) that uses investment as the proxy for unobserved productivity, Levinsohn and Petrin (2003) suggest to use the observed yearly smooth demand of the intermediate inputs as an alternative proxy.

We apply the method of Levinsohn and Petrin (2003) and Petrin, Poi and Levinsohn (2004) to estimate the coefficients of the production function and impute them to calculate firm level productivity, as it provides several advantages over ordinary least square, fixed effects and instrumental variables estimation (Van Beveren, 2012). First, the framework solves for simultaneity issues, and produces a consistent estimator.[33] Second, the data required for intermediate input used as the proxy for unobserved productivity fits well with our data set, as discussed above.[34] Levinsohn and Petrin (2003) apply the approximation in the third order polynomials for the unknown form of productivity shocks. Olley and Pakes (1996) note that either third or fourth polynomials show identical result in their estimations. Assumptions about the timing of the intermediate input choice may be applied to prevent the multi-collinearity of inputs (Ackerberg, Caves and Frazer, 2006). We check the multicollinearity among inputs and non-parametric productivity in the actual data and the results reject the hypothesis of Ackerberg, Caves and Frazer (2006).

[33]Levinsohn and Petrin (2003) show in detail the advantages of the method over OLS and FE methods.

[34]The method of Levinsohn and Petrin (2003) and Petrin, Poi and Levinsohn (2004) has been widely applied in the literature. For a review of applications in international trade, see e.g. Feenstra (2015); a review of applications in research of agglomeration effects is provided in Combes and Gobillon (2015); Caliendo et al. (2015) shows the similarity of TFP calculations by the method of Levinsohn and Petrin (2003), Olley and Pakes (1996) and others; a very recent application of the method is conducted by Poczter (2016) who uses electricity consumption as a proxy for unobserved productivity.

A.2 Production Function Estimation

As noted by Olley and Pakes (1996), coefficients of capital stocks estimated in the Cobb-Douglas production function by simply using OLS are biased upwards due to the correlation between capital stock and unobserved productivity shocks (TFP). In addition, the authors also indicate that using balanced panel data to estimate TFP, which ignores the entry and exit of firms in the industries, causes a selection bias problem. They argue that the efficient firm, which maximises its "expected discounted value of future net cash flow" in a framework of the Bellman equation, stays in the industry and invests more if its TFP level exceeds a certain threshold. A less efficient firm that has a TFP level below the threshold in contrast, exits the market (Olley and Pakes, 1996).

Olley and Pakes (1996) solve for the selection bias and simultaneity issues in dynamic TFP estimation by using unbalanced panel data and including the survival ratio of a firm in the industry in their estimation. Importantly, they use investment as the proxy for unobserved productivity. They argue that there is a correlation between the choice of the capital stock, investment demand and TFP. Capital stocks are determined at period $t-1$ such that:

$$K_{i,t} = (1-\delta)(K_{i,t-1}) + I_{i,t-1} \tag{A.1}$$

Where δ is the depreciation ratio, $K_{i,t}$ and $K_{i,t-1}$ are respectively the capital stocks in year t and year $t-1$, and $I_{i,t-1}$ is the investment of firm i in year $t-1$.

The investment demand is assumed to be monotonically increasing in TFP. Thus, the demand function of investment can be inverted and investment can be used as proxy for the productivity shock ω. The investment demand is defined as

$$I_t = f_t(K_t, \omega_t) \tag{A.2}$$

With the assumption that $I_t > 0$, after being inverted, we get

$$\omega_t = f_t^{-1}(I_t, K_t) \tag{A.3}$$

Due to the possibility of non-availability or negative values of investment reported in many data sets, Levinsohn and Petrin (2003) develop a theoretical framework based on Olley and Pakes (1996) and suggest to use intermediate inputs as alternative proxies for unobserved productivity shocks instead of investment. Important assumptions made by Olley and Pakes (1996) are kept in Levinsohn's (2003) model. Moreover, the demand of intermediate inputs chosen needs to be strictly increasing in productivity.

The Cobb-Douglas production function is assumed to be similar among firms in the same industry.

$$VA_{it} = A_{it}K_{it}^{\beta_k}L_{it}^{\beta l} \tag{A.4}$$

Taking logarithms of both sides we have

$$log(VA_{it}) = \beta_0 + \beta_k log(K_{it}) + \beta_l log(L_{it}) + \omega_{it} + \varepsilon_{it} \tag{A.5}$$

In equation (A.5), $log(VA_{it})$ is the logarithm of deflated value added, while $log(L_{it})$ is the logarithm of number of labourers, and $log(K_{it})$ is the logarithm of the real capital stock.[35] ω_{it} is the productivity shock (TFP) we need to estimate. ε_{it} is the error term that is unknown to the firm and the econometrician. ω_{it} is known by the firm when it makes the choice on intermediate inputs and the capital stock, but it is also unobserved by the econometricians.

Rewriting equation (A.5) in lower case, we have

$$va_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + \omega_{it} + \varepsilon_{it} \tag{A.6}$$

The assumptions implied in equation (A.6) follow Levinsohn and Petrin (2003) and Petrin, Poi and Levinsohn (2004), such that

(i) The choice of intermediate input m_{it} response to k_{it} and ω_{it}:

$$m_{it} = m(k_{it}, \omega_{it})$$

When a firm gains higher productivity than the threshold and stays in the market, it expands the demand for intermediate inputs, so $m_{it} > 0$, which allows for $m_{it}(k_{it}, \omega_{it})$ to be inverted. Therefore $\omega_{it} = \omega(k_{it}, m_{it})$.

(ii) Labour is not a state variable which means it is demanded when the productivity is realised. In this case, we choose the number of employees as labor input, as we do not have information on the wage or working hours.[36]

(iii) The first-order Markov process is applied to productivity shocks:

$$\omega_{it} = E[\omega_{i,t}|\omega_{i,t-1}] + \xi_{i,t} \tag{A.7}$$

where $\xi_{i,t}$ is the innovation to productivity.

[35] The Value added production function is popularly utilised in the literature, for instance in Petrin and Levinsohn (2012), De Loecker and Warzynski (2012), and Newman et al. (2015).Petrin, Poi and Levinsohn (2004) introduce two cases that apply the method by Levinsohn and Petrin (2003): a production function using value added and a production function using gross output.

[36] We also check for collinearity of labour with material and capital stock by using the STATA user-written command *collin*. The results of the variance inflation factor ($VIF = \frac{1}{1-R^2}$) which is less than 3 in our case does not indicate a problem of multicollinearity).

(iv) Firms are assumed to face the same input and output prices. Hence, in our paper, we estimate TFP by each industry, and assume that within the same industry this assumption holds.

Following Levinsohn and Petrin (2003), we estimate equation (A.6) in two steps by using levpet which is a Stata command written by Petrin, Poi and Levinsohn (2004). The explanation of the algorithm is as follows:

In the **first step**, making the assumption that

$$\omega_{it} = \omega(k_{it}, m_{it}) \tag{A.8}$$

We have

$$\phi(k_{it}, m_{it}) = \beta_0 + \beta_k k_{it} + \omega(k_{it}, m_{it}) \tag{A.9}$$

Since the form of $\phi_{it}(k_{it}, m_{it})$ is unknown, $\phi_{it}(k_{it}, m_{it})$ is estimated by using a third order polynomial approximation in k_{it} and m_{it}: $\phi(k_{it}, m_{it}) = \Sigma_{n=0}^{3} \Sigma_{j=0}^{3-n} \sigma_{nj} k_t^n m_t^j$.

We rewrite equation (A.6)

$$va_{it} = \beta_l l_{it} + \phi_{it}(k_{it}, m_t) + \varepsilon_{it} \tag{A.10}$$

This first step aims to estimate the consistent coefficient of l_{it} in the no-intercept OLS (equation A.10). It is assumed that $E[\varepsilon_{it}|l_{it}, k_{it}, m_{it}] = 0$.[37]

In the **second step**, coefficients estimated in the first step are used to identify β_k. From equation (A.9), we see that $\widehat{\omega_{it}}$ can also be expressed as

$$\widehat{\omega_{it}} = \widehat{\phi_{it}} - \beta_k^* k_{it} \tag{A.11}$$

With the grid search, for each β_k^* we can define the appropriate $\widehat{\omega_{it}}$. Using the value $\widehat{\omega_{it}}$ from equation A.11, Levinsohn and Petrin (2003) approximate $E[\omega_{it}|\widehat{\omega_{i,t-1}}]$ with a third-degree polynomial. With $\widehat{\beta_l}$ derived in the first step, $E[\omega_{it}|\widehat{\omega_{i,t-1}}]$ and β_k^*, rearranging equation A.4 and combining it with the first-order Markov process, the sample residual of the production function is equal to

$$\widehat{\varepsilon_{it} + \xi_{it}} = va_{it} - \widehat{\beta_l} l_{it} - \beta_k^* k_{it} - E[\omega_{it}|\widehat{\omega_{i,t-1}}] \tag{A.12}$$

The solution to find $\widehat{\beta_k}$ is

[37] Being different from Olley and Pakes (1996), Levinsohn and Petrin (2003) accumulate capital stock by using current investment value $K_{i,t} = (1-\delta)(K_{i,t-1}) + I_{i,t}$.

$$min_{\beta_k^*} \Sigma_{it}(va_{it} - \widehat{\beta}_l l_{it} - \beta_k^* k_{it} - E[\omega_{it}|\widehat{\omega_{i,t-1}}])^2 \quad \text{(A.13)}$$

This yields a consistent estimate of β_k since $E[(\varepsilon_{it} + \xi_{it})|k_{it}] = 0$, and because k_{it} was chosen at time $t-1$ by the accumulation of $k_{i,t-1}$ and $i_{i,t}$ (Levinsohn and Petrin, 2003).

After obtaining consistent coefficients β_k and β_l, the log(TFP), $\widehat{\omega_{it}}$ can be computed as follows (Olley and Pakes, 1996; Van Beveren, 2012; Newman et al., 2015)

$$\widehat{\omega_{it}} = va_{it} - \widehat{\beta_k} k_{it} - \widehat{\beta}_l l_{it} \quad \text{(A.14)}$$

Table A.1 specifies how the main variables are constructed using available firm level information from the Vietnamese Enterprise Survey. Value added is calculated by the addition method using firm-level records on profit, wage bills, and indirect tax[38] and depreciation (see Ha and Kiyota, 2014). The depreciation ratio is assumed to be 10%. In addition, different deflators are used to convert the nominal values in the current prices to the base year price which is the year 2000.[39]

Table A.1: Measurement of Main Variables

Variables	**Measurement**
Total output (Y_{it})	Total revenue (TR_{it}) at the end of year t
Wage(W_{it})	Total wage paid to employees at the end of year t
Labor (L_{it})	Total employees at the end of year t
Capital Stocks (K_t)	Net booked values of fixed assets at the end of year t,
Profit (Π_{it})	Total profit before taxes at the end of year t
Value Added (VA_{it})	$\Pi_{it} + W_{it} + indirecttax_{it} + depreciation_{it}$
Materials and Services (MS_{it})	TR_{it}-$\Pi_{it} - W_{it} - (K_{it} - K_{i,t-1})$
Total Cost(TC_{it})	$TR_{it} - \Pi_{it}$
Depreciation ($Depre_{it}$)	$K_{it} * \frac{depreciationratio}{1-depreciationratio}$

Notes: Authors' compilation using data drawn from the Vietnamese Enterprise Survey 2005–2010.

A.3 Results of TFP Estimation

The estimation results of total factor productivity are shown in Table A.2 in logarithmic form. The results reveal that the mean value of log(TFP) is higher in foreign firms than domestic firms, hence foreign firms feature higher productivity than domestic firms. Additionally, annual growth in TFP differs between foreign and domestic firms: while domestic firms' productivity grew by just 1.4 percent, it was 3.3 percent among foreign firms.

[38] The indirect tax is the difference between the total tax paid by the firm and its income tax. See Ha and Kiyota (2014).

[39] Specifically, the producer price index of each industry is the deflator for output and value added. We calculate the index by using the annual producer price index (PPI) by industry provided by the General Statistic Offices of Vietnam (GSO; www.gso.gov.vn). Capital stocks are converted to the base year price by the gross fixed capital formation deflators which are calculated using the annual nominal gross fixed capital formation values of Vietnam provided by the World Bank country database available at www.worldbank.org. Nominal values of materials and services are deflated using the annual GDP deflators downloaded from the World Economic Outlook database available at www.imf.org.

Table A.2: Summary of Covariates and Estimated Total Factor Productivity

Variables	Domestics Firms			Foreign Invested Firms			All Observations			Unit
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	
Value Added	156922	4815	64628	20035	35271	172258	176957	8264	84596	Million VND
Capital Stock	158145	8842	183939	20127	71070	341877	178272	15868	208799	Million VND
No. of Workers	163214	71	285	20255	452	1596	183469	113	606	Workers
Material Inputs	150924	25104	364197	18904	159615	779192	169828	40077	432717	Million VND
Log(TFP)	150301	8.344	2.017	19541	9.369	2.054	169842	8.462	2.048	
Growth in TFP	88,150	.014	.803	14398	.033	.822	102548	.017	.806	%

Notes: Authors' compilation and estimation using data drawn the Vietnam Enterprise Survey 2005–2010. Variables (except for estimated log(TFP)) are in nominal values.

For further investigation of the difference between foreign and domestic firms' total factor productivity distributions, Kernel densities of log(TFP) by year and by firms' ownership are presented in Figure A.1. The figure reveals that for all the years from 2005 through 2010 foreign firms' productivity distribution was consistently shifted towards the right tail, hence higher productivity levels, compared to their domestic counterparts. The mean in log(TFP) (average over all years in Table A.2) was also consistently higher in all years for foreign firms compared to domestic firms. While the mean of domestic firm's log(TFP) is steadily increasing over time from 8.1 to 8.3, the foreign firms' productivity does not show a steady increase over time (not shown in the figure). This trend might indicate a TFP catch-up of domestic firm towards foreign firms in our study period. Figure A.1 supports the notion that foreign firms are more productive so that technology and knowledge are more likely to spill over from foreign to domestic firms. In the following part, we explore the causal link between the temporal variation of the presence of foreign firms in proximity of domestic firms and domestic firms' subsequent TFP growth.

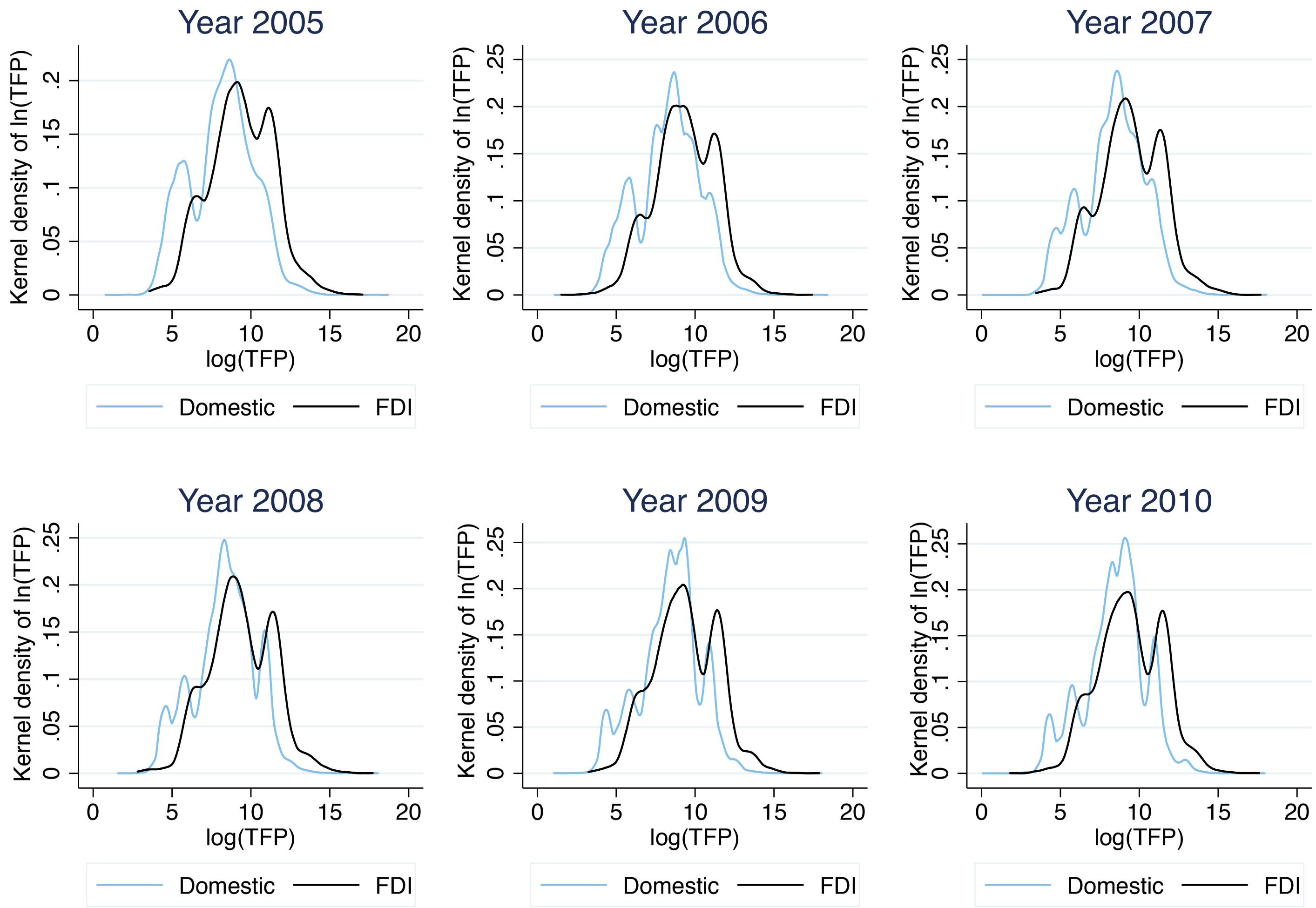


Figure A.1: Kernel Distribution of Log(TFP) by Year and by Ownership

Notes: The figure displays a Kernel density estimator using a Epanechnikov Kernel function for foreign and domestic firms for each year. Log(TFP) is estimated by the methodology of Levinsohn and Petrin (2003) and based on data of the Vietnam Enterprise Survey, 2005–2010.

B Supplement Figures and Data Description Appendix

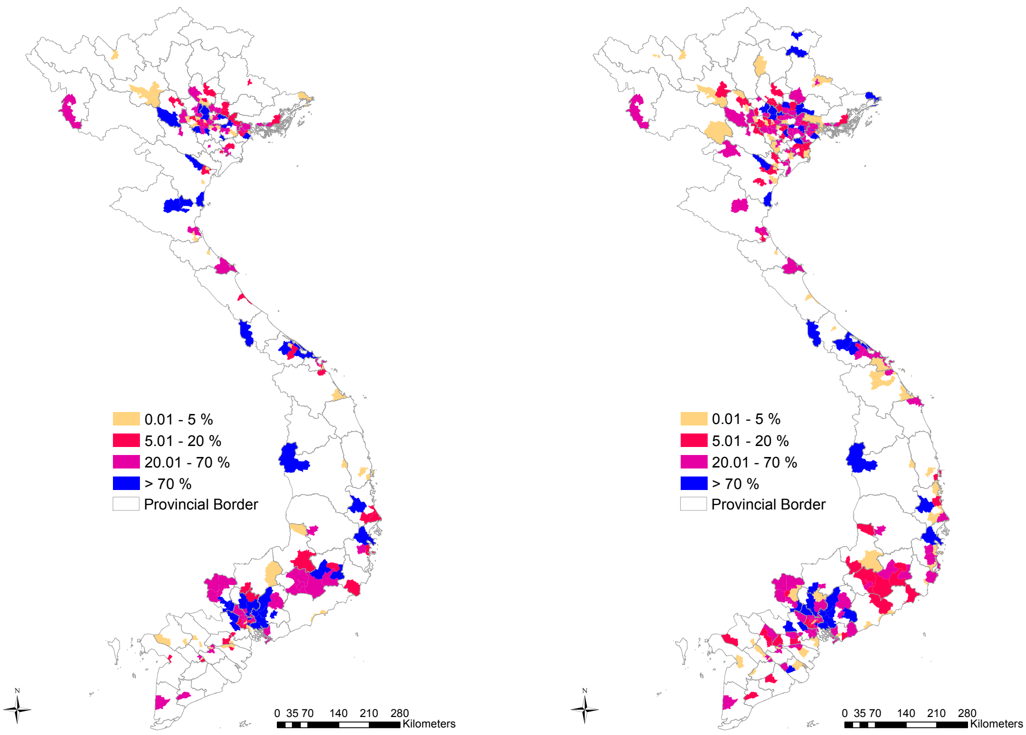
Table B.1: Number of Firms by Industry

Code	**Industry**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**Code**	**Industry**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
23	Meat products	94	155	141	179	215	231	54	Medicine, chemical prophylaxis & pharmacy	196	194	210	264	273	291
24	Fishery products	663	762	858	1024	1039	1032	55	By-product rubber	212	218	276	303	346	355
25	Products of vegetables and fruit	185	347	317	407	386	410	56	By-product plastic	1211	1394	1661	2019	2341	2533
26	Vegetable and animals oils and fats	34	34	45	54	60	64	57	Glass and by-product glass	83	84	111	112	119	147
27	Milk products	39	48	57	88	115	106	58	Cements	117	117	122	141	165	188
28	Rice	1207	1177	1115	1128	1145	1012	59	Other non-metallic mineral products	114	143	127	168	198	200
29	Flour (all kinds)	83	97	108	120	142	136	60	Iron, steel, iron	226	243	311	446	483	515
30	Sugar	41	41	37	45	48	51	61	Other metal products	130	138	184	264	320	424
31	Cocoa, chocolate and candy, cake	253	269	321	452	492	530	62	Electronic device, computer and peripheral	23	27	36	62	82	69
33	Other remaining food	1052	1108	1185	1343	1343	1392	63	Machinery & equipment for broadcasting	186	196	228	261	294	332
34	Animal feed	288	320	359	469	472	468	64	Electrical household appliance	74	75	106	180	242	264
35	Alcohol	52	46	58	102	130	130	65	Other electronic & optical products	192	242	251	270	340	361
36	Beer	17	20	17	18	20	17	66	Motor, electric generator, transformers	106	114	137	199	218	244
37	Non-alcohol water and soft drinks	720	756	1081	1380	1551	1586	67	Cell and battery	26	28	32	34	41	33
38	Cigarettes	25	24	25	26	25	24	68	Electric conductor	99	131	142	173	182	181
39	Fiber (all kinds)	370	322	385	470	628	612	69	Electric light equiptment	36	61	51	61	88	109
40	Textile products (all kinds)	292	399	439	536	694	733	70	Consumer electronic equipment	209	231	317	410	458	450
41	Costume (all kinds)	1809	2161	2545	3444	3711	4207	71	Other electric equipments	128	115	92	120	177	181
42	Leather products	202	192	239	292	375	457	72	General-purpose machinery	213	225	254	280	331	377
43	Shoes, sandal (all kinds)	361	366	413	523	554	636	73	Special-purpose machinery	1358	1758	2028	2680	2982	3132
44	Wood products	1489	1851	2158	3094	3493	3558	74	Cars (all kinds)	163	221	220	261	250	261
45	Paper products	943	1075	1190	1509	1650	1734	75	Car engines with tractor (not automotive)	21	41	34	38	42	41
46	Products of printing activities	1176	1650	1803	2253	2854	3338	76	Ships and boats	153	292	237	299	380	343
47	Coke & coal products	4	9	9	12	12	19	77	Motor vehicles, motor bikes	143	152	181	203	201	203
48	Gasoline, lubricants	10	21	15	21	28	37	78	Other transport means	54	65	69	83	70	74
49	Other products from oil, gas	11	17	15	16	15	17	79	Bed, cabinet, tables, chairs	1284	1438	1735	2397	2441	2636
50	Basic organic chemicals	75	74	97	116	159	155	80	Jewelry; instruments; sports, games	146	154	174	230	252	299
51	Fertilizer and nitrogen compound	122	133	169	221	257	285	81	Medical equipments	82	113	123	150	159	166
52	Plastic and primary synthetic rubber	26	77	82	98	106	121	82	Others	1338	1010	1562	1991	3047	3167
53	Other chemical products; fibers	236	277	301	373	389	436		**Total**	**20202**	**23048**	**26595**	**33912**	**38630**	**41110**

Notes: Authors' compilation using data drawn from the Vietnamese Enterprise Survey 2005–2010. Names of industries are shortened, further details are provided on: http://www.gso.gov.vn/default.aspx?tabid=512&idmid=5&ItemID=10752.

Figure B.1: Shares of Total Revenue of Foreign Invested Firms by District in Vietnam 2005 & 2010

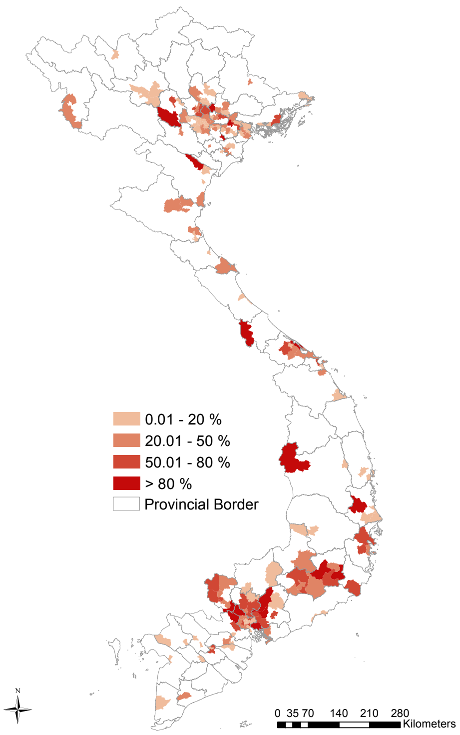
(a) 2005 (b) 2010



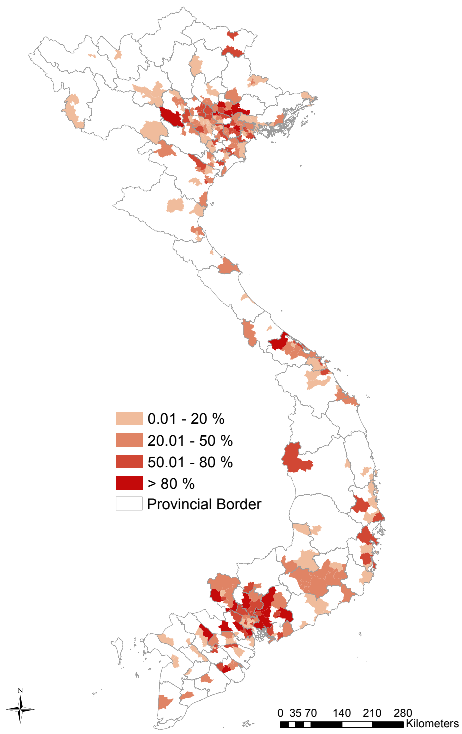
Notes: The share of total revenue of foreign invested firms per district is equal to the revenue of foreign invested firms in the district over the total revenue of all firms. The maps are based on authors' calculations using the Vietnam Enterprise Survey 2005 & 2010. Administrative boundaries are based on Global Administrative Areas data (www.gadm.org). Several Vietnamese islands (e.g. Hoang Sa and Truong Sa) are not displayed due to the limitation of the GADM administrative boundaries data.

Figure B.3: Shares of Total Labor Force of Foreign Invested Firms by District in Vietnam 2005 & 2010

(a) 2005



(b) 2010



Notes: The share of total labor force of foreign invested firms per district is equal to the number of workers of foreign invested firms in the district over the total number of workers of all firms. The maps are based on authors' calculations using the Vietnam Enterprise Survey 2005 & 2010. Administrative boundaries are based on Global Administrative Areas data (www.gadm.org). Several Vietnamese islands (e.g. Hoang Sa and Truong Sa) are not displayed due to the limitation of the GADM administrative boundaries data.

Table B.2: Variable Description & Data Sources

Variable	Description	Source
Dependent Variable		
$\triangle log(TFP_{ik,t})$	$log(TFP_{ik,t}) - log(TFP_{ik,t-1})$ Annual growth in total factor productivity	Own calculations based on Levinsohn and Petrin (2003) and Petrin, Poi and Levinsohn (2004). Source: Vietnamese Enterprise Survey 2005–2010.
Main Explanatory Variables		
Horizonal Linkages:		
$\triangle$Log No. of FDI Firms	$log(\sum_{j=1}^{N} firm_{jk,t}^{RD}) - log(\sum_{j=1}^{N} firm_{jk,t-1}^{RD})$ Annual change in the number of foreign firms j in industry k within radius RD around each firm i	Own calculations based on sample of geo-referenced firms. Source: Vietnamese Enterprise Survey 2005–2010.
$\triangle$Log Tot. Rev. of FDI Firms	$log(\sum_{i=1}^{N} TR_{jk,t}^{RD}) - log(\sum_{i=1}^{N} TR_{jk,t-1}^{RD})$ Annual change in the sum of total revenue of foreign firms j in the same industry k within circle of radius RD around each domestic firm i	Own calculations based on sample of geo-referenced firms. Source: Vietnamese Enterprise Survey 2005–2010.
Vertical Linkages:		
$\triangle$Log FWL Manufacturing	$log(\sum_{i=1}^{N} \alpha_{fk} TR_{jf,t}^{RD}) - log(\sum_{i=1}^{N} \alpha_{fk} TR_{jf,t-1}^{RD})$ Annual change in the forward linked foreign manufacturing firms in industries f within circle of radius RD around each domestic firm i; α_{fk} is the coefficient measuring the link in the input-output table.	Own calculations based on geo-referenced firms of the Vietnamese Enterprise Survey 2005–2010 and the GSO input-output table (2007).
$\triangle$Log BWL Manufacturing	$log(\sum_{i=1}^{N} \beta_{kb} TR_{jb,t}^{RD}) - log(\sum_{i=1}^{N} \beta_{kb} TR_{jb,t-1}^{RD})$ Annual change in the forward linked foreign manufacturing firms in industries b within circle of radius RD around each domestic firm i; β_{fk} is the coefficient measuring the backward link from upstream industry k to downstream industry b in the input-output table.	Own calculations based on geo-referenced firms of the Vietnamese Enterprise Survey 2005–2010 and the GSO input-output table (2007).
$\triangle$Log FWL Services	$log(\sum_{i=1}^{N} \alpha_{fk} TR_{jf,t}^{RD}) - log(\sum_{i=1}^{N} \alpha_{fk} TR_{jf,t-1}^{RD})$ Annual change in the forward linked foreign service firms in industries f within circle of radius RD around each domestic firm i; α_{fk} is the coefficient measuring the forward link from upstream industry f to downstream industry k in the input-output table.	Own calculations based on geo-referenced firms of the Vietnamese Enterprise Survey 2005–2010 and the GSO input-output table (2007).
$\triangle$Log BWL Services	$log(\sum_{i=1}^{N} \beta_{kb} TR_{jb,t}^{RD}) - log(\sum_{i=1}^{N} \beta_{kb} TR_{jb,t-1}^{RD})$ Annual change in the forward linked foreign service firms in industries b within circle of radius RD around each domestic firm i; β_{kb} is the coefficient measuring the backward link from upstream industry k to downstream industry b in the input-output table.	Own calculations based on geo-referenced firms of the Vietnamese Enterprise Survey 2005–2010 and the GSO input-output table (2007).
Control Variables		
$\triangle$Log No. of Dom. Firms	$log(\sum_{d=1}^{D} firm_{dk,t}^{RD}) - log(\sum_{d=1}^{D} firm_{dk,t-1}^{RD})$ Annual change in the number of domestic firms d in the same industry k within radius RD around each firm i	Own calculations based on sample of geo-referenced firms. Source: Vietnamese Enterprise Survey 2005–2010.
$\triangle$Log No. of FDI Firms in Oth. Ind.	$log(\sum_{j=1}^{J} firm_{j,-k,t}^{RD}) - log(\sum_{j=1}^{J} firm_{j,-k,t-1}^{RD})$ Annual change in the number of foreign firms j in all other industries $-k$ within radius RD around each firm i	Own calculations based on sample of geo-referenced firms. Source: Vietnamese Enterprise Survey 2005–2010.
$\triangle$Log No. of Dom. Firms in Oth. Ind.	$log(\sum_{d=1}^{D} firm_{d,-k,t}^{RD}) - log(\sum_{d=1}^{D} firm_{d,-k,t-1}^{RD})$ Annual change in the number of domestic firms d in all other industries $-k$ within radius RD around each firm i	Own calculations based on sample of geo-referenced firms. Source: Vietnamese Enterprise Survey 2005–2010.
$\triangle$Log Labor Force	$log(\sum_{i=1}^{N} L_{i,t}^{RD}) - log(\sum_{i=1}^{N} L_{i,t-1}^{RD})$ Annual change in the labor force measured as number of employees of all firms i in all industries within radius RD around each firm i	Own calculations based on sample of geo-referenced firms. Source: Vietnamese Enterprise Survey 2005–2010.
$\triangle$HHI	$\sum_{i=1}^{N} RS_{ik,t}^{2} - \sum_{i=1}^{N} RS_{ik,t-1}^{2}$ Annual change the Herfindahl-Hirschman-Index, measuring the concentration in industry k; RS is the revenue share of firm i in industry k	Own calculations. Source: Vietnamese Enterprise Survey 2005–2010.

Note: Additional control variables not shown in the table are forward and backward linkages to domestic firms. They are constructed identically as the forward and backward links to foreign firms.

Table B.3: Descriptive Statistics, Variables 2nd Stage

Variable	Mean	SD	Min	Max
Log TFP	8.50	2.04	-12.73	18.70
No. of FDI Firms same industry within 2km	1.04	3.13	0	41
No. of FDI Firms same industry within 5km	4.19	9.53	0	71
No. of FDI Firms same industry within 10km	12.29	24.58	0	151
No. of FDI Firms same industry within 20km	33.31	60.89	0	307
No. of FDI Firms same industry within 50km	66.74	104.26	0	400
No. of FDI Firms in other industries w. 2km	13.40	29.32	0	250
No. of FDI Firms in other industries w. 5km	57.90	88.00	0	549
No. of FDI Firms in other industries w. 10km	174.93	202.93	0	895
No. of FDI Firms in other industries w. 20km	511.98	540.11	0	1792
No. of FDI Firms in other industries w. 50km	1162.10	1078.68	0	2824
No. of Dom. Firms same industry w. 2km	19.32	39.88	0	374
No. of Dom. Firms same industry w. 5km	82.09	163.78	0	1083
No. of Dom. Firms same industry w. 10km	189.61	342.47	0	1839
No. of Dom. Firms same industry w. 20km	311.16	466.98	0	2177
No. of Dom. Firms same industry w. 50km	442.99	529.75	0	2305
No. of Dom. Firms other industries w. 2km	174.87	256.31	0	1477
No. of Dom. Firms other industries w. 5km	871.89	1215.05	0	5509
No. of Dom. Firms other industries w. 10km	2255.41	2816.27	0	10629
No. of Dom. Firms other industries w. 20km	4198.82	4362.99	0	14007
No. of Dom. Firms other industries w. 50km	6533.28	5449.62	0	16315
Tot. Rev. of FDI Firms same industry w. 2km	100093.29	626292.73	0	31232608
Tot. Rev. of FDI Firms same industry w. 5km	328837.22	1135717.29	0	39137876
Tot. Rev. of FDI Firms same industry w. 10km	957467.25	2242035.04	0	46199108
Tot. Rev. of FDI Firms same industry w. 20km	2882964.91	5081311.32	0	72626352
Tot. Rev. of FDI Firms same industry w. 50km	6484466.72	9947152.11	0	79454896
Tot. Rev. of Dom. Firms same industry w. 2km	266918.53	879812.54	0	56786672
Tot. Rev. of Dom. Firms same industry w. 5km	1085313.87	2491800.48	0	59184680
Tot. Rev. of Dom. Firms same industry w. 10km	2531337.59	4690283.07	0	60782644
Tot. Rev. of Dom. Firms same industry w. 20km	4421958.43	6606477.32	0	63819400
Tot. Rev. of Dom. Firms same industry w. 50km	6845696.40	8274545.71	0	65283704
Forward Link Manufacturing within 2km	37617.66	271070.67	0	17667644
Forward Link Manufacturing within 5km	122793.13	442392.01	0	18044086
Forward Link Manufacturing within 10km	357022.36	755365.05	0	18044148
Forward Link Manufacturing within 20km	1133495.24	1640861.77	0	19821206
Forward Link Manufacturing within 50km	3133920.07	3938335.80	0	22581422
Backward Link Manufacturing within 2km	58218.98	361762.98	0	15738135
Backward Link Manufacturing within 5km	192268.78	629518.34	0	18898828
Backward Link Manufacturing within 10km	594485.27	1336049.96	0	35745540
Backward Link Manufacturing within 20km	1802038.94	3028895.42	0	56167772
Backward Link Manufacturing within 50km	4454358.90	6277958.30	0	61560848
Forward Link Service within 2km	18809.66	100777.43	0	3231617
Forward Link Service within 5km	120686.37	354250.81	0	4279436
Forward Link Service within 10km	371498.34	680569.41	0	4805906
Forward Link Service within 20km	691641.92	924463.45	0	5518592
Forward Link Service within 50km	1127771.62	1222494.12	0	6451718
Backward Link Service within 2km	19549.29	167056.40	0	9920492
Backward Link Service within 5km	127136.05	601172.86	0	13172639
Backward Link Service within 10km	397668.17	1229185.76	0	14228132
Backward Link Service within 20km	700315.62	1750618.28	0	16847164
Backward Link Service within 50km	1058043.97	2302171.41	0	19576840
Total Labor force within 2km	15793.16	20774.29	0	121229
Total Labor force within 5km	71830.16	79005.63	0	357626
Total Labor force within 10km	205165.73	209403.77	0	783254
Total Labor force within 20km	491031.33	477715.79	0	1409818
Total Labor force within 50km	957948.55	806019.73	0	2071620
HHI	429.69	709.47	33	7802
Observations	164349			

Notes: xxx.

C Empirical Appendix

In this section we present several robustness checks applying variants of the basic specification.

Table C.1: Number of FDI Firms and TFP Growth of Domestic Firms, only southern Vietnam

Dep. Var.: $\triangle Log(TFP_{ik,t})$	Circle Radius				
	2km	5km	10km	20km	50km
	(1)	(2)	(3)	(4)	(5)
Panel A: Ordinary Least Squares without controls					
$\triangle$ Log No. of FDI firms within industry	0.304*	0.331**	0.326**	0.282*	0.217^{+}
	(0.119)	(0.116)	(0.121)	(0.119)	(0.113)
R^2	0.08	0.09	0.10	0.09	0.08
Observations	55500	55500	55500	55500	55500
Panel B: Ordinary Least Squares with controls					
$\triangle$ Log No. of FDI firms within industry	0.267**	0.316**	0.338**	0.313**	0.210^{+}
	(0.097)	(0.096)	(0.105)	(0.108)	(0.105)
R^2	0.08	0.10	0.10	0.09	0.08
Observations	55500	55500	55500	55500	55500
Panel C: 2SLS, Instrumented Lagged Dependent Variable					
$\triangle$ Log No. of FDI firms within industry	0.277*	0.376**	0.418**	0.339*	0.226^{+}
	(0.116)	(0.121)	(0.136)	(0.136)	(0.131)
$\triangle$ Log No. of FDI firms in other industries	−0.122**	−0.117*	−0.109^{+}	−0.078	−0.130*
	(0.042)	(0.059)	(0.063)	(0.055)	(0.060)
$\triangle$ Log No. of dom. firms within industry	0.039	−0.055	−0.116^{+}	−0.118	−0.072
	(0.064)	(0.063)	(0.069)	(0.087)	(0.132)
$\triangle$ Log No. of dom. firms in other industries	−0.012	0.035	0.038	0.013	0.024
	(0.033)	(0.030)	(0.041)	(0.049)	(0.053)
$\triangle Log(TFP_{i,t-1})$	0.535***	0.524***	0.519***	0.528***	0.538***
	(0.043)	(0.044)	(0.045)	(0.045)	(0.046)
Observations	32797	32797	32797	32797	32797
First Stage F-statistic	717.16	668.89	630.20	643.14	663.84
Panel D: Placebo Test, Lead of Change in Foreign Firms					
Lead $\triangle$ Log No. of FDI firms within industry	−0.005	−0.011	−0.011	0.007	0.033
	(0.026)	(0.033)	(0.031)	(0.027)	(0.027)
$\triangle Log(TFP_{i,t-1})$	0.429***	0.428***	0.427***	0.429***	0.430***
	(0.065)	(0.065)	(0.064)	(0.065)	(0.065)
Observations	19750	19750	19750	19750	19750
First Stage F-statistic	324.06	320.94	321.37	320.97	323.58
Time FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Province-Time FE	Yes	Yes	Yes	Yes	Yes

Notes: Dependent Variable is annual TFP growth, defined as $log(TFP_{ik,t}) - log(TFP_{ik,t-1})$. Our main explanatory variable is $\triangle$ *Log No. of FDI firms*, defined as the annual change of the log of number of foreign invested firms within a circle of radius RD. Estimations include a lagged dependent variable $\triangle log(TFP_{i,t-1})$ that is instrumented with its lagged value in levels $log(TFP_{ik,t-2})$. The control variables (Panels B, C, and D) are measured for each firm within a circle of radius RD over time, and calculated as annual change in logarithms. They include the number of domestic firms in the same industry k, the number of foreign firms in all other manufacturing industries, the number of domestic firms in all other manufacturing industries, and the labor force (total number of workers) of all manufacturing industries. Further included is the annual change of the Herfindahl-Index at the industry level. All estimations include year fixed effects, province-year fixed effects, and industry fixed effects. Huber-White standard errors in parentheses are clustered at the industry level. + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$ *** $p < 0.001$.

Table C.2: Number of FDI Firms and TFP Growth of Domestic Firms, only northern Vietnam

Dep. Var.: $\triangle Log(TFP_{ik,t})$	Circle Radius				
	2km	5km	10km	20km	50km
	(1)	(2)	(3)	(4)	(5)
Panel A: Ordinary Least Squares without controls					
$\triangle$ Log No. of FDI firms within industry	0.144^{**}	0.190^{***}	0.131^{*}	0.132^{+}	0.138
	(0.047)	(0.053)	(0.055)	(0.073)	(0.085)
R^2	0.06	0.06	0.06	0.06	0.06
Observations	32650	32650	32650	32650	32650
Panel B: Ordinary Least Squares with controls					
$\triangle$ Log No. of FDI firms within industry	0.135^{**}	0.171^{***}	0.103^{*}	0.093	0.111
	(0.044)	(0.048)	(0.046)	(0.066)	(0.078)
R^2	0.06	0.07	0.06	0.07	0.06
Observations	32650	32650	32650	32650	32650
Panel C: 2SLS, Instrumented Lagged Dependent Variable					
$\triangle$ Log No. of FDI firms within industry	0.138^{**}	0.159^{**}	0.109^{+}	0.076	0.078
	(0.052)	(0.054)	(0.060)	(0.075)	(0.083)
$\triangle$ Log No. of FDI firms in other industries	-0.074^{**}	-0.042^{+}	0.028	0.003	−0.014
	(0.027)	(0.024)	(0.040)	(0.028)	(0.022)
$\triangle$ Log No. of dom. firms within industry	0.026	0.079	0.090	0.120	0.079
	(0.038)	(0.050)	(0.059)	(0.080)	(0.094)
$\triangle$ Log No. of dom. firms in other industries	0.010	0.020	−0.001	0.070	0.055
	(0.021)	(0.024)	(0.033)	(0.046)	(0.059)
$\triangle Log(TFP_{i,t-1})$	0.507^{***}	0.504^{***}	0.506^{***}	0.507^{***}	0.507^{***}
	(0.042)	(0.042)	(0.042)	(0.042)	(0.043)
Observations	19663	19663	19663	19663	19663
First Stage F-statistic	595.35	591.44	589.63	584.41	579.18
Panel D: Placebo Test, Lead of Change in Foreign Firms					
Lead $\triangle$ Log No. of FDI firms within industry	0.039	0.037	−0.015	−0.009	0.005
	(0.047)	(0.038)	(0.036)	(0.044)	(0.038)
$\triangle Log(TFP_{i,t-1})$	0.453^{***}	0.454^{***}	0.455^{***}	0.454^{***}	0.454^{***}
	(0.083)	(0.082)	(0.083)	(0.083)	(0.083)
Observations	11411	11411	11411	11411	11411
First Stage F-statistic	275.87	278.08	275.26	273.90	276.24
Time FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Province-Time FE	Yes	Yes	Yes	Yes	Yes

Notes: Dependent Variable is annual TFP growth, defined as $log(TFP_{ik,t}) - log(TFP_{ik,t-1})$. Our main explanatory variable is $\triangle$ *Log No. of FDI firms*, defined as the annual change of the log of number of foreign invested firms within a circle of radius RD. Estimations include a lagged dependent variable $\triangle log(TFP_{i,t-1})$ that is instrumented with its lagged value in levels $log(TFP_{ik,t-2})$. The control variables (Panels B, C, and D) are measured for each firm within a circle of radius RD over time, and calculated as annual change in logarithms. They include the number of domestic firms in the same industry k, the number of foreign firms in all other manufacturing industries, the number of domestic firms in all other manufacturing industries, and the labor force (total number of workers) of all manufacturing industries. Further included is the annual change of the Herfindahl-Index at the industry level. All estimations include year fixed effects, province-year fixed effects, and industry fixed effects. Huber-White standard errors in parentheses are clustered at the industry level. + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$ *** $p < 0.001$.

Table C.3: Total Revenue FDI Firms and TFP Growth of Domestic Firms, including Ward-Time FE

Dep. Var.: $\triangle Log(TFP_{ik,t})$	Circle Radius				
	2km	5km	10km	20km	50km
	(1)	(2)	(3)	(4)	(5)
Panel A: Ordinary Least Squares without controls					
$\triangle$ Log Tot. Rev. of FDI firms	0.020*	0.022**	0.016	0.012	0.001
	(0.009)	(0.008)	(0.009)	(0.013)	(0.011)
R^2	0.18	0.18	0.18	0.18	0.18
Observations	81640	81640	81640	81640	81640
Panel B: Ordinary Least Squares with controls					
$\triangle$ Log Tot. Rev. of FDI firms	0.019*	0.020**	0.014	0.011	0.002
	(0.009)	(0.007)	(0.009)	(0.012)	(0.011)
R^2	0.19	0.19	0.18	0.18	0.18
Observations	81640	81640	81640	81640	81640
Panel C: 2SLS, Instrumented Lagged Dependent Variable					
$\triangle$ Log Tot. Rev. of FDI firms within industry	0.016^{+}	0.019*	0.013	0.003	−0.004
	(0.010)	(0.009)	(0.010)	(0.013)	(0.011)
$\triangle$ Log Tot. Rev. of FDI firms in other industries	−0.012*	0.003	0.005	0.007	−0.002
	(0.006)	(0.008)	(0.011)	(0.011)	(0.011)
$\triangle$ Log Tot. Rev. of dom. firms within industry	−0.007	−0.012	−0.005	−0.007	−0.035
	(0.005)	(0.009)	(0.012)	(0.016)	(0.029)
$\triangle$ Log Tot. Rev. of dom. firms in other industries	−0.034*	−0.074***	−0.077***	−0.021	0.037
	(0.014)	(0.016)	(0.020)	(0.034)	(0.118)
$\triangle Log(TFP_{i,t-1})$	0.543***	0.543***	0.545***	0.546***	0.545***
	(0.043)	(0.044)	(0.043)	(0.043)	(0.043)
Observations	47670	47670	47670	47670	47670
First Stage F-statistic	865.96	864.81	873.16	884.12	896.28
Panel D: Placebo Test, Lead of Change in Foreign Firms					
Lead $\triangle$ Log Tot. Rev. of FDI firms	0.004	0.006	0.003	0.000	0.005
	(0.003)	(0.004)	(0.004)	(0.005)	(0.005)
$\triangle Log(TFP_{i,t-1})$	0.470***	0.471***	0.470***	0.470***	0.470***
	(0.058)	(0.058)	(0.058)	(0.059)	(0.059)
Observations	27832	27832	27832	27832	27832
First Stage F-statistic	537.74	537.95	535.70	535.98	536.12
Time FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Ward-Time FE	Yes	Yes	Yes	Yes	Yes

Notes: Dependent Variable is annual TFP growth, defined as $log(TFP_{ik,t}) - log(TFP_{ik,t-1})$. Our main explanatory variable is $\triangle$ *Log Tot. Rev. of FDI firms*, defined as the annual change of the log of the total revenue of foreign invested firms within a circle of radius RD . Estimations include a lagged dependent variable $\triangle log(TFP_{i,t-1})$ that is instrumented with its lagged value in levels $log(TFP_{ik,t-2})$. The control variables (Panels B, C, and D) are measured for each firm within a circle of radius RD over time, and calculated as annual change in logarithms. They include the sum of total revenue of all other domestic firms in the same industry k , the sum of total revenue of foreign firms in all other manufacturing industries, the sum of total revenue of domestic firms in all other manufacturing industries, and the labor force (total number of workers) of all manufacturing industries. Further included is the annual change of the Herfindahl-Index at the industry level. All estimations include time fixed effects, ward-time fixed effects, and industry fixed effects. Huber-White standard errors in parentheses are clustered at the industry level. + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$ *** $p < 0.001$.

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