Productivity spillovers from foreign multinationals and trade policy: firm-level analysis of Vietnamese manufacturing

Truong Thi Ngoc Thuyen
Asian Institute of Technology and University of Dalat
Juthathip Jongwanich, Asian Institute of Technology
Eric D. Ramstetter, ICSEAD and Kyushu University

Working Paper Series Vol. 2014-10
June 2014

The International Centre for the Study of East Asian Development, Kitakyushu

Productivity spillovers from foreign multinationals and trade policy: firm-level analysis of Vietnamese manufacturing

Truong Thi Ngoc Thuyen[1]*, Juthathip Jongwanich[2] and Eric D. Ramstetter[3]

Abstract

This article examines how the presence of foreign multinational enterprises (MNEs) affects productivity in local firms in Vietnamese manufacturing in 2005-2010. The paper also emphasizes how import protection has affected these productivity spillovers and how spillovers from wholly-foreign MNEs and joint ventures differ. The most consistent result suggests wholly-foreign MNEs impart negative spillovers while joint ventures generate positive spillovers. Theory and random effects estimates also indicate that import protection reduces local firm productivity and weakens the effect of spillovers from all MNEs, but this result is not obtained when a fixed effects estimator is used. Results are similar in samples of labour-intensive industries, which include close to three-fourths of all sample firms, but differ markedly for more capital-intensive groups.

JEL codes: F23, L60, O24, O53

Keywords: multinational enterprise, spillover, trade policy, manufacturing, Vietnam

[1] Asian Institute of Technology, Pathumthani, Thailand and University of Dalat, Dalat, Vietnam
*Corresponding author. Email: thuyenttn@dlu.edu.vn
[2] Asian Institute of Technology, Pathumthani, Thailand
[3] The International Centre for the Study of East Asian Development, Kitakyushu, Japan and Graduate School of Economics, Kyushu University, Fukuoka, Japan

I. Introduction

Developing economies often encourage foreign direct investment (FDI) by foreign multinational enterprises (MNEs) with the hope that they will contribute to improvements in production technology, marketing networks and know-how, and management skills. MNEs make direct contributions to the local economy and can also affect the productivity, wages, exports, and other activities of local firms through spillovers. Spillovers can occur when local firms learn from linkages with MNEs, hiring workers from MNEs, imitating MNEs, for example. Although many developing economies offer FDI incentives with the expectation of benefitting from spillovers, empirical evidence for Vietnam and other developing economies is mixed.

This paper adds to the existing literature by reexamining productivity spillovers during 2005-2010 in Vietnam, when the economy further liberalized while joining the World Trade Organization (WTO) in 2006. Examination of this recent period is important because previous studies have focused on the early 2000s, when the implementation of the Enterprise Law led to an unusually rapid growth in the number of private firms and correspondingly large changes in Vietnam's corporate landscape. The paper also contributes by emphasizing interactions between the trade policy regime and spillovers, which are particularly important during this period and have not been examined in previous studies.

Section II presents a brief literature review and the analytical framework. Section III then reviews patterns of MNE presence and trade liberalization, as well as important characteristics of the enterprise census data used in the study. The empirical model and variable measurement are detailed in Section IV and Section V analyzes empirical results. Section VI concludes.

II. The Literature and Analytical Framework

Spillovers occur when MNE presence affects local firms and can occur through several channels. First, spillovers may result from forward or backward linkages between MNEs and local firms, though backward linkages are usually thought to be more important (Dunning, 2008). Second, labour mobility can be an important source of spillovers, especially when relatively skilled workers move from MNEs to local firms or startup new local firms (Chen, 1983; Görg and Strobl, 2005; Katz, 1987; Kohpaiboon, 2006b).[4] However, MNEs often seek to minimize the turnover of high quality employees by paying higher wages and offering better benefits than local firms (Fosfuri, et al., 2001; Javorcik, 2004; Moran, 2002). Third, MNE presence often increases competition and encourage domestic firms to improve efficiency, often by imitating MNEs (Kokko, 1994; Meyer and Sinani, 2009; Wang and Blomstrom, 1992).

Most reviews of the large empirical literature on productivity spillovers emphasize that previous results have varied substantially depending on the economies and industry groups studied, the measure of foreign presence, and estimation methodology used (Gorg and Strobl, 2001; Görg and Greenaway, 2004; Lipsey and Sjöholm, 2005). For example, studies of Lithuania (Javorcik, 2004), Mexico (Kokko, 1994), China (Hale and Long, 2011), and Indonesia (Blalock and Gertler, 2008; Takii, 2005) often find positive productivity spillovers, while evidence for Venezuela (Aitken and Harrison, 1999), Morocco (Haddad and Harrison, 1993), the Czech Republic (Djankov and Hoekman, 2000), and Malaysia (Khalifah and Adam, 2009) suggests predominantly negative or insignificant spillovers. Estimates of spillovers also tend to be larger when estimated in cross section, but recent studies generally use fixed effects estimators primarily because they control for unobserved characteristics among local

[4] See also Czinkota *et al.*, (1999) and Meyer & Sinani, (2009). Blomström and Kokko (1996) argue that this effect is important in developing countries because education systems tend to be weak.

firms and are thus less vulnerable simultaneity problems that arise if MNEs are attracted to high productivity industries.

Standard international economics also emphasizes how high import protection creates large static welfare losses to small, open economies like Vietnam.[5] Protection may also create benefits associated with the growth of infant or strategic industries, but such benefits are probably minuscule in poor economies with weak industrial bases, like Vietnam. In this study, we focus on interactions between protection and spillovers. The rationale for this focus goes back to theoretical literature on immiserization ((Bhagwati, 1973, 1985; Brecher and Findlay, 1983; Brecher and Alejandro, 1977), who emphasized how capital inflows into a protected industry can result in welfare losses when profits earned by the foreign capital was repatriated.

In other words, import protection distorts resource allocation and reduces motives for productivity improvement. Correspondingly, some recent literature suggests that negligible or negative spillovers are more when protection is high (Moran, 2002; Kohpaiboon, 2006a). This is because MNEs often produce for relatively limited local markets, which they often dominate. In addition, when protection is high, MNEs and local firms are often more motivated to lobby for protection than to pursue productivity gains. In contrast, export promotion usually entails lower levels of protection, greater emphasis on international competitiveness, and thus fosters incentives for productivity improvements. Under export promotion, local firms are thus likely to be more motivated to imitate and better able to learn from MNEs, leading to greater spillovers.

Recent empirical studies of India (Kathuria (2002), Thailand (Kohpaipoon, 2006a), and Uruguay (Kokko *et al.,* 2001) provide evidence that spillovers from MNEs tended to be larger when protection was relatively low. Similarly, evidence for India (Ramaswamy, 1999), Thailand (Kohpaipoon, 2003) and Australia (Chand, 1999) also suggests that productivity

[5] Vietnam depends heavily on international trade; merchandise imports accounted for an average of 60% of GDP, and exports 73% , during 2005-2010 (Asian Development Bank 2013).

growth or FDI's growth effects were larger when protection was lower. Ruan and Gopinath (2008) also find that food industry productivity was higher in countries where protection was lower.

For Vietnam, cross section, Cobb-Douglas estimates from Nguyen, T.T.A. et al.(2006) indicated "little evidence of positive spillover effects at the firm level", but "no signs of negative spillover effect either" (p. 56). In contrast, Pham's (2008) cross section, Cobb-Douglas estimates generally suggested positive spillovers that were largest in Hanoi and Ho Chi Minh City, and from MNEs that were not wholly-foreign. Other cross section, Cobb-Douglas estimates from Nguyen, P.L.(2008) suggest that both horizontal and vertical spillovers were generally positive and largest in more advanced regions and in more sophisticated local firms. Using an unbalanced panel of the same data, Nguyen, N.A. et al. (2008) finds that backward, vertical spillovers were positive in manufacturing, while horizontal spillovers were positive in services. Le and Pomfret (2011) also used an unbalanced panel of all industrial firms, finding positive backward spillovers in manufacturing, but negative horizontal spillovers, which were relatively strong on private firms, domestic-oriented firms, firms without RandD, and firms in low technology industries. In contrast, translog, estimates by Ramstetter and Phan (2013) find no significant spillovers in unbalanced panels. In sum, reflecting the results for other countries, previous results for Vietnam suggest some degree of positive spillovers, especially in cross sections, but results vary markedly depending on specification, sample, and productivity measures, and evidence from panel analysis is relatively weak.[6] And although there are studies of trade liberalization (Athukorala, 2006; Anwar and Nguyen 2011; Bui and Kobayashi 2012), we know of no study

[6] Ramstetter and Phan (2008, 2013), Nguyen, N.A. et al. (2008), Nguyen, T.T.A. et al. (2006) use value-added-based estimates of productivity, while Le and Pomfret (2011) and Nguyen, P.L. (2008) use a sales-based measure.

that has investigated the interaction between the trade protection and productivity spillovers in Vietnam.

III. Foreign Presence in Vietnamese Manufacturing

Since the 1990s, FDI has been a relatively large source of foreign capital in Vietnam. MNEs accounted for 15% of Vietnam's GDP by 2005 with this share rising to 18% in 2010 according to revised national accounts data (General Statistics Office 2014). State-owned enterprises (SOEs) were even larger producers with corresponding GDP shares of 38 and 33%, respectively. MNEs accounted for larger shares of Vietnam's exports, 57 and 54% respectively. In other words, MNEs depended more on exports than local firms in Vietnam, partially because Vietnam encouraged export-oriented MNEs.

MNE shares of manufacturing production are substantially larger than corresponding shares of total GDP because Vietnam's household sector (mainly in agriculture and informal services) continues to account for about one-third of GDP (32-33% in 2005 and 2010; General Statistics Office, 2014) and because MNEs are more concentrated in manufacturing than SOEs or private firms. Correspondingly, MNEs accounted for 43-50% of the revenue, 46-57 of the fixed assets, and 39-48% of employment in samples of manufacturing enterprises used in this study (Table 1). These data are compiled from firm-level data underlying the annual enterprise census(General Statistics Office, various years). These censuses include the firms in all industries, but exclude household enterprises. This study focuses on manufacturing industries because manufacturing spillovers have been a focus of attention in Vietnam and in previous studies.

The data set is a highly unbalanced panel with 10,197-12,513 observations in 2005-2007, 7,188 observations in 2008, and 16,983-18,060 observations in 2009-2010. Rapid increases in number of employees and firms 2005-2010 primarily results from relatively rapid growth of

local, private firms. Private shares of employment grew from 42 to 44% of employment, and growth was even more rapid if calculated in terms of the number of firms. However, samples of all ownership types were relatively small because it was impossible to make realistic estimates of value added for many firms.

An important characteristic of these the firm-level data is that they do not contain information data on intermediate inputs. Intermediate inputs and value added are thus estimated from a separate data set containing information on revenue by major product and estimates of intermediate inputs for each product that are calculated using input-output ratios provided by the data source. Value added estimates are thus approximate and not reported or negative for many firms in 2007-2008. In order to facilitate productivity spillover estimates, firms that did not report positive values for revenue, value added, fixed assets, or employment, or lacked industry codes were dropped from the samples. In addition, it was necessary to remove several duplicate records, which are defined as firms with the same identity codes and the same values for revenue, fixed assets, and employment.[7]

Previous studies have also emphasize that predominantly small, local enterprises with under 20 employees usually have little connection with MNCs (Kokko and Sjoholm 2005, Ramstetter and Phan 2013). Thus, these small firms are also dropped from the samples. This adjustment also has the advantage of removing many outliers. Because lagged values of capital (fixed assets) and employment are used, data for 2004 were processed similarly.

As illustrated in Table 2, MNE shares of revenues varied greatly among industries. Shares were two-thirds or more in most of the machinery industries (office and computing, communication, and precision machinery, motor vehicles, other transport machinery), as well as leather and footwear (the vast majority of which is footwear). Large MNE shares are

[7] Many Vietnamese economists we consulted suggest that these data are less reliable for recent years (e.g., from 2007) than data for earlier years, partially because the number of firms has increased much more rapidly than the statistical authority's ability to track those firms.

common in machinery, largely because it is relatively easy to locate labour-intensive stages of production in labour abundant economies like Vietnam and because it is relatively cheap for MNEs to use their intangible capital (technology, market networks, etc.) in various locations.[8] The large MNE share in footwear results from large presence of many East Asian subcontractors to major multinationals like Nike and Adidas, for example. At the other end of the spectrum, shares were lowest in printing and publishing and in tobacco, largely because the government closely regulates these industries in Vietnam. Most of the MNEs in Vietnam are wholly foreign because Vietnam has long had relatively few overt restrictions on foreign ownership shares. On the other hand, joint ventures are relatively common in industries like motor vehicles, other transport machinery, oil and coal products, and non-metallic mineral products because the government has activity promoted joint ventures, especially with SOEs, in these industries.

As part of commitments under the ASEAN Free Trade Area, a bilateral agreement between Vietnam and the United States, and the WTO accession, tariffs on manufactures have declined over the past decade. However, there is still a wide variation of tariffs among products and tariff remain higher than neighboring countries (Athukorala, 2006). Correspondingly, effective rates of protection (ERPs) exceeded 40% in 2006-2010 in tobacco, apparel, leather and footwear, and furniture and miscellaneous manufacturing.[9] As mentioned above, the former industry is closely regulated, while the latter industries are all relatively labour intensive and sources of large exports from Vietnam. On the other hand, effective protection is notably low in wood, printing and publishing, the two metals industries, and four

[8] For example, Winkler (2012) reports that 21% of MNEs in Vietnam are relatively small-scale, subcontractors of large multinational companies. He also reports that 65% of MNEs are in labour-intensive industries such as apparel, shoes, light electronics and food processing.

[9] ERPs are calculated using the formula $ERP_j = \frac{t_j - \sum_{i=1}^{n} a_{ij} t_i}{1 - \sum_{i=1}^{n} a_{ij}}$ where t_j is nominal tariff on sector j, a_{ij} is the share of intermediate input i in the final value of product j. In other words, ERPs depend on both tariffs for final product and on related intermediate products.

of the machinery industries (non-electric, electrical, communication, and precision). Especially in the latter four machinery industries, relatively low protection often results because MNEs that dominate them lobby for low tariffs in order to facilitate trade in intermediate products.

IV. Empirical Model

Spillovers are estimated using the standard methodology of adding industry-level MNE shares to a translog production function estimated in samples of local firms.[10] The analysis is distinguished by addition of industry-level estimates of the ERP and interacting the ERP and MNE share variables to see if spillovers depend on the level of protection. Similar to Ramstetter and Phan (2013), the effect of market competition is controlled for by adding another industry-level variable, the four-firm concentration ratio (CR4), as an independent variable.[11] These industry variables are all measured at the 2-digit level of Vietnam's standard industrial classification. Because the samples include all local firms, and SOEs differ from private firms in important ways, intercepts (a measure of total factor productivity) are allowed to differ between SOEs and private firms.

The resulting specification is shown in equation (1) below:

$$Y_{ij} = \beta_o + \beta_1(FOR_j) + \beta_2\,(FOR_j * TP_j) + \beta_3(TP_j) + \beta_4\,(SOE_{ij}) + \beta_5(CR4_j) + \beta_6(L_{ij}) + \beta_7(L_{ij})^2 + \beta_8(K_{ij}) + \beta_9(K_{ij})^2 + \beta_{10}(L_{ij} * K_{ij}) + \varepsilon_{ij} \quad (1)$$

[10] The translog specifications allows for flexible assumptions about scale economies and elasticities of substitution. Ramstetter and Phan (2013) report that tests of Cobb-Douglas restrictions are usually rejected using the Vietnamese census data.

[11] Ramstetter and Phan (2013) also compared results using the Herfindahl Index but they did not differ much from results using CR4.

where

Y_{ij} = log of value added of firm i in industry j; calculated by deducting an estimate of intermediate cost from gross output as described above;

FOR_j = MNE share of output in industry j, %;

TP_j = effective protection rate in industry j, %;

SOE_{ij} = dummy variable identifying SOEs, %;

$CR4_j$ = the four-firm concentration ratio in industry j, %;

L_{ij} = log of the number of workers in firm i in industry j lagged one year;

K_{ij} = log of fixed assets (book values) in firm i in industry j lagged one year.

Real values of value added and fixed asset values are estimated in 1994 prices using corresponding 2-digit deflators for industrial output, which is reasonable for value added but less appropriate for fixed asset values; unfortunately no alternative is available. β_6 and β_8, marginal products of K and L, are expected to be positive, but $\beta_7, \beta_9,$ and β_{10} can be negative. Sign of β_4 reveals the difference in total factor productivity between SOEs and private firms. K and L are lagged one year to reduce possible endogeneity problems.[12]

As described above, endogeneity problems can also be mitigated by using a fixed effects estimator, which reveals how changes in MNE ownership or protection affect local firm productivity. Fixed effects estimates also make it possible to control for other, unobserved firm-level characteristics (Wooldridge, 2009). However, MNE shares and ERPs changed relatively little in many industries during the period studied (2005-2010), so it is also important to compare results from random effects estimates, which control for individual effects under alternative assumptions. In order to account for year-specific fluctuations in

[12] Lagged values were also tried as instrumental variables, but results of diagnostic tests suggest that the equation perform more reasonably if lagged values are used directly in equation (1).

local-firm productivity, time dummies are added to all equations. Industry dummies are included in random effects estimates, but excluded from fixed effects estimates because most firms are in the same industry throughout the sample.

The effects of concentration or MNE presence on local firm productivity are indeterminant *a priori*. However, for Vietnam during this period, we expect the direct effect of ERP (β_3) to be negative because higher ERPs are likely to reduce motives to pursue high productivity in local firms. Because protection is also likely to reduce the scope for positive spillovers from MNEs as described above, the sign of β_2 is expected to be negative. However, the signs of direct MNE spillovers (β_1) and total spillover, including the interaction of spillovers with trade protection ($\beta_1 + \beta_2 TP_j$) are indeterminant, as is the sign of (β_5).

We also investigate whether spillovers from wholly-foreign MNEs differ from spillovers from MNE joint ventures by estimating the following equation:

$$Y_{ij} = \alpha_o + \alpha_1(WOS_j) + \alpha_2(JVS_j) + \alpha_3(WOSj * TP_j) + \alpha_4(JVSj * TP_j) + \alpha_5(TP_j) + \alpha_6(SOE_{ij}) + \alpha_7(CR4_j) + \alpha_8(L_{ij}) + \alpha_9(L_{ij})^2 + \alpha_{10}(K_{ij}) + \alpha_{11}(K_{ij})^2 + \alpha_{12}(L_{ij} * K_{ij}) + \varepsilon_{ij} \qquad (2)$$

where

WOS_j = wholly-foreign MNE share of output in industry j

JVS_j = MNE joint venture share of output in industry j

Here again the signs of direct spillover coefficients are not clear though the previous research reviewed above suggests a weak tendency from spillovers to be relatively small from MNEs with large foreign ownership shares ($\alpha_1 < \alpha_2$). However, here again we expect protection to reduce the scope of spillovers ($\alpha_3 < 0,\ \alpha_4 < 0$).

In order to examine how the impacts of protection and spillovers changed over time, we compare estimates for the entire period studied (2005-2010) with results for two subperiods (2005-2007 and 2008-2010). Furthermore, because we are interested in the effects of trade policy and Vietnamese exports tend to be labour intensive, we also examine spillovers in three subsamples of industries sorted by capital intensity.[13] Results for these subsamples also provide important robustness checks.

V. Results

Random and fixed effects estimates of equations (1) and (2) in samples of all industries are presented in Tables 4 and 5, respectively. The Hausman test indicates that fixed effects estimates should be preferred to random effects estimates for both equations in all periods examined. However, in the fixed effects estimates coefficients on capital and labour are often insignificant and R-squared is quite low, suggesting that the production function does not perform well when fixed effects are assumed. On the other hand, if random effects are assumed, the underlying model performs more or less as expected. Moreover, because MNE

[13] To do this, we calculate the mean and standard deviation (SD) of the log of capital-labour ratio for each 2-digit manufacturing industry. When an industry's capital-labour ratio is lower than the mean minus SD, the industry is classified as low-capital intensity (apparel; textile; leather and footwear; wood and wood products; furniture and miscellaneous manufacturing; printing and publishing; non-electric machinery; precision machinery). When the capital-labour ratio is higher than the mean plus SD, it is defined as a capital intensive industry (oil and coal products; tobacco; basic metals; office and computing machinery, rubber and plastic products; chemicals; motor vehicles; other transport machinery; electrical machinery; communication machinery). Other industries (food and beverages; paper and paper products, fabricated metal, non-metallic mineral products) had intermediate capital intensity.

shares and ERPs change little over this relatively short period, random effects results are probably more meaningful economically (Wooldridge, 2009).

Productivity spillovers and protection effects in all industries

When equation (1) is estimated in large samples of all local firms, the coefficient on MNE presence was generally negative and significant, regardless of estimation method, the exception being random effects estimates for 2008-2010. In other words, these results suggest negative, direct spillovers from MNEs. Estimates also suggested that these negative, direct spillovers were stronger in 2005-2007 than in 2008-2010.

Random effects estimates of equation (1) also suggest that the negative spillovers are smaller in industries where protection is relatively high, and this interaction effect was strongest in 2008-2010 (Table 4). Moreover, the coefficient on the interaction variable was several times larger than the direct spillover coefficient in absolute value, suggesting that this interaction effect was relatively strong. Thus, the negative effects of protection appear to be relatively large, and to mitigate negative spillovers from MNEs. However, the direct protection effect and protection-spillover interaction effect were both statistically insignificant in fixed effects estimates (Table 5). In other words, this key result is not robust to the estimation method, probably because of the relatively small variation in protection over time in these short panels.

Random effects estimates of equation (2) for 2005-2010 and 2005-2007 further suggest that spillovers from joint ventures were significantly positive, but that spillovers from wholly foreign MNEs were significantly negative (Table 4). These estimates also suggest positive spillovers from joint ventures in 2008-2010 but insignificant spillovers from wholly foreign MNEs. Fixed effects estimates also indicate negative spillovers from wholly-foreign MNEs but insignificant spillovers from joint ventures in all periods (Table 5). The finding of similar

spillovers from all MNEs and wholly foreign MNEs reflects the fact that wholly-foreign MNEs accounted for the vast majority of sales by MNEs in most industries during this period.[14] The finding of significant spillovers contrast with Ramstetter and Phan (2011), who fail to find consistent evidence of spillovers from either joint ventures or wholly foreign firms in earlier periods.

These results are consistent with several previous results suggesting that spillovers from joint ventures are likely to larger than spillovers from wholly foreign firms (Javorcik & Spatareanu, 2008; Javorcik, 2004; Takii, 2005). Limited linkages between indigenous firms and wholly foreign MNEs probably hinder spillovers in some industries. For example, in several of the Vietnam's machinery industries there were relatively few firms and wholly foreign MNEs had relatively large market shares (Table 2). In other words, in several industries, there were relatively few local firms and wholly foreign firms often operated in enclaves, importing most of their inputs and often exporting most of their output. This is not surprising in a relatively poor economy such as Vietnam, which still has a relatively weak industrial base.

Although distinguishing between wholly foreign MNEs and joint ventures appears important for estimating direct spillovers, the effects of import protection remain qualitatively similar. Namely, random effects estimates of equation (2) suggest that the coefficient on the interaction terms between protection and all MNE shares (joint venture or wholly foreign) are negative and significant (Table 4). In addition, the direct effect of protection is also negative and significant in all estimates. In other words, higher protection leads to lower productivity in local firms both directly and indirectly by reducing positive spillovers from joint ventures and amplifying negative spillovers from wholly foreign MNEs. This reflects that fact that

[14] For example, the mean total MNE share in the 23 industries listed in Table 2 was 48%, while the mean share of wholly foreign MNEs was 34%. In the 15 industries where total MNE shares exceeded 40%, wholly foreign shares averaged were above two-thirds in 10 industries (Table 2).

high protection increases the tendency of MNEs to serve the domestic market and enjoy economic rents induced by protection. It also implies that liberalization could promote higher productivity in local firms directly and increase positive spillovers from all MNE ownership groups. However, this result is again not robust to estimation method with all coefficients on protection or protection-related interaction terms becoming insignificant when a fixed effects estimator is used (Table 5). Here again, relatively small changes in effective rates of protection during the period studied are a major reason that fixed effects estimates differ.

Productivity spillovers by level of labour intensity

Because most sample observations (over 25,000 out of totals of less than 34,000) and most of Vietnam's major exports (food and beverages, footwear, electronics-related machinery [mainly parts]) are labour intensive, we examine spillovers and the effects of protection in subsamples of firms in labour-intensive industries, capital-intensive industries, and industries with intermediate levels of labour intensity. These estimates also provide important robustness checks. Because space is limited, only the spillover, protection, and interaction coefficients from these estimates are reported in Tables 6-11.

The most prominent result is that estimates for labour-intensive industries closely resemble results for all industries, while results for the other two groups contrast markedly. Random effects results generally suggest negative spillovers from all MNEs (equation 1) or wholly foreign MNEs (equation 2) in 2005-2010 and 2005-2007, as well as positive spillovers from joint ventures in all periods (Table 6). Higher protection also reduces local firm productivity directly and exacerbates negative spillovers from MNEs, and all protection-related coefficients were significant. Spillover coefficients were also negative for all MNEs or wholly-foreign MNEs but positive for joint ventures in all fixed effects results (Table 7), but the effects of protection, direct or indirect through spillovers, become statistically insignificant. Because the vast majority of local firms were in labour intensive industries, it is

not surprising that results for labour-intensive industries dominate results for all industries combined.

In industries with moderate labour intensity, there is also some evidence of negative spillovers from wholly-foreign MNEs in 2005-2010 and 2005-2007 in both random effects and fixed effects estimates (Tables 8-9). However, coefficients on shares of all MNEs combined or joint ventures were usually insignificant statistically. And in capital-intensive industries all spillover coefficients were statistically insignificant at the standard 5% level or better (Tables 10-11). Coefficients on all protection variables were also insignificant at standard levels in industries with moderate labour intensity and were usually insignificant in capital intensive industries as well. The exception was the significantly negative, direct of protection in capital intensive industries in equation (1) for 2005-2010 and 2005-2007. It should also be pointed out that the explanatory power of equations (1) and (2) was weaker in capital intensive industries (R^2 of 0.04-0.06 for 2005-2010) and particularly in industries of moderate capital intensity (R^2 of 0.003-0.03 for 2005-2010) than in labour-intensive industries (R^2 of 0.06-0.14 for 2005-2010). The major results thus pertain primarily to labour-intensive industries, while evidence for other industry groups was weaker.

VI. Conclusions and policy inferences

This study generates two key results. First, most random effects estimates and all fixed effects estimates for all industries and for labour-intensive industries suggest negative productivity spillovers to local firms from the presence of all MNEs or wholly foreign MNEs, but positive spillovers from the presence of joint ventures. The result is clearly related to the facts that most local firms are in labour-intensive industries, wholly foreign MNEs account for large shares in many industries with large MNE presence. In addition, it probably relates to the tendency of wholly foreign MNEs to be concentrated in import-dependent, export-

oriented enclaves with limited linkages to local firms and is qualitatively consistent with several results for other countries. On the other hand, this result should be interpreted cautiously because previous spillover estimates, including those for Vietnam, are notoriously inconsistent among countries, industries, periods, and estimation methods. It is also important to recognize that Vietnam's firm-level data are relatively unreliable for the recent years studied here.

The second key result is observed in random effects results for all industries and labour-intensive industries and suggests that high effective rates of import protection have strong negative effects on local firm productivity and on the extent of spillovers (positive or negative) from MNEs. This result is also obvious to most international economists *a priori* because import protection clearly has large negative effects on static welfare in small, open economies like Vietnam. It also seems highly unlikely that local firms in Vietnam have reaped dynamic gains from infant industry protection. Thus, although econometric tests suggest that the fixed effects estimates should be preferred, the random effects results appear more economically reasonable in this important respect. The obvious policy implication, which extends well beyond consideration of spillovers, is that Vietnam's economy can benefit substantially from lowering import barriers and making them more uniform across industries.

References

Aitken, B., Harrison, A., and Lipsey, R. E. (1996). Wages and foreign ownership: A comparative study of Mexico, Venezuela, and the United States. *Journal of International Economics*, ***40***, 345.

Aitken, B. J., and Harrison, A. E. (1999). Do domestic firms benefit from direct foreign investment? Evidence from Venezuela. *The American Economic Review*, ***89***, 605–618.

Anwar, S., and Nguyen, L. P. (2011). Foreign direct investment and trade: The case of Vietnam. *Research in International Business and Finance*, ***25***, 39–52.

Athukorala, P. (2006). Trade policy reforms and the structure of protection in Vietnam. *World Economy*, ***29***, 161–187.

Bhagwati, J. (1973). The theory of immiserising growth: Further applications. In *International trade and money*. Toronto: University of Toronto Press.

Bhagwati, J. (1985). Protectionism: Old wine in new bottles. *Journal of Policy Modeling*, ***7***, 23–33.

Blalock, G., and Gertler, P. J. (2008). Welfare gains from Foreign Direct Investment through technology transfer to local suppliers. *Journal of International Economics*, ***74***, 402.

Blomström, M., and Kokko, A. (1996). The impact of foreign investment on host countries: A review of the empirical evidence. *Policy Research Working Paper*, *1745*.

Brecher, R. A., and Alejandro, C. F. D. (1977). Tariffs, foreign capital and immiserizing growth. *Journal of International Economics*, ***7***, 317–322.

Brecher, R. A., and Findlay, R. (1983). Tariffs, foreign capital and national welfare with sector-specific factors. *Journal of International Economics*, ***14***, 277–288.

Bui, T., and Kobayashi, K. (2012). Measuring the effective rate of protection in Vietnam's economy with emphasis on the manufacturing industry: An input-output approach. *Depocen, WP Series*, (2010/12).

Chand, S. (1999). Trade liberalization and productivity growth: Time-series evidence from Australian manufacturing. *Economic Record*, ***75***, 28–36.

Chen, K. (1983). *Multinational Corporations, Technology and Employment*, Macmillan, London.

Czinkota, M. R., Ronkainen, I. A., and Moffet, M. H. (1999). *International Business*, 5th ed., The Dryden Press, Forth Worth.

De Mello, L. (1997). Foreign direct investments in developing countries and Growth: A selective survey". *Journal of Development Studies*, ***34***, 11–34.

Djankov, S.and Hoekman, B. (2000). Foreign investment and productivity growth in Czech enterprises. *The World Bank Economic Review*, ***14***, 49.

Dunning, J. H. (2008). *Multinational Enterprises and the Global Economy*, 2nd ed., Edward Elgar, Cheltenham.

Fosfuri, A., Motta, M. and Rønde, T. (2001). Foreign direct investment and spillovers through workers' mobility. *Journal of International Economics*, ***53***, 205–222.

General Statistics Office. (various years). *Enterprises Annual Census data base*. Retrieved from www.gso.gov.vn

Görg, H. and Greenaway, D. (2004). Much ado about nothing? Do domestic firms really benefit from foreign direct investment? in *The World Bank Research Observer*, ***19***, 171–197.

Gorg, H. and Strobl, E. (2001). Multinational companies and productivity spillovers: A meta-analysis. *The Economic Journal*, ***111***, 723–739.

Görg, H. and Strobl, E. (2005). Spillovers from foreign firms through worker mobility: an empirical investigation. *The Scandinavian Journal of Economics*, ***107***, 693–709.

Haddad, M. and Harrison, A. (1993). Are there positive spillovers from direct foreign investment? Evidence from panel data for Morocco. *Journal of Development Economics*, ***42***, 51.

Hale, G. and Long, C. (2011). Are there productivity spillovers from foreign direct investment in China? *Pacific Economic Review*, ***16***, 135–153.

Javorcik. (2004). Does foreign direct investment increase the productivity of domestic firms? In search of spillovers through backward linkages. *The American Economic Review*, ***94***, 605–627.

Javorcik, B. S. and Spatareanu, M. (2008). To share or not to share: Does local participation matter for spillovers from foreign direct investment? *Journal of Development Economics*, ***85***, 194–217.

Kathuria, V. (2002). Liberalisation, FDI and productivity spillovers - an analysis of Indian manufacturing firms. *Oxford Economic Papers*, ***54***, 688–718.

Katz, J. (1987). *Technology creation in Latin American manufacturing industries*, St.Martin's Press, NewYork.

Khalifah, N. A. and Adam, R. (2009). Productivity spillovers from FDI in Malaysian manufacturing: Evidence from micro-panel data. *Asian Economic Journal*, ***23***, 143–167.

Kohpaiboon, A. (2003). Foreign trade regime and the FDI- growth nexus: A case study of Thailand. *Journal of Development Studies*, ***40***, 55–69.

Kohpaiboon, A. (2006a). Foreign direct investment and technology spillover: A cross-industry analysis of Thai manufacturing. *World Development*, ***34***, 541–556.

Kohpaiboon, A. (2006b). *Multinational enterprises and industrial transformation: Evidence from Thailand*, Edward Elgar Publishing, Cheltenham.

Kokko, A. (1994). Technology, market characteristics and spillovers. *Journal of Development Economics*, ***43***, 279.

Kokko, A. and Sjoholm, F. (2005). The internationalization of Vietnamese small and medium-sized Enterprises. *Asian Economic Papers*, ***4***, 152–177.

Kokko, A., Zejan, M. and Tansini, R. (2001). Trade regimes and spillover effects of FDI: Evidence from Uruguay. *Weltwirtschaftliches Archiv*, ***137***, 124–149.

Le, H. Q. and Pomfret, R. (2011). Technology spillovers from foreign direct investment in Vietnam: horizontal or vertical spillovers? *Journal of the Asia Pacific Economy*, ***16***, 183–201.

Lipsey, R. E. and Sjöholm, F. (2005). The impact of inward FDI on host countries: why such different answers? in *Does Foreign Direct Investment Promote Development, Institute for International Economics and Center for Global Development*, *Washington DC,* 23–43.

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

Moran, T. (2002). The relationship between trade, foreign direct investment and development: new evidence, strategy and tactics under the Doha Development Agenda negotiations, in *Asian Development Bank's Study on Regional Integration and Trade: Emerging Policy Issues for Selected Developing Member Countries*, Asian Development Bank, Manila.

Nguyen, L. P. (2008). Productivity spillovers from foreign direct investment: Evidence from Vietnamese firm data. *SSRN Working Paper Series*.

Nguyen, N. A., Nguyen, T., Le, D. T., Nguyen, D. C. and Nguyen, D. N. (2008). *FDI in Vietnam: is there any evidence of technological spillover effects,* Central Institute for Economic Management*, Hanoi*.

Nguyen, T. T. A. (2006). *Tác động của đầu tư nước ngoài đến tăng trưởng kinh tế Việt Nam*, Central Institute for Economic Management, Hanoi.

Ramaswamy, K. V. (1999). Productivity growth, protection and plant entry in a deregulating economy: The case of India. *Small Business Economics*, ***13***, 131–139.

Ramstetter, E.D. and Phan, M.D. (2013). Productivity, ownership and producer concentration in transition: Further evidence from Vietnamese manufacturing. *Journal of Asian Economics*, ***25***, 28–42.

Ruan, J. and Gopinath, M. (2008). Global productivity distribution and trade liberalisation: evidence from processed food industries. *European Review of Agricultural Economics*, *35*(4), 439–460.

Takii, S. (2005). Productivity spillovers and characteristics of foreign multinational plants in Indonesian manufacturing 1990–1995. *Journal of Development Economics*, ***76***, 521–542.

Wang, J. Y. and Blomstrom, M. (1992). Foreign investment and technology transfer: a simple model. *European Economic Review*, ***36***, 137.

Wooldridge, J. M. (2009). *Introductory econometrics: a modern approach*, Cengage Learning, Mason.

Table 1 Trends in production and employment of sample manufacturing enterprises

	2005	2006	2007	2008	2009	2010
Value added (trillion VND)	151.99	182.94	354.92	181.77	597.74	737.92
MNEs (%)	44.97	47.59	48.64	41.24	29.55	32.79
SOEs (%)	26.24	22.34	16.21	18.41	15.63	11.73
Revenue (trillion VND)	686.81	839.24	972.41	638.83	1794.60	2345.60
MNEs (%)	45.94	48.34	49.93	42.86	45.14	46.59
SOEs (%)	23.34	20.03	17.46	19.00	14.38	14.21
Fixed assets (trillion VND)	224.31	294.22	300.89	217.87	662.55	778.64
MNEs (%)	56.73	53.97	54.15	51.90	46.76	46.00
SOEs (%)	20.50	21.10	19.92	16.15	23.23	21.74
Employees (million)	2.85	3.13	2.80	1.64	3.86	4.07
MNEs (%)	38.66	42.25	46.29	42.20	45.31	47.87
SOEs (%)	19.51	15.17	12.94	15.29	11.10	7.92
Number of firms	11,721	12,513	10,197	7,188	16,983	18,060
MNEs	2,266	2,667	2,323	1,502	3,753	3,874
Domestic firms	9,455	9,846	7,874	5,686	13,230	14,186

Source: Authors' calculations from General Statistics Office (various years).

Table 2 MNE shares of revenue in Vietnam's manufacturing industries, 2005-2010

Industry group	Average MNE share (%)		
	MNEs	Wholly-foreign	Joint Venture
Food and beverages	33.92	21.80	12.12
Tobacco	10.91	0.00	10.91
Textiles	53.13	48.78	4.34
Apparel	48.48	44.66	3.82
Leather and footwear	79.29	71.96	7.33
Wood and wood products	25.71	16.38	9.33
Paper and paper products	29.37	28.14	1.22
Printing and publishing	7.62	7.01	0.61
Oil and coal products	47.88	2.21	45.67
Chemicals	45.24	28.12	17.12
Rubber and plastic products	42.70	35.98	6.72
Non-metallic mineral products	28.76	8.30	20.46
Basic metals	26.57	12.78	13.80
Fabricated metals	44.10	30.98	13.12
Non-electric machinery	44.34	41.07	3.27
Office and computing machinery	98.96	98.96	0.00
Electrical machinery	58.06	43.85	14.21
Communication machinery	86.43	53.26	33.17
Precision machinery	87.62	82.40	5.22
Motor vehicles	70.59	28.30	42.29
Other transport machinery	68.42	18.40	50.02
Furniture, miscellaneous manufacturing	55.35	52.77	2.59
Recycling	12.24	11.41	0.83

Source: Authors' calculations from General Statistics Office (various years).

Table 3 Effective Rates of Protection in Vietnam's manufacturing industries 2006-2010 (%)

Industry group	2006	2007	2008	2009	2010
Food and beverages	29.86	28.81	27.25	25.82	24.39
Tobacco	45.72	46.02	46.31	46.53	46.71
Textiles	61.76	17.89	18.30	18.63	18.83
Apparel	135.7	58.02	58.44	57.72	57.48
Leather and footwear	46.32	55.77	50.25	44.705	41.05
Wood and wood products	-2.29	-2.16	-2.6	-3.01	-2.9
Paper and paper products	23.59	22.35	20.82	19.42	18.28
Printing and publishing	-14.88	-14.52	-13.17	-11.925	-11.24
Oil and coal products	-0.97	-0.94	-0.56	-0.18	0.14
Chemicals	10.07	9.99	9.25	8.73	8.2
Rubber and plastic products	35.29	35.11	32.2	29.25	26.68
Non-metallic mineral products	29.50	28.43	26.04	23.57	22.98
Basic metals	-0.96	-0.74	-0.67	-0.6	-0.55
Fabricated metals	0.56	0.85	1.23	0.75	0.76
Non-electric machinery	-5.68	-5.07	-4.80	-4.74	-4.81
Electrical machinery	5.86	5.795	5.77	5.325	5.075
Communication machinery	3.92	3.24	1.56	1.02	0.19
Precision machinery	-2.845	-2.78	-2.915	-2.86	-2.82
Motor vehicles	34.12	32.86	30.84	28.92	26.88
Other transport machinery	20.92	21.18	20.31	19.33	18.27
Furniture, miscellaneous manufacturing	47.66	50.84	46.86	43.07	41.11

Source: Authors' calculations from MUTRAP (2010).

Table 4 Random effects estimates of spillovers in all industries

	2005-2010		2005-2007		2008-2010	
	Eq. (1)	Eq. (2)	Eq. (1)	Eq. (2)	Eq. (1)	Eq. (2)
FOR	-0.047		-0.030		-0.010	
	(-7.68)***		(-4.88)***		(-1)	
WOS		-0.070		-0.063		-0.013
		(-9.82)***		(-7.81)***		(-1.14)
JVS		0.024		0.031		0.028
		(3.85)***		(3.94)***		(3.26)***
SOE	0.051	0.039	0.085	0.070	0.074	0.060
	(2.52)**	(1.9)*	(4.38)***	(3.58)***	(2)**	(1.63)
TP	-0.162	-0.194	-0.177	-0.186	-0.330	-0.406
	(-14.13)***	(-6.31)***	(-16.5)***	(-6.41)***	(-12.71)***	(-7.5)***
FOR*TP	-0.098		-0.117		-0.170	
	(-8.85)***		(-10.69)***		(-8.89)***	
WOS*TP		-0.070		-0.056		-0.160
		(-5.86)***		(-4.68)***		(-7.37)***
JVS*TP		-0.071		-0.077		-0.087
		(-2.76)***		(-3)***		(-2.01)**
CR4	0.029	0.021	0.017	0.001	0.023	0.015
	(5.98)***	(4.28)***	(3.17)***	(0.27)	(2.79)***	(1.79)*
L (lag)	0.176	0.169	0.192	0.187	0.326	0.313
	(4.55)***	(4.37)***	(4.74)***	(4.63)***	(5.45)***	(5.23)***
L^2 (lag)	-0.246	-0.232	-0.268	-0.248	-0.481	-0.441
	(-4.8)***	(-4.51)***	(-4.98)***	(-4.63)***	(-5.71)***	(-5.22)***
K (lag)	0.043	0.054	-0.058	-0.045	0.032	0.060
	(1.44)	(1.8)*	(-1.74)*	(-1.35)	(0.67)	(1.27)
K^2(lag)	0.217	0.207	0.313	0.315	0.179	0.164
	(5.95)***	(5.68)***	(7.47)***	(7.52)***	(3.06)***	(2.81)***
K*L(lag)	-0.033	-0.045	0.025	-0.001	0.114	0.073
	(-0.54)	(-0.73)	(0.37)	(-0.03)	(1.1)	(0.7)
_cons	-0.186	-0.193	-0.139	-0.142	0.124	0.129
	(-19.14)***	(-19.73)***	(-16.71)***	(-17.07)***	(11.31)***	(11.48)***
# observations	33938	33808	16458	16382	17480	17426
# groups	14612	14566	8086	8045	11467	11434
R-square	0.1864	0.1814	0.2699	0.2589	0.1308	0.1296
Rho	0.7547	0.7545	0.8247	0.8244	0.7838	0.7828
F-statistics	4338.3***	4433.4***	2512.7***	2518.6***	1397.1***	1434.1***

Notes: Industry and time dummies included; numbers in parentheses are t-statistics;
*,**,*** indicate statistical significance at 10%, 5% and 1% levels, respectively.

Table 5 Fixed effects estimates of spillovers in all industries

	2005-2010		2005-2007		2008-2010	
	Eq. (1)	Eq. (2)	Eq. (1)	Eq. (2)	Eq. (1)	Eq. (2)
	-0.070		-0.045		-0.066	
FOR	(-7.89)***		(-3.91)***		(-3.21)***	
		-0.097		-0.089		-0.100
WOS		(-9.24)***		(-6.65)***		(-3.97)***
		0.001		0.014		-0.018
JVS		(0.14)		(1.17)		(-1.14)
	-0.020	-0.027	0.015	0.015	0.013	0.015
SOE	(-0.78)	(-1.04)	(0.59)	(0.59)	(0.15)	(0.17)
	0.014	0.004	0.009	0.012	-0.024	-0.043
TP	(0.97)	(0.12)	(0.52)	(0.29)	(-0.14)	(-0.21)
	0.026		0.006		0.011	
FOR*TP	(1.57)		(0.32)		(0.36)	
		0.008		0.012		-0.033
WOS*TP		(0.5)		(0.64)		(-0.8)
		0.001		-0.004		0.012
JVS*TP		(0.03)		(-0.12)		(0.16)
	-0.001	-0.004	-0.026	-0.027	-0.003	-0.008
CR4	(-0.3)	(-0.68)	(-3.52)***	(-3.58)***	(-0.25)	(-0.58)
	0.143	0.140	0.048	0.041	0.351	0.347
L (lag)	(2.66)***	(2.6)***	(0.77)	(0.67)	(3)***	(2.96)***
	-0.083	-0.085	0.090	0.091	-0.250	-0.244
L^2 (lag)	(-1.27)	(-1.29)	(1.21)	(1.22)	(-1.7)*	(-1.66)*
	-0.010	-0.016	-0.019	-0.019	0.021	0.029
K (lag)	(-0.26)	(-0.4)	(-0.4)	(-0.41)	(0.24)	(0.33)
	0.150	0.151	0.057	0.048	-0.049	-0.059
K^2(lag)	(3.21)***	(3.22)***	(1.05)	(0.88)	(-0.48)	(-0.58)
	-0.134	-0.123	-0.035	-0.019	0.027	0.023
K(lag)*L(lag)	(-1.71)*	(-1.58)	(-0.39)	(-0.21)	(0.16)	(0.14)
	-0.133	-0.141	-0.131	-0.141	0.224	0.231
_cons	(-17.09)***	(-17.8)***	(-21.85)***	(-23.54)***	(6.06)***	(5.63)***
# observations	33938	33808	16458	16382	17480	17426
# groups	14612	14566	8086	8045	11467	11434
R-square	0.0745	0.087	0.0248	0.04	0.0117	0.0184
F-statistics	160.78***	143.66***	40.73***	38.31***	13.83***	12.55***
Rho	0.8074	0.8051	0.8797	0.8767	0.8328	0.831
Hausman test	929.97***	833.01***	814.5***	616.71***	356.08***	325.56***

Notes: Time dummies included; numbers in parentheses are t-statistics;

*,**,*** indicate statistical significance at 10%, 5% and 1% levels, respectively.

Table 6 Random effects estimates of spillover coefficients in labour-intensive industries

	2005-2010		2005-2007		2008-2010	
	Eq. (1)	Eq. (2)	Eq. (1)	Eq. (2)	Eq. (1)	Eq. (2)
FOR	-0.053 (-7.56)***		-0.033 (-4.67)***		-0.008 (-0.7)	
WOS		-0.082 (-10.12)***		-0.070 (-7.67)***		-0.022 (-1.6)
JVS		0.025 (3.46)***		0.031 (3.5)***		0.029 (2.89)***
TP	-0.173 (-13.76)***	-0.242 (-7.07)***	-0.169 (-14.04)***	-0.202 (-6.22)***	-0.336 (-12.01)***	-0.446 (-7.18)***
FOR*TP	-0.112 (-9.11)***		-0.114 (-9.11)***		-0.180 (-8.41)***	
WOS*TP		-0.083 (-6.22)***		-0.059 (-4.38)***		-0.178 (-7.26)***
JVS*TP		-0.114 (-3.98)***		-0.099 (-3.46)***		-0.126 (-2.49)**

Notes: Industry and time dummies included; numbers in parentheses are t-statistics;
*,**,*** indicate statistical significance at 10%, 5% and 1% levels, respectively;
full results are shown in Appendix Table 1.

Table 7 Fixed effects estimates of spillovers in labour-intensive industries

	2005-2010		2005-2007		2008-2010	
	Eq. (1)	Eq. (2)	Eq. (1)	Eq. (2)	Eq. (1)	Eq. (2)
FOR	-0.082 (-7.81)***		-0.046 (-3.41)***		-0.085 (-3.26)***	
WOS		-0.114 (-9.11)***		-0.100 (-6.55)***		-0.125 (-3.96)***
JVS		0.004 (0.37)		0.023 (1.64)		-0.016 (-0.85)
TP	-0.001 (-0.06)	-0.040 (-0.85)	0.006 (0.33)	-0.011 (-0.24)	-0.072 (-0.35)	-0.063 (-0.27)
FOR*TP	0.014 (0.83)		0.005 (0.28)		0.018 (0.52)	
WOS*TP		-0.002 (-0.12)		0.013 (0.59)		-0.033 (-0.7)
JVS*TP		-0.030 (-0.78)		-0.026 (-0.68)		0.037 (0.41)

Notes: Time dummies included; numbers in parentheses are t-statistics;
*,**,*** indicate statistical significance at 10%, 5% and 1% levels, respectively;
full results are shown in Appendix Table 2.

Table 8 Random effects estimates of spillovers in industries of intermediate labour intensity

	2005-2010		2005-2007		2008-2010	
	Eq. (1)	Eq. (2)	Eq. (1)	Eq. (2)	Eq. (1)	Eq. (2)
FOR	-0.019 (-1.29)		-0.008 (-0.5)		-0.017 (-0.61)	
WOS		-0.052 (-2.72)***		-0.048 (-1.99)**		-0.006 (-0.23)
JVS		0.020 (1.28)		0.049 (2.26)**		0.024 (1.2)
TP	-0.031 (-0.8)	-0.026 (-0.3)	-0.015 (-0.46)	-0.132 (-1.55)	-0.057 (-0.67)	-0.239 (-1.67)*
FOR*TP	-0.005 (-0.16)		0.018 (0.59)		0.009 (0.12)	
WOS*TP		-0.009 (-0.27)		0.001 (0.04)		-0.109 (-1.78)*
JVS*TP		-0.002 (-0.03)		-0.107 (-1.23)		0.006 (0.06)

Notes: Industry and time dummies included; numbers in parentheses are t-statistics;
*,**,*** indicate statistical significance at 10%, 5% and 1% levels, respectively;
full results are shown in Appendix Table 3.

Table 9 Fixed effects estimates of spillover coefficients in industries of intermediate labour intensity

	2005-2010		2005-2007		2008-2010	
	Eq. (1)	Eq. (2)	Eq. (1)	Eq. (2)	Eq. (1)	Eq. (2)
FOR	-0.042 (-2.19)**		-0.048 (-1.9)*		-0.025 (-0.63)	
WOS		-0.054 (-2.25)**		-0.091 (-2.7)***		-0.045 (-0.85)
JVS		-0.000 (-0.03)		0.002 (0.08)		-0.023 (-0.66)
TP	0.108 (1.56)	0.111 (1.08)	0.019 (0.43)	-0.063 (-0.56)	0.230 (0.51)	0.120 (0.21)
FOR*TP	0.059 (1.55)		-0.008 (-0.2)		-0.000 (-0.01)	
WOS*TP		0.042 (0.98)		-0.031 (-0.64)		-0.028 (-0.27)
JVS*TP		0.014 (0.18)		-0.070 (-0.74)		-0.047 (-0.28)

Notes: Time dummies included; numbers in parentheses are t-statistics;
*,**,*** indicate statistical significance at 10%, 5% and 1% levels, respectively;
full results are shown in Appendix Table 4.

Table 10 Random effects estimates of spillover coefficients in capital-intensive industries

	2005-2010		2005-2007		2008-2010	
	Eq. (1)	Eq. (2)	Eq. (1)	Eq. (2)	Eq. (1)	Eq. (2)
	-0.041		-0.027		-0.046	
FOR	(-1.74)*		(-1.13)		(-1.19)	
		-0.039		-0.045		-0.026
WOS		(-1.45)		(-1.29)		(-0.63)
		0.001		0.015		0.020
JVS		(0.08)		(0.45)		(0.65)
	-0.121	0.016	-0.160	-0.074	-0.189	-0.190
TP	(-1.97)**	(0.12)	(-2.89)***	(-0.55)	(-1.38)	(-0.87)
	-0.047		-0.077		-0.118	
FOR*TP	(-0.95)		(-1.56)		(-1.31)	
		-0.025		-0.028		-0.079
WOS*TP		(-0.48)		(-0.52)		(-0.88)
		0.120		0.033		-0.022
JVS*TP		(1.06)		(0.27)		(-0.14)

Notes: Industry and time dummies included; numbers in parentheses are t-statistics;
*,**,*** indicate statistical significance at 10%, 5% and 1% levels, respectively;
full results are shown in Appendix Table 5.

Table 11 Fixed effects estimates of spillover coefficients in capital-intensive industries

	2005-2010		2005-2007		2008-2010	
	Eq. (1)	Eq. (2)	Eq. (1)	Eq. (2)	Eq. (1)	Eq. (2)
	-0.046		-0.043		-0.102	
FOR	(-1.49)		(-0.88)		(-1.5)	
		-0.070		-0.005		-0.144
WOS		(-1.9)*		(-0.09)		(-1.79)*
		-0.023		-0.106		-0.013
JVS		(-0.66)		(-1.53)		(-0.23)
	-0.036	0.254	0.025	0.536	0.536	0.762
TP	(-0.49)	(1.35)	(0.3)	(1.40)	(0.66)	(0.83)
	0.023		0.032		0.056	
FOR*TP	(0.37)		(0.32)		(0.38)	
		0.050		0.125		0.099
WOS*TP		(0.69)		(1.11)		(0.59)
		0.264		0.467		-0.032
JVS*TP		(1.54)		(1.57)		(-0.12)

Notes: Time dummies included; numbers in parentheses are t-statistics;
*,**,*** indicate statistical significance at 10%, 5% and 1% levels, respectively;
full results are shown in Appendix Table 6.

Appendix Table 1 Random effects estimates of spillovers in labour-intensive industries

	2005-2010		2005-2007		2008-2010	
	Eq. (1)	Eq. (2)	Eq. (1)	Eq. (2)	Eq. (1)	Eq. (2)
FOR	-0.053 (-7.56)***		-0.033 (-4.67)***		-0.008 (-0.7)	
WOS		-0.082 (-10.12)***		-0.070 (-7.67)***		-0.022 (-1.6)
JVS		0.025 (3.46)***		0.031 (3.5)***		0.029 (2.89)***
SOE	0.082 (3.33)***	0.071 (2.89)***	0.101 (4.28)***	0.088 (3.75)***	0.143 (3.13)***	0.134 (2.92)***
TP	-0.173 (-13.76)***	-0.242 (-7.07)***	-0.169 (-14.04)***	-0.202 (-6.22)***	-0.336 (-12.01)***	-0.446 (-7.18)***
FOR*TP	-0.112 (-9.11)***		-0.114 (-9.11)***		-0.180 (-8.41)***	
WOS*TP		-0.083 (-6.22)***		-0.059 (-4.38)***		-0.178 (-7.26)***
JVS*TP		-0.114 (-3.98)***		-0.099 (-3.46)***		-0.126 (-2.49)**
CR4	0.028 (5.06)***	0.020 (3.6)***	0.018 (2.94)***	0.004 (0.7)	0.015 (1.6)	0.010 (1.11)
L (lag)	0.130 (2.97)***	0.115 (2.64)***	0.172 (3.79)***	0.160 (3.53)***	0.254 (3.66)***	0.223 (3.21)***
L^2 (lag)	-0.260 (-4.29)***	-0.241 (-3.99)***	-0.264 (-4.31)***	-0.242 (-3.95)***	-0.449 (-4.27)***	-0.412 (-3.91)***
K (lag)	0.004 (0.13)	0.012 (0.31)	-0.044 (-1.05)	-0.039 (-0.94)	-0.010 (-0.16)	0.018 (0.28)
K^2(lag)	0.167 (2.9)***	0.148 (2.59)**	0.235 (3.89)***	0.237 (3.93)***	0.135 (1.35)	0.077 (0.77)
K*L(lag)	0.076 (0.9)	0.079 (0.95)	0.062 (0.73)	0.047 (0.55)	0.207 (1.38)	0.219 (1.47)
_cons	-0.253 (-22.23)***	-0.260 (-22.78)***	-0.210 (-20.95)***	-0.215 (-21.39)***	0.066 (4.84)***	0.068 (4.89)***
#observations	25178	25103	12750	12708	12428	12395
#groups	10877	10850	6381	6357	8155	8137
R-square	0.1365	0.1328	0.1941	0.1808	0.0896	0.0903
Rho	0.7335	0.7332	0.8383	0.8284	0.7677	0.7664
F-statistics	2723.7***	2832.2***	1288.6***	1329.9***	691.73***	746.36***

Notes: Industry and time dummies included; numbers in parentheses are t-statistics;
*,**,*** indicate statistical significance at 10%, 5% and 1% levels, respectively.

Appendix Table 2 Fixed effects estimates of spillovers in labour-intensive industries

	2005-2010		2005-2007		2008-2010	
	Eq. (1)	Eq. (2)	Eq. (1)	Eq. (2)	Eq. (1)	Eq. (2)
	-0.082		-0.046		-0.085	
FOR	(-7.81)***		(-3.41)***		(-3.26)***	
		-0.114		-0.100		-0.125
WOS		(-9.11)***		(-6.55)***		(-3.96)***
		0.004		0.023		-0.016
JVS		(0.37)		(1.64)		(-0.85)
	0.004	-0.003	0.022	0.023	0.060	0.058
SOE	(0.15)	(-0.09)	(0.7)	(0.74)	(0.56)	(0.54)
	-0.001	-0.040	0.006	-0.011	-0.072	-0.063
TP	(-0.06)	(-0.85)	(0.33)	(-0.24)	(-0.35)	(-0.27)
	0.014		0.005		0.018	
FOR*TP	(0.83)		(0.28)		(0.52)	
		-0.002		0.013		-0.033
WOS*TP		(-0.12)		(0.59)		(-0.7)
		-0.030		-0.026		0.037
JVS*TP		(-0.78)		(-0.68)		(0.41)
	-0.003	-0.007	-0.024	-0.026	-0.008	-0.015
CR4	(-0.46)	(-1.02)	(-2.94)***	(-3.02)***	(-0.51)	(-0.93)
	0.154	0.154	0.059	0.053	0.419	0.413
L (lag)	(2.48)**	(2.49)**	(0.84)	(0.76)	(3.04)***	(2.99)***
	-0.151	-0.151	0.079	0.078	-0.344	-0.334
L^2 (lag)	(-1.95)*	(-1.96)*	(0.94)	(0.94)	(-1.95)*	(-1.89)*
	-0.024	-0.027	-0.028	-0.030	-0.026	-0.010
K (lag)	(-0.48)	(-0.53)	(-0.5)	(-0.53)	(-0.24)	(-0.09)
	0.106	0.108	0.073	0.064	-0.011	-0.027
K^2(lag)	(1.52)	(1.55)	(0.98)	(0.86)	(-0.08)	(-0.18)
	-0.029	-0.028	-0.043	-0.025	0.071	0.058
K(lag)*L(lag)	(-0.29)	(-0.27)	(-0.39)	(-0.23)	(0.32)	(0.26)
	-0.261	-0.264	-0.261	-0.269	0.050	0.065
_cons	(-26.73)***	(-26.57)***	(-33.4)***	(-33.99)***	(1.43)	(1.69)*
#observations	25187	25103	12750	12708	12428	12395
#groups	10877	10850	6381	6357	8155	8137
R-square	0.0585	0.0714	0.0081	0.0229	0.0171	0.0276
F-statistics	113.23***	102.37***	28.44***	28.19***	9.47***	8.8***
Rho	0.7876	0.7848	0.8739	0.8705	0.816	0.8135
Hausman test	548.94***	471.38***	1145.15***	965.6***	210.78***	178.19***

Notes: Time dummies included; numbers in parentheses are t-statistics;

*,**,*** indicate statistical significance at 10%, 5% and 1% levels, respectively.

Appendix Table 3 Random effects estimates of spillovers in industries of intermediate capital intensity

	2005-2010		2005-2007		2008-2010	
	Eq. (1)	Eq. (2)	Eq. (1)	Eq. (2)	Eq. (1)	Eq. (2)
FOR	-0.019 (-1.29)		-0.008 (-0.5)		-0.017 (-0.61)	
WOS		-0.052 (-2.72)***		-0.048 (-1.99)**		-0.006 (-0.23)
JVS		0.020 (1.28)		0.049 (2.26)**		0.024 (1.2)
SOE	0.007 (0.16)	-0.017 (-0.4)	0.041 (1)	0.028 (0.71)	0.035 (0.43)	-0.023 (-0.3)
TP	-0.031 (-0.8)	-0.026 (-0.3)	-0.015 (-0.46)	-0.132 (-1.55)	-0.057 (-0.67)	-0.239 (-1.67)*
FOR*TP	-0.005 (-0.16)		0.018 (0.59)		0.009 (0.12)	
WOS*TP		-0.009 (-0.27)		0.001 (0.04)		-0.109 (-1.78)*
JVS*TP		-0.002 (-0.03)		-0.107 (-1.23)		0.006 (0.06)
CR4	0.016 (1.25)	0.013 (1.11)	-0.016 (-1.22)	-0.034 (-2.47)**	0.050 (2.31)**	0.026 (1.27)
L (lag)	0.367 (3.06)***	0.366 (3.25)***	0.108 (0.89)	0.145 (1.26)	0.657 (3.67)***	0.535 (3.22)***
L^2 (lag)	-0.067 (-0.36)	-0.182 (-1.08)	-0.079 (-0.42)	-0.006 (-0.04)	-0.284 (-0.85)	-0.310 (-1.06)
K (lag)	-0.099 (-0.79)	-0.132 (-1.14)	-0.055 (-0.43)	-0.003 (-0.03)	0.150 (0.66)	0.234 (1.07)
K^2(lag)	0.455 (2.42)**	0.377 (2.17)**	0.133 (0.68)	0.201 (1.12)	0.256 (0.88)	0.009 (0.04)
K*L(lag)	-0.515 (-1.72)*	-0.343 (-1.26)	0.028 (0.09)	-0.194 (-0.66)	-0.573 (-1.11)	-0.296 (-0.65)
_cons	0.065 (2.09)**	0.059 (2)**	0.213 (8.11)***	0.198 (7.85)***	0.392 (9.23)***	0.296 (8.49)***
# observations	5235	5862	2235	2553	3000	3309
# of groups	2368	2436	1154	1180	2037	2151
R-square	0.0299	0.0300	0.0652	0.0668	0.0285	0.0291
Rho	0.7873	0.7898	0.8012	0.7978	0.8030	0.8105
F-statistics	411.14***	483.9***	148.84***	168.56***	79.07***	91.99***
Time dummy	yes	yes	yes	yes	Yes	yes

Notes: Industry and time dummies included; numbers in parentheses are t-statistics;
*,**,*** indicate statistical significance at 10%, 5% and 1% levels, respectively.

Appendix Table 4 Fixed effects estimates of spillovers in industries of intermediate capital intensity

	2005-2010		2005-2007		2008-2010	
	Eq. (1)	Eq. (2)	Eq. (1)	Eq. (2)	Eq. (1)	Eq. (2)
	-0.042		-0.048		-0.025	
FOR	(-2.19)**		(-1.9)*		(-0.63)	
		-0.054		-0.091		-0.045
WOS		(-2.25)**		(-2.7)***		(-0.85)
		-0.000		0.002		-0.023
JVS		(-0.03)		(0.08)		(-0.66)
	-0.054	-0.054	-0.008	-0.009	0.031	0.032
SOE	(-1.02)	(-1.01)	(-0.16)	(-0.18)	(0.19)	(0.19)
	0.108	0.111	0.019	-0.063	0.230	0.120
TP	(1.56)	(1.08)	(0.43)	(-0.56)	(0.51)	(0.21)
	0.059		-0.008		-0.000	
FOR*TP	(1.55)		(-0.2)		(-0.01)	
		0.042		-0.031		-0.028
WOS*TP		(0.98)		(-0.64)		(-0.27)
		0.014		-0.070		-0.047
JVS*TP		(0.18)		(-0.74)		(-0.28)
	-0.008	-0.005	-0.039	-0.034	0.009	0.008
CR4	(-0.55)	(-0.36)	(-2.1)**	(-1.79)*	(0.26)	(0.23)
	0.215	0.208	0.122	0.105	0.330	0.330
L (lag)	(1.5)	(1.44)	(0.69)	(0.59)	(1.07)	(1.06)
	-0.034	-0.051	0.059	0.055	-0.304	-0.308
L^2 (lag)	(-0.19)	(-0.27)	(0.28)	(0.26)	(-0.76)	(-0.77)
	-0.315	-0.345	0.045	0.051	0.016	0.014
K (lag)	(-2.29)**	(-2.46)**	(0.28)	(0.31)	(0.06)	(0.05)
	0.499	0.509	0.087	0.053	-0.033	-0.038
K^2(lag)	(2.37)**	(2.4)**	(0.35)	(0.22)	(-0.1)	(-0.11)
	-0.380	-0.343	-0.177	-0.128	0.012	0.023
K(lag)*L(lag)	(-1.24)	(-1.12)	(-0.49)	(-0.35)	(0.02)	(0.04)
	0.241	0.226	0.249	0.227	0.627	0.412
_cons	(8.44)***	(7.82)***	(7.99)***	(7.34)***	(4.43)***	(3.05)***
# observations	5884	5837	2573	2543	3311	3294
# of groups	2445	2430	1188	1174	2158	2147
R-square	0.0032	0.0058	0.0358	0.0289	0	0
F-statistics	35.28***	30.64***	8.09***	7.31***	3.49***	3.06***
Rho	0.8268	0.8247	0.8309	0.8279	0.8437	0.8422
Time dummy	yes	yes	yes	yes	Yes	yes
Hausman test	164.25***	152.27***	89.54***	128.81***	51.66***	-23.31

Notes: Time dummies included; numbers in parentheses are t-statistics;

*,**,*** indicate statistical significance at 10%, 5% and 1% levels, respectively.

Appendix Table 5 Random effects estimates of spillovers in capital-intensive industries

	2005-2010		2005-2007		2008-2010	
	Eq. (1)	Eq. (2)	Eq. (1)	Eq. (2)	Eq. (1)	Eq. (2)
	-0.041		-0.027		-0.046	
FOR	(-1.74)*		(-1.13)		(-1.19)	
		-0.039		-0.045		-0.026
WOS		(-1.45)		(-1.29)		(-0.63)
		0.001		0.015		0.020
JVS		(0.08)		(0.45)		(0.65)
	-0.077	-0.088	-0.041	-0.055	-0.038	-0.038
SOE	(-1.17)	(-1.32)	(-0.63)	(-0.83)	(-0.35)	(-0.35)
	-0.121	0.016	-0.160	-0.074	-0.189	-0.190
TP	(-1.97)**	(0.12)	(-2.89)***	(-0.55)	(-1.38)	(-0.87)
	-0.047		-0.077		-0.118	
FOR*TP	(-0.95)		(-1.56)		(-1.31)	
		-0.025		-0.028		-0.079
WOS*TP		(-0.48)		(-0.52)		(-0.88)
		0.120		0.033		-0.022
JVS*TP		(1.06)		(0.27)		(-0.14)
	0.020	0.014	-0.003	-0.019	-0.005	-0.022
CR4	(1.02)	(0.7)	(-0.13)	(-0.8)	(-0.16)	(-0.68)
	0.421	0.423	0.335	0.313	0.579	0.571
L (lag)	(2.6)***	(2.61)***	(1.76)*	(1.64)	(2.48)**	(2.44)**
	0.451	0.420	0.229	0.209	0.462	0.451
L^2 (lag)	(2.19)**	(2.04)**	(0.98)	(0.89)	(1.26)	(1.22)
	0.360	0.363	-0.133	-0.142	0.295	0.334
K (lag)	(2.66)***	(2.68)***	(-0.87)	(-0.92)	(1.17)	(1.32)
	0.392	0.366	0.512	0.489	0.330	0.286
K^2(lag)	(2.4)**	(2.23)**	(3)***	(2.85)***	(1.1)	(0.96)
	-1.189	-1.149	-0.633	-0.578	-1.241	-1.216
K*L	(-4.14)***	(-4)***	(-1.91)*	(-1.74)*	(-2.25)**	(-2.2)**
	0.160	0.156	0.347	0.357	0.686	0.684
_cons	(2.95)***	(2.87)***	(6.55)***	(6.81)***	(7.35)***	(7.26)***
# observations	2876	2868	1135	1131	1741	1737
# groups	1290	1286	517	514	1154	1150
R-square	0.0554	0.055	0.1454	0.1484	0.0296	0.0295
Rho	0.7992	0.8003	0.8272	0.8165	0.8107	0.8112
F-statistics	261.55***	264.52***	139.83***	139.87***	52.49***	51.23***

Notes: Industry and time dummies included; numbers in parentheses are t-statistics;
*,**,*** indicate statistical significance at 10%, 5% and 1% levels, respectively.

Appendix Table 6 Fixed effects estimates of spillovers in capital-intensive industries

	2005-2010		2005-2007		2008-2010	
	(10.1)	(10.2)	(11.1)	(11.2)	(12.1)	(12.2)
	-0.046		-0.043		-0.102	
FOR	(-1.49)		(-0.88)		(-1.5)	
		-0.070		-0.005		-0.144
WOS		(-1.9)*		(-0.09)		(-1.79)*
		-0.023		-0.106		-0.013
JVS		(-0.66)		(-1.53)		(-0.23)
	-0.132	-0.130	0.046	0.036	-0.259	-0.253
SOE	(-1.51)	(-1.47)	(0.47)	(0.36)	(-0.89)	(-0.86)
	-0.036	0.254	0.025	0.536	0.536	0.762
TP	(-0.49)	(1.35)	(0.3)	(1.40)	(0.66)	(0.83)
	0.023		0.032		0.056	
FOR*TP	(0.37)		(0.32)		(0.38)	
		0.050		0.125		0.099
WOS*TP		(0.69)		(1.11)		(0.59)
		0.264		0.467		-0.032
JVS*TP		(1.54)		(1.57)		(-0.12)
	0.022	0.022	-0.013	-0.008	-0.028	-0.041
CR4	(0.9)	(0.91)	(-0.41)	(-0.23)	(-0.5)	(-0.72)
	0.342	0.344	0.091	0.075	0.304	0.292
L (lag)	(1.63)	(1.64)	(0.31)	(0.26)	(0.79)	(0.76)
	0.620	0.599	0.316	0.304	0.640	0.670
L^2 (lag)	(2.48)**	(2.4)**	(0.98)	(0.95)	(1.23)	(1.28)
	0.324	0.325	-0.056	-0.078	0.337	0.336
K (lag)	(2.15)**	(2.15)**	(-0.3)	(-0.42)	(0.96)	(0.95)
	0.493	0.474	0.176	0.171	0.127	0.136
K^2(lag)	(2.59)**	(2.5)**	(0.84)	(0.81)	(0.32)	(0.34)
	-1.363	-1.328	-0.285	-0.243	-1.004	-1.026
K(lag)*L(lag)	(-4.18)***	(-4.07)***	(-0.67)	(-0.57)	(-1.46)	(-1.49)
	0.287	0.270	0.468	0.495	0.845	0.895
_cons	(5.38)***	(4.97)***	(7.2)***	(7.67)***	(3.83)***	(3.74)***
# observations	2876	2868	1135	1131	1741	1737
# groups	1290	1286	517	514	1154	1150
R-square	0.0424	0.0424	0.0691	0.0375	0.0031	0.0015
F-statistics	16.3***	14.68***	5.21***	4.92***	2.35***	2.08***
Rho	0.8275	0.8285	0.8506	0.859	0.843	0.8485
Hausman test	46.91***	49.89***	86.01***	-111.15	-8.34	2.34

Notes: Time dummies included; numbers in parentheses are t-statistics;

*,**,*** indicate statistical significance at 10%, 5% and 1% levels, respectively.