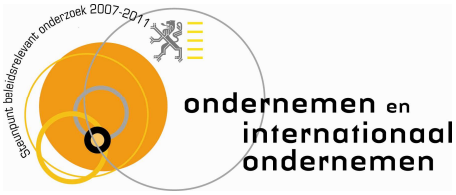

Productivity Spillovers from Foreign Affiliates and Domestic Firm Internationalization: Firm-Level Evidence for Belgium

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ABSTRACT

We examine to what extent local firms can reap productivity gains from knowledge spillovers due to the presence of manufacturing affiliates of multinational firms, taking into account that domestic firms' internationalization through import and export activities may also lead to productivity growth. We examine spillovers occurring within sectors as well as those potentially occurring across industries due to client or supply relations of local firms with foreign-owned affiliates in downstream and upstream sectors, respectively. Fixed affects panel analysis on a sample of 4594 local Belgian firms during 2000-2007 reveal significant positive effects of horizontal and backward spillovers on the productivity levels of local firms. Evidence of productivity benefits due to forward linkages from foreign-owned affiliates supplying local firms is only be found for local firms with no export or import activities. Both importing and exporting activities are associated with higher productivity. In general, backward spillovers are weaker for exporting firms, and forward spillovers do not benefit importing firms, suggesting that local spillovers from client/supply relations with foreign multinationals and internationalization can be seen as alternative ways in which internationalization of an economy can enhance productivity performance.

1. Introduction

Affiliates of multinationals (MNEs) generally report higher productivity levels compared to their local domestic counterparts (Girma et al., 2001; De Backer en Sleuwaegen, 2005, Driffield, 2001). Although foreign affiliates may have great incentives to protect their technologies (Veugelers and Cassiman, 2004), an important part of knowledge and technology may still spill over to domestic firms and increase local productivity levels. The international literature on knowledge diffusion distinguishes different transmission channels through which spillovers may occur (Blomström and Kokko, 1998; Görg and Greenaway, 2004). On the one hand local firms can observe and imitate the technologic advanced production methods of foreign owned affiliates. Spillover effects can also arise as a result of labor mobility: local firms can benefit from transfers of knowledge and technology by attracting high skilled employees from multinationals (Fosfuri et al, 2001). The entrance of multinationals may also reinforce competition within the sector and encourage domestic firms to become more efficient (Glass & Saggi, 2002).

Although an extensive literature has examined the importance of spillovers from inward foreign direct investment (FDI) in industrialized countries (Görg en Greenaway, 2004; Görg en Strobl, 2001; Girma et al., 2001; Doms en Jensen, 1998; Pessoa, 2007), studies have not disentangled the heterogeneous spillover effects due to differences in the international profile of domestic firms. In this paper we examine to what extent the total factor productivity (TFP) of local firms can be influenced by the presence of affiliates of foreign multinationals, explicitly taking into account the internationalization strategy of local firms. Firms with an international profile are likely to be less dependent of the domestic economy and consequently may benefit less from local knowledge spillovers, while exposure to international markets may instead lead to international knowledge spillovers (Bernard en Jensen, 2004; Muuls en Pisu, 2008). We investigate how local spillovers from foreign affiliate and local firm internationalization through import and export activities interact in affecting the productivity levels of local firms. We examine the effects of horizontal (intra-industry) spillovers within the sector as well as vertical (inter-industry) spillovers across industries through local client and supplier relations with affiliates of foreign multinationals. We employ fixed effects panel analysis on a representative

sample of 4594 local Belgian firms based in the regions of Flanders and Brussels for the period 2000-2007.

The remainder of our paper is organized as follows. The next section briefly reviews the international literature on foreign direct investment and knowledge spillovers. The data and empirical methods are described in section 3 and the empirical results in section 4. Finally section 5 offers some concluding comments and future research recommendations.

2. Previous Literature

In the recent years, the attraction of foreign direct investment (FDI) has been an important topic on the agenda of many governments. Policy mechanisms such as tax rebates for foreign firms tempt to stimulate inward FDI. The main reason for this growing interest stem from the positive externalities the presence of foreign multinational affiliates may generate in the host country. Accordingly, the entrance of foreign multinationals is often seen as a conduit for transfer of technology and knowledge within and across sectors. The linkages between foreign MNEs and local host-country firms can be distinguished between horizontal and vertical spillovers. On the one hand, technology from foreign MNEs may spill over to local competitors within the same industry (horizontal spillovers), On the other hand productivity enhancing knowledge may be absorbed by local client firms or supplier firms across industries due to vertical linkages (vertical spillovers).

The results of studies analyzing spillover effects due to inward FDI are rather inconclusive, ranging from negative to positive depending on the data and method used.[1] Mainly focusing on horizontal spillovers, the earliest empirical industry-level analyses found positive evidence of FDI externalities in Australia (Caves, 1974) and Canada (Globerman, 1975). Both analyses concerned sectoral (rather than firm-level) production functions and found a positive correlation between the local firms' productivity growth on industry-level and FDI inflows. Other studies discussed the effects of FDI using well-elaborated case studies (Rhee & Belot, 1989; Larrain et al., 2000), but the results of these studies lack the potential to be generalized

[1] Gorg and Greenaway (2004) and Pessoa (2007) survey the existing literature on the externalities of foreign direct investments.

into clear-cut policy implications. More recently, some cross-sectional studies at the firm level have confirmed the existence of intra-industry spillovers using data from UK and Greece respectively (Driffield, 2001; Dimelis and Louri, 2002). As highlighted by Görg and Strobl (2001), technology diffusion is a dynamic phenomenon making panel data analysis the most appropriate method to estimate improvements in host-country firms' productivity. Recent econometric studies using panel data find positive effects on of FDI spillovers on productivity performance for host country firms (Keller and Yeaple, 2003; Haskel et al., 2002). Based on a micro-level study of US manufacturing firms, Keller and Yeaple (2003) estimated that the share of productivity growth between the sample period 1987-1996 accounted by FDI spillovers at 14%. In the same vein, Haskel et al. (2002) found that the foreign-affiliate presence in an industry, measured by the industry share of employment accounted by foreign firms, is positively correlated with the domestic firms' total factor productivity (TFP) in that industry. Their estimations indicate that spillovers from inward FDI explain about five percent of the ten percent rise of TFP in local UK manufacturing firms during the period 1973-1992. On the other hand, other studies have reported inconclusive or even negative effects of FDI on host country firm productivity (Girma and Wakelin, 2001; Barrios and Strobl, 2002).

Previous empirical studies have mainly focused on the intra-industry spillover effects on domestic firms' productivity, while little attention was given to inter-industry spillovers through customer and supplier linkages with foreign multinationals. The first studies analyzing the effect of backward and forward spillovers on host-country firms' productivity dynamics have focused on developing countries (Blalock, 2001; Javorcik, 2004; Kugler, 2006). These studies could not find any evidence for the existence of forward spillover effects, but report significant productivity-enhancing backward spillovers to local upstream firms. Positive horizontal spillover effects due to the presence of foreign-owned affiliates within the sector were found, but these results were not robust across all different specifications of the models. The failure to find evidence for horizontal spillovers may not be surprising, as foreign multinationals will have strong incentives to protect their superior technology by patenting mechanisms or secrecy in order to prevent leakages to local competitors (Veugelers and Cassiman, 2004). Moreover, at least in the short run, the entrance of foreign multinationals may also be harmful to local firms through increased competition effects. Foreign MNEs may reduce growth opportunities and the

potential to reap scale economies by domestic firms, and they may attract the most qualified employees (De Backer and Sleuwaegen, 2003), which negative productivity consequences for domestic firms. Eventually, this may drive the less cost-efficient host-country firms out of the market.

The presence of foreign MNEs is not likely to affect the productivity performance of domestic firms equally. A number of studies have suggested that the gains from spillovers due to FDI are conditional on the absorptive capacity and catching-up capabilities of local firms and on the geographical proximity to foreign affiliates (Görg and Greenaway, 2004). According to the absorptive capacity argument of Cohen and Levinthal (1989) domestic firms need to possess a certain level of human capital and technological knowledge in order to understand, assimilate and use incoming spillovers from foreign-affiliates. Domestic firms are better able to catch-up with superior technologies of foreign firms when the technology gap between both parties is not too large (Findlay, 1978). Following this reasoning, different empirical studies have analyzed the correlation between the domestic firms' technological capabilities and their ability to benefit from FDI spillovers. In a panel data study on 4000 UK manufacturing firms covering the period 1991-1996, Girma et al. (2001) analyses the conditional effects of intra-industry FDI spillovers on labor productivity according to the skill intensity and competitiveness in the sector and the technology gap between firms and the productivity frontier. The results show, among others, that FDI spillovers benefit domestic firms with a relatively small technology gap relative to the technology leader in a positive way, irrespective of the competition and skill level in the sector.

Besides local spillover effects, an extensive literature has analyzed the importance of international trade for the productivity performance of firms. Based on a cross-country study at the macro level, Coe and Helpman (1995) analyzed international spillover effects and found a positive relation between country's total factor productivity and international trade. More recently cross-sectional studies investigated how productivity is driven by international trade, with a focus on learning by exporting. These studies have provided mixed results on the productivity improvement due to export experience (Arnold and Hussinger 2005; Clerides et al., 1998; Bernard and Jensen, 1999; Salomon and Shaver, 2005; Damijan et al, 2009). Several empirical studies found positive effects of exporting on firms' productivity for data samples in

the United States (Bernard and Jensen, 2004), Spain (Delgado et al., 2002), UK (Girma et al., 2004) and Italy (Castellani, 2002). But other studies suggest this positive correlation may be due to a reverse causality, since high-productivity firms are likely to self-select themselves into exporting markets (Arnold and Hussinger, 2005; Aw and Hwang 1995). Empirical investigation on the positive impact of imports on productivity or innovation performance is much scarcer and mainly focusing on developing or transition countries (Amiti en Konings, 2007; Altomonte et al, 2008).

In this current paper, we analyze the impact of horizontal and vertical spillovers due to FDI on the domestic firms' total factor productivity performance. Simultaneously, we examine to what extent the local host-country firms' engagement in international activities through export and import can lead to improve their productivity. Since firms with an international profile will benefit from international spillovers due to their trade relations on foreign markets and are likely to be less dependent on local suppliers and customers, we investigate whether internationalization reduces the benefits of local FDI spillovers.

3. Data, Variables and Empirical Methods

The data for our study were drawn from the Amadeus/Belfast database containing financial reports of all active firms in Belgium if they employ personnel. We only take into account firms with at least five employees as the calculation of the total factor productivity proved to be less accurate for smaller firms due to unreliable data. We estimate our models on a balanced sample of manufacturing firms based in the regions of Flanders and Brussels, including firms that were active throughout the period 2000-2007. We only include domestic firms in the analysis, i.e. firms with headquarters situated in Belgium. This led to a sample of 4594 domestic firms. The distribution of firms over industries is roughly similar as the industry distribution of all firms in the population and is presented in Table 1.

- INSERT TABLE 1 –

We use the total factor productivity of domestic firms as dependent variable in our models. We follow the index number method of Aw et al. (2001) to calculate total factor productivity.[2] One of the main advantages of the index number method is that it allows for heterogeneity in the production technology of individual firms. All other methods used for calculation of TFP assume an identical production technology among firms within a sector. The index number method does not produce productivity levels in absolute terms but constructs an index of productivity for each firm within its sector.[3] It quantifies the relative difference of the TFP of a firm in a certain year compared to the sectoral TFP mean in a reference period. We use the first year of the sample period as reference base period (year 2000). The index number method is described more in detail in appendix A. To calculate this relative productivity index of each firm in each year, we use the entire population of firms (including foreign affiliates) for which accurate data were available.

Given the time dimension of the data, we use deflators to discount all the financial variables to the same base year 2000. Producer price indices are used to deflate firm-level output and are obtained from Eurostat at the two-digit NACE level. Additionally we use deflators for investments in material fixed assets obtained from Belgostat. The mean values of the total factor productivity indices for Flemish domestic firms are presented per sector in table 2 for the period 2000-2007. The mean productivity level monotonically increases over time during the period 2000-2007. The chemical industry and the electrical equipments sector have seen the most outspoken growth in the sample period.

- INSERT TABLE 2 –

[2] A more general index number method was originally developed by Caves, Christensen and Diewert (1982). For more information concerning the different alternatives to calculate total factor productivity levels, we refer to extended review papers of Van Biesebroeck (2007) and Van Beveren (2007) in which the different methods are compared to each other.

[3] We also attempted semi-parametric methods of Olley and Pakes and Levinshon-Petrin as alternative ways to calculate total factor productivity levels. Regression estimation with Olley-Pakes method proved non-robust with negative estimated coefficient for fixed assets. The Levinshon-Petrin could not be performed due to a lack of data on materials which are used as proxy to control for the simultaneity bias.

Turning to the explanatory variables, we proxy spillovers by the presence of foreign owned affiliates in the sector. The horizontal spillover proxy (HS_{jt}) is defined as the share of the output of foreign affiliates of multinationals in the total output of the sector. In other words, it captures the extent of foreign presence in sector *j* in period *t*. A more dominant presence of foreign-owned affiliates in a sector is likely to lead to more (potential) spillover benefits for domestic firms within that sector.

$$HS_{jt} = \sum Y^{FMNE}{}_{jt} / \sum Y_{jt}$$

Spillover effects may also occur across sectors. Foreign-owned affiliates may for instance be less reluctant to transfer knowledge and technology to upstream sectors, since they may benefit from a better performance of local suppliers. Wee capture the extent of potential spillovers to domestic supplier firms from foreign-owned clients by the presence of foreign affiliates in downstream industries. The backward spillovers (BS_{jt}) to sector *j* in period *t* are measured by the proportion of intermediary goods in sector *j*'s output supplied to foreign-owned firms in downstream industries. We define backward spillovers as:

$$BS_{jt} = \sum_{k} \alpha_{jk} HS_{kt}$$

The parameter α_{jk} denotes the proportion of sector *j*'s output supplied to sector *k*. We derive this proportion from the input-output matrix for the Flemish region of Belgium in 2000.[4] We do not take into account intermediary input flows that stay within the sector since these are already captured by the horizontal spillover proxy. Domestic firms may also benefit from productivity gains from they maintain with upstream related foreign-owned affiliates. This productivity enhancement can be reached by sourcing more qualitative and less expensive intermediary goods from foreign multinationals. Accordingly we define the forward spillover indicator for sector *j* as the share of intermediary goods that is sourced by sector *j* from foreign-owned affiliates in upstream sectors in the total inputs sector j purchase from those upstream sectors. This measure is defined as:

[4] Since more recent input-output matrices are not available for the Flemish region, we cannot take into account the changes in industry proportions over time, but it is quite unlikely that the input output relationships between sectors have fluctuated substantially.

$$FS_{jt} = \sum_{k} \beta_{jk} HS_{kt}$$

The parameter β_{jk} equals the share of intermediary goods purchased by sector *j* from sector *k* in the total inputs purchased by sector *j*. Also here we only take into account intermediary flows across sectors to avoid double counting of horizontal spillovers. In order to take into account the criticism of Gorg and Strobl (2001) that the effects of spillovers will not be immediately captured in existing productivity levels, all variables in the model are one year lagged with respect to the year we measure factor productivity.

- INSERT TABLE 3 -

Table 3 presents the means of the horizontal, backward and forward spillover proxies per sector over the period 2000-2007. Sectors with high means for horizontal spillovers are characterized by an important presence of foreign-owned affiliates. Sectors with a dominant foreign multinational's presence are the chemical and transport industry, followed by the sector in electrical equipment and the metal and machinery industries. Means for backward spillovers are relatively low in the food and transport sectors, as these industries are characterized by a high export intensity and direct sales to consumers. Forward spillovers are relatively high in the rubber and plastic industry followed by the machinery and transport sectors.

Besides spillover effects, we also investigate to what extent import and export activities can influence the total factor productivity levels of domestic firms. On the one hand, firms can benefit from productivity enhancing effects from international trade with clients and suppliers from foreign markets. On the other hand, firms with international trade relations may be less dependent on clients and suppliers in the local economy and may benefit less from local spillover effects. We investigate the impact of these internationalization strategies on the productivity performance by including one year lagged dummy variables for export and import in the model.[5] To assess whether international active firms may face lower productivity enhancing effects from

[5] Note that given that we estimate fixed effects models, the effect of importing and exporting are indentified if firms switch to these internationalization strategies, or revert back to domestic sales and purchases.

local spillovers, interaction effects between local spillovers and import and export activities are incorporated in the model. Specifically, we examine whether exporting firms benefit less from local backward spillovers, and whether importing reap fewer benefits from local forward spillovers.

- INSERT TABLE 4 -

In addition to the main variables of interest, we also control for environmental and firm specific effects that could influence productivity levels. First, as indicated above, we control for time-invariant firm-specific effects influencing productivity levels, by employing fixed effects panel data models. Second, we control for time-variant firm specific characteristics. The size of the firm may be important, as economies of scale may help larger firms may reach higher productivity levels. We include the lagged number of employees as a control variable. We also control for the age of the firm, since more experienced firms may use more efficient working methods and production processes. Finally we control for macro-economic trends by including six year dummies in the period 2001-2007. Table 4 provides descriptives of the total factor productivity (differentiated by the internationalization profile of firms) and the independent variables used in the model. On average, more than 50 percent of the firms are active in import or export activities. The mean of the total factor productivity of internationalizing companies is larger than the respective value for firms without import or export activity. Correlations between the variables are given in Appendix B.

4. Empirical Results

We report the results of the fixed effects panel models in Table 5. In the first model all firms are included. The results suggest positive productivity effects for both horizontal and backward spillovers. No productivity enhancing effects are found due to forward spillovers: the coefficient is even negative, but insignificant. The results are in line with prior work on foreign direct investment where empirical evidence was found for intra-industry and backward spillovers

(Javorcik, 2004; Blalock, 2001; Kugler, 2006), but not for forward spillovers. Table 5 also shows that firms with import or export activities have significantly larger productivity levels, which is consistent with the notion of learning effects from internationalization (Clerides et al., 1998; Bernard and Jensen, 1999; Delgado et al., 2002; Salomon and Shaver, 2005) and the productivity enhancing effects of using quality inputs from abroad (Altomonte et al, 2008). The negative signs of the interaction effects of export and import with respectively backward and forward spillovers indicate that internationally operating local firms benefit less from local technology spillovers. The net effect of local backward spillovers, while smaller, remains positive for exporting firms. In contrast, the net effect for forward spillovers for importing firms is negative.[6] The results for the control variables show that more experienced and larger firms have significantly higher productivity levels. These findings are in line with results of previous studies (Castany et al., 2007). The year dummies indicate a monotonic rising trend of the total factor productivity over time during the period 2000-2007.

INSERT FIGURE 1 –

Figure 1 illustrates the substitution effect between internationalization and local spillovers. The graphs represent the predicted change in TFP due to one standard deviation difference in local spillovers and show how the effects of backward and forward spillovers on the productivity level differ between firms that are internationally active and firms that dot have international operations. The graph at the right clearly shows that exporting firms have higher productivity levels compared to non-exporting firms if they are based in industries with relatively little potential backward spillovers. This advantage disappears in sectors with above average levels of backward spillovers. This illustrates how export to foreign markets and client relations with foreign-owned affiliates could be seen as alternative ways to enhance productivity

[6] One potential explanation for the negative association between forward spillovers and productivity for importing firms is that import-intensive firms are be located in sectors with relatively high forward spillovers. Due to the unavailability of information on import and export intensities at the firm level, we can however not ascertain this.

levels. In the left graph we compare the effects of forward spillovers for importing and non-importing firms. Forward spillovers have no significant effects on the productivity levels of non-importing firms. The higher productivity level of importing firms is transformed into a productivity underperformance in industries with higher levels of forward spillovers.

- INSERT TABLE 5 -

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The empirical findings of the first model may suggest that forward spillovers are not important to reach higher productivity levels. However, the analysis could not control for the import and export intensities of firms, such that the results may not be fully representative of the potential effects of forward spillovers. In a second model we therefore focus only on firms without export or import activities. The results of this model confirm the importance of horizontal and backward spillovers but also show a positive and significant effect of forward spillovers. The results further strengthen support for the thesis that import and export activities and spillovers from foreign owned affiliates can be seen as substitutes in the pursuit of higher productivity levels.

5. Conclusions

Although an extensive literature has examined the importance of spillovers from inward foreign direct investment (FDI) in industrialized countries (Görg en Greenaway, 2004; Görg en Strobl, 2001; Girma et al., 2001; Doms en Jensen, 1998; Pessoa, 2007), studies have not disentangled the heterogeneous spillover effects due to differences in the international profile of domestic firms. In this paper we examine to what extent the total factor productivity (TFP) of local firms can be influenced by the presence of affiliates of foreign multinationals, explicitly taking into account the interaction with the internationalization strategies of local firms. Firms with an international profile are likely to be less dependent of the domestic economy and consequently may benefit less from local knowledge spillovers, while exposure to international

markets may instead lead to international knowledge spillovers (Bernard en Jensen, 2004; Muuls en Pisu, 2008). We investigate how local spillovers from foreign affiliate and local firm internationalization through import and export activities interact in affecting the productivity levels of local firms. We examine the effects of horizontal (intra-industry) spillovers within the sector as well as vertical (inter-industry) spillovers across industries through local client and supplier relations with affiliates of foreign multinationals. We employ fixed effects panel analysis on a representative sample of 4594 local Belgian firms based in the regions of Flanders and Brussels for the period 2000-2007.

The analysis reveals significantly positive effects of horizontal and backward spillovers on the productivity levels of local firms. In sectors where foreign multinationals are strongly represented, domestic firms show higher productivity levels (horizontal spillovers). The same holds for domestic firms that supply intermediary goods to sectors where foreign multinationals are well represented (backward spillovers). On the other hand, no evidence was found for positive effects of forward spillovers due to a greater exposure to inputs supplier locally by foreign affiliates. These results are in line with previous literature analyzing horizontal and vertical spillover effects due to foreign direct investments (Javorcik, 2004; Kugler, 2006; Blalock, 2001).

However, further analysis restricting attention to firms that do not engage in import or export activities do show a positive and significant effect of forward spillovers. This suggests that the mixed findings in prior studies on forward spillovers may be due the failure to take into account alternative ways to productivity growth through input sourcing on international markets. In general, we find that while both importing and exporting activities are associated with higher productivity levels, importing firms do not benefit from forward spillover and exporting firms benefit significantly less from backward spillovers. This implies that local spillovers from client/supply relations with the affiliates of foreign multinationals and firms' own internationalization can be seen as alternative ways in which internationalization of an economy can enhance productivity performance.

The results emphasize the importance of internationalization for productivity and welfare growth, both through the internationalization of domestic firms as through foreign direct

investments by multinational firms. The results imply that export promotion policies and FDI promoting policies should be designed in a balanced manner, as they may potentially be substitutes in reaching productivity growth. Policies aiming to facilitate internationalization of domestic firms should furthermore not focus solely on developing export markets but also on the facilitation of import activities for high quality inputs.

We suggest that further research along these lines can focus on the use of spillover indicators taking productivity differences between domestic firms and multinationals into account. More attention should also be given to the heterogeneity of firms in their capacity to use and assimilate knowledge and technology spillovers. Firms with more absorptive capacity (i.e. as indicated by the employment of higher skilled personnel or a limited productivity gap with productivity leaders) may benefit more from external spillovers. Finally, indicators of the intensity of export and import activities and foreign investment by domestic firms will allow for a more detailed analysis of potential substitution effect of local spillovers and internationalization strategies.

Bibliography

Altomonte, C., Bekes, G. & Murakozy, H., 2008. Trading activities and productivity: Evidence from Hungary. Mimeo, Bocconi University.

Amiti, M. & Konings, J., 2007. Trade Liberalization, Intermediate Inputs, and Productivity: Evidence from Indonesia. American Economic Review, 97 (5), 1611-1638.

Arnold, J. M., en Hussinger, K. 2005. Export behavior and firm productivity in German manufacturing. Weltwirtschaftliches Archiv, 141 (2): 219 - 243.

Aw, B. Y., Chen, X. & Roberts, M.J., 2001. Firm-level evidence on productivity differentials and turnover in Taiwanese manufacturing. Journal of Development Economics, 66: 51–86.

Aw, B.Y. and Hwang A.R. 1995. Productivity in the Export Market: a Firm Level Analysis. Journal of Development Economics, 47:313–32.

Barrios, S. and Strobl, E. (2002). Foreign Direct Investment and Productivity Spillovers: Evidence from The Spanish Experience. Weltwirtschaftliches Archiv 138, 459-481.

Bernard, A. B., and J. B. Jensen. 2004. Exporting and Productivity in the USA. Oxford Review of Economic Policy 20, no. 3:343-357.

Bernard, A., en Jensen, J.B. 1999. Exceptional export performance: cause, effect, or both? Journal of International Economics, 47: 1–25.

Blalock, G. (2001). Technology from foreign direct investment: strategic transfer through supply chains. Mimeo, UC Berkeley.

Blomström, M. and A. Kokko (1998). Multinational Corporations and Spillovers. Journal of Economic Surveys 12(3), 247-277.

Castellani, D. and A. Zanfei (2002). Technology Gaps, Absorptive Capacity and the Impact of Inward Investments on Productivity of European Firms. Working Paper, University of Urbino, Italy.

Caves, D.W., Christensen, L.R. & Diewert, W.E., 1982. Multilateral Comparisons of Output, Input, and Productivity Using Superlative Index Numbers. The economic journal, 92 (365): 73-86.

Caves, R. E. (1974). Multinational Firms, Competition and Productivity in Host-Country Markets. Economica 41(162), 176-93.

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Clerides, S. K., Lach, S. , & Tybout, J.R. 1998. Is Learning by Exporting Important? Microdynamic Evidence from Colombia, Mexico, and Morocco. Quarterly Journal of Economics, 113(3): 903-947.

Coe, D. and, E. Helpman, E., (1995)., 'International R&D spillovers',. *European Economic Review*, **39** (5), 859-887.

Cohen, W. and D. Levinthal (1989). Innovation and Learning: The Two Faces of R&D. Economic Journal 99, 569–596.

Damijan, Joze P.; Kostevc, Crt and Polanec, Saso. 2009, "From Innovation to Exporting or Vice Versa? Causal Link between Innovation Activity and Exporting in Slovenian Microdata." Licos Discussion Paper Series, 2008, 204.

De Backer, K. and Sleuwaegen, L. (2003). Does foreign direct investment crowed out domestic entrepreneurship? Journal of Industrial Organization 22 (1), 67-84.

Delgado, M., Farinas J., and Ruano S. 2002. Firm Productivity and Export Markets: a Nonparametric Approach. Journal of International Economics 57:397–422.

Dimelis, S. and H. Louri (2002). Foreign ownership and production efficiency: a quantile regression analysis. Oxford Economic Papers 54(3), 449–469.

Doms, M. E. & Jensen, J., 1998. Comparing Wages, Skills, and Productivity between Domestically and Foreign-Owned Manufacturing Establishments in the United States, in Robert E.B., Lipsey, R.E. & Richardson, J.D. (Ed.) Geography and Ownership as Bases for Economic Accounting, Studies in Income and Wealth, Vol. 59, Chicago, University of Chicago Press, 235-258.

Driffield, N. (2001). The Impact on Domestic Productivity of Inward Investment into the UK. Manchester School 69(1), 103-119.

Findlay, R. (1978). Relative Backwardness, Direct Foreign Investment, and the Transfer of Technology: A Simple Dynamic Model. Quarterly Journal of Economics 92(1), 1-16.

Fosfuri, A., M. Motta and T. Ronde (2001). Foreign Direct Investment and Spillovers through Workers' Mobility. Journal of International Economics 53 (1), 205-22.

Girma, S. and K. Wakelin (2001). Regional Underdevelopment: Is FDI the solution? A semiparametric analysis, GEP Working Paper 2001/14. University of Nottingham.

Formatted: English (U.S.)

Girma, S., Greenaway, D. & Wakelin, K., 2001. Who benefits from foreign direct investment in the UK? Scottish Journal of Political Economy, 48: 19-33.

Glass, A. and K. Saggi (1998). International Technology Transfer and the Technology Gap. Journal of Development Economics 55(2), 369-398.

Globerman, S. (1975). Technological diffusion in the Canadian tool and dye industry. Review of Economics and Statistics 57(4), 428-444.

Görg, H. & Strobl, E., 2001. Multinational Companies and Productivity Spillovers: A Meta-Analysis. The Economic Journal, 111, F723-F739.

Görg, H. and D. Greenaway (2004). Much Ado about Nothing: Do Domestic Firms Really Benefit from Foreign Direct Investment. The World Bank Researcher Observer 19(2), 171-197.

Haskel, J. E., S. C. Pereira and M. J. Slaughter (2002). Does Inward Foreign Direct Investment Boost the Productivity of Domestic Firms? NBER Working Paper n. 8724.

Javorcik, B. S. (2004). Does Foreign Direct Investment Increase the Productivity of Domestic Firms? In Search of Spillovers through Backward Linkages. American Economic Review 94(3), 605-627.

Keller, W. and S. R. Yeaple (2003). Multinational Enterprises, International Trade, And Productivity Growth: Firm Level Evidence From The United States, NBER Working Paper 9504, National Bureau Of Economic Research.

Kugler (2006). Spillovers from foreign direct investment: Within or between industries? Journal of Development Economics 80, 444-477.

Larrain, F. B., L. F. Lopez-Calva and A. Rodriguez-Clare (2000). Intel: A Case Study of Foreign Direct Investment in Central America. Center for International Development Working Paper 58, Harvard University.

Levinsohn, J. and Petrin, A. (2003). "Estimating Production Functions using Inputs to Control for Unobservables", Review of Economic Studies 70, pp.317-341.

Muûls, M., & Pisu, M. 2007. Imports and Exports at the Level of the Firm: Evidence from Belgium. *Research series 200705-03*. National Bank of Belgium.

Olley, S. and Pakes, A. (1996). "The Dynamics Of Productivity In The Telecommunications Equipment Industry", Econometrica 64, pp.1263-1297.

Pessoa, A. (2007). FDI and Host Country Productivity: a Review. FEP Working Papers, no. 251.

Rhee, Y-W. and T. Belot (1990). Export Catalysts in Developing Countries: A Review of Eleven Success Stories. Washington, DC: World Bank, Discussion Paper No. 72.

Salomon, R., & Shaver, J. M. 2005. Learning by Exporting: New Insights from Examining Firm Innovation. Journal of Economics and Management Strategy, 14 (2): 431-460.

Van Beveren, I., 2007. Total factor productivity estimation: A practical review. Licos Discussion Paper Series, 182/2007.

Van Biesebroeck, J., 2007. Robustness of productivity estimates. Journal of Industrial Economics, 55 (3): 529–569.

Veugelers, R., Cassiman, B., 2004. Foreign subsidiaries as channel of international technology diffusion: some direct firm level evidence from Belgium, European Economic Review 48 (2): 455-476.

Table 1: Distribution of firms across industries

Industry	Firms	
	Numbers	%
Food, drink and tobacco	655	14.3
Textiles and leather	542	11.8
Paper, printing and publishing	741	16.1
Chemical industry	212	4.6
Rubber and plastic	155	3.4
Non-metal mineral products	287	6.2
Metals	889	19.4
Machinery	351	7.6
Electrical equipment	266	5.8
Cars and transport equipment	89	1.9
Other manufacturing industries	407	8.9
Total	4594	100

Table 2: Mean of the total factor productivity index of Flemish firms across sectors for the period 2000-2007

Industry	2000	2001	2002	2003	2004	2005	2006	2007
Food, drink and tobacco	-0.06	0.11	0.27	0.45	0.65	0.85	1.06	1.26
Textiles and leather	-0.05	0.06	0.20	0.36	0.46	0.57	0.68	0.82
Paper, printing and publishing	-0.05	0.08	0.23	0.37	0.52	0.65	0.80	0.96
Chemical industry	-0.12	0.05	0.27	0.56	0.92	1.13	1.47	1.80
Rubber and plastic	-0.08	0.09	0.22	0.41	0.54	0.62	0.69	0.75
Non-metal mineral products	-0.06	0.01	0.07	0.11	0.20	0.35	0.44	0.54
Metals	-0.06	-0.02	0.02	0.07	0.13	0.18	0.22	0.27
Machinery	-0.08	0.03	0.15	0.29	0.44	0.58	0.73	0.86
Electrical equipment	-0.08	0.07	0.25	0.43	0.64	0.84	1.06	1.37
Cars and transport equipment	0.04	0.15	0.17	0.28	0.40	0.55	0.82	1.05
Other manufacturing industries	-0.07	0.04	0.14	0.22	0.30	0.31	0.40	0.49

Table 3: Means of horizontal, backward and forward spillovers across sectors, period 2000-2007

Industry	Horizontal spillover	Backward spillover	Forward spillover
Food, drink and tobacco	0.51	0.03	0.09
Textiles and leather	0.29	0.14	0.18
Paper, printing and publishing	0.35	0.16	0.14
Chemical industry	0.92	0.14	0.08
Rubber and plastic	0.63	0.44	0.40
Non-metal mineral products	0.52	0.35	0.17
Metals	0.68	0.30	0.13
Machinery	0.65	0.13	0.34
Electrical equipment	0.75	0.28	0.15
Cars and transport equipment	0.88	0.09	0.23
Other manufacturing industries	0.24	0.25	0.28

Table 4: Descriptive Statistics

	Flemish firms (n=4594)			
	Mean	Standard Dev.	Minimum	Maximum
Total factor productivity (natural logarithm)	0.35	0.56	-3.86	4.91
- Firms with import or export activities	0.40	0.56	-1.59	4.91
- Firms without import or export activities	0.23	0.52	-3.86	4.81
Horizontal spillovers	0.52	0.20	0.20	0.94
Backward spillovers	0.20	0.11	0.03	0.46
Forward spillovers	0.17	0.08	0.07	0.41
Exporting firm (dummy)	0.55	0.50	0	1
Importing firm (dummy)	0.59	0.49	0	1
Export*Backward spillovers	0.11	0.11	0	0.41
Import*Forward spillovers	0.11	0.13	0	0.46
Age of the firm	19	1.97	0	108
Number of employees	21	2.67	0	4219

Figure 1: Productivity effects of local spillovers and internationalization

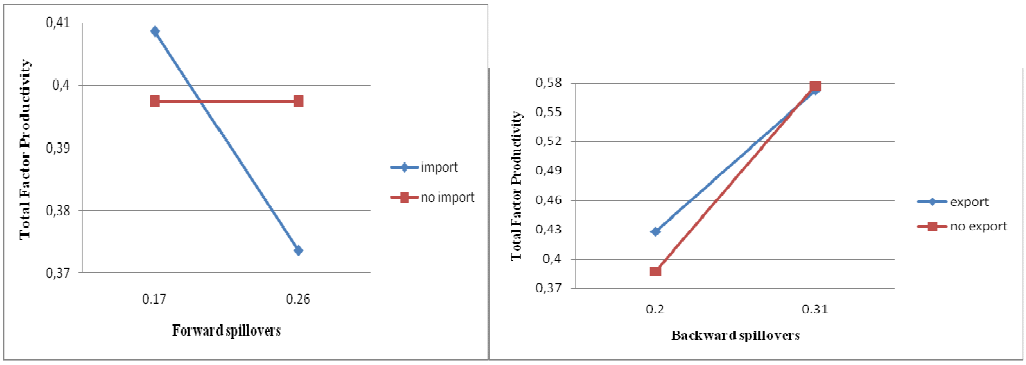

Table 5: Determinants of total factor productivity for Flemish firms, period 2000-2007

	Total factor productivity	
	All Flemish firms	**Flemish firms without export or import**
Horizontal spillover	1.084	1.578
	[0.034]***	[0.064]***
Backward spillover	1.746	1.6
	[0.111]***	[0.170]***
Forward spillover	-0.184	2.734
	[0.266]	[0.561]***
Export	0.082	
	[0.015]***	
Import	0.083	
	[0.020]***	
Interaction effects		
Export * Backward spillovers	-0.283	
	[0.065]***	
Import * Forward spillovers	-0.416	
	[0.102]***	
Age of firrm	0.041	0.055
	[0.014]***	[0.023]**
Number of employees	0.024	-0.007
	[0.008]***	[0.013]
Year 2001	0.105	0.1
	[0.006]***	[0.009]***
Year 2002	0.228	0.228
	[0.006]***	[0.010]***
Year 2003	0.355	0.354
	[0.007]***	[0.011]***
Year 2004	0.545	0.584
	[0.009]***	[0.016]***
Year 2005	0.656	0.7
	[0.009]***	[0.017]***
Year 2006	0.774	0.824
	[0.010]***	[0.020]***
Year 2007	0.909	0.955
	[0.010]***	[0.020]***
Constant	-1.178	-1.928
	[0.073]***	[0.129]***
Number of observations	30343	9887
Number of groups	4594	1772
R squared	0.61	0.59
F test	(16, 25733)	(12, 8103)
	2473.49***	958.25***

Notes: Robust standard errors in parentheses; *, **, *** is significant at 10%; 5%, and 1%, respectively.

Appendix A: Total factor productivity: index number method

To obtain comparable productivity levels across firms we use the index number method following Aw et al. (2001). Productivity levels are calculated as an index where the total factor productivity for each individual firm is compared with the mean TFP level in its industry in a certain base period. The total factor productivity is calculated as the proportion of the value added (Y) that is not explained by the input factors (X). To obtain the TFP in an index number format, the deviation of the natural logarithm of respectively the output and input factors of firm *f* and the arithmetic means of these factors on industry level are taken into account (respectively $(\ln Y_{ft} - \overline{\ln Y_t})$ and $(\ln X_{ift} - \overline{\ln X_{it}})$, with *i* indicating the input factor labor or capital). In order to get an index that compares productivity performances with the industry mean at a certain point in time, deviations in the means over two consecutive years are chain-linked over time for both output and input factors ($\sum_{s=2}^{t}(\overline{\ln Y_s} - \overline{\ln Y_{s-1}})$ and $\sum_{s=2}^{t}\sum_{t=1}^{n}(\overline{\ln X_{is}} - \overline{\ln X_{is-1}})$). The model also controls for heterogeneity in the production technology of individual firms by incorporating the respective input cost shares into the formula (denoted by the S factors). The formula to calculate the TFP index in its natural logarithmic form, following Aw et al. (2001, p. 11) is:

$$\ln TFP_{ft} = (\ln Y_{ft} - \overline{\ln Y_t}) + \sum_{s=2}^{t}(\overline{\ln Y_s} - \overline{\ln Y_{s-1}}) - \left[\sum_{i=1}^{n}\frac{1}{2}(S_{ift} + \overline{S_{it}})(\ln X_{ift} - \overline{\ln X_{it}}) + \sum_{s=2}^{t}\sum_{t=1}^{n}\frac{1}{2}(\overline{S_{is}} + \overline{S_{is-1}})(\overline{\ln X_{is}} - \overline{\ln X_{is-1}})\right]$$

Appendix B: Correlations between variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
(1) Total factor productivity	1.000																
(2) Horizontal spillovers	0.018	1.000															
(3) Backward spillovers	-0.249	0.214	1.000														
4() Forward spillovers	-0.121	-0.142	0.325	1.000													
(5) Export	0.154	0.004	-0.073	0.071	1.000												
(6) Import	0.151	0.031	-0.032	0.100	0.573	1.000											
(7) Export * Backward spillovers	-0.003	0.088	0.424	0.258	0.763	0.436	1.000										
(8) Import * Forward spillovers	0.044	-0.038	0.153	0.586	0.448	0.787	0.477	1.000									
(9) Age of firm	0.124	-0.060	-0.075	-0.026	0.133	0.145	0.067	0.095	1.000								
(10) Number of employees	0.120	-0.015	-0.040	0.021	0.405	0.418	0.302	0.314	0.166	1.000							
(11) Year 2001	-0.214	0.030	0.043	0.048	-0.010	-0.017	0.012	0.008	-0.092	-0.008	1.000						
(12) Year 2002	-0.129	0.003	0.043	0.036	0.004	-0.002	0.023	0.015	-0.055	0.005	-0.150	1.000					
(13) Year 2003	-0.040	0.002	0.039	0.025	0.007	0.008	0.024	0.017	-0.010	0.011	-0.149	-0.146	1.000				
(14) Year 2004	0.052	-0.018	-0.065	-0.031	-0.026	0.007	-0.049	-0.008	0.025	0.007	-0.147	-0.145	-0.144	1.000			
(15) Year 2005	0.128	-0.025	-0.041	-0.033	0.012	0.008	-0.008	-0.009	0.056	0.000	-0.144	-0.142	-0.141	-0.140	1.000		
(16) Year 2006	0.218	-0.002	-0.041	-0.056	0.013	0.009	-0.008	-0.018	0.088	0.003	-0.143	-0.141	-0.140	-0.139	-0.136	1.000	
(17) Year 2007	0.308	-0.017	-0.024	-0.050	0.014	0.009	-0.002	-0.015	0.119	0.018	-0.141	-0.139	-0.138	-0.137	-0.134	-0.133	1.000