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**International and Domestic Technology Transfers and
Productivity Growth: Empirical Evidence for Flanders**

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EXTENDED ABSTRACT

We examine the drivers of international and domestic technology transfer strategies of firms and the impact of these transfers on firms' productivity performance in a sample of 457 Flemish innovating firms during 2003-2006. We use data on innovating firms from the 4th Community Innovation Survey for Flanders. In this survey, responding firms indicate whether they sourced technology externally and if so, whether the source of this technology was domestic or foreign. Technology transfers may occur through R&D contracting, purchase of licenses and know how, purchase of specialized machinery, hiring of specialized personnel, and various informal channels. Estimates of a dynamic productivity model show that firms engaging in international knowledge sourcing strategies record significantly higher productivity growth. The largest impact is found for firms combining foreign transfer strategies with local technology acquisition, suggesting that a diverse external technology strategy combining local technologies as well as know how from abroad is most likely to improve firm performance.

Analysis of the drivers of technology sourcing strategies shows that combined technology sourcing strategies are more likely to be adopted by firms that 1) face resource limitations in their innovative effort 2) have a basic research orientation and conduct more R&D 3) successfully use various technology protection strategies to appropriate the benefits of innovation efforts 4) are engaged in international R&D collaboration. Affiliates owned by foreign multinationals and highly export oriented firms are significantly more likely to rely on foreign-only technology acquisitions, but domestic multinational enterprises do not differ significantly from domestic firms in this respect. Although our results are still preliminary, they may suggest that policies to stimulate innovation should pay close attention to the facilitation of international technology acquisitions as they are an important factor in the performance effects of innovation efforts.

1. Introduction

There is widespread consensus that the diffusion of knowledge and technologies is essential for economic growth and prosperity (e.g., Grossman & Helpman, 1991; Romer, 1990). Knowledge flows are not restricted to national boundaries and international knowledge flows have been found to be a major source of productivity growth (Coe and Helpman, 1995; Griffith et al., 2004). A number of empirical studies have analyzed the diffusion of technological knowledge through trade flows (e.g. Coe and Helpman, 1995; Griffith et al., 2004). A different literature has focused on foreign direct investment (FDI) by multinational enterprises (MNEs) and the potential knowledge spillovers that FDI creates to host country economies (e.g. Gorg and Strobl, 2005; Kugler, 2006; Van Pottelsberghe and Lichtenberg, 2001). Related empirical work inferring knowledge flows from patent citation data has indicated that the foreign affiliates of MNEs also source technology in (advanced) host economies, which may lead to ‘reverse’ intra-firm knowledge transfer to the home country (Singh 2007; Almeida, 1996; Branstetter, 2006; Frost, 2001; Song and Shin, 2008; Frost and Zhou, 2005). While these approaches use indirect or partial measures of knowledge flows, little research has focused on direct evidence of international knowledge and technology transfers. A number of papers have restricted attention to the impact of international technology licensing on firm productivity, primarily in the context of local firms in developing and newly industrializing countries (Basant and Fikkert, 1996; Braga and Wilmore, 1991; Branstetter and Chen, 2006; Belderbos et al., 2008). The literature on technology ‘make’ and ‘buy’ decisions and external technology sourcing strategies has used a broad definition of technology transfer, but has not examined the international dimension of such transfers (e.g. Bonte, 2003; Lokshin et al., 2008; Cassiman and Veugelers, 2006; 2007; Veugelers and Cassiman, 1999).¹

In this paper, we examine the impact of both international and domestic technology transfers on productivity growth in a sample of 457 Flemish firms during 2003-2006. We can use a broad and direct measure of incoming technology transfers² - including the transfer of technology through licensing and know how transfers, R&D contracting, the purchase of specialized machinery, hiring of specialized personnel, and transfers through informal

¹ A partial exception is Veugelers and Cassiman (2004), who examine the co-occurrence in MNE affiliates of outgoing transfers to the host economy and incoming transfers from abroad.

² From the viewpoint of the receiving firm, (incoming) technology transfers can be equated to technology acquisition. We will use the two terms interchangeably in the remainder of this paper.

channels -, on the basis of information available in the 4th Community Innovation Survey (CIS) for Flanders. We derive our econometric specification of productivity growth from an augmented Cobb Douglas production function where changes in the knowledge stock are a function of internal R&D and domestic and international technology transfers. The model also takes into account potential productivity convergence by including lagged productivity levels. Apart from analyzing the impact of technology transfers on productivity, we also examine what firm characteristics govern the decision to engage in international transfers, domestic transfers, or both. Here we pay attention to potentially different transfer patterns across firms, distinguishing between local (Flemish) firms, Flanders-based MNEs, and the affiliates of foreign MNEs.

The remainder of our paper is structured as follows. The next section briefly reviews the relevant existing literature on knowledge transfers and productivity growth. This is followed by a description of the productivity model in section 3. The data and empirical methods are described in section 5 and the empirical results in section 6. Finally section 6 offers some concluding comments and future research recommendations.

2. Previous Literature

The literature on FDI spillovers and productivity has established that foreign affiliates are more productive than their domestic counterparts, as affiliates can draw on the transfer of technological and other assets from the parent (e.g. De Backer and Sleuwaegen, 2005). On the other hand, the literature on the spillover and productivity effects of FDI has produced mixed evidence on the impact of FDI on the performance of local firms (Blomström and Kokko, 1998; Gorg and Greenaway, 2004). A number of studies have shown positive effects of FDI on host country labor productivity (e.g. Globerman 1978) and product and process innovations (e.g. Bertsek 1995) in the case of developed countries. Studies have provided less support for spillovers in developing countries (e.g. Haddad and Harrison, 1993; Gorg and Strobl, 2001). The strongest impact is found on intersectoral spillovers to suppliers and clients through backward and forward linkages of the foreign affiliates in the host economies (Javorcik, 2004; Kugler, 2006; Blalock and Gertler, 2008). Recent work has also suggested that spillovers are conditional on a productivity or technology gap between domestic firms and the foreign affiliates that is not too large (Gorg and Greenaway, 2004, 181; Guellec and Van Pottelsberghe, 2001). Only if local firms possess sufficient ‘absorptive capacity’ to

understand, assimilate, and utilize technologies and know how introduced in the local economy by MNEs, positive effects on local productivity growth are expected (Glass and Saggi, 1998; Gorg and Greenaway, 2004). Similarly, Griffith et al. (2004) examine productivity growth at the industry level across a panel of OECD countries and find that local R&D expenditures increases the impact of international R&D spillovers, allowing countries behind the technological frontier to catch up with technology leaders. Veugelers and Cassiman (2004) point out that foreign affiliates that receive substantial knowledge transfers from their international network and foreign parent may have greater incentives to protect their technologies. They confirm for a sample of Belgian firms that foreign owned affiliates are less likely to transfer technology locally compared with domestically owned firms. Belderbos, Duivier and Van Roy (2008) present preliminary results for a sample of Flemish startups that the incoming international transfers of foreign affiliates do spill over to local firms in the sector, with a positive impact on productivity growth.

An alternative approach used in the literature is to trace knowledge flows through citations between patents (Jaffe et al., 1993; Almeida, 1996; Frost, 2001). This approach exploits the notion that existing innovations provide ideas and inspiration for further innovation, such that patent citations are likely to capture part of the knowledge flows across organizations. While the productivity literature has focused on the role of MNEs in enabling technology transfer to host countries, the citation based literature has emphasized that MNEs can use foreign subsidiaries as a means of accessing knowledge from host countries. Frost (2001) and Almeida (1996) found that foreign affiliates tended to be locally embedded and citing host country inventors more actively. Singh (2007) obtained similar findings in a larger scale analysis of patent data examining bi-directional knowledge flows between host countries and MNE affiliates. In particular in the United States, foreign MNEs more intensively cite local firms than local firms cite MNEs, providing further evidence that foreign owned affiliates are active in technology sourcing. These findings indicate local knowledge sourcing and are consistent with the finding of Branstetter (2006) that Japanese firms with affiliates in the US have a significantly higher probability of citing other US firms' patents.

Local knowledge sourcing by foreign affiliates still does not imply that this knowledge is further diffused in the international R&D network of the multinational firm. Frost (2001) argues that effective intra-firm knowledge diffusion requires 'dual embeddedness' on the part of the affiliate, i.e. embeddedness in both external and in intra-firm networks and the combination of local and international knowledge transfers. With respect to such 'reverse' international transfers from foreign affiliates to the parent firm, the evidence is more

ambiguous. In particular acquired firms, while locally embedded, often appear to maintain autonomy without substantial integration into the MNEs R&D network (Frost, 2001). Gupta and Govindarajan (2000) also suggest that the flows of knowledge from overseas affiliates back to headquarters have remained limited, and propose more intensive use of a variety of (informal and formal) communication networks between headquarters and affiliates to facilitate technology transfers. Frost and Zhou (2005) similarly show that collaboration across affiliates and parents facilitates subsequent exchange of knowledge.

Recent studies find qualified evidence for reverse technology transfer. Song and Shin (2008) and Penner Hahn and Shaver (2005) find that effective transfers require a sufficient 'absorptive capacity' at corporate headquarters to utilize foreign know how and R&D results. Iwasa and Odagiri (2003) find that R&D in US affiliates of Japanese firms have a positive impact on parent firms' patent applications in Japan, provided that R&D activities are focusing on basic research and that they are located in US states with particular technological strengths in the technology field of interest. Griffith, Harrison & van Reenen (2006) find that foreign R&D in the US by UK MNEs has a positive impact on their productivity if US R&D efforts result in patents and if R&D is 'locally embedded' in the sense that the patents are citing US firms or US institutions. Todo and Shimizutani (2005) similarly find qualified evidence of reverse technology flows associated with technology sourcing R&D for Japanese firms. Overall, there appears to be emerging evidence that foreign R&D can lead to reverse technology transfer and a positive impacts on the productivity of parent firm operations.

Another different line of research has analyzed n technology transfers as external technology acquisition strategies, and has focused on the relationship between internal R&D ('make') and technology acquisition ('buy') strategies (e.g. Veugelers and Cassiman, 1999; Aurora and Gambardella, 1990). The combination of external technology sourcing and internal R&D can allow firms to benefit from research complementarities though involvement in multiple technological trajectories, research directions that cannot be developed simultaneously (at sufficient speed) in-house, and external skills in the exploitation of in-house research activities. Access to complementary research and development activities performed externally, hence, can improve the performance effects of internal R&D efforts (Cassiman and Veugelers, 2006; Bonte, 2003; Lokshin et al, 2008). Several studies have provided empirical evidence in this regard. Beneito (2006) using a sample of Spanish firms, finds that contracted R&D improves firms' patent application performance only if it is combined with internal R&D. Cassiman and Veugelers (2006) found that (Belgian) firms that combine internal R&D with technology sourcing strategies show a better innovative

performance as measured by the proportion of innovative products in sales. Lokshin et al. (2008) examined the joint impact of internal and external R&D expenditures on productivity in a 6-year panel of innovative firms in the Netherlands. They found complementary effects of internal and external R&D, with a positive impact of external R&D only evident in case of sufficient internal R&D.

In the current paper, we follow a similar approach as Lokshin et al. (2008) in examining the joint impact of internal R&D and incoming transfers on productivity growth, in a sample of Flemish firms. We distinguish between transfers with international and domestic origin and we examine to what extent affiliates of foreign MNEs or domestic MNEs are more likely to adopt these technology sourcing strategies. We will investigate, following the ‘double embeddedness’ argument of Frost (2001), whether a combination of both technology sourcing strategies is most likely to improve productivity performance.

3. A Model of Productivity Growth

In this section we develop a model of technology transfers and productivity growth. We draw on Lokshin et al. (2008) and use an augmented Cobb Douglas framework, with the knowledge stock considered as a production factor:

$$Y_{it} = C_{it}^{\alpha} L_{it}^{\beta} K_{it}^{\gamma} e^{\sigma_{it}} \quad (1)$$

where Y is value added of affiliate firm i at time t , L is the labor input, C is the physical capital stock and K is the knowledge stock. α , β and γ are elasticities with respect to physical capital, labor and the knowledge stock, respectively. The parameter σ is a time variant and affiliate-specific efficiency parameter. Dividing both sides by labor, taking the log and differencing the resulting equation in the two consecutive periods, we obtain the equation in its growth form:

$$\Delta q_{it} = (\beta - 1)\Delta l_{it} + \alpha\Delta c_{it} + \gamma\Delta k_{it} + \Delta\sigma_{it} \quad (2)$$

where $\Delta q_{it} = \log(Y_{it}) - \log(L_{it})$ denotes the growth in labor productivity, with lower case letters denoting variables in natural logarithms. In equation (2) fixed firm differences in

productivity are eliminated from $\Delta\sigma_{it}$, but can take the change in firm-specific efficiency levels as a function of past productivity:

$$\Delta\sigma_{it} = \theta q_{it-1} + \varepsilon_{it} \quad (3)$$

where ε_{it} is a serially uncorrelated error term. This specification allows for gradual convergence in efficiency levels between firms, which has been observed to be important in the empirical productivity literature (Klette, 1996; Blundell and Bond 2000; Lokshin et al., 2008). We expect θ to fall within the interval $[-1,0]$. If θ is zero there is no gradual convergence; if θ is -1 complete convergence materializes in one period.

We transform the knowledge stock portion of the specification (cf. Jones, 2002, p. 233) as follows:

$$\gamma\Delta k_{it} \approx \frac{\partial Y}{\partial K} \frac{K_{t-1}}{Y_{t-1}} \frac{\Delta K}{K_{t-1}} \approx \varphi \frac{\Delta K_{it}}{Y_{t-1}} \quad \text{with } \varphi = \frac{\partial Y}{\partial K} \quad (4)$$

The change in the knowledge capital stock is taken as a function of international and domestic technology transfer and R&D investments in the affiliate (RD_{it-1}). We distinguish three exclusive technology acquisitions strategies: international transfers only (T_{it-1}^{int}), domestic transfers only (T_{it-1}^{dom}), and joint international and domestic transfers ($T_{it-1}^{\text{int,dom}}$)

$$\Delta K_{it} = f(T_{it-1}^{\text{int}}, T_{it-1}^{\text{dom}}, T_{it-1}^{\text{int,dom}}, RD_{it-1}) \quad (5)$$

We approximate the unknown function (5) by a linear function.³ If the depreciation rate of the knowledge stock is small⁴ we can write:

$$\gamma\Delta k_{it} = \varphi(\eta_1 T_{it-1}^{\text{dom}} + \eta_2 T_{it-1}^{\text{int}} + \eta_3 T_{it-1}^{\text{int,dom}} + \eta_4 RD_{it-1})/Y_{it-1} \quad (6)$$

Combining equations (2), (3), and (6), we arrive at the dynamic equation:

³ We do not focus on potential interactions between internal R&D and the different transfer variables in the current analysis, as this would increase the complexity of the estimated equation substantially.

$$\Delta q_{it} = \theta q_{it-1} + (\beta - 1)\Delta l_{it} + \alpha \Delta c_{it} + \varphi(\eta_1 T_{it-1}^{dom} + \eta_2 T_{it-1}^{int} + \eta_3 T_{it-1}^{int,dom} + \eta_4 RD_{it-1})/Y_{it-1} + \varepsilon \quad (7)$$

Productivity in year t is a function of past productivity levels, the growth in employment, the augmentation of the capital stock, and the intensity of internal R&D expenditures and technology transfer activities.

4. Data, Variables and Empirical Methods

The data for our study were drawn from the fourth Community Innovation Survey (CIS) conducted in the Flanders region of Belgium. This CIS survey, conducted in 2005, contains information on firms' innovation strategies in manufacturing and service industries for the period 2002-2004.⁵ The detailed questionnaire is answered by firms that are innovation active and covers virtually all larger firms and a sample of small and medium size enterprises in Flanders. The survey contains information on 878 firms engaged in innovation efforts and/or formal R&D expenditures. We linked this dataset to yearly corporate accounts data of the firms in order to analyze the impact of R&D and technology transfers on productivity growth.⁶ Due to missing values for a number of variables (e.g. on fixed capital investments in the corporate accounts data, or on technology transfers in the CIS data), we were able to estimate a productivity equation model for 489 firms. In the model explaining technology transfer strategies this number is reduced to 457, as for 32 firms no exporting information was available. The distribution of firms over industries is roughly similar as the distribution of all firms in the survey and is presented in Table 1. The firms are fairly evenly distributed over manufacturing industries, with the largest number in the metal products sector, followed by food and drinks, and the electrical equipment industry. Among the service industries, the largest number of firms is in the transport and telecommunication industries, while the financial sector is less well represented.

INSERT TABLE 1

⁴ Higher depreciation rates lead to an upward bias of the estimate on the rate of return.

⁵ Because the question on the origin of technology transfers has no longer been included in later innovation surveys, we have to limit the analysis to the 4th survey.

Productivity Analysis

In a first model we analyze the impact of technology transfers on Flemish firms' productivity growth on the basis of equation (7). The core variables of interest are the presence of international and domestic technology transfer, or both. In the CIS survey, innovative companies are asked to report whether they acquired and transferred technology in the years 2002-2004 through various channels. The channels include the transfer of technology through licensing and know how transfers, R&D contracting, the purchase of specialized machinery, hiring of specialized personnel, and transfers through informal channels.⁷ We omit from our definition of technology transfer the channel 'consultants', as firms are likely to tick this question also in case of more general consultancy services contracted (e.g. Cassiman and Veugelers, 2007). Similarly the channel 'acquisition of other firms' is omitted as it is seldom reported and since takeovers may often be associated with a variety of other impacts on productivity (e.g. through rationalization efforts, or post-acquisition integration difficulties) than through technology transfer.

The 4th CIS survey also asks firms to indicate from which location the technology transfer occurred: from inside Belgium, outside Belgium but within Europe or outside Europe. We combined the information on these five channels of transfers considered and the information on the origin of these transfers to construct three exclusive dummy variables. The variable *domestic technology transfer* takes the value 1 if a firm reported to have been active in one or more channels of transfers, while the origin of these technologies was restricted to Belgium. The variable *international technology transfer* takes the value 1 if a firm reported to have been active in one or more channels of transfers, but the origin of these technologies was invariably abroad. The variable *domestic & international technology transfer* takes the value 1 if the firm transferred technology from within Belgium as well as from abroad. As we do not have information on the actual value of these transfers,⁸ we include the three dummy variables in the empirical model since we cannot calculate the transfer intensities suggested in

⁶ The corporate accounts data were drawn from the ISF database developed in the Flanders Centre of Policy Research on Entrepreneurship and International Entrepreneurship (STOIO), on the basis of the BELFIRST database published by Bureau van Dijk.

⁷ Hence the transfers are a broad measure of knowledge flows and are a mixture of knowledge transfers that may be involuntary and due to spillovers (informal channels, personnel transfer) and technology acquisition through market transactions (e.g. licensing purchases). Blalock and Gertler (2008) argue for such a broader definition of technology transfers that is not limited to the spillovers but includes purposeful transfers.

⁸ For some channels (e.g. licensing purchases) there is limited information on the total value of transfers, but these values are not differentiated with respect to the origin of transfers.

equation (7). *Intramural R&D intensity* is intramural R&D expenditure reported in the CIS survey for the year 2004, scaled by value added in the same year.

The dependent variable in the productivity analysis, *growth in labor productivity*, is measured as difference in the log value added per employee in 2006 and the log value added per employee in 2003. We took a three-year period to examine productivity growth, as the impact of firms' innovation strategies on performance may be more gradual, and because we are interested in sustained performance differences. The period includes productivity growth during 2003-2004 because the core variable of interest, technology transfers, are measured over the years 2002-2004 and may have their impact before 2004-2005. By including growth during 2003-2004, we want to limit the possibility that the effect of technology transfers is already largely captured in existing productivity levels. *Lagged productivity* thus is the log of value added per employee in 2003. Equation (7) further suggests inclusion of the *growth in fixed assets*, the log difference in the value of machinery and equipment between 2003 and 2006, and the *growth in employment*, measured in the same manner. We augment the equation by including two dummy variables for the type of firm: *domestic multinational firm* and (affiliate of) *foreign multinational firm*. These are identified by questions in the CIS survey concerning the ownership of the firms' equity and the presence and control of foreign affiliates. Finally, we include a set of 17 2-digit *industry dummies*, with the wholesale and retail trade industry as the reference industry, to control of industry differences in productivity dynamics.

The drivers of domestic and international technology transfers

In a subsequent analysis, we examine empirically what firm characteristics are the main drivers of the different technology transfer strategies. Firms adopt one of four strategies: no external technology acquisition, domestic technology transfers, international technology transfer, and technology transfer both from domestic and foreign sources. We use a multinomial logit model to relate the probability that firms choose one of these strategies to a set of firm characteristics, taking the case of no technology acquisition as reference choice. First, we expect that firms with an export orientation are more likely to explore and get access to foreign sources of knowledge. They may also have a greater need to use foreign technologies in order to adapt products to foreign markets and to learn by exporting (e.g. Clerides et al, 1998). We include the *export ratio* of the firms and expect a positive impact on technology acquisition strategies including technology transfer from abroad.

Following the absorptive capacity argument (Cohen and Levinthal, 1989) we expect that firms that are more active in R&D are also more likely to engage in technology sourcing strategies (Cassiman and Veugelers, 2006). Internal R&D capabilities are likely to increase the effective utilization of external know how (Arora and Gambardella, 1990). We include the log of firms' intramural R&D expenditures. In addition, firms with a greater orientation towards basic research in their R&D activities may possess greater capabilities in combining technologies from different sources, with a greater likelihood of complementarities between in-house R&D and technology sourcing. Following Cassiman and Veugelers (2007), we include as the indicator of *basic R&D orientation*, the importance of universities and research centers as an information source for the innovation process relative to the importance of other sources of information.

Domestic and international R&D collaboration is expected to be associated with external technology acquisition. This may follow from employee mobility and informal transfers made possible through collaboration, or it may be that collaboration is associated with R&D contracting and technology licensing between partners. Furthermore, international R&D collaboration indicates an international orientation in R&D activities, which will be associated with better abilities to scan the international environment for technology sourcing opportunities. We include two dummy variables taking the value 1 if the firm indicates to have collaborated (2002-2004) with domestic partners, *domestic R&D collaboration*, (collaboration with suppliers, clients, universities, competitors, or research institutes) and taking the value 1 if the firm cooperated with foreign partners, *foreign R&D collaboration*. We expect that these are drivers of domestic and foreign transfers, respectively, while they may have a positive effect on combined (domestic, international) sourcing strategies.

Obstacles to in-house innovation may be a driver of external technology sourcing (Cassiman and Veugelers, 2006; Bonte, 2003). A lack of organizational resources to complete in-house R&D projects may provide the motivation to source technologies externally (Cassiman and Veugelers, 2007). We include the variable *resource limitations*, the importance of a lack of technical personnel and financial resources as an obstacle to innovation as measured on a scale of 0 (not important) to 9 (very important). We also expect that the effectiveness of protection strategies to appropriate the benefits from innovation activities increases the incentives to invest in external technology acquisitions and R&D activities in general (Cohen et al, 2003, Cassiman and Veugelers, 2007; Belderbos et al. 2008). We include as a measure of the effectiveness of technology and innovation protection

strategies, *technology protection*, the sum of values (ranging from 0-3) on the importance of the various means to protect technologies (secrecy, lead time, complexity, and patents).

Last but not least, we examine whether, after controlling for the above factors, domestic MNEs and affiliates of foreign MNEs are more likely to adopt specific technology sourcing strategies. Domestic MNEs may have the possibility to engage in foreign technology sourcing, while affiliates of foreign MNEs can rely on parent technologies or access to the broader network of the parent to source foreign technologies. Hence we include the dummy variables *domestic multinational firm* and (affiliate of) a *foreign multinational firm*. Finally, we also include a set of industry dummies to control for industry wide differences in technology sourcing strategies, e.g. as related to the maturity of the technologies used in the industry.⁹

Descriptive Statistics

Table 2 presents the means and standard deviation of the variables as well the variable definitions. Correlations between the variables are given in Appendix A. Table 2 shows that the average (nominal)¹⁰ three-year labor productivity growth for the firms in the sample is 22.6 percent. Employment growth has been negative on average,¹¹ while fixed assets growth on average was close to 7 percent. The majority of firms are domestic with no foreign operations, while Flemish multinationals and foreign affiliates making up 10 and 31 percent of the sample, respectively. The majority of firms had acquired external technology, close to 46 percent both of domestic and foreign origin, close to 14 percent of foreign origin only, and 26 percent only of domestic origin. About 15 percent of firms did not engage in the acquisition of technology.

INSERT TABLE 2

Further insights are obtained when we differentiate means and standard deviations by type of technology transfer (table 3) and by type of firm (table 4). Table 3 shows that firms engaged in both domestic and foreign technology transfer record the highest productivity

⁹ Given the lack of observations on specific technology sourcing strategies in industries with few sample firms, we aggregated 4 industries with their closest counterpart and include 13 industry dummies.

¹⁰ The growth measures are in nominal terms. Instead of using industry specific deflators for value added and fixed capital, our productivity analysis includes a set of industry dummies to control for differences in price increases across sectors..

¹¹ This may indicate rationalization efforts during the period, but is also partly due to the presence of a number of firms in the sample reporting particularly strong declines in employment.

growth (25.1 percent), closely followed by firms with foreign transfers only (24.0 percent) and firms with domestic transfers only (21.7 percent), while there is an important gap with firms not engaged in technology acquisition (14.8 percent). Foreign multinational firms are best represented among the group of firms engaged in foreign sourcing strategies (49.3 percent), followed by joint sourcing strategies (40.8 percent). Foreign and joint sourcing strategies are associated with high export ratios (54.6 and 54.7), double the average export ratio of firms with no or only domestic transfers. A similar pattern holds for foreign R&D cooperation. Firms with both domestic and foreign transfer are clearly distinguishable in terms of their size, high basic R&D reliance, R&D intensity, and use of technology protection mechanisms. Resource limitations are also associated with technology sourcing strategies including domestic sources.

INSERT TABLE 3

Table 4 provides further information on the differential characteristics of multinational firms. Foreign multinationals report relatively high productivity growth (23.6 percent), slightly exceeding growth in domestic firms (22.7 percent) and, surprisingly perhaps, exceeding even more the growth in domestic multinational firms (18.7 percent). This growth is not due to investments in plants and equipment, as on average the value of fixed capital investments declined for foreign multinationals. Foreign and domestic multinationals do not differ much in export intensity (export intensity is on average slightly higher for domestic MNEs), as well as size, R&D cooperation, basic R&D orientation, and joint technology transfer strategies. Foreign MNEs are less likely to engage in domestic technology acquisition and are instead more likely to engage in foreign transfer strategies.. Domestic MNEs face higher resource limitations but report the highest R&D intensity on average and see more means to effectively protect their technologies. On almost all variables, the MNEs differ strongly from domestic firms, which are more reliant on domestic technology transfers, less engaged in foreign R&D cooperation, less export intensive, and less engaged in joint domestic and international transfers.

INSERT TABLE 4

5. Empirical Results

The empirical results for the augmented version of equation (7) are presented in table 5. Estimates are obtained with ordinary least squares regression with robust standard errors. The estimated coefficient on past labor productivity show a convergence parameter θ of -0.249, suggesting that a little less than a fourth of a productivity lead is neutralized by the next period. The growth of employment and capital stock are significant (at the 5 percent level) and imply an elasticity of 0.70 (1-0.30) for labor and 0.049 for fixed capital.¹² Intramural R&D has the expected positive effect on productivity growth and is significant. The coefficient approximates the marginal return on R&D. The estimated return of 0.18 is somewhat lower than those found in earlier studies.¹³ All three technology transfer dummies have positive coefficients, but only the dummies for foreign and joint technology sourcing strategies are significant. Hence, only firms that source technology from abroad, either in isolation or in combination with local technology acquisition show significantly greater productivity growth. This gain in productivity growth is 10.5 percent points for foreign transfer strategy, while joint technology acquisition strategies have the largest impact on productivity growth (12.5 percent points). Finally, firms in the petroleum, chemicals & pharmaceuticals industry record higher productivity growth compared with the wholesale and retail trade sector, while the textiles industry and IT services sector shows significantly lower productivity growth.

INSERT TABLE 5

Table 6 presents the results of the multinomial logit model of the choice between technology sourcing strategies, with firms reporting no technology transfers as the benchmark case. Export intensity increases the probability that firms use the foreign technology sourcing strategy, but there is no significant effect on joint sourcing strategies. Affiliates of foreign multinationals are significantly more likely to use foreign-only sourcing strategies, while there is strong evidence that foreign MNEs are less likely to rely on domestic technology acquisition only. Perhaps surprisingly, domestic multinationals are not more likely to use any

¹² The former is somewhat higher in comparison to earlier work, while the latter is rather low. E.g. Lokshin et al (2008) find elasticities of 0.60 and 0.10 respectively for a sample of Dutch innovating firms. Differences may be due to the distribution over industries and measurement error in the fixed capital stock related to the use of book values of capital.

type of sourcing strategies, but we note that this is after controlling for all other firm characteristics included in the model. The R&D cooperation variables have the expected impact on technology acquisition: domestic cooperation positively affects the likelihood of domestic technology transfer, while foreign R&D cooperation positively affects the likelihood that firms engage in foreign-only or joint technology transfer strategies. The coefficients of the other variables demonstrate that firms adopting joint sourcing strategies show the strongest differences compared with firms that are not engaged in technology sourcing. R&D intensity, basic R&D orientation, resource limitations and technology protection are all characteristics associated with joint sourcing strategies. They reflect greater absorptive capacity and broader scope of innovative activities, greater need to access other technology sources and greater returns expected on technology investments in general. Domestic technology acquisition is also associated with these drivers but to a lesser extent. Foreign-only technology acquisition strategies are mostly driven by export intensity, foreign collaboration, and the effectiveness of technological protection. Apart from a preference for domestic technology sourcing strategies in the print and publishing industry and for joint sourcing strategies in the textile industry, there are no significant differences across industries in technology acquisition.

INSERT TABLE 6

The results in tables 5 and 6 suggest that foreign multinational firms are able to record higher productivity growth in particular through a greater use of foreign technology sourcing strategies. This is consistent with the idea that foreign MNEs can draw on technologies developed by their parent firms and have access to a wider range of channels of transfers through the international presence of these parents. The greater effect on productivity of joint domestic and foreign technology sourcing strategies, is consistent with the ‘double embeddedness’ argument of Frost (2001) which holds that affiliates should use local technologies as well as technology available from their parent network in order to reach their full innovative potential. Our results suggest that affiliates generally are more likely to rely on foreign-only technology sourcing strategies and could potentially benefit from greater involvement in local technology sourcing. The results of the productivity model suggest that this is a more general pattern in firm productivity dynamics: a broader, national as well as

¹³ Lokshin et al (2008) report coefficients close to 0.3. A coefficient of around 0.18 suggests that hundred Euro spent on R&D increase value add by around 18 Euros.

international, reach of technology sourcing strategies is likely to be beneficial. Such a joint domestic and foreign sourcing strategy is not directly associated with an internationalization strategy through exporting or foreign investment, but is related to a stronger reliance on R&D, basic research activities, and international R&D collaboration.

Domestic multinational firms were not found more likely to adopt technology sourcing strategies or to record higher productivity growth compared to domestic firms (firms that do not operate foreign affiliates). One possible explanation is that this group of multinationals is too heterogeneous and includes firms with only a limited foreign presence (e.g. distribution or service affiliates) which does not facilitate additional technology transfers. At the same time, one has to note that the coefficient for domestic multinationals in the models measures the impact on technology transfer and productivity *beyond* the variables already included in the model. Domestic multinationals on average do adopt joint technology strategies more frequently than their domestic peers in the industry in which they are operating. We examined this by estimating a restricted multinomial logit model with the variables limited to a set of industry dummies and the two dummies for foreign and domestic multinational firms. The results, reported in appendix B, show that both foreign and domestic multinationality increases the probability of joint transfers significantly, with the coefficient for domestic multinationals larger than the coefficient for foreign multinationals. In the results reported in table 5, this adoption of joint sourcing strategies by domestic multinationals is explained by related characteristics of these multinationals, such as a greater R&D intensity and a more intensive use of R&D collaboration strategies.¹⁴

6. Conclusions

We examine the drivers of international and domestic technology transfer strategies of firms and the impact of these transfers on firms' productivity performance in a sample of 457 Flemish innovating firms during 2003-2006. We use data on innovating firms from the 4th Community Innovation Survey for Flanders. In this survey, responding firms indicate whether they sourced technology externally and if so, whether the source of this technology was domestic or foreign. Technology transfers may occur through R&D contracting, purchase of

¹⁴ We conducted a sensitivity test to examine whether there was an additional direct effect of R&D collaboration on productivity (e.g. Cincera, 2003) once technology transfer effects are controlled for. Adding the two cooperation variables in the productivity model produced insignificant coefficients, while the coefficients and significance of the technology transfer variables were left largely unchanged.

licenses and know how, purchase of specialized machinery, hiring of specialized personnel, and various informal channels. Estimates of a dynamic productivity model show that only firms that are engaged in foreign technology sourcing, either in isolation or in combination with local technology sourcing, record significantly higher productivity growth, with the highest impact recorded for joint sourcing strategies. This suggests that a diverse external technology strategy combining local technologies as well as know how from abroad is most likely to improve firm performance.

Analysis of the drivers of technology sourcing strategies shows that combined technology sourcing strategies are more likely to be adopted by firms that 1) face resource limitations in their innovative effort 2) have a basic research orientation and conduct more R&D 3) successfully use various technology protection strategies to appropriate the benefits of innovation efforts 4) are engaged in foreign R&D collaboration. After taking these factors into account, affiliates of foreign multinational and domestic multinational enterprises are not more likely to engage in joint sourcing strategies. Affiliates of foreign multinational firms are more likely to rely on foreign-only technology acquisition, and the same applies to firms with the highest export intensities.

Although our results are still preliminary, they may suggest that policies to stimulate innovation should pay close attention to the facilitation of technology acquisition transactions, with in particular international technology acquisition an important factor in the performance effects of technological efforts. Policies to encourage R&D collaboration likewise should pay due attention to international R&D collaboration (c.f. Cincera, 2003) as international collaboration is most likely to impact firm performance as it leads to, or facilitates, international technology transfers.

The findings suggest a broad agenda for further investigation. An important limitation of the current research was that we did not examine the role of in-house R&D (nature and size of R&D activities) in the effective utilization of external technology transfers, i.e. the role of absorptive capacity. Further research can examine this in more detail by analyzing the moderating impact on the relationship between productivity and transfers. Further, the type of technology transfer can be examined in more detail, such as the specific role of intra-group transfers within multinational enterprises and a possible differential impact of the different channels of technology transfer. The role of multinationals in technology transfers and productivity growth can also be examined by collecting information on the characteristics of these multinationals, such as size and degree of internationalization, parent firm R&D intensity and country of origin. Finally, an important question for further research is whether

international knowledge transfers to the Flemish economy also spill over to other firms in the industry or in related industries. Veugelers and Cassiman (2004) suggest that foreign multinationals, while more active in international knowledge sourcing, are less inclined to transfer technologies domestically. On the other hand, a previous study for a sample of Flemish startup firms by Belderbos, Duvivier, and Van Roy (2008) did find that productivity growth was higher in industries with a relatively greater use of international technology transfers by affiliates of foreign multinationals – as long as these startups were collaborating on R&D with partners in the sector. Future research should explore in much more detail the contingencies and size of spillover effects of international and national knowledge transfers due to the innovation strategies of multinational as well as domestic firms.

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Table 1: Distribution of firms across industries

Industry	# Firms
Food, drink and tobacco	40
Textiles and leather	29
Paper, printing and publishing	25
Petroleum, chemicals and pharmaceutical	28
Rubber and plastic	16
Non-metal mineral products	16
Metals	46
Machinery	32
Electrical equipment	40
Cars and transport equipment	17
Other manufacturing industries	9
Utilities and construction	14
Retail and wholesale trade	64
Transportation and telecommunication services	23
Financial services	3
IT services	37
Technical services	14
Health and social services	36
Total	489

Table 2: Description of variables, means, and standard deviations

Variable name	Mean	Std. Dev.	Variable Definition
Productivity growth 2003-2006	0,226	0,338	Growth in gross value added per employee: log labour productivity 2006 - log labour productivity 2003)
Productivity 2003	4,216	0,469	Natural logarithm of the gross value added per employee in 2003
Employment growth 2003-2006	-0,090	0,404	Growth in employment: log employment 2006 - log employment 2003
Fixed asset growth 2003-2006	0,069	0,854	Growth in fixed assets: log fixed assets 2006 - log fixed assets 2003
Intramural R&D intensity	0,077	0,175	Ratio of intramural R&D expenditures to gross value added, 2004
Domestic technology transfer	0,262	0,440	Dummy indicating firms with only domestic incoming technology transfers
Foreign technology transfer	0,137	0,344	Dummy indicating firms with only foreign incoming technology transfers
Domestic & foreign technology transfer	0,456	0,499	Dummy indicating firms with both domestic & foreign incoming technology transfers
Domestic multinational firm	0,098	0,298	Dummy indicating domestic multinational firms (firms with headquarters in Belgium and at least one foreign affiliate)
Foreign multinational firm	0,309	0,462	Dummy indicating affiliate of foreign multinational firms
Export ratio	0,434	0,370	Ratio of exports to sales, 2004
Employment	4,177	1,476	Natural logarithm of the number of employees, 2004
Intramural R&D	7,969	6,242	Natural logarithm of the intramural R&D expenditures, 2004
Domestic R&D collaboration	0,417	0,494	Dummy indicating firms cooperating with domestic partners
Foreign R&D collaboration	0,350	0,477	Dummy indicating firms cooperating with foreign partners
Resource limitations	3,409	2,450	Importance of lack of technical personnel and financial resources as barrier to innovation, on a scale of 0 (unimportant) to 9 (crucial)
Basic R&D orientation	0,401	0,475	Importance of for the innovation process of information from research institutes and universities relative to information from suppliers and customers. Sum of scores for research and universities divided by sum of scores of suppliers and clients
Technology Protection	3,274	3,154	Effectiveness of secrecy, complexity, lead time and patents as means to protect innovation and technology. Sum of scores for each means of protection, with scale 0 (unimportant) to 3 (crucial)

Table 3: Descriptives for firms by type of technology transfers

<i>Variables</i>	<i>No technology transfer (n=71)</i>		<i>Domestic technology transfer (n=128)</i>		<i>Foreign technology transfer (n=67)</i>		<i>Domestic & Foreign technology transfer (n=223)</i>	
	<i>Mean</i>	<i>Std. Dev.</i>	<i>Mean</i>	<i>Std. Dev.</i>	<i>Mean</i>	<i>Std. Dev.</i>	<i>Mean</i>	<i>Std. Dev.</i>
<i>Productivity growth 2003-2006</i>	0,148	0,295	0,217	0,354	0,240	0,394	0,251	0,321
<i>Intramural R&D intensity</i>	0,044	0,123	0,067	0,186	0,053	0,103	0,101	0,196
<i>Foreign multinational firm</i>	0,254	0,438	0,070	0,257	0,493	0,504	0,408	0,493
<i>Domestic multinational firm</i>	0,028	0,167	0,078	0,269	0,075	0,265	0,139	0,347
<i>Export ratio (n=457)</i>	0,248	0,311	0,269	0,313	0,546	0,370	0,547	0,361
<i>Employment</i>	3,442	1,147	3,607	0,983	4,176	1,381	4,740	1,606
<i>Domestic R&D collaboration</i>	0,113	0,318	0,344	0,477	0,373	0,487	0,570	0,496
<i>Foreign R&D collaboration</i>	0,042	0,203	0,086	0,281	0,433	0,499	0,574	0,496
<i>Resource limitations</i>	2,280	2,590	3,640	2,490	3,150	2,500	3,710	2,270
<i>Basic R&D orientation</i>	0,143	0,261	0,359	0,466	0,313	0,346	0,534	0,521
<i>Technology protection</i>	1,296	2,193	2,555	2,550	3,373	3,084	4,287	3,350

Table 4: Descriptives by type of firm

<i>Variable</i>	<i>Domestic firms (n=290)</i>		<i>Domestic Multinational firms (n=48)</i>		<i>Foreign multinational firms (n=151)</i>	
	<i>Mean</i>	<i>Std. Dev.</i>	<i>Mean</i>	<i>Std. Dev.</i>	<i>Mean</i>	<i>Std. Dev.</i>
<i>Productivity growth 2003-2006</i>	0,227	0,330	0,187	0,354	0,236	0,348
<i>Labour productivity 2003</i>	4,087	0,405	4,277	0,408	4,444	0,512
<i>Employment growth 2003-2006</i>	-0,075	0,413	-0,136	0,512	-0,104	0,345
<i>Fixed asset growth 2003-2006</i>	0,120	0,710	0,142	0,935	-0,051	1,052
<i>Intramural R&D intensity</i>	0,069	0,166	0,132	0,167	0,074	0,191
<i>Domestic technology transfer</i>	0,376	0,485	0,208	0,410	0,060	0,238
<i>Foreign technology transfer</i>	0,100	0,301	0,104	0,309	0,219	0,415
<i>Domestic & foreign tech transfer</i>	0,348	0,477	0,646	0,483	0,603	0,491
<i>Export ratio (n=457)</i>	0,315	0,325	0,646	0,317	0,589	0,380
<i>Employment</i>	3,569	1,076	5,222	1,759	5,013	1,457
<i>Domestic R&D collaboration</i>	0,376	0,485	0,542	0,504	0,457	0,500
<i>Foreign R&D collaboration</i>	0,241	0,429	0,479	0,505	0,517	0,501
<i>Resource limitations</i>	3,530	2,470	3,750	2,390	3,070	2,410
<i>Basic R&D orientation</i>	0,360	0,449	0,492	0,395	0,451	0,536
<i>Technology protection</i>	2,552	2,815	5,021	3,455	4,106	3,268

Table 5: Determinants of productivity growth in Flemish firms: OLS results

Labour productivity 2003	-0,249
	[0,047]***
Employment growth 2003-2006	-0,302
	[0,096]***
Fixed asset growth 2003-2006	0,049
	[0,019]**
Intramural R&D intensity	0,180
	[0,092]*
Incoming technology transfers:	
- Only domestic	0,017
	[0,042]
- Only foreign	0,105
	[0,052]**
- Both domestic and foreign	0,125
	[0,040]***
Foreign multinational firm	0,045
	[0,036]
Domestic multinational firm	-0,074
	[0,055]
Industry dummies:	
Food, drinks and tobacco	0,038
	[0,062]
Textiles and leather	-0,211
	[0,057]***
Paper, printing and publishing	0,043
	[0,068]
Petroleum, chemicals and pharmaceuticals	0,140
	[0,077]*
Rubber and plastics	-0,115
	[0,086]
Non-metal mineral products	0,049
	[0,060]
Metals	0,028
	[0,051]
Machinery	0,072
	[0,063]
Electrical equipment	0,063
	[0,067]
Cars and transport equipment	-0,104
	[0,080]
Other manufacturing industries	-0,103
	[0,074]
Utilities and construction	-0,094
	[0,079]
Transportation and telecommunication services	0,002
	[0,058]
Financial services	0,222
	[0,145]
IT services	-0,104
	[0,054]*
Technical services	-0,058
	[0,076]
Health and social services	0,069
	[0,078]
Constant	11,484
	[0,197]***
Observations	489
R-squared	0,290
F (26, 462)	4,32***

Notes: Robust standard errors in parentheses; *, **, *** is significant at 10%; 5%, and 1%, respectively. Omitted industry dummy is wholesale and retail trade.

Table 6: Multinomial Logit Model of the Drivers of Technology Transfer Strategies

	Technology transfers		
	Only domestic	Only foreign	Domestic & foreign
Export ratio	0,292 [0,638]	1,847 [0,682]***	0,990 [0,624]
Employment	0,353 [0,189]*	0,183 [0,212]	0,425 [0,189]**
Foreign multinational firm	-1,143 [0,550]**	1,031 [0,524]**	0,633 [0,481]
Domestic multinational firm	0,196 [0,910]	0,486 [1,010]	0,447 [0,902]
Intramural R&D	0,001 [0,034]	-0,006 [0,040]	0,070 [0,035]**
Domestic R&D collaboration	1,321 [0,513]***	0,448 [0,615]	0,482 [0,540]
Foreign R&D collaboration	-0,577 [0,819]	2,230 [0,807]***	2,316 [0,760]***
Resource limitations	0,169 [0,073]**	0,119 [0,087]	0,221 [0,076]***
Basic R&D orientation	0,993 [0,541]*	0,608 [0,651]	1,329 [0,555]**
Technology Protection	0,131 [0,077]*	0,179 [0,085]**	0,193 [0,077]**
Industry dummies:			
Food, drinks and tobacco	0,551 [0,756]	-0,569 [0,897]	-0,108 [0,763]
Textiles and leather	0,842 [1,067]	0,226 [1,183]	1,773 [0,986]*
Paper, printing and publishing	1,539 [0,834]*	0,592 [0,910]	0,722 [0,845]
Petroleum, chemicals and pharmaceuticals	-0,483 [1,082]	-0,773 [0,993]	-0,267 [0,901]
Rubber and plastics	0,546 [1,361]	0,719 [1,348]	0,485 [1,294]
Non-metal mineral products	1,985 [1,247]	1,538 [1,333]	1,451 [1,283]
Metals	-0,081 [0,724]	-0,338 [0,800]	-0,192 [0,716]
Machinery	0,345 [0,792]	-1,190 [0,938]	-1,045 [0,851]
Electrical equipment	1,097 [0,989]	0,052 [1,041]	-0,113 [0,983]
Cars and transport equipment	0,750 [1,180]	-0,811 [1,220]	-1,648 [1,228]
Construction, transport and telecommunication	0,683 [0,689]	-1,025 [0,967]	-0,285 [0,754]
IT, financial and technical services	0,497 [0,700]	-0,250 [0,771]	0,009 [0,677]
Health and social services	0,710 [0,718]	-1,209 [1,002]	-0,436 [0,775]
Constant	-2,420 [0,793]***	-2,771 [0,853]***	-3,689 [0,805]***

Observations : 457

Pseudo R-squared : 0,262

Chi-squared : 301,98***

Notes: Firms without technology transfers are the reference category. Standard errors in parentheses; *, **, *** is significant at 10%; 5%, and 1%, respectively. Omitted industry dummy is wholesale and retail trade.

APPENDIX A: Correlations between variables

Productivity growth model (N=489)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) Productivity growth	1,000									
(2) Labour productivity 2003	-0,280	1,000								
(3) Employment growth	-0,367	0,161	1,000							
(4) Fixed assets growth	0,045	0,019	0,210	1,000						
(5) Intramural R&D intensity	-0,010	0,131	0,141	0,032	1,000					
(6) Domestic technology transfer	-0,016	-0,197	-0,052	0,073	-0,034	1,000				
(7) Foreign technology transfer	0,017	0,096	-0,016	-0,036	-0,056	-0,237	1,000			
(8) Domestic & foreign technology transfer	0,070	0,148	0,042	0,011	0,123	-0,545	-0,365	1,000		
(9) Foreign multinational firm	0,021	0,325	-0,024	-0,094	-0,010	-0,307	0,159	0,197	1,000	
(10) Domestic multinational firm	-0,038	0,043	-0,038	0,028	0,103	-0,040	-0,032	0,126	-0,221	1,000

Technology transfer model (N=457)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) No technology transfer	1,000													
(2) Domestic technology transfer	-0,238	1,000												
(3) Foreign technology transfer	-0,167	-0,236	1,000											
(4) Domestic & foreign technology transfer	-0,381	-0,537	-0,377	1,000										
(5) Export ratio	-0,207	-0,258	0,124	0,284	1,000									
(6) Foreign Multinational firm	-0,076	-0,294	0,171	0,189	0,283	1,000								
(7) Domestic Multinational firm	-0,096	-0,043	-0,032	0,128	0,192	-0,226	1,000							
(8) Employment	-0,236	-0,201	-0,001	0,342	0,370	0,357	0,241	1,000						
(9) Intramural R&D	-0,262	-0,164	-0,060	0,369	0,374	0,096	0,291	0,456	1,000					
(10) Domestic R&D collaboration	-0,247	-0,093	-0,028	0,274	0,162	0,069	0,070	0,352	0,367	1,000				
(11) Foreign R&D collaboration	-0,262	-0,341	0,082	0,424	0,396	0,247	0,105	0,441	0,389	0,634	1,000			
(12) Resource limitations	-0,181	0,063	-0,045	0,104	0,024	-0,088	0,043	-0,027	0,060	0,079	0,048	1,000		
(13) Basic R&D orientation	-0,226	-0,055	-0,064	0,252	0,131	0,049	0,083	0,213	0,294	0,360	0,288	0,071	1,000	
(14) Technology protection	-0,257	-0,126	0,015	0,281	0,313	0,162	0,185	0,312	0,395	0,235	0,299	0,083	0,293	1,000

APPENDIX B: Multinomial Logit Model of the Drivers of Technology Transfer Strategies: Foreign and Domestic MNEs

	Technology transfers		
	Only domestic	Only foreign	Domestic & foreign
Foreign multinational firm	-1,162 [0,478]**	1,345 [0,423]***	1,131 [0,36]***
Domestic multinational firm	0,793 [0,808]	1,533 [0,884]*	2,051 [0,763]***
Industry dummies:			
Food, drinks and tobacco	0,773 [0,684]	0,099 [0,805]	0,814 [0,638]
Textiles and leather	0,309 [1,009]	0,390 [1,096]	1,976 [0,837]**
Paper, printing and publishing	1,288 [0,776]*	0,890 [0,858]	0,994 [0,755]
Petroleum, chemicals and pharmaceuticals	-0,224 [1,013]	0,134 [0,882]	0,957 [0,733]
Rubber and plastics	0,697 [1,299]	1,533 [1,207]	1,625 [1,127]
Non-metal mineral products	1,475 [1,178]	1,586 [1,246]	1,483 [1,154]
Metals	0,229 [0,655]	0,256 [0,715]	0,606 [0,590]
Machinery	0,516 [0,704]	-0,090 [0,805]	0,365 [0,651]
Electrical equipment	1,265 [0,912]	1,150 [0,914]	1,515 [0,833]*
Cars and transport equipment	1,076 [0,986]	0,414 [0,978]	0,202 [0,908]
Construction, transport and telecommunication	0,273 [0,611]	-1,164 [0,901]	-0,554 [0,623]
IT, financial and technical services	0,602 [0,631]	0,036 [0,709]	0,616 [0,577]
Health and social services	0,353 [0,648]	-1,040 [0,919]	-0,240 [0,632]
Constant	0,167 [0,439]	-0,732 [0,474]	0,068 [0,397]

Observations : 457

Pseudo R-squared : 0,104

Chi-squared : 119,37***