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Productivity Spillovers from Foreign Investment: The Role of Neglected Conditionalities

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PRODUCTIVITY SPILLOVERS FROM FOREIGN DIRECT INVESTMENT: THE ROLE OF THE NEGLECTED CONDITIONALITIES*

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Abstracts
During the past decades many governments in both developing and transition countries have offered significant incentives in order to attract foreign direct investments (FDI), being motivated to do so by expectations of possible spillover benefits. Using an unbalanced panel of firm level data in Bulgaria, Poland and Romania over the 1995-2003 period, we examine the impact of foreign firms on domestic firms' productivity. In particular, we try to answer the following research questions: 1) Are there any spillover effects of FDI, and if so, are they positive or negative? 2) Are spillover effects more likely to occur within or across sectors? 3) Are the existence, the direction and the magnitude of spillovers conditioned by region, sector and firm-specific characteristics? Our findings show that FDI spillovers do exist both within and across complementary manufacturing sectors, and that inter-sectoral spillovers dominate intra sectoral effects. More interestingly, we find that geography, technological content of foreign firms' production, and domestic firm size are all factors able to condition the exploitation of productivity spillovers. Although these results should be interpreted with caution, they provide a good starting point for further research in this area.

Key words: foreign direct investment, transition countries, spillovers
JEL codes: F23, P31, P52.

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PRODUCTIVITY SPILLOVERS FROM FOREIGN DIRECT INVESTMENT: THE ROLE OF THE NEGLECTED CONDITIONALITIES

1. Introduction

During the past decades, many governments in developing and transition countries have offered significant incentives in order to attract foreign direct investments (FDI), being motivated to do so by expectations of possible spillover benefits. This strong belief in the positive effects of FDI, however, does not find support in the empirical evidence. Recent surveys on this topic (Gorg and Strobl, 2001; Alfaro and Rodriguez-Clare, 2003; Glass et al. 2000) suggest that the lack of consistency in the empirical literature on FDI-induced spillovers depends on the estimation techniques adopted by researchers (cross-section vs. panel data, industry-data vs. firm level data) and the use of different measures of foreign presence in the host countries. In this paper we argue that other factors, independent of data characteristics and methodologies, may affect the existence, the direction, and the magnitude of spillover effects. In particular, we try to answer the following research questions: 1) Are there any spillover effects of FDI, and if so, are they positive or negative? 2) Are spillover effects more likely to occur *within* or *across* sectors? 3) Are the existence, the direction and the magnitude of FDI spillovers conditioned by region, sector and firm-specific characteristics?

In answering these questions, we offer a positive contribution to the existing literature in several ways. First of all, we estimate sectoral production functions using a new and up-to-date methodology which enables us to overcome most of the problems encountered by the earlier literature. Secondly, we investigate the existence and the intensity of spillovers by considering not only the *density* of foreign firms but also the *nature* of the possible interactions between indigenous and foreign firms. Thirdly, we consider some factors often neglected by previous studies – such as the technology characteristics of foreign affiliates and their location within the host countries and the size of the indigenous firms – to further

explore the relationship between the technological competence of local firms and the extent of spillovers. In so doing, we reach a number of interesting conclusions. We find evidence of positive intra and inter-sectoral FDI spillovers, which are on average exploited by indigenous firms according to their own absorptive capacity. The opportunity to reap the FDI spillovers of less advanced indigenous firms improves substantially when we control for factors such as the location in the region hosting the capital cities, the technological characteristics of the foreign firms, and indigenous firm size.

The paper is organized as follows. The next section reviews the main theoretical and empirical literature on FDI productivity spillovers, dealing in particular with studies focused on the evidence from Central and Eastern European countries (CEECs). Section 3 describes the data source and the empirical strategy we adopted to answer the above-mentioned research questions. Section 4 presents the results of our estimations, while section 5 summarizes the main results and concludes.

2. FDI spillovers in the theoretical and empirical literature

FDI productivity spillovers depend on a variety of factors ranging from the nature of FDI, through the characteristics of multinational firms and their role in transferring technology, to the way in which foreign affiliates interact with indigenous firms and alter the structure of host markets. Put very briefly, multinational enterprises rely on intangible assets, such as a superior technology, in order to be internationally competitive (Markusen, 1995). Part of this know-how is usually transferred to their foreign affiliates but, given its nature as a public good, it spills over into the host economy through several channels which have been extensively described in the recent literature (Blomstrom et al., 2001; Gorg and Greenaway, 2002; Glass et al., 2000). In particular, domestic firms may learn about new products, production techniques and organization skills from foreign companies, thus increasing their efficiency.[†] This transfer of benefits may occur either voluntarily, through input output linkages between domestic and foreign firms (Hirschman, 1958; Rodriguez-Clare, 1996; Markusen and Venables, 1999) or involuntarily through competition, imitation and training (Fosfuri et at. 2001; Mansfield and Romeo, 1980; Dunning, 1993). Generally speaking, the

[†] Of course, foreign firms may also generate negative effects for domestic firms, such as tougher competition in the final markets as well as in the source - i.e. labour – ones. It is widely believed, however, that positive effects outweigh negative ones (UNCTAD, 2001).

former encourage flows of *generic knowledge* between foreign and indigenous firms linked by client-supplier relationships (vertical spillovers), while the latter concern flows of *specific knowledge* between foreign firms and their local competitors, i.e. indigenous firms operating at the same stage of the production chain (horizontal spillovers).[‡] In both cases, domestic firms become more productive and efficient, thus fostering local industrial development.[§] MNEs, instead, are likely to benefit from vertical spillovers, because they reach upstream suppliers and downstream clients, and they are likely to be penalized by horizontal externalities because these accrue to their direct competitors. Therefore, foreign firms will try to minimize outflows of specific knowledge, while encouraging outflows of generic knowledge to local clients and suppliers.

Despite this widely-accepted theoretical wisdom, there is little conclusive evidence supporting these claims. The existing evidence on whether there are spillovers is of three types.[**] First, there are case studies and surveys (Steward, 1976; Crone and Watts, 2000; Brand, Hill and Munday, 2000; Turok, 1993; Driffield and Noor, 1999; Pavlinek and Smith, 1998) furnishing a variety of qualitative information on specific FDI projects and locations, but their findings are difficult to generalise. Although these studies focus on different countries and economic sectors, they find little or no evidence of linkages between MNEs and their local suppliers. The second group consists of industry-level studies. Using cross-sector data, a number of these studies have shown that foreign affiliates achieve higher productivity than local firms (Aitken and Harrison, 1999; Blomstrom and Sjoholm, 1999). Nonetheless, spillovers often prove to be insignificant or negative, especially when industry dummies are controlled for (Haddad and Harrison, 1999; Aitken and Harrison, 1999). The only two exceptions are Blomstrom and Sjoholm (1999) and Altomonte and Resmini (2002) who find positive spillovers for indigenous firms from sectoral FDI. The third type of study consists of micro-level analysis. Firm level panel data are now the standard framework for empirical investigation of the validity of FDI spillover effects. Using an extended production function, these studies examine whether the productivity of domestic firms is affected by the presence of foreign firms. Both intra and inter-industry spillovers are considered, although geographical proximity between domestic and foreign firms is not always included in the

[‡]See Kugler (2005) for an in-depth discussion of horizontal and vertical spillovers and the type of knowledge they transmit to firms.

[§] See Glass et al. (2000) for an in-depth survey of these and other theoretical studies on spillovers between domestic and foreign firms.

[**] Gorg and Greenaway (2002), Alfaro and Rodriguez Clare (2003), and UNECE (2001) extensively document the empirical evidence on spillovers generated by foreign firms. Only the latter focuses on CEECs.

analysis. Djankov and Hoeckman (2000), Smarzynska Javornic (2004), Haskel et al. (2002), Peri and Urban (2004), Yudaeva et al. (2003), Schoor and van der Tol (2002) and Konings (2001) are recent examples of this kind of study. Most of them fail to find evidence on positive spillovers, especially in the case of developing countries. As far as CEECs are concerned, Djankov and Hoeckman (2000) document negative spillovers in the Czech Republic; Schoor and van der Tol (2002) highlight the existence of positive spillovers in Hungary; Konings (2000) finds negative spillovers in Bulgaria and Romania and no spillovers in Poland; Smarzynska Javornic (2004) provides mixed evidence for spillovers in Lithuania; and Yudaeva et al. (2003) document positive intra-industry spillovers but negative inter-industry spillovers between foreign and indigenous firms in Russia.

The paucity of the results obtained to date indicates that the mechanism through which MNEs may affect indigenous firms is still poorly understood. It is therefore important to gather further empirical evidence as the basis for future theoretical work.

3. Data and methodology

The data used in this study constitute an unbalanced panel with annual information on more than 40,000 domestic manufacturing firms and about 10,000 foreign owned firms located in three transition countries, namely Bulgaria, Poland, and Romania.[††] Although these countries started with very similar technological levels and managerial skills, their transitions to a market economy have followed very different paths whereby Poland became a member of the European Union in 2004, while Bulgaria and Romania had to wait another three years before joining the EU. The development of the transition phase has affected the inflows of FDI (Resmini, 2000), which have responded positively to the structural reforms undertaken in Poland and negatively to stagnation of the reform process in Bulgaria and Romania. Consequently, Poland has rapidly become one of the most important FDI recipients in the area, while Bulgaria and Romania fail to attract a substantial stock of foreign capitals. Given our research objectives, these and other socio-economic characteristics make comparison among these three countries of considerable interest.

The data are taken from the Amadeus database published by Bureau Van Djik, which besides standard financial information gives details on several qualitative variables, such as

[††] From a temporal perspective, the study covers the period from 1995 to 2003, although for Bulgaria the analysis is restricted to more recent years (1998-2003) owing to data unavailability.

ownership characteristics, industry classification, and geographical location within countries.[‡‡] Firms with a share of foreign ownership greater than 10 per cent have been classified as foreign affiliates, using the definition provided by the OECD and the IMF. All other firms with a percentage of foreign ownership below 10 per cent have been classified as domestic. Although it seems common practice to classify a firm as domestic even in the absence of any information on the nationality of the ownership (Peri and Urban, 2004), we prefer to adopt a more restrictive strategy in order to avoid overestimating the possible impact of foreign firms on domestic firm performance. We consequently excluded from the sample all firms whose ownership could not be properly identified.[§§]

Table 1 summarizes the most important facts and figures concerning domestic and foreign firms in the above-mentioned countries. Important insights can be gained from how the three countries considered differ in terms of the characteristics of both foreign and indigenous firms operating within their boundaries.

First to be noted is that the capital regions account for a large proportion of both domestic and foreign firms. The ranges are 17-32 per cent for indigenous firms and 21-52 per cent for foreign firms, respectively. The Sofia region accounts for the largest percentages in both cases.[***] Secondly, most of the FDI undertaken in the above-mentioned countries pertains to low tech manufacturing sectors.[†††] The share of this kind of FDI ranges from 68 per cent in Poland to 87 per cent in Romania, where the distribution of foreign firms between high and low tech manufacturing sectors is quite similar to that of local firms. Both geographical and sectoral concentrations may have important analytical implications. On the one hand, spillovers may be limited to the capital regions, given the high concentration of foreign firms located there. On the other hand, the large presence of foreign firms in traditional labour intensive sectors – such as textiles, clothing, footwear, furniture, etc. – may reduce the scope for technology transfer from the parent houses to the foreign affiliates. Consequently, spillovers to domestic firms may be small or non-existent, regardless of the ability of domestic firms to reap them.

[‡‡] Amadeus provides the latest available information on stakeholders' nationalities. We must therefore assume that ownership remains unchanged over the sample period.

[§§] This restrictive strategy prevents us from including other countries, such as Hungary or Czech Republic, in the sample.

[***] Since the Amadeus dataset is based on balance sheet data, one may argue that this phenomenon might reflect the location of headquarters rather than of production plants. However, these results are consistent with other studies on the location of MNEs in the CEECs which use other databases recording production plants only. See Altomonte and Resmini (2001) and Pusterla and Resmini (2007).

[†††] See the appendix for the classification of low and high tech manufacturing sectors.

Average total factor productivity (TFP) levels vary considerably across countries. Regardless of their ownership, firms located in Poland are characterized by the highest TFP, while firms located in Bulgaria exhibit the lowest average productivity. In all countries, the capital regions host the most productive firms, regardless of the nationality of the ownership. Last but not least, it is interesting to note that foreign firms are *on average* more productive than indigenous firms. However, when we control for the manufacturing activity and the geographical location within the host country, this is not necessarily the case. Polish firms located in the capital region and/or belonging to low tech manufacturing sectors are more productive than the corresponding foreign firms, while in Romania the productivity gap between low tech foreign and domestic firms is very narrow. As a result, we wonder whether and to what extent indigenous firms may benefit from spillovers, provided that they exist.

In what follows, we shall seek to determine the role played by these striking features in the distribution of spillovers across countries and their exploitation by domestic firms. In so doing, we shall cast new light on the FDI-induced spillovers issue.

(insert table 1 about here)

3.1 The empirical strategy

In order to test whether and to what extent indigenous firms become more productive because of spillovers emanated by multinational enterprises, we first needed to generate an appropriate measure for local firms' total factor productivity (TFP). For this purpose, we started from the following two factor Cobb-Douglas production function:

$$y_{it} = \alpha_0 + \alpha_l l_{it} + \alpha_k k_{it} + \omega_{it} + \varepsilon_{it} \qquad (1)$$

where y_{it} is the log of output from plant *i* at time *t*, l_{it} is the log of its labour input, k_{it} is the log of its capital input, ω_{it} its (unobserved) productivity level and ε_{it} is either a measurement error or an unobserved productivity shock.[‡‡‡]

Following the approach most commonly used in the recent literature on the topic, we estimated eq. (1) by applying the semi parametric estimation technique developed by Olley and Pakes (1996). This technique takes into account the simultaneity bias due to the

[‡‡‡] Total factor productivity at firm level was estimated using turnover as a proxy for total output, the stock of tangible fixed assets as a proxy for physical capital and number of employees. We lacked industry specific deflators, so that financial data are expressed in thousands of US dollars. This implies that TFP may also capture price and demand shocks (De Loecker, 2005) and that we cannot rule out that MNEs' may not affect prices rather than real productivity. Most studies focusing on CEECs do not explicitly consider this potential distortion (Tydell and Yudaeva, 2005; Torlak, 2004). We considered it in the second step of our empirical analysis, as explained later.

endogeneity of the firm's input selection, which may arise if a firm responds to unobservable productivity shocks by adjusting its input choice. This would imply a correlation between the inputs and the error term which biases traditional OLS coefficient estimates. Olley and Pakes suggest as a solution to this problem the use of firm's investment decisions as a proxy for unobserved productivity shock.[§§§] By applying this two step procedure on a sectoral base, we obtained sector-specific labour and capital intensities.[****] We then fitted eq. (1) and constructed the individual error terms u_{it}, which were the logs of our estimated plant TFP.[††††] We used this variable to analyse the impact of FDI spillovers on its changes over the period 1995-2003.

For this purpose, we assumed that geographical proximity enhances spillovers, as suggested by several previous studies (Keller, 2002; Peri and Urban, 2004). We therefore measured the presence of foreign firms by summing the number of foreign firms in sector *s*, region *r* at time *t-1* (fdi_{srt-1}). This rough measure of FDI density was then interacted with factors able to explain both the degree of interdependence of manufacturing sectors and the nature – i.e. source for inputs or destination for output – of such interdependence. Both these characteristics can be inferred from input-output tables which suggest that each manufacturing sector is at the same time both a supplier (*S*) and a customer (*C*) of several manufacturing sectors, itself included.[‡‡‡‡] We thus ended up with the following four measures for FDI-induced spillovers:

$$INTER\_SPILL^{S}_{srt} = \sum_{k \neq s} \alpha_{sk} * fdi_{krt-1} \quad (2)$$

$$INTRA\_SPILL^{S}_{srt} = \alpha_{ss} * fdi_{irt-1} \quad (3)$$

$$INTER\_SPILL^{C}_{srt} = \sum_{k \neq s} \omega_{sk} * fdi_{krt-1} \quad (4)$$

$$INTRA\_SPILL^{C}_{srt} = \omega_{ss} * fdi_{srt-1} \quad (5)$$

[§§§] This implied that all firms with zero or negative investment could not be included in the sample. Alternatively, Levinsohn and Petrin (2003) suggest that material inputs may be a better proxy for the firm's reaction to productivity shocks.

[****] Two sectors, namely manufacturing of refined petroleum products (NACE 23) and recycling (NACE 37), were excluded because the small number of firms operating in these sectors made it impossible to apply the Olley and Pakes procedure.

[††††] The advantage of this estimate is that it allowed us to consider also information on productivity of firms active in period *t* but with zero investments. In fact, omitting plants with zero investment would have meant omitting plants with low or declining productivities, thus introducing a sample bias in the next step, i.e. the one devoted to exploring the existence and the magnitude of FDI spillovers on indigenous firms.

[‡‡‡‡] We used the latest available national Input Output tables at two digit level for each country. We therefore could not exclude that supplier and client relationships may occur within sectors as well. This concept can be clarified if we consider two firms, one producing cotton fibres and the other producing cotton fabrics. Both firms belong to the same manufacturing sector, i.e. textiles (Nace 17), although they produce at different stages of the production chain.

Eq. (2) and (4) measure foreign firm penetration in industries from which industry *i's* domestic firms source and sell their inputs and output, thus accounting for forward and backward spillovers within region *r*, respectively. α_{sk} (ω_{sk}) is the share of sector *k* output (input) that is supplied (sold) to sector *s*, as indicated by the input-output tables. Eq. (3) and (5) have the same meaning as the corresponding inter-sectoral spillover equations but refer to foreign firms operating in the same sector (and region) as indigenous firms.[§§§§] While the coefficients taken by the input output tables remain fixed over time, the number of foreign firms operating in each sector changes. Hence, the variables capturing inter and intra-sectoral spillovers within each region are time-varying sector-specific variables.

In order to control for possible observable factors that may affect productivity growth trajectories, we extended this basic framework by including other regressors, which helped us capture firm, sector and time variation in TFP. This vector included the level of TFP lagged by one period, absorptive capacity, the size of the firm (defined as the number of employees, in the log form), and a product market competition index to capture potential efficiency-enhancing effects of international product market competition.

As several previous studies suggested, it is necessary for domestic firms to have enough absorptive capacity in order to be able to benefit from FDI-induced spillovers. In order to account for this important effect, we constructed a productivity gap variable. This has been defined as the difference between the average TFP of sector *i* in region *r* at time *t*, and the TFP of firm *i* in the same sector, region and year (Jabbour Mucchielli, 2005).[*****] We then created a firm specific, time varying dummy variable (GAP_{it}) taking the value of 1 if firm *i*'s TFP was below the industry average and 0 otherwise. This dummy variable was interacted with the spillover variables in order directly to identify the impact of foreign firms on indigenous firms with a low or a high level of absorptive capacity, respectively.

Nor is the idea that the degree of competition may affect firms' productivity new in the literature, both theoretical and empirical (Markusen and Venables, 1999; Blomstrom et al., 2001; Haskel et al., 2002; Sinani and Mayer, 2005). Competition may stimulate firms to use the existing technology more efficiently in order to maintain their market shares. However, it may also be detrimental for firms if the entry of a new competitor forces incumbent firms to

[§§§§] We are aware that this specification did not allow us fully to capture intra-sectoral spillovers, which also stem from foreign activity taking place at the same production stage as domestic firms. These spillovers derive from imitation and or demonstration effects, as well as from personnel training and mobility. However, as we stated in the introduction, it is likely that multinational firms try to minimize them, because they involve the transmission of specific knowledge to their local competitors.

[*****] Foreign firms were excluded from this calculation in order not to introduce any multicollinearity in the estimations.

move up their average cost curves. Both these effects can be a direct consequence of the entry of a MNE. Therefore, without a direct control on competition, the coefficients of spillover variables may pick up both technological spillovers and pro-competitive effects.[†††††] In order to obtain a measure as close to technological spillovers as possible, we decided to control for the degree of competition faced by firms in their respective product markets. The variable we included in the set of the explanatory variables ($MARKUP_{srt}$) was computed at sectoral level as operational turnover minus employment and material costs over operational turnover. Its interpretation was straightforward: the greater the difference between revenues and variable costs, the greater the power of firms to set prices, the less competitive is the local sector *s*, considered at region level.[‡‡‡‡‡] Given the opposite effects that competition may exert on firm productivity, we could not predict its sign.

Finally, we controlled for a number of sources of heterogeneity by including sector, time and region dummy variables.

Our baseline specification, therefore, consisted in the following two equations:

$$\Delta P_{isrt} = \alpha_0 + \beta_1 logP_{isrt-1} + \beta_2 INTER\_SPILL^S_{srt} + \beta_3 INTRA\_SPILL^S_{srt} + \beta_4 GAP_{it} * INTER\_SPILL^S_{srt} + \\ + \beta_5 GAP_{it} * INTRA\_SPILL^S_{srt} + \beta_6 MARKUP_{srt} + \beta_7 logEMPL_{isrt} + \alpha_r + \alpha_t + \alpha_s + \varepsilon_{isrt} \quad (6)$$

$$\Delta P_{isrt} = \delta_0 + \gamma_1 logP_{isrt-1} + \gamma_2 INTER\_SPILLC_{srt} + \gamma_3 INTRA\_SPILLC_{srt} + \gamma_4 GAP_{it} * INTER\_SPILLC_{srt} + \\ + \gamma_5 GAP_{it} * INTRA\_SPILLC_{srt} + \gamma_6 MARKUP_{srt} + \gamma_7 logEMPL_{isrt} + \delta_r + \delta_t + \delta_s + \eta_{isrt} \quad (7)$$

Eq. (6) accounts for possible spillover effects generated by multinational firms which source their intermediates from local producers, while eq. (7) captures spillover effects exerted by multinational enterprises supplying intermediates to local clients. This estimation approach helped us separately to evaluate the magnitude of respectively backward and forward linkages both across but also within sectors. Therefore, the total effect that foreign firms may exert on domestic firms' productivity growth depends on the sign and the magnitude of the estimated βs in eq. (6) and the corresponding γs in eq. (7).[§§§§§] In particular, if both the βs and the γs are

[†††††] Some scholars (Aitken and Harrison, 1999; Konings, 2001) ascribe their findings of negative spillovers to pro-competitive effects. However, these are not pure technological spillovers – i.e. Pareto improving positive externalities – but a transfer of welfare from the employees – who put more efforts in doing their job in order to keep the firm viable – to the shareholders (Haskel et al. 2002).

[‡‡‡‡‡] This index is a proxy for the Lerner index. It therefore ranges from zero (perfect competition) to one (monopoly).

[§§§§§] This estimation strategy is quite different from previous studies, where similar backward and forward measures for spillovers have been simultaneously included in the same equation (Smarzynska Javornic, 2004; Schoor and van der Tol, 2002). However, we thought it the best way to proceed, given the high levels of pairwise correlation that characterize spillover variables (see table A.1 in the appendix).

positive and statistically significant, we have evidence of both inter and intra sectoral spillovers. Instead, if only the βs (γs) are positive and statistically significant, this indicates that domestic firms are able to reap spillovers from their foreign client (supplier), provided that $\beta > |\gamma|$ ($\gamma > |\beta|$).

Separate analyses were conducted for the three countries included in the data base. Regressions were run using panel fixed effect techniques, since these enabled us to accommodate unobservable heterogeneity at industry, region and time level.[******]

4. Estimation Results

In this section we present and discuss the empirical estimates of the impact of FDI-induced spillovers on domestic firms' TFP growth. We first focus on the estimations of eq. (6) and (7) and then discuss how, whether, and to what extent general results are conditioned by three factors, namely location in the capital regions, the concentration of FDI in traditional labour intensive manufacturing sectors, and the size of the indigenous firms.

4.1 The baseline model

Table 2 shows the results of estimating eq. (6) and eq. (7) for Bulgaria, Poland and Romania. Overall, the results confirm the importance of the absorptive capacity of local firms as a determinant of FDI spillovers. A low level of absorptive capacity, in fact, does not allow indigenous firms to exploit any kind of spillovers, as indicated by the coefficient of the spillover variables interacted with the GAP variables, which are negative and significant at the conventional levels in all specifications.[††††††] This indicates that the technological delay is so severe that it prevents this type of domestic firms from reaping any kind of knowledge brought into their respective countries and regions by MNEs. The latter, therefore, have been seen as "cathedrals in the desert" by this group of firms.

[******] We obviously estimated the above-mentioned regression equations by using both fixed and random effect estimation techniques. Although the latter were not supported by statistics, the sign and the magnitude of the spillover variables were almost unchanged with respect to fixed effect estimations. Results are available upon request.

[††††††] Given the way in which spillover variables have been constructed, the coefficients of the interacted variables indicate by how much the slope coefficients of the less productive firms (GAP_{it}=1) differ from the slope coefficients of the more productive firms (GAP_{it}=0). Since the differential slope coefficients are negative and larger than the coefficients of spillover variables for the more productive firms, we can conclude that on average less productive firms do not reap any externalities from MNEs.

Both intra and inter-sectoral FDI spillovers accrue to indigenous firms with a high level of absorptive capacity. However, the magnitude of the spillover variables suggests that inter-sectoral spillovers are more important than intra-sectoral ones. This result is consistent in all specifications. Nevertheless, Bulgarian firms are found to experience the largest FDI productivity spillovers, and Romanian ones the lowest effects.

As far as the other variables are concerned, it can be seen that the estimated coefficients of the lagged level of TFP are always negative and statistically significant at the conventional levels. This is consistent with the notion of β-convergence where low productivity firms grow faster than high productivity ones. Conditional on the initial TFP level, larger firms grow at faster rates in Bulgaria, while the opposite occurs in Poland and Romania. By contrast, market competition exerts a negative effect on productivity growth in Bulgaria, while it is unable to affect productivity growth in Poland and Romania. As expected, productivity changes are also affected by sector and time-specific effects in all countries, while region-specific fixed effects are statistically significant in Poland and Romania but not in Bulgaria.

These results change substantially when conditionalities are taken into account, as will be shown in the next sub-sections.

(insert table 2 about here)

4.2 Is location in the capital region an advantage for domestic firms?

As shown in section 3, capital regions have attracted consistent FDI flows in all the countries considered. This highly concentrated pattern of location may affect the distribution of FDI benefits, confining them within the capital region's borders. In order to test this hypothesis, we interacted the capital dummy with the spillover variables. Table 3 shows the results.

Generally speaking, a high level of absorptive capacity allows domestic firms to reap both inter and intra-sectoral FDI spillovers, regardless of whether location is within or outside the capital region, as indicated by the differential slope coefficients, which are negative but lower than that of the spillover variables in all specifications.[‡‡‡‡‡‡] As before, inter-sectoral

[‡‡‡‡‡‡] The final impact of FDI spillovers on indigenous firms with levels of absorptive capacity above the sectoral average and located in the capital region can be calculated by summing the coefficients of the spillover variables which represent the benchmark case, i.e. firms with a high level of absorptive capacity ($GAP_{it}=0$) located outside the capital region (capital dummy = 0), with the corresponding differential slope coefficients, i.e. the estimated coefficients of the interacted variables (capital*spillovers). The final impact of FDI spillovers on indigenous firms with a low level of absorptive capacity ($GAP_{it}=1$) within and outside the capital regions can be calculated accordingly.

spillovers dominate intra-sectoral spillovers. With very few exceptions, FDI-spillovers are less intense in the capital regions than in the other regions.[§§§§§§]

Matters are entirely different in the case of firms with levels of absorptive capacity below the sectoral average. Rather surprisingly, these firms are able to reap intra-sectoral spillovers when they are located in the capital regions. This result is consistent in all specifications. We may therefore conclude that urban diversity and externalities partially compensate for the lack of technological capabilities, thus enabling indigenous firms to benefit from FDI spillovers.

(insert tables 3 about here)

4.3 Are all foreign firms able to generate spillovers?

In this sub-section we investigate whether foreign firm characteristics affect the transmission of spillovers to domestic firms. In particular, we seek to determine whether foreign affiliates with different technology intensity are able to exert the same impact on domestic firms' productivity. For this purpose, we created separate variables for spillovers from foreign firm operating in high tech manufacturing sectors and foreign firms operating in low tech manufacturing sectors. Given that the scope for technological transfer is higher in high-tech than in low-tech manufacturing sectors, we expected FDI-spillovers in the former to be more intense than in the latter. This hypothesis is confirmed by the results shown in Table 4 – which, however, highlight another, more interesting fact concerning the differing allocation of FDI spillovers among indigenous firms in the two sub-samples of manufacturing sectors.

In particular, we found that, whereas the evidence concerning low tech manufacturing sectors reflects previous results, with more productive indigenous firms as the only beneficiaries of FDI-induced spillovers, the exploitation of FDI spillovers in high-tech manufacturing sectors displays some distinctive features. Firstly, it is not necessarily the case that inter-sectoral spillovers are more intense than intra-sectoral spillovers. Secondly, and more interestingly, even fewer productive domestic firms are able to reap some spillovers. In particular, Bulgarian indigenous firms seem to benefit from intra-sectoral spillovers, while Polish firms' are able to increase their productivity and thus catch up with more productive indigenous firms by sourcing their input from foreign firms. Rather surprisingly, the FDI spillovers accruing to Polish firms with high levels of absorptive capacity are very limited and confined to firms selling their output to MNEs operating in the same manufacturing sector. As regards

[§§§§§§] In Romania, inter-sectoral spillovers are more intense in the district of Bucharest, while in Bulgaria spillovers from multinational enterprises operating in upstream sectors have the same intensity in all regions, as indicated by the coefficient of the inter-sectoral spillover variables interacted with the capital dummy, which is not significantly different from that of the benchmark case (capital dummy=0).

Romania, the standard results are confirmed, with spillovers accruing to more productive domestic firms only.

Overall, these findings suggest that the sector of activity of foreign firms affects both the magnitude and the allocation of productivity spillovers among indigenous firms. Differences across countries can be explained by the presence of technological complementarities between the FDI home and host countries.[*******]

(insert Table 4 about here)

4.5 The size of the firms

As a final step, we investigated whether spillovers depend on the scale of the indigenous firms by considering the following three sub-samples: small firms (fewer than 50 employees), medium-sized firms (between 50 and 250 employees) and large firms (more than 250 employees).[†††††††] The results are set out in Table 5, which highlights some interesting facts, in that several differences emerge both within and across countries.

In Bulgaria, FDI spillovers accrue mostly to small and medium-sized enterprises. Small firms with a high level of absorptive capacity benefit from both intra and inter-sectoral spillovers regardless of the sector of activity of the multinational firms, while those with a low level of absorptive capacity enjoy only intra-sectoral spillovers from high tech foreign firms. As firm size increases, spillovers effects weaken. Only medium-sized firms with a high level of absorptive capacity are able to reap some of the benefits generated by foreign firms, i.e. both intra and inter-sectoral backward spillovers in low tech manufacturing sectors and intra-sectoral spillovers in high tech manufacturing sectors. Finally, large firms enjoy intra-sectoral spillovers generated by foreign firms in high tech manufacturing sectors regardless of their absorptive capacity.

In Poland, the pattern is clear: firm size does not matter in the low tech manufacturing sectors, once absorptive capacity has been controlled for. On the contrary, only medium and large firms are able to exploit spillovers generated by foreign firms operating in high tech manufacturing sectors from which indigenous firms source their inputs. A similar picture emerges in Romania, where, however, only small and medium-sized enterprises benefit from spillovers generated by foreign firms in high-tech sectors. However, while both intra and

[*******] The importance of technology complementarities as determinants of FDI spillovers has been suggested by Blomstrom et al. (1999). There is, however, not much evidence supporting this point in the literature.

[†††††††] These intervals are those established by the European Commission in defining small and medium-sized enterprises (see Recommendation 2003/361/EC).

inter-sectoral spillovers accrue to small firms, medium ones reap inter-sectoral spillovers only.

Finally, it is worth noting that once firm size has been controlled for, backward spillovers, i.e. spillovers generated by foreign firms producing downstream in the production chain, become less significant. This phenomenon is particularly apparent in Poland, where it regards all classes of firms, while in Bulgaria and Romania it affects mainly large firms. Overall, these findings suggest that in laggard countries large firms benefit the least from foreign spillovers. This probably reflects the fact that these firms are still hampered by inefficiencies inherited from the past, such as bureaucratic sluggishness and overstaffing.

(insert Table 5 about here)

5. Summary and Conclusions

In this paper we have sought to answer three questions concerning the effects of FDI on domestic firms' productivity in three CEECs, namely Bulgaria, Poland and Romania. We have provided an answer, though not a definitive one, to all of these questions.

In particular, we have shown that MNEs do generate positive productivity spillovers, both within and across complementary manufacturing sectors. The results, however, indicate that these spillovers accrue to the more productive domestic firms only, thus confirming the important role played by absorptive capacity as a determinant of FDI-induced productivity spillovers.

These standard results change substantially when other geographical, sectoral and firm specific factors are taken into account. We have therefore contributed to the existing literature by highlighting the importance of these conditionalities.

In this regard, our findings indicate that, despite their backwardness, indigenous firms with a productivity level below the sectoral average can take advantage from spillovers generated by MNEs provided that they locate in the region hosting the capital city. This result suggests that urbanization externalities may mitigate the technology gap, thus enabling less efficient firms to take advantage of the presence of foreign firms. This is a novelty with regard to the findings of similar previous studies.

Secondly, we have investigated the relationship between the technological characteristics of foreign-owned enterprises and the impact of spillovers. This analysis is especially important given the large number of foreign firms operating in traditional labour intensive

manufacturing sectors which have established foreign affiliates in Central and Eastern European countries. Our findings show that foreign affiliates producing in low tech manufacturing sectors do generate productivity spillovers, but these are less intense than those generated by foreign firms operating in high tech manufacturing sectors. More importantly, we have shown that in low tech manufacturing sectors spillovers accrue to more productive indigenous firms only, while in high tech manufacturing sectors also less productive firms are able to benefit from spillovers from FDI.

Finally, we have found that spillover effects depend on the scale of the firm. Contrary to the previous cases, however, these effects vary not only across manufacturing sectors but also across countries. As firm size increases, FDI spillovers become less significant in Bulgaria and Romania, and more significant in Poland. These differences, however, are more apparent in high tech than in low tech manufacturing sectors.

While these results should be interpreted with caution, they provide a good starting point for future research in this area, which should focus more closely on the analysis of region, sector, and firm specific factors able to affect the nature and the magnitude of FDI induced spillovers.

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Table 1 – Domestic and foreign firms in the transition countries:

	Bulgaria		Poland		Romania	
	domestic	foreign	domestic	foreign	domestic	foreign
n of firms	2623	1159	4526	1502	33970	7165
of which:						
in the capital region	827	608	755	322	6098	1771
outside the capital region	1796	551	3771	1180	27872	5394
low tech sectors	1977	979	3304	1027	30236	6206
high tech sectors	646	180	1222	475	3734	959
Percentages:						
in the capital region	0.315	0.525	0.167	0.214	0.180	0.247
outside the capital region	0.685	0.475	0.833	0.786	0.820	0.753
max %	*0.218*	*0.107*	*0.121*	*0.150*	*0.175*	*0.194*
min %	*0.048*	*0.015*	*0.012*	*0.090*	*0.063*	*0.040*
low tech sectors	0.754	0.845	0.730	0.684	0.890	0.866
high tech sectors	0.246	0.155	0.270	0.316	0.110	0.134
Estimated Productivity index (averages):						
all sample	2.660	3.342	4.660	4.885	3.163	3.459
in the capital region	2.804	3.646	5.212	5.039	3.529	3.887
outside the capital region	2.584	2.941	4.585	4.849	3.102	3.339
low tech sectors	2.604	3.198	4.882	4.763	3.674	3.749
high tech sectors	2.865	4.129	4.146	5.147	3.099	3.417

Own calculations. Productivity indexes have been computed as simple means of TFP (in log form) of firms. TFP at firm level has been estimated using Olley and Pakes's (1996) semiparametric procedure, as described in the text.

Table 2 - The baseline model

	Bulgaria	Poland	Romania
Supplier sectors			
productivity level *(t-1)*	-.258 (.0089)[a]	-.280 (.0062)[a]	-.414 (.0023)[a]
intra-sectoral spillovers	.024 (.0060)[a]	.004 (.0010)[a]	.003 (.0001)[a]
inter-sectoral spillovers	.079 (.0113)[a]	.025 (.0038)[a]	.007 (.0003)[a]
gap * intra-sect. Spillovers	-.061 (.0051)[a]	- .008 (.0010)[a]	-.007 (.0001)[a]
gap *inter-sect. Spillovers	-.154 (.0079)[a]	-.055 (.0021)[a]	-.019 (.0002)[a]
markup	.390 (.0750)[a]	.000 (.0003)	-.055 (.0361)
size of the firm	.011 (.0057)[c]	-.008 (.0041)[c]	-.013 (.0015)[a]
region dummies	$F_{[5,4861]}=1.54$	$F_{[15,8259]}=2.85^a$	$F_{[7,85065]}=56.37^a$
sector dummies	$F_{[19,4861]}=28.58^a$	$F_{[18,8259]}=95.06^a$	$F_{[20,85065]}=256.07^a$
time dummies	$F_{[7,4861]}=35.86^a$	$F_{[8,8259]}=278.57^a$	$F_{[7,85065]}=306.85^a$
n. of obs	4900	8308	85107
R-sq	0.20	0.43	0.31
Client sectors			
productivity level *(t-1)*	-.242 (.0088)[a]	-.272 (.0062)[a]	- .424 (.0022)[a]
intra-sectoral spillovers	.026 (.0045)[a]	.005 (.0008)[a]	.003 (.0001)[a]
inter-sectoral spillovers	.050 (.0078)[a]	.026 (.0028)[a]	.007 (.0003)[a]
gap * intra-sect. Spillovers	-.051 (.0032)[a]	-.010 (.0007)[a]	-.006 (.0001)[a]
gap *inter-sect. Spillovers	-.088 (.0050)[a]	-.045 (.0019)[a]	-.019 (.0002)[a]
markup	.387 (.0758)[a]	.000 (.0003)	-.057 (.0358)
size of the firm	.012 (.0057)[b]	-.010 (.0041)[b]	-.012 (.0015)[a]
region dummies	$F_{[5,4861]}=1.39$	$F_{[15,8259]}=2.41^a$	$F_{[7,85065]}=63.34^a$
sector dummies	$F_{[19,4861]}=26.24^a$	$F_{[18,8259]}=91.25^a$	$F_{[20,85065]}=256.49^a$
time dummies	$F_{[7,4861]}=35.09^a$	$F_{[8,8259]}=279.59^a$	$F_{[7,85065]}=315.94^a$
n. of obs	4900	8308	85107
R-sq	0.19	0.42	0.33

Standard error in parenthesis; a, b, c denote significance at 1, 5 and 10% level, respectively.

Table 3 – The role of the capital region

	Bulgaria	Poland	Romania
Supplier sectors			
productivity level *(t-1)*	-.272 (.0089)[a]	-.284 (.0062)[a]	-.423 (.0022)[a]
intra-sectoral spillovers	.063 (.0135)[a]	.010 (.0014)[a]	.006 (.0001)[a]
inter-sectoral spillovers	.103 (.0133)[a]	.036 (.0026)[a]	.008 (.0003)[a]
capital*intra-sectoral spillovers	-.045 (.0116)[a]	-.007 (.0014)[a]	-.003 (.0001)[a]
capital* inter-sectoral spillovers	-.019 (.0127)	-.012 (.0030)[a]	.005 (.0003)[a]
gap * intra-sect. Spillovers	-.164 (.0127)[a]	-.017 (.0015)[a]	-.009 (.0001)[a]
gap *inter-sect. Spillovers	-.197 (.0151)[a]	-.059 (.0026)[a]	-.018 (.0002)[a]
capital*gap * intra-sect. Spillovers	.118 (.0137)[a]	.013 (.0019)[a]	.006 (.0002)[a]
capital*gap *inter-sect. Spillovers	.049 (.0166)[a]	.013 (.0041)[a]	-.001 (.0004)[a]
markup	.408 (.0734)[a]	.000 (.0003)	.029 (.0348)
size of the firm	.005 (.0056)	-.007 (.0041)[c]	-.014 (.0014)[a]
sector dummies	$F_{[19,4862]}=32.52$[a]	$F_{[18,8270]}=99.54$[a]	$F_{[20,85068]}=287.66$[a]
time dummies	$F_{[7,4862]}=39.18$[a]	$F_{[7,8270]}=285.94$[a]	$F_{[7,85068]}=299.41$[a]
n. of obs	4900	8308	85107
R-sq	0.22	0.43	0.32
Client sectors			
productivity level *(t-1)*	-.271 (.0088)[a]	-.279 (.0062)[a]	-.433 (.0022)[a]
intra-sectoral spillovers	.054 (.0111)[a]	.010 (.0011)[a]	.005 (.0001)[a]
inter-sectoral spillovers	.116 (.0163)[a]	.033 (.0024)[a]	.008 (.0002)[a]
capital*intra-sectoral spillovers	-.033 (.0092)[a]	-.006 (.0012)[a]	-.003 (.0001)[a]
capital* inter-sectoral spillovers	-.071 (.0138)[a]	-.015 (.0026)[a]	.003 (.0003)[a]
gap * intra-sect. Spillovers	-.126 (.0086)[a]	-.017 (.0012)[a]	-.008 (.0001)[a]
gap *inter-sect. Spillovers	-.205 (.0129)[a]	-.054 (.0023)[a]	-.019 (.0002)[a]
capital*gap * intra-sect. Spillovers	.082 (.0090)[a]	.011 (.0015)[a]	.005 (.0001)[a]
capital*gap *inter-sect. Spillovers	.128 (.0134)[a]	.024 (.0035)[a]	.002 (.0003)[a]
markup	.423 (.0753)[a]	.000 (.0003)	-.041 (.0346)
size of the firm	.004 (.0056)	-.010 (.0041)[b]	-.013 (.0141)[a]
sector dummies	$F_{[19,4862]}=32.95$[a]	$F_{[18,8270]}=96.32$[a]	$F_{[20,85068]}=295.94$[a]
time dummies	$F_{[7,4862]}=39.83$[a]	$F_{[7,8270]}=283.14$[a]	$F_{[7,85068]}=308.36$[a]
n. of obs	4900	8308	85107
R-sq	0.22	0.43	0.34

Standard error in parenthesis; a, b, c denote significance at 1, 5 and 10% level.

Table 4 – High Tech vs. Low Tech foreign firms

	Bulgaria	Poland	Romania
Supplier sectors			
productivity level *(t-1)*	-.270 (.0089)[a]	-.265 (.0061)[a]	-.424 (.0023)[a]
Low tech manufacturing sectors:			
intra-sectoral spillovers	.029 (.0060)[a]	.011 (.0017)[a]	.003 (.0001)[a]
inter-sectoral spillovers	.046 (.0126)[a]	.066 (.0065)[a]	.005 (.0003)[a]
gap * intra-sect. Spillovers	-.062 (.0051)[a]	-.017 (.0017)[a]	-.006 (.0001)[a]
gap *inter-sect. Spillovers	-.099 (.0114)[a]	-.113 (.0060)[a]	-.014 (.0002)[a]
High Tech manufacturing sectors:			
intra-sectoral spillovers	.797 (.1474)[a]	-.019 (.0178)	.006 (.0011)[a]
inter-sectoral spillovers	.153 (.0262)[a]	-.036 (.0099)[a]	.026 (.0013)[a]
gap * intra-sect. Spillovers	-.751 (.1333)[a]	.088 (.0222)[a]	-.020 (.0013)[a]
gap *inter-sect. Spillovers	-.262 (.0210)[a]	.040 (.0108)[a]	-.059 (.0012)[a]
markup	.403 (.0743)[a]	-.000 (.0003)	-.064 (.0359)[c]
size of the firm	.013 (.0056)[b]	-.010 (.0042)[b]	-.012 (.0015)[a]
region dummies	$F_{[5,4872]}$=1.43	$F_{[15,8255]}$=2.10[a]	$F_{[7,85061]}$=46.88[a]
sector dummies	$F_{[19,4872]}$=30.61[a]	$F_{[18,8255]}$=88.35[a]	$F_{[20,85061]}$=196.73[a]
time dummies	$F_{[7,4872]}$=36.24[a]	$F_{[7,8255]}$=286.48[a]	$F_{[7,85061]}$=310.67[a]
n. of obs	4915	8308	85107
R-sq	0.21	0.42	0.32
Client sectors			
productivity level *(t-1)*	-.260 (.0089)[a]	-.250 (.0061)[a]	-.434 (.0023)[a]
Low tech manufacturing sectors:			
intra-sectoral spillovers	.030 (.0048)[a]	.011 (.0015)[a]	.003 (.0001)[a]
inter-sectoral spillovers	.038 (.0080)[a]	.032 (.0055)[a]	.005 (.0003)[a]
gap * intra-sect. Spillovers	-.052 (.0031)[a]	-.017 (.0014)[a]	-.006 (.0001)[a]
gap *inter-sect. Spillovers	-.063 (.0057)[a]	-.062 (.0045)[a]	-.014 (.0002)[a]
High Tech manufacturing sectors:			
intra-sectoral spillovers	.369 (.0823)[a]	.025 (.0078)[a]	.008 (.0014)[a]
inter-sectoral spillovers	.206 (.0447)[a]	.010 (.0076)	.028 (.0019)[a]
gap * intra-sect. Spillovers	-.284 (.0728)[a]	-.027 (.0099)[a]	-.026 (.0015)[a]
gap *inter-sect. Spillovers	-.280 (.0242)[a]	-.021 (.0084)[a]	-.066 (.0016)[a]
markup	.446 (.0760)[a]	-.000 (.0003)	-.032 (.0362)
size of the firm	.010 (.0057)[c]	.008 (.0042)[c]	-.011 (.0014)[a]
region dummies	$F_{[5,4872]}$=1.49	$F_{[15,8255]}$=2.31[a]	$F_{[7,85061]}$=55.45[a]
sector dummies	$F_{[19,4872]}$=29.17[a]	$F_{[18,8255]}$=79.01[a]	$F_{[20,85061]}$=238.57[a]
time dummies	$F_{[7,4872]}$=32.77[a]	$F_{[7,8255]}$=286.87[a]	$F_{[7,85061]}$=321.50[a]
n. of obs	4915	8308	85107
R-sq	0.2	0.41	0.34

Standard error in parenthesis; a, b, c denote significance at 1, 5 and 10% level.

Table 5. FDI spillovers and the size of the indigenous firms

	Bulgaria			Poland			Romania		
	<50	50-250	>250	<50	50-250	>250	<50	50-250	>250
Supplier sectors									
productivity level *(t-1)*	-.317 (.0143)[a]	-.290 (.0143)[a]	-.273 (.0037)[a]	-.235 (.0142)[a]	-.271 (.0089)[a]	-.382 (.0109)[a]	-.434 (.0024)[a]	-.340 (.0089)[a]	-.328 (.0174)[a]
Low tech manufacturing sectors:									
intra-sectoral spillovers	.063 (.0112)[a]	.008 (.0073)	-.000 (.0120)	.014 (.0052)[a]	.012 (.0021)[a]	.008 (.0227)[a]	.003 (.0001)[a]	.004 (.0006)[a]	.004 (.0013)[a]
inter-sectoral spillovers	.113 (.0262)[a]	.024 (.0159)	-.011 (.0170)	.096 (.0190)[a]	.068 (.0092)[a]	.049 (.0094)[a]	.005 (.0003)[a]	.005 (.0013)[a]	.008 (.0029)[a]
gap * intra-sect. Spillovers	-.086 (.0090)[a]	-.052 (.0064)[a]	-.044 (.0151)[a]	-.022 (.0054)[a]	-.016 (.0021)[a]	-.017 (.0028)[a]	-.006 (.0001)[a]	-.006 (.0005)[a]	-.005 (.0012)[a]
gap *inter-sect. Spillovers	-.134 (.0202)[a]	-.074 (.0153)[a]	-.077 (.0198)[a]	-.131 (.0168)[a]	-.11 (.0082)[a]	-.093 (.0092)[a]	-.014 (.0003)[a]	-.010 (.0010)[a]	-.009 (.0024)[a]
High Tech manufacturing sectors:									
intra-sectoral spillovers	1.244 (.2941)[a]	.661 (.1943)[a]	.445 (.2179)[b]	-.129 (.0457)[a]	-.041 (.0257)	.073 (.0264)[a]	.006 (.0011)[a]	.001 (.0040)	-.008 (.0078)
inter-sectoral spillovers	.183 (.0440)[a]	-.130 (.0362)[a]	.094 (.0462)[b]	-.075 (.0289)[b]	-.033 (.0126)[a]	-.030 (.0163)[c]	.025 (.0014)[a]	.051 (.0065)[a]	.092 (.0189)[a]
gap * intra-sect. Spillovers	-1.044 (.2536)[a]	-.804 (.1848)[a]	-.416 (.2032)[b]	.092 (.0618)	.155 (.0305)[a]	-.050 (.0337)	-.020 (.0013)	-.012 (.0050)[b]	-.007 (.0078)
gap *inter-sect. Spillovers	-.312 (.0353)[a]	-.245 (.0285)[a]	-.115 (.0443)[b]	.046 (.0292)	.046 (.0142)[a]	.039 (.0178)[b]	-.060 (.0013)[a]	-.056 (.0056)[a]	-.096 (.0170)[a]
markup	.689 (.1408)[a]	.196 (.0990)[b]	.310 (.1032)[a]	-.011 (.0680)	-.000 (.0003)	.000 (.0004)	-.105 (.0379)[a]	.192 (.1203)	.520 (.1901)[a]
size of the firm	-.011 (.0142)	.032 (.0244)	.014 (.0258)	-.11 (.0152)[a]	.046 (.0138)[a]	.062 (.0131)[a]	-.002 (.0020)	-.028 (.0151)[c]	-.034 (.0133)[b]
region dummies	$F_{[5,2198]}$=4.37[a]	$F_{[5,1926]}$=1.71	$F_{[5,667]}$=0.58	$F_{[15,1504]}$=1.57[c]	$F_{[15,3887]}$=2.17[a]	$F_{[15,2810]}$=1.50[c]	$F_{[8,79534]}$=46.77[a]	$F_{[7,3703]}$=0.44	$F_{[7,1732]}$=0.59
sector dummies	$F_{[18,2198]}$=15.23[a]	$F_{[19,1926]}$=17.73[a]	$F_{[18,667]}$=6.81[a]	$F_{[18,1504]}$=14.42[a]	$F_{[18,3837]}$=48.97[a]	$F_{[17,2810]}$=68.17[a]	$F_{[20,79534]}$=180.84[a]	$F_{[20,3703]}$=15.52[a]	$F_{[20,1732]}$=10.02[a]
time dummies	$F_{[6,2198]}$=13.45[a]	$F_{[7,1926]}$=30.12[a]	$F_{[5,667]}$=12.66[a]	$F_{[7,1504]}$=78.54[a]	$F_{[8,3837]}$=116.89[a]	$F_{[8,2810]}$=62.86[a]	$F_{[7,79534]}$=305.72[a]	$F_{[7,3703]}$=21.64[a]	$F_{[7,1732]}$=19.21[a]
n. of obs	*2293*	*1969*	*707*	*1556*	*3890*	*2862*	*79580*	*3749*	*1778*
R-sq	*0.24*	*0.26*	*0.24*	*0.46*	*0.39*	*0.47*	*0.33*	*0.33*	*0.29*
Client sectors									
productivity level *(t-1)*	-.307 (.0142)[a]	-.282 (.0144)[a]	-.277 (.0240)[a]	-.216 (.0140)[a]	-.251 (.0088)[a]	-.376 (.0108)[a]	-.443 (.0024)[a]	-.358 (.0090)[a]	-.332 (.0176)[a]
Low tech manufacturing sectors:									
intra-sectoral spillovers	.050 (.0088)[a]	.014 (.0060)[b]	.004 (.0095)	.015 (.0047)[a]	.011 (.0019)[a]	.008 (.0024)[a]	.003 (.0001)[a]	.003 (.0005)[a]	.003 (.0012)[a]
inter-sectoral spillovers	.054 (.0150)[a]	.029 (.0109)[a]	.010 (.0116)	.048 (.0170)[a]	.026 (.0066)[a]	.041 (.0097)[a]	.005 (.0003)[a]	.003 (.0113)[c]	.003 (.0028)
gap * intra-sect. Spillovers	-.068 (.0054)[a]	-.044 (.0039)[a]	-.034 (.0102)[a]	-.023 (.0045)[a]	-.017 (.0017)[a]	-.016 (.0023)[a]	-.006 (.0001)[a]	-.005 (.0004)[a]	-.004 (.0011)[a]
gap *inter-sect. Spillovers	-.090 (.0107)[a]	-.051 (.0073)[a]	-.039 (.0098)[a]	-.068 (.0126)[a]	-.054 (.0055)[a]	-.070 (.0081)[a]	-.014 (.0002)[a]	-.008 (.0010)[a]	-.009 (.0023)[a]
High Tech manufacturing sectors:									
intra-sectoral spillovers	.654 (.1657)[a]	.256 (.1026)[b]	-.014 (.1225)	-.026 (.0190)	-.036 (.0117)[a]	.044 (.0115)[a]	.008 (.0015)[a]	-.001 (.0056)	.002 (.0107)
inter-sectoral spillovers	.329 (.0795)[a]	.126 (.0633)[b]	.080 (.0715)	.016 (.0215)	-.000 (.0097)	.016 (.0123)	.027 (.0019)[a]	.048 (.0099)[a]	.101 (.0276)[a]
gap * intra-sect. Spillovers	-.366 (.1357)[a]	-.289 (.0944)[a]	-.196 (.1163)[c]	-.064 (.0344)[c]	-.015 (.0132)	-.051 (.0149)[a]	-.026 (.0016)[a]	-.014 (.0058)[b]	-.015 (.0107)
gap *inter-sect. Spillovers	-.330 (.0392)[a]	-.246 (.0074)[a]	-.197 (.00497)[a]	-.014 (.0208)	-.005 (.0108)	-.024 (.0159)	-.066 (.0016)[a]	-.082 (.0077)[a]	-.112 (.0236)[a]
markup	.731 (.1431)[a]	.252 (.1023)[b]	.264 (.1061)[b]	-.021 (.0688)	-.000 (.0003)	.000 (.0004)	-.082 (.0383)[b]	.244 (.1222)[b]	.555 (.1956)[a]
size of the firm	-.012 (.0143)	.025 (.0247)	.024 (.0262)	-.111 (.0154)[a]	.056 (.0140)[a]	.062 (.0131)[a]	-.001 (.0020)	-.027 (.0150)[c]	-.034 (.0133)[b]
region dummies	$F_{[5,21.98]}$=3.81[a]	$F_{[5,1926]}$=0.91	$F_{[5,667]}$=1.63	$F_{[15,1504]}$=1.30	$F_{[15,3887]}$=2.44[a]	$F_{[15,2810]}$=1.90[b]	$F_{[8,79534]}$=51.38[a]	$F_{[7,3703]}$=3.18a	$F_{[7,1732]}$=0.99
sector dummies	$F_{[18,2198]}$=13.97[a]	$F_{[19,1926]}$=16.19[a]	$F_{[18,667]}$=7.03[a]	$F_{[18,1504]}$=12.48[a]	$F_{[18,3837]}$=43.19[a]	$F_{[17,2810]}$=66.55[a]	$F_{[20,79534]}$=220.53[a]	$F_{[20,3703]}$=17.16[a]	$F_{[20,1732]}$=9.26[a]
time dummies	$F_{[6,2198]}$=12.00[a]	$F_{[7,1926]}$=27.02[a]	$F_{[5,667]}$=11.36[a]	$F_{[7,1504]}$=78.41[a]	$F_{[8,3837]}$=118.10[a]	$F_{[8,2810]}$=63.57[a]	$F_{[7,79534]}$=313.25[a]	$F_{[7,3703]}$=23.70[a]	$F_{[7,1732]}$=16.91[a]
n. of obs	*2239*	*1969*	*707*	*1556*	*3890*	*2862*	*79580*	*3749*	*1778*
R-sq	*0.24*	*0.24*	*0.23*	*0.45*	*0.38*	*0.47*	*0.34*	*0.34*	*0.29*

Standard error in parenthesis; a, b, c denote significance at 1, 5 and 10% level.

Appendix

Table A.1 Spillover variables: correlation matrix

	HOR_SPILL^S	VER_SPILL^S	HOR_SPILL^C	VER_SPILL^C
HOR_SPILL^S	BG: 1.00 PL: 1.00 RO: 1.00			
VER_SPILL^S	BG: .009 PL: .015** RO: - .21**	BG: 1.00 PL: 1.00 RO: 1.00		
HOR_SPILL^C	BG: .97** PL: .99** RO: .97**	BG: .054** PL: .012* RO: - .07**	BG: 1.00 PL: 1.00 RO: 1.00	
VER_SPILL^C	BG: - .19** PL: - .054** RO: - .13**	BG: .57** PL: .80** RO: .57**	BG: -.25** PL: - .10** RO: - .17**	BG: 1.00 PL: 1.00 RO: 1.00

**, * denote significance at 1and 5% level.

Table A.2. Classification of Manufacturing Industries (Nace Rev. 1 codes in parenthesis*)*

High-Technology Industries	Low-Technology industry
Aircrafts and Spacecrafts (353)	Building and repair of ships and boats (351)
Office, accounting and computing machinery (30)	Rubber and plastic products (25)
Radio, TV and communications equipment (32)	Coke, refined petroleum products and nuclear fuel(23)
Medical, precision and optical instruments (33)	Other non-metallic mineral products (26)
Electrical machinery and apparatus n.e.c. (31)	Basic metals and fabricated metal products (27-28)
Motor Vehicles, trailers and semi-trailers (34)	Manufacturing n.e.c., recycling (36-37)
Chemicals (excluding pharmaceuticals) (24)	Wood, pulp, paper prod., printing and publishing (20-22)
Railroad and transport equipment (352, 353, 354)	Food products, beverages and tobacco (15-16)
Machinery and equipments n.e.c. (29)	Textiles, textile products, leather and footwear (17-19)