To Share or Not To Share: Does Local Participation Matter for Spillovers from Foreign Direct Investment?

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Abstract: This study examines whether foreign ownership share in investment projects affects the extent of spillovers from foreign direct investment. The analysis, based on a Romanian firm-level data set produces evidence consistent with positive intra-sectoral spillovers resulting from wholly-owned foreign affiliates but not from projects with joint domestic and foreign ownership. This finding is in line with the literature suggesting that foreign investors tend to put more resources into technology transfer to their wholly-owned projects than to those owned partially. Further, the data indicate that the presence of partially foreign-owned investments is correlated with higher productivity of domestic firms in upstream industries suggesting that domestic suppliers benefit from contacts with multinational customers. The opposite is true, however, in the case of wholly-owned foreign affiliates. These results are consistent with the observation that foreign investors entering a host country through greenfield projects are less likely to source locally than those engaged in joint ventures or partial acquisitions. They are also in line with the evidence suggesting that wholly-owned foreign subsidiaries use newer or more sophisticated technologies than jointly owned investment projects and thus may have higher requirements vis-à-vis suppliers.

Keywords: spillovers, foreign direct investment, joint venture, technology transfer

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Introduction

While domestic equity ownership requirements had been extensively utilized by governments in developing countries, their incidence has sharply declined in recent years (UNCTAD, 2003). Increasingly competitive environment for foreign direct investment (FDI) as well as the need to comply with international commitments have put pressure on governments to relax restrictions vis-à-vis multinationals. One of the reasons for the existence of ownership sharing condition was the belief that local participation in foreign investment projects reveals their proprietary technology and thus benefits domestic firms by facilitating technology diffusion. If this is indeed the case, are host countries depriving themselves of the potential technological benefits by allowing multinationals unrestricted ownership of their affiliates?

The ownership structure is especially important if a multinational's competitive advantage stems from its intangible assets. As it is difficult to write a contract that specifies all aspect of the rights to use intangible assets, local and foreign ownership sharing may result in knowledge dissipation. This problem can be reduced when the multinational is the sole owner of its affiliate.[1] Therefore, foreign investors may have an incentive to transfer more sophisticated technologies and management skills to their wholly-owned subsidiaries than to partially-owned affiliates.[2] As a result, wholly-owned investment project may present a larger potential for spillovers as they possess more sophisticated intangible assets.[3] The overall relationship between the share of foreign ownership and spillovers depends on the relative magnitudes of these two effects and is, therefore, ambiguous.

While a lot of research effort has been put into looking for the evidence of FDI spillovers,[4] little attention has been devoted to how the degree of foreign ownership affects this phenomenon. The few studies that attempted to examine this question compared intra-industry

[1] This argument is in line with the property rights approach developed by Grossman and Hart (1986) and Hart and Moore (1990).
[2] For empirical evidence see Ramacharandran (1993) and Mansfield and Romero (1980).
[3] Alternatively, it is also possible that a higher technological gap between domestic and foreign firms will prevent technology diffusion.
[4] The existing firm level studies produce mixed results with respect to horizontal (i.e., intra-industry) spillovers from FDI in developing countries. For instance, while Haddad and Harrison (1993), Aitken and Harrison (1999), Djankov and Hoekman (2000) and Konings (2000) fail to find a significant effect or produce evidence of negative spillovers, Kinoshita (2001) reaches an opposite conclusion for R&D intensive sectors in the Czech Republic and Damijan et al (2003) find evidence of positive horizontal spillovers in Romania but not in other transition economies. The picture is more optimistic in the case of inter-industry, or vertical spillovers, taking place through contacts between domestic firms and their multinational customers, as Javorcik (2004) provides evidence consistent with the presence of positive FDI spillovers operating through this channel.

spillovers from minority- versus majority-owned foreign affiliates, and either found no statistically significant difference between the two (Blomström and Sjöholm, 1999, on Indonesia) or concluded that the former are associated with greater externalities (Dimelis and Louri, 2001, on Greece).

This paper is a step forward in understanding the impact of the ownership structure on FDI spillovers. It extends the analysis to: (i) examine the difference between spillovers associated with *wholly-* and *partially-owned* foreign investments in addition to comparing the impact of majority- and minority-owned foreign projects; (ii) study both intra- (horizontal) as well as inter-industry (vertical) spillovers stemming from different types of foreign establishments, and (iii) account for the degree of concentration in the industry. Furthermore, this paper significantly improves upon the econometric techniques employed by Blomström and Sjöholm (1999) and Dimelis and Louri (2001) by controlling for unobserved firm heterogeneity and taking into account simultaneity between input selection and firm productivity.[5] These improvements are possible as, unlike the earlier studies, we employ a firm level panel data set rather than cross-sectional information.

Our results, based on a Romanian data set, suggest that the degree of foreign ownership matters for intra- as well as for inter-industry spillovers from FDI. We find that positive horizontal spillovers are linked to wholly-owned but not to partially-owned foreign projects. The difference between the effects from these two types of FDI is statistically significant. Based on the estimated coefficients, we find that a one-standard-deviation increase in the presence of wholly-owned foreign affiliates is associated with a 6.2 percent increase in the productivity of domestic firms operating in the same industry. This result suggests that the higher technological content of wholly-owned may outweigh the diffusion benefits of the shared ownership.

The pattern of vertical spillovers is also consistent with our expectations. The results point to positive externalities being associated with partially-owned foreign projects which are hypothesized to rely more heavily on local suppliers. On the other hand, wholly-owned foreign subsidiaries appear to have a negative effect on the productivity of domestic firms in upstream sectors. This negative effect may be due to the possibility that after acquiring a domestic enterprise, foreign investors frequently upgrade production facilities and as a result demand more

[5] Griliches and Mairesse (1995) argue that inputs should be considered endogenous since they are chosen by a firm based on its productivity, which is observed by the producer but not by the econometrician. Not taking into account the endogeneity of input choices biases the estimated production function coefficients. Since the focus of this paper is on firm productivity, the consistency of the estimates is crucial for the analysis.

complex, higher quality inputs which leads to severing existing relationships with local suppliers and relying on imported inputs. The subsequent decrease in demand for intermediates produced in Romania may prevent local producers from reaping the benefits of scale economies.[6]

This paper is structured as follows. In the next section, we argue that the degree of foreign ownership matters for knowledge spillovers. Next, we discuss FDI inflows into Romania. Then we present our data, estimation strategy and the empirical results. The last section concludes.

Why Should the Degree of Foreign Ownership Influence the Extent of Spillovers?

The ownership structure of FDI may affect the presence of horizontal (or intra-industry) spillovers in two ways. First, fear of technology leakage, especially in countries with limited rule of law, may induce firms with most sophisticated technologies to shy away from shared ownership and instead choose to invest only in wholly-owned projects.[7] This outcome may also stem from the tradeoff between using a joint venture to secure a better position in the product market and sharing profits with the local partner, as illustrated in the theoretical contribution by Javorcik and Saggi (2004) whose model predicts that the more technologically advanced foreign investor is less likely to choose a joint venture and prefers to enter directly. Further, as Ramacharandran (1993) demonstrates, foreign investors tend to devote more resources to technology transfer to their wholly-owned subsidiaries than to partially-owned affiliates. In the same manner, Mansfield and Romeo (1980) point out that the transfer of technology is more rapid within wholly-owned networks of multinationals' subsidiaries than to joint ventures or licensees. Similarly, Desai, Foley and Hines (2003) find evidence that majority and wholly-owned affiliates receive more intangible property from their parents companies than do minority-owned affiliates. In sum, wholly-owned investment project may present a larger potential for spillovers due to their higher technological content. On the other hand, it is generally believed by policy makers in developing countries that participation of local capital in a foreign investment

[6] This finding is consistent with anecdotal evidence from the Czech Republic indicating that multinationals upgrading or changing the nature of their production may switch from local to global sourcing and thus drop their suppliers in a host country (KPMG 2002). This result is also in line with the theoretical predictions of Saggi (2002) who shows that local suppliers of intermediates will be worse off after the entry of multinationals if the technology gap between local and foreign producers of final goods is large.

[7] For empirical evidence see Smarzynska and Wei (2000).

project reveals the multinational's proprietary technology and thus facilitates spillovers (UNCTAD 2003, Blomström and Sjöholm, 1999). The overall relationship between the share of foreign ownership and spillovers is the result of these two forces and its sign is, therefore, ambiguous.

Turning to the determinants of vertical (or inter-industry) spillovers, it has been argued that affiliates established through joint ventures or mergers and acquisitions are more likely to source their inputs locally than those taking form of greenfield projects (UNCTC, 2001). While the latter need to put significant efforts into developing linkages with local suppliers, the former can take advantages of the supplier relationships of the acquired firm or the local partner. [8] Empirical evidence supporting this view has been found for Japanese investors (Belderbos et al., 2001) and for Swedish affiliates in Eastern and Central Europe (UNCTC, 2000). On the other hand, anecdotal evidence also suggests that foreign investors acquiring local firms in transition countries tend to dramatically reduce the number of local suppliers as they integrate the subsidiary in the supplier network of the parent company.[9]

While in our dataset we cannot distinguish between acquisitions, joint ventures and greenfield projects, we have detailed information on the foreign equity share. To the extent that full foreign ownership is a proxy for greenfield projects and full acquisitions, we expect that wholly-owned foreign affiliates will rely more on imported inputs, while investment projects with local capital will source more locally.[10] Therefore, we anticipate larger vertical spillovers to be associated with partially-owned foreign projects than with wholly-owned foreign subsidiaries.

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[8] Evidence from *greenfield* investments in Hungary confirms this point: Philips and Sony reported local content below 10 percent and General Motors and Volkswagen below 5 percent in 1999 (Case study in "How Important are Global Strategies and Local Linkages of Multinational Corporations?", May 2003).

[9] One of the largest FDI projects in Romania, Renault's purchase of an equity stake in Dacia, the local automobile maker, may serve as an example. The initial transaction took place in 1999 with subsequent increases in Renault's share in 2001and 2002. After the acquisition, the French company promised to continue sourcing inputs from local suppliers provided they lived up to the expectations of the new owner. This, however, does not seem to have been the case. In 2002, eleven foreign suppliers of the French group were expected to start operating in Romania, thus replacing the Romanian producers from whom Dacia used to source (Ziarul Financiar (Financial Newspaper) April 19, 2001).

[10] A recent survey of multinationals operating in Latvia provides support for this view as it shows that while 52 percent of firms with joint domestic and foreign ownership had at least one local supplier of intermediate inputs, the same was true of only 9 percent of fully-owned foreign subsidiaries. Moreover, partially-owned foreign buyers reported offering more technical, managerial and financial assistance to their suppliers than fully-owned ones (FIAS 2003).

Further, the results of a study of the largest exporters in Hungary also indicate that foreign affiliates with larger share of foreign equity tend to purchase fewer inputs from Hungarian companies (Toth and Semjen 1999). Desai, Foley and Hines (2003) also found evidence that whole ownership is most common when firms integrate production activities across different locations.

This effect may be reinforced by the fact that wholly-owned foreign affiliates may use newer or more sophisticated technologies than their partially-owned counterparts and thus may have higher requirements vis-à-vis suppliers which only a handful of domestic firms, if any, would be able to meet. Furthermore, if wholly-owned foreign affiliates import a large portion of their inputs, they may even generate negative backward linkage effects. Such a scenario is illustrated in the theoretical contribution by Rodriguez-Clare (1996) where an increase in the importance of foreign firms relative to domestic enterprises leads to a reduction in input variety and specialization and thus results in a lower productivity of domestic producers of intermediates.

So far we have concentrated only on knowledge spillovers associated with FDI. However, as postulated by Aitken and Harrison (1999), the presence of multinationals may have yet another effect on domestic firms. Foreign entrants may take some market share away from local companies operating in the same industry, thus forcing them to spread the fixed costs over a smaller production scale, increasing the average cost and resulting in a lower observed productivity. While this effect may disappear in the long run as less competitive local producers exit, it may be observable in the period immediately following the foreign entry.[11] To take this possibility into account, we will control for the industry concentration in our analysis.

FDI in Romania

Compared to Central and Eastern European countries Romania was a late bloomer as an FDI destination in the region. The Romanian government's cautious approach to privatization and to transition in general, had led to relatively slow FDI inflows during the early 1990s. The situation changed dramatically in 1997 when substantial privatization efforts along with changes in the legislative framework provided new opportunities for foreign investors. As a result, the volume of FDI inflows in 1997 and 1998 was thirteen and twenty-one times larger, respectively, than the amount received in 1993 (see Table 1). In the following two years a slowdown was registered as FDI inflows decreased from 4.9 percent of GDP in 1998 to 3 percent in 1999 and 2.8 percent in 2000. Nevertheless, the total FDI stock accumulated between 1993 and 2000,

[11] A survey conducted by the World Bank found that 48 percent of Czech firms interviewed believed that the presence of multinationals increased the level of competition in their sector. The same was true of two-fifth of Latvian enterprises. Almost 30 percent of the firms in each country reported losing market share as a result of FDI inflows (Javorcik and Spatareanu, 2004).

equal to 6,429 million dollars, made Romania the fourth largest FDI recipient among ten countries in the region.

At the end of 2000, there were 77,241 companies with foreign capital in Romania, which represented about 9 percent of all companies registered in the country.[12] Foreign companies played an important role in the Romanian economy accounting for two-fifths of sales and exports. About 45 percent of FDI stock in 2000 was concentrated in manufacturing industries, with the rest found mainly in trade and financial services. In terms of the distribution of FDI by the source country, at the end of 2000, 61 percent of the FDI stock was accounted for by investors from the European Union, 10 percent by the Asian capital and 8 percent by American investors (Hunya, 2002).

Data Description

The data used in this study come from the commercial database Amadeus compiled by Bureau van Dijk, which contains comprehensive information on companies operating in thirty-five European countries, including Romania. The Amadeus database covers 387,357 firms registered in Romania.[13] In addition to the standard financial statements, Amadeus includes detailed information about the ownership structure of firms which allows us to determine the foreign equity stake in each company. The ownership information pertains mostly to 2000 and 1999 and no historical figures.[14] For this reason, we limit our analysis to an unbalanced panel spanning over the period 1998-2000. We assume that firms which were foreign-owned in the year for which we have the ownership information were foreign-owned during the whole three-year period. However, this may not be a very strong assumption as greenfield investments accounted for about 50-60 percent of FDI inflows into Romania before 2002 (Voinea 2003), which is the period covered by our sample.

Our sample includes firms with more than five employees in 1999. We remove inactive firms, missing observations and outliers (i.e., observations in the top and bottom one percentile of all the firm-specific output and input variables). We are left with 54,032 firms or 131,396

[12] Source: http://www.factbook.ro/countryreports/ro/Ro_InvestmentClimate.htm
[13] The Amadeus database does not cover state owned enterprises or cooperatives.
[14] Despite this shortcoming many researchers studying European economies have employed the Amadeus data. See, for instance, Budd, Konings and Slaughter (2002) and Konings and Murphy (2001).

firm-year observations, between 42,246 and 52,240 observations per year. In 6,262 firms the foreign capital share exceeds ten percent of the total and thus we classify them as foreign firms.

We also employ the input-output (IO) matrix provided by the Statistical Institute of Romania for the first year covered by the sample 1998.[15] The input-output matrix contains 105 sectors and each firm in our dataset is matched with the IO sector classification based on its primary three-digit NACE code. The concordances between the IO industry codes and three digits NACE codes can be obtained from the authors upon request. All sectors of the economy are represented in our sample. A detailed sectoral distribution of firms is presented in Appendix-Table A. As summary statistics presented in Table 2 indicate, a large degree of heterogeneity is found in the case of outputs, inputs and ownership type.

Empirical Strategy

Model and Estimation Issues

To examine the effect of foreign presence on productivity of domestic firms, we estimate a log-linear transformation of a Cobb-Douglas production function:

$$\ln Y_{it} = \alpha_i + \beta_1 \ln K_{it} + \beta_2 \ln L_{it} + \beta_3 \ln M_{it} + \beta_4 Horizontal\_Type1_{jt} + \beta_5 Horizontal\_Type2_{jt} + \\ + \beta_6 Vertical\_Type1_{jt} + \beta_7 Vertical\_Type2_{jt} + \beta_8 Concentration_{jt} + \alpha_t + \varepsilon_{it} \quad (1)$$

where subscripts *i, j* and *t* refer to firm, industry and time, respectively. Y_{it} stands for firm output. K_{it}, L_{it} and M_{it} represent production inputs: capital, labor, and materials. α_i and α_t capture firm and year effects, respectively. We define output as a firm's turnover deflated by industry specific producer price indices at the three-digit NACE classification. We measure labor by the number of employees. Capital is proxied by the value of tangible fixed assets deflated using the GDP deflator. Material inputs are deflated by a weighted average of the producer price indices of the supplying sectors. The weights are given by the input-output matrix and represent the proportion of inputs sourced from a given sector. $Concentration_{jt}$ is proxied by the Herfindahl index and

[15] Ideally we would like to use multiple input-output matrices since relationships between sectors may change over the years or with FDI inflows, albeit radical changes are unlikely. Unfortunately, input-output matrices for later years are not available.

controls for industry concentration. The index is defined as the sum of the squared market shares of the four largest producers in a given sector and its value ranges from 0 to 1.[16]

In addition to the standard production function variables, we include measures of foreign presence in the same sector (Horizontal) as well as in downstream sectors (Vertical), which are defined as follows. $Horizontal_{jt}$ is the share of an industry j's output produced by firms with at least ten percent foreign equity, calculated for each of the 105 industries. Since we are interested in exploring spillovers stemming from different types of FDI projects, we calculate separately measures of foreign presence pertaining to minority- and majority-owned foreign investments as well as to partially- and wholly-owned foreign projects.

The variable $Vertical_{jt}$ is a proxy for the foreign presence in downstream sectors (i.e., sectors supplied by the industry to which the firm in question belongs) and thus is intended to capture the effect multinational customers have on domestic suppliers. It is defined in the following way:

$$Vertical_{jt} = \Sigma_k \alpha_{jk} Horizontal_{kt}$$

Where α_{jk} is the proportion of sector j's output used by sector k taken from the 1998 input-output matrix including 105 sectors.[17] We calculate two separate measures of Vertical: one for partially- and one for wholly-owned foreign projects by using the appropriate definition of Horizontal variables defined above.[18] For summary statistics on these and other variables see Table 2.

We restrict our attention to domestic establishments to avoid a potential bias stemming from the fact that foreign investors tend to acquire stakes in large and most successful domestic companies (see Djankov and Hoekman, 2000). We use firm fixed effects estimation in order to take into account the unobserved firm characteristics, such a managerial talent, access to financing, etc., which may affect firm productivity. Doing so will allow us to control for time invariant determinants of productivity across firms that are also potentially correlated with FDI variables.

[16] As pointed out by Nickell (1996), predictions of the theoretical literature with respect to the impact of competition on productivity are ambiguous. In the empirical analysis, however, he finds evidence of competition being positively correlated with a higher rate of productivity growth.

[17] In calculating α_{jk} sector j's output sold for final consumption was excluded.

[18] Note that we do not calculate separate measures of Vertical for minority and majority foreign projects, as there is no theoretical argument suggesting that they should be different.

Further, we employ the semi-parametric approach, suggested by Olley and Pakes (1996) and modified by Levinsohn and Petrin (2003), to control for the possibility that a firm's private knowledge of its productivity (unobserved by the econometrician) may affect its input choices thus leading to biased estimates of the coefficients on factor shares.[19] This method allows for firm-specific productivity differences that exhibit idiosyncratic changes over time and thus addresses the simultaneity bias. Since our study relies on correctly measuring firm productivity, obtaining consistent estimates of the production function coefficients is crucial to our analysis.

Results

We begin our analysis by examining the difference between horizontal spillovers associated with partially- and wholly-owned foreign projects. We exploit the panel nature of our dataset and estimate a model with firm specific fixed affects. The results, presented in the first column of Table 3, indicate the presence of positive intra-industry spillovers, which are however, significant only in the case wholly-owned foreign establishments. This finding is consistent with the view that multinationals transfer newer technologies and invest more resources in knowledge transfer to their wholly-owned affiliates and thus such affiliates represent a greater potential for spillovers.[20] Moreover, there is a statistically significant difference in the magnitude of the coefficients associated with the two types of FDI.

Next, we focus on vertical spillovers from FDI by adding to our model two measures of foreign presence in downstream sectors. We find that proxies for vertical spillovers exhibit a very different sign pattern. Namely, partially-owned foreign projects appear to be associated with positive vertical spillovers, while full foreign ownership is correlated with lower productivity of domestic firms in upstream industries. The two coefficients as well as the difference between them are statistically significant at the one percent level. Their sign pattern is consistent with the hypothesis that foreign investors entering a host country through greenfield projects or full acquisitions are less likely to source their inputs locally than those who invested

[19] See the Appendix for a detailed description of the method.
[20] Additional regressions (not reported here) performed on a combined sample of both domestic and foreign indicate that fully-owned foreign subsidiaries have higher productivity levels than partially-owned foreign projects and domestic firms.

through joint ventures or partial acquisitions.[21] This may be due to the fact that the former group faces higher costs of finding and establishing a local network of suppliers and that foreign owners tend to reduce the number of existing suppliers of the fully acquired enterprise as they integrate the subsidiary into their global supplier network.

Finally, we add the Herfindahl index to the model in order to take into account the extent of industry concentration. This additional control may be important, since the estimates of spillover effects may capture the net impact of knowledge externalities and the competition effect. Our measure of industry concentration is statistically significant, but does not affect the signs or the magnitude of the estimated coefficients of the variables of interest. The concentration coefficient is negative and statistically significant suggesting that firms in more competitive industries exhibit higher productivity.

The results presented so far do not take into account the possible simultaneity between productivity shocks and firm input choices. To address this potentially serious problem, we apply the modified Olley and Pakes approach to estimate firm-specific total factor productivity (TFP) and then use it as the dependent variable in the second stage estimation. As TFP estimates come from regressions estimated for each industry separately, the second stage model includes industry (but not firm) fixed effects. As several industries lack a sufficient number of observations to apply the Olley-Pakes procedure, the estimates presented in Table 4 are based on a smaller number of observations. We estimate the second stage model in levels (columns 1 and 2) as well as in first differences (columns 3 and 4).

The results are broadly consistent with our previous findings. First, we show that the share of foreign ownership matters for both horizontal and vertical spillovers. In all regressions, the difference between spillovers associated with wholly- and partially-owned foreign projects is statistically significant. This is true for both inter- and intra-industry effects. Second, as before the empirical evidence is consistent with positive spillovers from wholly-owned foreign investments taking place within sectors. The estimated coefficients are significant at the one percent level in all four regressions. Based on the estimated coefficients, we find that an increase in wholly-owned foreign presence by one standard deviation increases the productivity of domestic firms operating in the same industry by 6.2 percent. We find, however, a change with

[21] About 50-60 percent of FDI inflows into Romania before 2002 took form of greenfield investments (Voinea 2003), while full acquisitions accounted for 15 percent of the total mergers and acquisitions (authors calculations based on Securities Data Corporation (SDC) Mergers and Acquisitions Database).

respect to horizontal spillovers associated with partially foreign-owned projects. While in the levels regressions their effect is not statistically significant, the first difference results suggest that the performance of domestic firms is negatively correlated with partially foreign-owned projects in the same sector. This suggests that in the case of partially foreign-owned investments the negative competition effect may outweigh the impact of knowledge externalities.

As in the earlier regressions, the data suggest that there exist significant negative effects associated with the presence of wholly foreign-owned projects in downstream sectors. Based on the estimated coefficients, a one-standard-deviation increase in the foreign presence in the downstream sectors decreases the productivity of domestic firms in the supplying by 2.5 percent. The first difference model also produces the evidence of a positive correlation between the presence of partially foreign-owned projects in downstream sectors and the productivity of domestic firms in upstream industries. As before, the results are robust to accounting for the extent of concentration in the industry.

Robustness checks

As a robustness check, we test whether our findings are driven by the distinction between the full and partial ownership or whether what matters is having a majority share and thus control over the enterprise management. We start by narrowing our controls to include only proxies for the minority- and the majority-owned foreign establishments. The results, presented in Table 5, point to the presence of positive spillovers in the case of majority-owned foreign projects and to negative spillovers associated with the minority-owned foreign investments. Moreover, there is a statistically significant difference in the magnitude of the coefficients associated with the two types of FDI.

Next, we test whether the positive effects associated with the majority-owned owned foreign investments are driven by the wholly-owned foreign subsidiaries. Thus, we include three measures of Horizontal: minority (pertaining to firms with 10-50 percent of foreign share), majority-but-not-wholly-owned (above 50 but less than 100 percent foreign ownership) and wholly-owned (100 percent foreign ownership). We find that in both types of regressions the positive and statistically significant effect is associated only with wholly-owned foreign subsidiaries. The test of equality of coefficients reveals a significant difference between the

effects associated with the three types of FDI. Finally, we add proxies for vertical spillovers and the Herfindhal index but the results remain unchanged.

We repeat the exercise using a first difference specification. The coefficients on the Horizontal variables follow the same pattern as in the model in levels, with the exception of spillovers from majority-but-not-wholly-owned investments which now become statistically significant but their effect is much smaller than that of fully-owned FDI projects. Again the difference between the two coefficients is statistically significant at the one percent level.

Finally, we perform yet another robustness check, not reported here, by narrowing our sample to manufacturing firms only. The results for the manufacturing sector confirm our previous findings that domestic firms' productivity is positively associated with the presence of wholly-owned foreign firms in the same sector and negatively associated with the presence of wholly-owned firms in downstream sectors. The results are robust to using both the levels and the first difference specifications. The coefficient on the proxy for horizontal spillovers is statistically insignificant in the case of partially foreign-owned subsidiaries. The proxies for vertical spillovers follow the same pattern as before. In sum, the additional robustness checks lend support to our hypothesis that the degree of spillovers vary with the degree of foreign ownership.

Conclusions

Governments of developing countries often favor joint ventures over wholly-owned FDI projects believing that active participation of local firms facilitates the absorption of new technologies and know-how. To test whether this belief is warranted, this paper tests whether there is a difference in the magnitude of horizontal and vertical spillovers associated with different degrees of foreign ownership. We find evidence consistent with positive horizontal spillovers resulting from wholly-owned foreign establishments but not from partially-owned foreign projects. This finding is in line with the literature suggesting that foreign investors tend to put more resources into technology transfer to their wholly-owned projects than into joint ventures. This result implies that the higher technological content of wholly-owned may outweigh the diffusion benefits of shared ownership.

A different pattern emerges in the case of vertical spillovers. The data indicate that the presence of partially-owned foreign projects is correlated with higher productivity of domestic

firms in upstream industries suggesting that domestic suppliers of intermediates may benefit from contacts with multinational customers. The opposite is true, however, in the case of wholly-owned foreign establishments which appear to have a negative effect on domestic firms in upstream sectors. The latter finding is consistent with the observation that foreign investors entering a host country through greenfield projects are less likely to rely on local sourcing due to costs associated with finding domestic suppliers. This result is also supported by the anecdotal evidence suggesting that after a full acquisition of a domestic enterprise, multinationals tend to reduce the number of suppliers often severing existing links with domestic firms in upstream sectors.

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Table 1. FDI Inflows into Central and Eastern Europe, 1993-2000

	FDI inflow (millions of US$)								
	1993	1994	1995	1996	1997	1998	1999	2000	1993-2000
Poland	1,715	1,875	3,659	4,498	4,908	6,365	7,270	9,342	39,632
Czech Republic	654	878	2,568	1,435	1,286	3,700	6,313	4,583	21,417
Hungary	2,350	1,144	4,519	2,274	2,167	2,037	1,977	1,692	18,159
Romania	**94**	**341**	**419**	**263**	**1,215**	**2,031**	**1,041**	**1,025**	**6,429**
Slovak Republic	199	270	236	351	174	562	354	2,052	4,198
Bulgaria	40	105	90	109	505	537	806	1,002	3,194
Latvia	45	214	180	382	521	357	348	407	2,454
Lithuania	30	31	73	152	355	926	486	379	2,432
Estonia	162	214	201	150	266	581	305	387	2,268
Slovenia	113	128	177	194	375	248	181	181	1,597

Source: IMF International Financial Statistics

Table 2. Summary Statistics

Variable	No. of Obs.	Mean	Std. Dev.	Min	Max
Sales (th. Lei 1995)	131,396	7,113.6	11,498.8	17.8	208,280.0
Fixed assets (th. Lei 1995)	131,396	1,399.9	3,757.3	0.004	56,666.2
Materials (th. Lei 1995)	131,396	5,265.0	9,042.1	8.4	102,814.1
Number of Employees	131,396	20.4	37.1	2.0	410.0
Horizontal minority	131,396	0.033	0.02	0	0.29
Horizontal majority	131,396	0.146	0.07	0	0.88
Horizontal partially-owned	131,396	0.107	0.04	0	0.81
Horizontal majority- but not wholly-owned	131,396	0.740	0.03	0	0.80
Horizontal wholly-owned	131,396	0.072	0.05	0	0.67
Vertical partially-owned	131,396	0.062	0.04	0	0.70
Vertical wholly-owned	131,396	0.040	0.02	0	0.21
Concentration measure	131,396	0.0028	0.0155	0.000	0.564

Table 3. Fixed Effects Regressions Results

	Fixed Effects	**Fixed Effects**	**Fixed Effects**	**Fixed Effects**
Horizontal partially-owned [10,100)	-0.068		-0.023	-0.029
	[0.045]		[0.045]	[0.045]
Horizontal wholly-owned [100]	**0.371*** **		**0.401*** **	**0.435*** **
	[0.044]		**[0.044]**	**[0.045]**
Vertical partially-owned		**0.591*** **	**0.641*** **	**0.648*** **
		[0.061]	**[0.062]**	**[0.062]**
Vertical wholly-owned		**-1.284*** **	**-1.259*** **	**-1.275*** **
		[0.076]	**[0.076]**	**[0.076]**
Concentration				-0.611***
				[0.128]
Ln fixed assets	0.038***	0.037***	0.037***	0.037***
	[0.001]	[0.001]	[0.001]	[0.001]
Ln materials	0.746***	0.747***	0.747***	0.746***
	[0.002]	[0.002]	[0.002]	[0.002]
Ln labor	0.170***	0.168***	0.168***	0.168***
	[0.002]	[0.002]	[0.002]	[0.002]
Year Dummies	yes	yes	yes	yes
Firm Specific Dummies	yes	yes	yes	yes
No. of observations	131,396	131,396	131,396	131,396
Adj. R squared	0.86	0.86	0.87	0.87
F test for equal coefficients on Horizontal	**48.88**		**45.9**	**54.02**
Prob. > F test Horizontal	**0.00**		**0.00**	**0.00**
F test for equal coefficients on Vertical		**467.36**	**478.77**	**488.91**
Prob. > F test Vertical		**0.00**	**0.00**	**0.00**

The dependent variable is firm output. Standard errors are listed in parentheses. ***, **, * denote significance at the one, five and ten percent level, respectively.

Table 4. Olley and Pakes Regressions Results

	Levels	Levels	First Differences	First Differences
Horizontal partially-owned	-0.094	-0.12	**-0.287****	**-0.287****
	[0.202]	[0.202]	**[0.126]**	**[0.127]**
Horizontal wholly-owned	**1.187*****	**1.277*****	**1.060*****	**1.205*****
	[0.200]	**[0.201]**	**[0.134]**	**[0.127]**
Vertical partially-owned	-0.057	-0.034	**1.004*****	**1.062*****
	[0.400]	[0.400]	**[0.285]**	**[0.286]**
Vertical wholly-owned	**-1.605*****	**-1.648*****	**-1.181*****	**-1.220*****
	[0.390]	**[0.391]**	**[0.236]**	**[0.236]**
Concentration		-1.489**		-2.175***
		[0.597]		[0.383]
Year Dummies	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	No	No
First Difference	No	No	Yes	Yes
No. of observations	117,668	117,668	71,517	71,517
F test for equal coefficients on Horizontal	**20.83**	**24.36**	**63.39**	**80.58**
Prob. > F test Horizontal	**0.00**	**0.00**	**0.00**	**0.00**
F test for equal coefficients on Vertical	**8.46**	**9.17**	**38.38**	**41.52**
Prob. > F test Vertical	**0.003**	**0.003**	**0.00**	**0.00**

The dependent variable is firm productivity calculated for each industry separately using the Olley-Pakes procedure. Standard errors are listed in parentheses. ***, **, * denote significance at the one, five and ten percent level, respectively.

Table 5. Olley and Pakes Regression Results - Robustness Checks

	Levels	Levels	Levels	Levels	First Differences	First Differences	First Differences	First Differences
Horizontal minority foreign owned [10,50]	**-0.810****	**-0.761****	**-1.016*****	**-1.097*****	**-1.549*****	**-1.506*****	**-1.697*****	**-1.783*****
	[0.374]	**[0.375]**	**[0.378]**	**[0.380]**	**[0.217]**	**[0.218]**	**[0.219]**	**[0.218]**
Horizontal majority foreign owned (50,100]	**0.833*****				**0.652*****			
	[0.153]				**[0.105]**			
Horizontal majority (excluding wholly owned) (50,100)		0.265	0.356	0.354		0.159	**0.341****	**0.380****
		[0.249]	[0.250]	[0.250]		[0.158]	**[0.161]**	**[0.161]**
Horizontal wholly-owned [100]		**1.197*****	**1.176*****	**1.272*****		**0.981*****	**1.059*****	**1.218*****
		[0.198]	**[0.200]**	**[0.201]**		**[0.132]**	**[0.136]**	**[0.127]**
Vertical partially-owned			0.039	0.069			**1.141*****	**1.212*****
			[0.400]	[0.401]			**[0.285]**	**[0.285]**
Vertical wholly-owned			**-1.754*****	**-1.808*****			**-1.357*****	**-1.410*****
			[0.393]	**[0.394]**			**[0.237]**	**[0.238]**
Concentration				-1.600***				-2.364***
				[0.598]				[0.382]
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	No	No	No	No
First Difference	No	No	No	No	Yes	Yes	Yes	Yes
No. of observations	117,668	117,668	117,668	117,668	71,517	71,517	71,517	71,517
F test for equal coefficients on Horizontal	**16.4**	**4.88**	**8.63**	**9.57**	**84.51**	**36.07**	**53.55**	**60.7**
Prob. > F test Horizontal	**0.001**	**0.027**	**0.003**	**0.002**	**0.00**	**0.00**	**0.00**	**0.00**
	(min vs. maj)	(min vs. maj)	(min vs. maj)	(min vs. maj)	(min vs. maj)	(min vs. maj)	(min vs. maj)	(min vs. maj)
F test for equal coefficients on Horizontal		**8.43**	**6.52**	**8.15**		**17.92**	**13.49**	**18.98**
Prob. > F test Horizontal		**0.004**	**0.011**	**0.004**		**0.00**	**0.00**	**0.00**
		(maj vs fully)	(maj vs fully)	(maj vs fully)		(maj vs fully)	(maj vs fully)	(maj vs fully)
F test for equal coefficients on Horizontal		**22.01**	**27.34**	**31.16**		**100.92**	**121.19**	**149.82**
Prob. > F test Horizontal		**0.00**	**0.00**	**0.00**		**0.00**	**0.00**	**0.00**
		(min vs. fully)	(min vs. fully)	(min vs. fully)		(min vs. fully)	(min vs. fully)	(min vs. fully)
F test for equal coefficients on Vertical			**11.17**	**12.19**			**49.55**	**54.21**
Prob. > F test Vertical			**0.001**	**0.00**			**0.00**	**0.00**

The dependent variable is firm productivity calculated for each industry separately using the Olley-Pakes procedure.
Standard errors are listed in parentheses. ***, **, * denote significance at the one, five and ten percent level, respectively.

Appendix

Estimation Details

We employ the semi-parametric estimation of the production function parameters, as suggested by Olley and Pakes (1996) and modified by Levinsohn and Petrin (2003), to account for the simultaneity bias. To illustrate the method, we start with the following production function:

$$va_{it} = y_{it} - m_{it} = \alpha + \beta_l * l_{it} + \beta_k * k_{it} + \omega_{it} + \eta_{it} \quad (1)$$

where *va* stands for value added (i.e., output minus material inputs), *l* and *k* for labor and capital, respectively, and *i* and *t* are subscripts denoting firm and year. Capital is treated as a state variable, while labor and materials are assumed to be freely variable inputs. η_{it} represents the error term capturing unpredictable shocks, while ω_{it} is a productivity shock which is unobserved by the econometrician but known to the firm. Firms adjust their variable inputs based on their anticipation or knowledge of the productivity component (ω_{it}). Since there exists a correlation between the error term ($\omega_{it} + \eta_{it}$) and the explanatory variables, a simple OLS procedure leads to inconsistent parameter estimates.

The insight of the method is that the observable characteristics of the firm can be modeled as a monotonic function of its productivity. Inverting such a function allows for expressing the unobserved component of the productivity in terms of the observed variables. While Olley and Pakes (1996) use investment to model the unobserved productivity shock we follow Levinsohn and Petrin (2003) and employ materials inputs to correct for the simultaneity bias (as was done by Hallward-Driemeier et al., 2001). We do so because of the lack of reliable information on investment expenditures. The advantage of using intermediate inputs is that they generally respond to the *entire* productivity term, while investment may respond only to the 'news' in the unobserved term. Further, intermediate inputs provide a simpler link between the estimation strategy and the economic theory, primarily because they are not typically state variables.

The demand for material inputs can be modeled as a monotonic function of the capital stock and the unobserved productivity shock.

$m_{it} = f(k_{it}, \omega_{it})$ (2)

Assuming the function *f(.)* is invertible, the unobservable productivity shock can be expressed as a function of observable variables.

$\omega_{it} = h(m_{it}, k_{it})$ (3)

We assume that materials are a variable input whose choice is affected by ω_{it} while capital is determined by past values of productivity only. Substituting (3) into (1), we get the equation to be estimated in the first stage of the procedure:

$va_{it} = \alpha + \beta_l * l_{it} + \beta_k * k_{it} + h(m_{it}, k_{it}) + \eta_{it}$ (4)

Note that the functional form of h(.) is not known. Therefore, β_k cannot be obtained at this stage. We estimate equation (4) using a third order polynomial expansion in capital and materials to approximate the unknown form of h(.). From this stage we obtain the consistent estimate of the labor input coefficient as well as the estimate of the third order polynomial in m_{it} and k_{it}, to which we refer as ψ_{it}.

$\psi_{it} = \beta_k * k_{it} + h(m_{it}, k_{it})$ (5)

Thus, $h(m_{it}, k_{it}) = \psi_{it} - \beta_k * k_{it}$ (6)

We proceed with the second stage where we estimate the effect of capital on output. Let's consider the expectation of $va_{t+1} - \beta_l * l_{t+1}$ conditional on the information at time *t*. Assuming that ω_{it} follows a first order Markov process, one can rewrite ω_{it+1} as a function of ω_{it}, letting ξ_{it+1} be the innovation in ω_{it+1}. And ω_{it} can be replaced with a function of $h(m_{it}, k_{it})$. Therefore the equation to be estimated in the second stage becomes:

$$va_{it+1} - \beta_l * l_{it+1} = c + \beta_k * k_{it+1} + g(h_{it}(.)) + \xi_{it+1} + \eta_{it+1} \quad (7)$$

Since the functional form of g(.) is not known, we use once more the third order polynomial expansion. Since the capital in use in a given period is assumed to be known at the beginning of the period and ξ_{it+1} is mean independent of all variables known at the beginning of the period, ξ_{it+1} is mean independent of k_{it+1}. The consistent coefficient β_k can thus be obtained by running non linear least squares on equation (7).

We use the above procedure to generate time-varying firm-specific measures of productivity that are consistent even in the presence of input shares being influenced by the private knowledge of firm's productivity. We perform the estimation for each sector separately and the obtained measures of productivity are then used in the analysis of spillover effects. As the procedure described above calls for using lagged variables, we employ a longer panel 1996-2000 to obtain the productivity estimates, but in the subsequent analysis of spillovers the timeframe is restricted to 1998-2000

Table A. Distribution of Firms with Foreign Capital by Industry

Industry code	Domestic Firms	Firms with Foreign Capital			Total
	<10%	10<=FO<50	50<=FO<100	FO=100	
1	798	12	30	21	861
3	94	2	2	1	99
6	26	0	0	0	26
8	543	10	27	26	606
9	37	1	5	1	44
13	673	7	11	5	696
14	44	2	3	2	51
15	14	1	1	0	16
16	82	0	3	1	86
18	646	20	28	26	720
19	27	0	0	2	29
20	134	4	10	11	159
21	62	0	7	5	74
22	298	9	11	7	325
23	461	18	21	21	521
24	18	1	2	3	24
25	2164	49	150	116	2479
26	343	17	27	23	410
28	1807	45	139	213	2204
29	87	4	3	7	101
30	30	1	2	0	33
31	379	6	50	90	525
32	1183	31	104	91	1409
33	138	12	25	13	188
34	1010	46	68	45	1169
36	7	0	1	3	11
38	74	6	10	9	99
40	59	3	7	3	72
41	90	6	4	5	105
42	54	3	8	17	82
43	63	2	3	3	71
44	3	1	0	0	4
45	112	5	6	8	131
46	274	21	34	40	369
47	110	4	11	6	131
48	57	3	5	5	70
49	8	0	0	0	8
50	90	0	8	5	103
51	11	0	1	1	13
52	98	5	4	4	111
53	52	0	5	1	58
54	14	0	5	2	21
55	13	0	2	5	20

56	9	0	2	1	12
57	9	1	1	1	12
58	20	1	7	3	31
59	65	1	3	5	74
60	1014	24	49	53	1140
61	41	2	7	3	53
62	78	5	9	5	97
63	21	0	6	1	28
64	41	1	6	6	54
65	67	1	12	7	87
67	37	4	4	5	50
68	98	8	13	15	134
69	141	6	15	18	180
70	54	11	6	10	81
71	109	6	11	11	137
72	89	5	8	4	106
73	69	1	4	2	76
74	17	0	1	0	18
77	551	18	49	40	658
78	191	3	19	21	234
79	18	0	2	0	20
80	4	0	3	1	8
81	43	1	1	1	46
82	71	0	0	0	71
83	4193	60	86	54	4393
84	19900	385	904	887	22076
85	321	8	20	13	362
86	2065	26	73	46	2210
87	8	1	2	2	13
88	1528	40	111	117	1796
90	30	1	4	2	37
91	9	1	0	1	11
92	113	7	8	13	141
93	275	9	24	28	336
95	234	11	16	17	278
97	214	7	19	11	251
98	376	20	49	54	499
99	78	2	2	4	86
100	541	18	30	16	605
101	1150	38	91	100	1379
102	13	0	1	0	14
103	142	3	1	4	150
104	208	3	21	10	242
105	1228	26	100	58	1412
Total	**47770**	**1122**	**2643**	**2497**	**54032**

FO stands for share of foreign capital in total firm's equity. Industry codes correspond to sector codes used in the input-output matrix.