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Does It Matter Where You Come From? Vertical Spillovers from Foreign Direct Investment and the Nationality of Investors

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Abstract: This study uses a firm-level panel data set from Romania to examine whether the nationality of foreign investors affects the degree of vertical spillovers from FDI. Investors' country of origin may matter for spillovers to domestic producers in upstream sectors (supplying intermediate inputs) in two ways. First, the share of intermediate inputs sourced by multinationals from a host country is likely to increase with the distance between the host and the source economy. Second, the sourcing pattern is likely to be affected by preferential trade agreements that cover some but not other source economies. In our case, the Association Agreements signed between Romania and the EU implies that inputs sourced from the EU are subject to a lower tariff than inputs sourced from the US or Asia. Moreover, while for European investors intermediate inputs sourced from home country suppliers comply with the rules of origin and thus can be exported to the EU on preferential terms, this would not be the case for home country suppliers of American or Asian multinationals. Therefore, we would expect that American and Asian investors source more from Romania than EU investors and thus present greater potential for vertical spillovers. The empirical analysis produces evidence in support of our hypothesis. We find a positive association between presence of American and Asian companies in downstream sectors and the productivity of Romanian firms in the supplying industries. Further, the productivity of Romanian firms in the supplying sectors is negatively correlated with operations of European investors in downstream sectors. The differences between the effects associated with investors of different origin are statistically significant.

Keywords: spillovers, foreign direct investment, technology transfer

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Introduction

Many countries strive to attract foreign direct investment (FDI) by offering ever more generous incentive packages and justifying their actions with the expected knowledge externalities to be generated by foreign affiliates. Despite being hugely important to public policy, there is little conclusive evidence to support this claim, as the empirical literature searching for spillovers operating within sectors has produced mixed results.[1] 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 operating in the same country. Blalock and Gertler (2004), Javorcik (2004), and Javorcik and Spatareanu (2003) provide evidence consistent with the presence of positive FDI spillovers working through this channel. Little is known, however, about factors affecting such spillovers.

This is the first paper to examine factors driving the degree of vertical spillovers from FDI. Using a comprehensive data set of firms operating in Romania, this study tests whether there exists a difference in the magnitude of vertical spillovers associated with multinationals from different regions of the world (Europe, America and Asia). We believe that such difference are likely to exist for three reasons. First, as the theoretical models of vertical linkages predict, the share of intermediate inputs sourced by multinationals in a host country is positively correlated with the distance between the headquarters and the production plant in the host country (Rodrigues-Clare, 1996 and Markusen and Venables, 1999).[2] And a larger share of local sourcing implies more contacts between multinationals and local firms in upstream sector and a greater potential for knowledge spillovers.[3] Therefore, we would expect a higher degree of

[1] Most of the existing firm level studies, including Haddad and Harrison (1993) on Morocco, Aitken and Harrison (1999) on Venezuela, Djankov and Hoekman (2000) on the Czech Republic, and Konings (2001) on Bulgaria, Poland and Romania cast doubt on the existence of horizontal (i.e., intra-industry) spillovers from FDI in developing countries. They either fail to find a significant effect or produce the evidence of negative impact the presence of multinational corporations has on domestic firms in the same sector. The few studies finding evidence of positive within-sector spillovers focus on developed countries (e.g., Haskel, Pereira and Slaughter, 2002, on the UK).

[2] This prediction is confirmed by empirical evidence. Hanson, Mataloni and Slaughter (2003) demonstrate that sales of intermediate inputs by U.S. multinationals to their overseas affiliates decline with the trade costs. Local sourcing by Japanese investors in the United States has been reported to serve operational needs given transportation distance and potential shipping delays from Japan (Chung et al., 2003 and Martin and Swaminathan, 1995). In a recent survey of multinationals operating in the Czech Republic, when asked "Why did you choose to source inputs from a Czech supplier?" over half of the respondents mentioned the importance of proximity to suppliers and the savings on transportation costs (Javorcik and Spatareanu, 2004).

[3] See Pack and Saggi (2001) and Lin and Saggi (2004) for models of vertical technology transfer from multinationals to local suppliers.

vertical spillovers to be associated with American and Asian investors than with European multinationals, since home countries of the former are located much farther away from Romania.

Second, preferential trade agreements, which cover some but not all investors' home countries, are likely to affect the sourcing patterns of multinationals. For example, since Romania signed the Association Agreements with the European Union (EU), its tariffs on imports from the EU and United States are sharply different. During 1999, the average tariff applied by Romania on manufacturing imports from the US and Japan was 15.78 percent whereas the corresponding tariff on imports from the EU was only 4.88 percent.[4]

Third, multinationals using Romania as the export platform can enjoy preferential (or even duty-free) access to EU provided a sufficient share of value in their product was added within the area covered by the agreement. This implies that while for European investors intermediate inputs purchased from home country suppliers would still comply with the rules of origin, this would not be the case for home country suppliers of American or Asian multinationals. Therefore, we expect that American and Asian investors would have a greater incentive to source locally and thus would be associated with greater knowledge spillovers to Romanian firms in the supplying sectors.[5,6]

Several cases studies from the automotive industry suggest that investor nationality may indeed affect the extent of local sourcing. For instance, UNCTAD (2001, p. 166) reports that in the case of Suzuki's investment in Hungary rules of origin under the Association Agreement with the EU were a factor in the firm's decision to locate there, create local linkages and increase local value added, so as to enjoy duty-free access for car exports to EU markets. Similarly, Daewoo, which invested in Romania, stated that it intended to reach a 60 percent localization level of the production. In 1997, 16.9 percent of the components of Daewoo's Cielo

[4] Source: WITS database. The figures in the text refer to simple averages which were calculated based on the tariff data for 8- (for EU) or 6-digit (for US and Asia) HS categories. Manufacturing sectors are defined as HS 25-97.

[5] Of course, this will not be true of all American or Asian investors as many of them may still choose to import their inputs from countries covered by the Agreement. Nevertheless, we would expect to observe a broad trend following this pattern. Similarly, a certain number of European investors are likely to engage in local sourcing. Overall, however, we would expect that importing intermediate inputs would be more advantageous to European than to other multinationals as European multinationals can combine sourcing for their headquarters, Romanian plants and possibly sister companies in Europe in order to enjoy volume discounts. It has been pointed out that centralized or pooled group-sourcing arrangements may encourage affiliates to use foreign sources even when local suppliers are available (see UNCTC 2001, p. 136).

[6] Note that preferential trade agreements may also alter the incentives for investment. Lured by low wages and guaranteed access to European Union market, foreign investment in the auto industry in Central European countries has soared in recent years. For example, the South Korean Hyundai group is expected to build a $850 m Kia plant in Slovakia (The Economist, March 6th-12th 2004).

model were produced in Romania, and these 300 Romanian components were supplied by 43 Romanian companies. In the same year, about 40 percent of Cielos produced in Romania were exported, mainly to other Eastern European countries which signed the Association Agreements with the EU. On the other hand, when the French multinational, Renault, purchased an equity stake in Dacia, the Romanian car maker, in 1999, it promised to continue sourcing inputs from local suppliers provided they lived up to its expectations. 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).

The low propensity of European investors to source intermediate inputs from Romania may actually hurt domestic firms in upstream sectors. The entry of foreign investors is likely to increase the level of competition in downstream industries driving weaker firms out of business. As they exit, part of their market share may be acquired by European multinationals, resulting in lower demand for domestically produced intermediate inputs. Moreover, European investors entering Romania through acquisitions of local firms are likely to sever existing linkages to local suppliers again lowering the demand for domestically produced intermediates. A drop in demand for intermediates, on the other hand, will force producers in the supplying sectors to spread their fixed cost over a smaller market share and thus will lower their productivity.

Our hypothesis is tested using data from the Amadeus database which includes information on 50,597 firms operating in Romania. Over 11 percent of these firms are foreign owned with 4,856 firms being affiliates of European companies, 434 of American and 406 of Asian corporations. We estimate a production function controlling for the share of output in a given industry coming from foreign owned entities (a proxy for intra-industry spillovers from FDI) and for the foreign presence in downstream sectors (potential buyers of intermediate inputs). The latter measure is calculated separately for European, American and Asian owned companies.

Our results can be summarized as follows. We find a statistically significant and positive association between the presence of American and Asian companies in downstream sectors and the productivity of Romanian firms in the supplying industries. At the same time, the productivity of Romanian firms in the supplying sectors is negatively correlated with operations of European investors in downstream industries. The differences between the effects stemming

from investors of different origin are statistically significant. The findings are robust to controlling for firm-specific fixed effects. Moreover, the results do not change after we implement the Olley and Pakes (1996) correction for endogeneity of input selection.

We conclude that the observed pattern is consistent with our hypothesis that FDI inflows from far away source countries which are not part of the preferential trade agreement are more likely to be associated with local sourcing and thus vertical productivity spillovers taking place through contacts with local suppliers of intermediate inputs.

This paper is structured as follows. In the next section, we discuss FDI inflows into Romania. Then we present our data, estimation strategy and the empirical results. The last section concludes.

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 as a percentage of GDP decreased from 4.9 percent in 1998 to 3.0 percent in 1999 and 2.8 percent in 2000. Nevertheless, the total FDI stock accumulated between 1993 and 2000, equal to 6,429 million dollars, made Romania the fourth largest FDI recipient among ten countries in the region.

According to the UNCTAD's Inward FDI performance index, Romania success in attracting FDI was also particularly visible in 1997 and 1998. The index is computed as the ratio of a country's share in global FDI flows to its share in the global GDP. Countries with an index value of one are FDI recipients in line with their relative GDP, while those with an index above one attract more FDI than what would be expected given their economic size. In 1996 the index value for Romania was 0.58 increasing to above 2 in 1997-98 and then declining to 0.82 and 0.59 in the two following years (UNCTAD, 2001).

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.[7]

Foreign companies played an important role in the Romanian economy accounting for two-fifths of sales and exports. FDI is mainly concentrated in labor intensive industries and have been primarily export-driven (Dumitriu and Hunya, 2002, Voinea, 2002). About 45 percent of FDI stock in 2000 was concentrated in manufacturing industries, with the rest found mainly in trade and financial services (Hunya, 2002).

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). The largest source countries included the Netherlands, France, Italy, Germany, the United States, the United Kingdom and Greece.[8]

Data Description

The data used in this study come from a commercial database Amadeus compiled by Bureau van Dijk, which contains comprehensive information on companies operating in 35 European countries, including Romania. The Amadeus database covers 387,357 out of 783,969 (308,064 reported active) firms registered in Romania at the end of year 2000.[9] The difference comes from the fact that while Amadeus includes some inactive companies, it does not cover state owned firms or co-operatives. Information on the firms included in Amadeus comes from the Chamber of Commerce and Industry of Romania.

In addition to the standard financial statements, Amadeus includes detailed information about the ownership structure of firms which allows us to determine the amount and the country of origin of the foreign equity stake in each company. While having information on the foreign equity share is not difficult to find, knowing the source country of the foreign capital is a unique feature of our data set. The database contains only the latest available ownership information

[7] http://www.factbook.ro/countryreports/ro/Ro_InvestmentClimate.htm
[8] Ibid.
[9] Source: Romanian Statistical Yearbook (2001).

(mostly for 2000 and 1999) and no historical figures.[10] For this reason, we limit our analysis to an unbalanced panel spanning 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.

The sample includes firms with more than five employees in 1999. After deleting inactive firms and missing observations and removing outliers,[11] we are left with 50,597 firms (or 131,396 firm-year observations, between 42,246 and 50,597 observations per year). For 5,696 firms the foreign capital share exceeds 10 percent of the total.

We also employ the input-output matrix provided by the Statistical Institute of Romania for the first year covered by the sample 1998.[12] The input-output matrix covers 105 sectors and each firm in our dataset is matched with the IO sector classification based on its primary three-digit NACE code.[13] Both manufacturing and service sectors (87 in total) are represented in our sample. A detailed sectoral distribution of firms is presented in Table 2. As summary statistics presented in Table 3 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 the productivity of domestic firms, we estimate a log-linear transformation of a Cobb-Douglas production function:

$$\ln VA_{it} = \ln Y_{it} - \ln M_{it} = \alpha_i + \beta_1 \ln K_{it} + \beta_2 \ln L_{it} + \beta_3 \text{Vertical\_European}_{jt} + \beta_4 \text{Vertical\_American}_{jt} + \beta_5 \text{Vertical\_Asian}_{jt} + \beta_6 \text{Horizontal}_{jt} + \alpha_t + \varepsilon_{ijt} \quad (1)$$

[10] Despite this shortcoming many researchers studying European economies have employed the Amadeus data. See, for instance, Budd, Konings and Slaughter (2002), Castellani and Zanfei (2001), Konings and Murphy (2001), Konings, Rizov and Vandenbussche (2003), Schoors and van der Tol (2001).

[11] Firms in the top and bottom one percentile of all the firm-specific output and input variables were deleted from the sample.

[12] 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.

[13] For the concordances between the IO industry codes and three digits NACE codes see Javorcik and Spatareanu (2003).

where subscripts *i, j* and *t* refer to firm, industry and time, respectively. VA_{it} stands for firm's value added, Y_{it} output, M_{it}, K_{it}, L_{it} and represent production inputs: materials, capital and labor. α_i and α_t capture firm and time fixed effects, respectively. Firm fixed effects control for unobserved firm characteristics, such a managerial talent, availability of better infrastructure or access to financing, etc., which may affect firm productivity. We define firm's output as turnover deflated by industry specific producer price indices at the two-digit NACE classification. 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. We measure labor by the number of employees. Capital is proxied by the value of tangible fixed assets deflated using the GDP deflator.

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 10 percent foreign equity, calculated for each of the 87 industries. Even though the number of foreign firms does not change during the sample period, output fluctuates and thus it is a sector-specific time-varying variable.

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 from a particular region of origin have on domestic suppliers. It is defined in the following way:

$$Vertical\_Origin_{jt} = \Sigma_k \alpha_{jk} Horizontal\_Origin_{kt}$$

where α_{jk} is the proportion of sector j's output used by sector k taken from the input-output matrix.[14] We calculate three separate measures of Vertical for three regions of origin of foreign investors: Europe, America and Asia. In order to do so, each foreign affiliate is assigned to one of the three regions in following manner. Europe encompasses investors from all European countries (EU members, accession countries and non-members) as well as Turkey.[15] America includes both North and South America, but the grouping consists primarily of the U.S. and Canadian investors. Among Asian investors China, Lebanon, Syria, Iraq have the higher number

[14] In calculating α_{jk} sector j's output sold for final consumption was excluded.
[15] We have 342 Turkish investors in the sample. Turkey has been classified as a European country because of its proximity and the fact that since 1995 it has formed a Customs Union with the EU.

of projects but in terms of volume the Republic of Korea is the dominant source country. Firms with shareholders of multiple origins were dropped from the sample.[16]

Table 1A in the Appendix presents the distribution of foreign affiliates in the three groups across sectors. Note that it is quite similar across the three groups of investors. The regional distribution of the multinationals follow similar patterns for the American and Asian as well as the European investors. The summary statistics of all variables are listed in Table 2. The model specified in equation (1) is estimated on the sample of purely Romanian firms, since we are primarily interested in the impact of foreign presence on domestic producers.

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.

Further, we control for the fact that firm's private knowledge of its productivity (unobserved by the econometrician) may affect the input decisions, leading to biased estimates of the coefficients on factor shares, and employ the semi-parametric approach to estimating production function parameters suggested by Olley and Pakes (1996) and modified by Levinsohn and Petrin (2003).[17] 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

First, we present the results from the fixed effect model (without the Olley-Pakes correction), which, as evident from Table 3, lend support to our hypothesis. As anticipated, we find that the productivity of domestic firms is positively correlated with the presence of

[16] There were 1,335 such firm-year observations.
[17] See Appendix for a detailed description of the method.

American and Asian investors in downstream sectors (potential buyers of intermediate inputs). Further, consistent with our expectations, the data indicate that operations of European firm in sectors purchasing intermediates is negative correlated with the productivity of Romania firms in the supplying industries. All of these effects are statistically significant at the one percent level, both when entered individually or together into the estimated equation. The differences between the effects associated with European and Asian as well as European and American investors are statistically significant at the one percent level. Finally, we find evidence of positive spillovers working within industries.

Next we correct for the endogeneity of input selection by applying the Olley-Pakes procedure to estimate the total factor productivity (TFP) for each sector separately, and then use the TFP estimates as the dependent variable in the regression including spillover proxies. The results, shown in the first two columns of Table 4, are consistent with those obtained from the fixed effect model. Again all measures of vertical spillovers bear the expected signs and are statistically significant at the one percent level.

Finally, we correct the standard errors to take into account the fact that the measures of potential spillovers are industry specific while the observations in the data set are at the firm level. As Moulton (1990) pointed out, failing to make such a correction may lead to a downward bias in the estimated errors, thus resulting in a spurious finding of statistical significance for the aggregate variable of interest. We perform the correction by clustering the standard errors for firms operating in the same industry in the same year. The results with this modification are presented in the last two columns of Table 4. As expected, the correction inflated standard errors on spillover variables, and caused the coefficients on Vertical_Asian and Horizontal to lose their significance. However, the coefficients on vertical spillover proxies associated with American and European FDI remained statistically significant. Moreover, the difference between the magnitudes of the two effects remained statistically significant as well.

Conclusions

This study uses a firm-level panel data set from Romania to examine whether nationality of foreign investors affects the degree of vertical spillovers from FDI. Foreign investors' country of origin may matter for spillovers to domestic producers in upstream sectors (supplying intermediate inputs) in two ways. First, the share of intermediate inputs sourced by

multinationals from a host country is likely to increase with the distance between the host and the source economy. In turn, a larger share of local sourcing implies more contacts between multinationals and local firms in upstream sectors and thus a greater potential for knowledge spillovers. Second, preferential trade agreements of which some but not other investors are members are also likely to affect the sourcing patterns of foreign affiliates. In our case, the Association Agreements signed between Romania and the EU implies that while for European investors intermediate inputs sourced from home country suppliers comply with the rules of origin and thus can be exported to the EU on preferential terms, this would not be the case for home country suppliers of American or Asian multinationals.

Given these two effects, we expect that American and Asian investors have a greater incentive to source locally than European multinationals and thus are likely to be associated with greater knowledge spillovers to Romanian firms in the supplying sectors. We also anticipate that the low propensity of European investors to source from Romania may hurt domestic firms in upstream sectors. Entry of foreign investors is likely to increase the level of competition in downstream industries driving weaker firms out of business and shifting part of their market share to European multinationals, which results in lower demand for domestically produced intermediates. Moreover, European investors entering Romania through acquisitions of local firms are likely to sever existing linkages to local suppliers again lowering the demand for domestically produced intermediates. This drop in demand for intermediates will force producers in the supplying sectors to spread their fixed cost over a smaller market share and thus will lower their productivity.

Our empirical analysis produces evidence in support of the above hypothesis. We find a statistically significant and positive association between the presence of American and Asian companies in downstream sectors and the productivity of Romanian firms in the supplying industries. The data also indicate that operations of European investors in downstream sectors are negatively correlated with the productivity of Romanian firms in the supplying industries. The differences between the effects stemming from investors of different origin are statistically significant. We conclude that the observed pattern is consistent with our hypothesis that FDI inflows from far away source countries that are not part of the preferential trade agreement are more likely to be associated with positive vertical spillovers. Thus in sum, nationality of foreign investors does seem to matter for FDI spillovers.

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Table 1. FDI Inflows into CEEC-10 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 (FDI figures)

Table 2. Summary Statistics

	Variable	Obs	Mean	Std. Dev.
Domestic firms	Turnover (th. Lei 1995)	117,039	6,671.4	11,187.2
	Value Added (th. Lei 1995)	117,039	2,131.2	5,073.2
	Fixed Assets (th. Lei 1995)	117,039	1,399.7	3,750.6
	Materials (th. Lei 1995)	117,039	4,132.0	7,328.8
	Labor	117,039	20.9	38.2
European affiliates	Turnover (th. Lei 1995)	11,962	13,680.0	18,503.1
	Value Added (th. Lei 1995)	11,962	6,474.7	11,023.5
	Fixed Assets (th. Lei 1995)	11,962	3,010.8	5,714.3
	Materials (th. Lei 1995)	11,962	6,492.7	10,478.2
	Labor	11,962	31.8	51.8
American affiliates	Turnover (th. Lei 1995)	1,059	14,513.9	18,233.1
	Value Added (th. Lei 1995)	1,059	6,812.7	11,592.6
	Fixed Assets (th. Lei 1995)	1,059	3,299.2	5,992.0
	Materials (th. Lei 1995)	1,059	6,996.0	10,626.1
	Labor	1,059	27.1	41.4
Asian affiliates	Turnover (th. Lei 1995)	887	12,661.8	17,750.7
	Value Added (th. Lei 1995)	887	3,702.8	7,674.0
	Fixed Assets (th. Lei 1995)	887	2,070.9	4,415.9
	Materials (th. Lei 1995)	887	8,117.1	11,974.2
	Labor	887	19.5	33.8
Spillover variables	Horizontal	132,282	0.170	0.080
	Vertical European	132,282	0.090	0.050
	Vertical American	132,282	0.006	0.005
	Vertical Asian	132,282	0.005	0.003
Spillover variables		**No. of sectors**	**Mean**	**Std. Dev.**
	Horizontal	87	0.216	0.130
	Vertical European	87	0.129	0.085
	Vertical American	87	0.009	0.006
	Vertical Asian	87	0.005	0.004

Table 3. Results from Regressions with Firm Fixed Effects

Fixed Assets	0.136***	0.137***	0.137***	0.137***	0.136***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Labor	0.629***	0.629***	0.631***	0.629***	0.630***
	(0.007	(0.007)	(0.007)	(0.007)	(0.007)
Vertical European	**-0.925*** **			**-1.349*** **	**-1.169*** **
	(0.181)			**(0.187)**	**(0.190)**
Vertical American		**9.218*** **		**10.581*** **	**9.968*** **
		(1.158)		**(1.207)**	**(1.212)**
Vertical Asian			**15.878*** **	**13.959*** **	**15.109*** **
			(1.914)	**(1.924)**	**(1.936)**
Horizontal					**0.517*** **
					(0.096)
Intercept	4.260***	4.117***	4.108***	4.176***	4.069***
	(0.028)	(0.023)	(0.024)	(0.029)	(0.035)
No. of obs.	117,039	117,039	117,039	117,039	117,039
Adjusted R-squared	0.36	0.36	0.36	0.35	0.35
Year fixed effects	yes	yes	yes	yes	yes
test V European = V American					
F stat				88.42	76.05
prob>F stat				**0.00**	**0.00**
test V European = V Asian					
F stat				63.11	70.77
prob>F stat				**0.00**	**0.00**
test V Asian = V American					
F test				2.01	4.57
prob>F stat				0.16	**0.03**

Robust standard errors in parentheses* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4. Results from Regressions with Olley-Pakes Correction

Vertical European	**-1.801*** **	**-1.687*** **	**-1.801** **	**-1.687** **
	(0.315)	**(0.321)**	**(0.854)**	**(0.805)**
Vertical American	**6.771*** **	**6.409*** **	**6.771***	**6.409***
	(2.144)	**(2.153)**	**(3.873)**	**(3.846)**
Vertical Asian	**9.108*** **	**9.780*** **	9.108	9.78
	(3.297)	**(3.323)**	(9.313)	(9.148)
Horizontal		**0.318** **		0.318
		(0.151)		(0.339)
Intercept	3.857***	3.813***	3.857***	3.813***
	(0.047)	(0.052)	(0.115)	(0.112)
No. of obs.	117,039	117,039	117,039	117,039
Adjusted R-squared	0.13	0.13	0.13	0.13
Year fixed effects	yes	yes	yes	yes
Industry fixed effects	yes	yes	yes	yes
Clustering of standard errors	no	no	yes	yes
test V European = V American				
F stat	14.88	13.09	3.71	3.45
prob>F stat	**0.00**	**0.00**	**0.00**	**0.06**
test V European = V Asian				
F stat	10.85	11.86	1.46	1.66
prob>F stat	**0.00**	**0.00**	0.23	0.20
test V Asian = V American				
F test	0.32	0.66	0.04	0.09
prob>F stat	0.57	0.42	0.84	0.76

Robust standard errors in parentheses * significant at 10%; ** significant at 5%; *** significant at 1%

Appendix

Olley and Pakes Procedure

We employ the semi-parametric estimation of the production function parameters suggested by Olley and Pakes (1996) and modified by Levinsohn and Petrin (2000) to account for the simultaneity bias. Productivity can be thought of as having two components, one that is random each period (η_{it}) and another that is known to the firm but unknown to the econometrician (ω_{it}). Firms would thus adjust their inputs based on their anticipation or knowledge of the productivity component (ω_{it}), introducing a simultaneity bias. The insight of the method is that the observable characteristics of the firm can be modeled as a monotonic function of the productivity of the firm. Inverting such a function allows the modeling of the unobserved component of the productivity as a function of the observed variables. While Olley and Pakes (1996) use investment to model the unobserved productivity shock we follow Levinsohn and Petrin (2000) approach and use raw materials as the instrument to correct for simultaneity bias (as was done by Hallward-Driemeier et al., 2001). We do so because of the lack of reliable information on investment expenditures.

To illustrate the insights of the method, we start with the following production function:

$$va_{it} = y_{it} - m_{it} = \alpha + \beta_l * l_{it} + \beta_k * k_{it} + \omega_{it} + \eta_{it} \quad (2)$$

where va stands for value added (i.e., output minus material inputs), l labor, k capital, and i and t are subscripts denoting firm and time, respectively. 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.

As Levinsohn and Petrin (2003) showed, the unobserved productivity can be identified from the firms' observable variable input choices. The chosen variable input is material inputs.[18] The demand for materials can be modeled as a monotonic function of the capital stock and the unobserved (to the econometrician) productivity shock.

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

The first 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.

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 (2), 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}

[18] While Olley and Pakes (1996) use investment to model the unobserved productivity shock, we follow Levinsohn and Petrin (2000) approach and use materials as the instrument to correct for simultaneity bias (as was done by Hallward-Driemeier et al., 2001). We do so because of the lack of reliable information on investment expenditures.

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

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

Since the functional for of g(.) is not known, we use once more the third order polynomial expansion (with all interactions). 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).

In summary, following Olley and Pakes(1996) and Levinsohn and Petrin (2003) we use a semi-parametric estimator to generate time-varying firm-specific measures of plant productivity that are consistent even in the presence of input shares being influenced by the private knowledge of firm's productivity. The above procedure is performed for each sector separately and the obtained measures of productivity are used in the estimation of equation (1).[19]

[19] Since the procedure described above calls for using lagged variables, we employ a longer panel 1996-2000 to obtain productivity estimates but in the subsequent analysis of spillovers the timeframe is restricted to years 1998-2000.

Table A1. Distribution of Firms With Foreign Capital By Industry

Industry code	Industry	Domestic firms	European affiliates	American affiliates	Asian affiliates	All firms
		percentages				
1	Vegetable production	1.61	0.91	0.69	1.48	1.54
2	Breeding	0.19	0.08	0.00	0.00	0.18
6	Fishing and aquaculture	0.06	0.00	0.00	0.00	0.05
8	Extraction of petroleum (incl. auxiliary services)	0.88	0.95	0.46	0.25	0.88
9	Extraction of natural gas (incl. auxiliary services)	0.07	0.14	0.00	0.00	0.08
13	Extraction of building material ores	1.47	0.43	0.46	0.00	1.35
14	Extraction of clay and sand	0.10	0.14	0.00	0.00	0.10
15	Extraction and processing of chemical ores	0.03	0.02	0.23	0.00	0.03
16	Extraction and processing of salt	0.18	0.08	0.00	0.00	0.17
18	Meat production and processing	1.34	1.09	2.07	1.48	1.33
19	Processing and preserving of fish and fish products	0.06	0.02	0.00	0.25	0.06
20	Processing and preserving of fruits and vegetables	0.30	0.45	0.46	0.25	0.31
21	Production of vegetable and animal oil and fat	0.13	0.16	0.23	0.74	0.14
22	Production of milk products	0.65	0.43	0.46	0.49	0.63
23	Production of milling and starch products	1.00	1.07	0.69	0.49	1.00
24	Manufacture of fodder	0.04	0.08	0.00	0.00	0.04
25	Processing of other food products	4.51	4.88	4.38	7.14	4.56
26	Beverages	0.73	1.01	1.38	1.48	0.77
28	Textile industry	3.91	7.31	4.84	2.22	4.23
29	Apparel	0.18	0.29	0.00	0.00	0.19
30	Manufacture of leather and fur clothes	0.07	0.04	0.23	0.00	0.07
31	Footwear and other leather goods	0.84	2.86	0.23	0.99	1.03
32	Wood processing (excluding furniture)	2.60	4.08	1.61	2.46	2.73
33	Pulp, paper and cardboard; related items	0.30	0.84	0.23	0.49	0.35
34	Publishing, printing, reproduction of recorded media	2.02	2.76	2.07	0.25	2.08
36	Crude oil processing	0.02	0.06	0.23	0.00	0.02
38	Basic chemical products	0.16	0.49	0.00	0.00	0.19
40	Dyes and varnishes	0.13	0.27	0.00	0.00	0.14
41	Medicines and pharmaceutical products	0.20	0.21	0.00	0.74	0.20
42	Soaps, detergents, cosmetics, perfumery	0.12	0.37	0.69	0.99	0.15
43	Other chemical products	0.14	0.10	0.46	0.00	0.13
44	Synthetic and man made fibers	0.01	0.02	0.00	0.00	0.01
45	Rubber processing	0.25	0.25	0.46	0.74	0.25
46	Plastic processing	0.60	1.50	1.84	2.22	0.71
47	Glass and glassware	0.24	0.37	0.46	0.00	0.26
48	Processing of ceramics (excl. building items)	0.13	0.25	0.00	0.00	0.14
49	Ceramic boards and flags	0.02	0.00	0.00	0.00	0.02
50	Brick, tile and other building material processing	0.20	0.25	0.00	0.25	0.20
51	Cement, lime and plaster	0.02	0.04	0.00	0.00	0.03
52	Processing of concrete, cement and lime items	0.22	0.27	0.00	0.00	0.22
53	Cutting, shaping and finishing of stone	0.11	0.10	0.00	0.00	0.11
54	Other non-metallic mineral products	0.03	0.14	0.00	0.00	0.04
55	Metallurgy and ferroalloys processing	0.03	0.12	0.23	0.00	0.04
56	Manufacture of tubes	0.02	0.06	0.00	0.00	0.02
57	Other metallurgy products	0.02	0.06	0.00	0.00	0.02

58	Precious metals and other non-ferrous metals	0.04	0.19	0.00	0.00	0.06
59	Foundry	0.14	0.14	0.46	0.00	0.15
60	Metal structures and products	2.23	2.33	1.15	0.49	2.22
61	Manufacture of equipment for producing and using of mechanical power	0.09	0.14	0.69	0.00	0.10
62	Machinery for general use	0.17	0.33	0.23	0.25	0.19
63	Agricultural and forestry machinery	0.05	0.12	0.00	0.25	0.06
64	Machine tools	0.09	0.25	0.23	0.00	0.10
65	Other machines for special use	0.15	0.37	0.46	0.00	0.17
67	Labor-saving devices and domestic machinery	0.08	0.19	0.23	0.00	0.09
68	Computers and office means	0.21	0.45	1.61	0.99	0.25
69	Electric machinery and appliances	0.31	0.70	0.23	0.25	0.35
70	Radio, TV and communication equipment	0.12	0.41	0.92	0.74	0.16
71	Medical, precision, optical instruments and apparatus	0.24	0.45	0.69	0.00	0.26
72	Means of road transport	0.20	0.29	0.23	0.25	0.21
73	Naval engineering and repair	0.15	0.12	0.00	0.25	0.15
74	Production and repair of railway transport means	0.04	0.02	0.00	0.00	0.03
77	Furniture	1.22	1.89	1.61	0.99	1.28
78	Other industrial activities	0.42	0.78	0.23	0.25	0.45
79	Electric power production and distribution	0.04	0.04	0.00	0.00	0.04
80	Gas production and distribution	0.01	0.08	0.00	0.00	0.02
81	Production and distribution of thermal energy	0.08	0.02	0.23	0.00	0.08
82	Water collection, treatment and distribution	0.15	0.00	0.00	0.00	0.14
83	Construction	9.24	3.50	2.53	1.97	8.57
84	Wholesale and retail	40.21	31.47	34.33	50.49	39.40
85	Hotels	0.70	0.64	0.92	0.25	0.69
86	Restaurants	4.45	1.94	3.23	5.17	4.20
87	Railway transport	0.02	0.10	0.00		0.03
88	Road transport	3.18	4.76	2.07	3.20	3.32
90	Water transport	0.06	0.10	0.00	0.25	0.07
91	Air transport	0.02	0.02	0.00	0.00	0.02
92	Auxiliary transport activities and travel agencies	0.25	0.39	0.00	1.72	0.27
93	Tourism agencies and assistance	0.60	1.01	0.92	0.74	0.64
95	Telecommunication	0.47	0.56	3.00	0.00	0.50
97	Real estate activities	0.47	0.60	0.92	0.25	0.48
98	Computer and related activities	0.82	2.00	4.61	0.49	0.97
99	Research and development	0.17	0.12	0.46	0.00	0.17
100	Architecture, engineering and other technical services	1.19	1.01	2.07	0.25	1.17
101	Other business activities	2.51	3.58	6.45	2.22	2.65
102	Public administration and defense, compulsory social assistance	0.03	0.00	0.00	0.00	0.03
103	Education	0.31	0.14	0.23	0.00	0.29
104	Health and social work	0.45	0.49	0.92	0.99	0.46
105	Other services (collective, social and personal services)	2.66	3.15	3.00	1.97	2.70
	TOTAL	100	100	100	100	100