Foreign ownership, sales to multinationals, and firm efficiency: The Case of Brazil, Morocco, Pakistan, South Africa, and Vietnam

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Summary

Using a one-step stochastic frontier model for five developing countries (Brazil, Morocco, Pakistan, South Africa, and Vietnam), we show that foreign firms benefit from a better investment climate, which significantly explains why they are more efficient than local firms. Unlike former studies, this paper uses the share of each firm's sales to multinationals located in the country to assess the importance of vertical spillovers, and it controls for the direct impact of the investment climate on efficiency. The results show that firms (particularly small local firms) that sell more of their production to multinationals are more efficient.

JEL classification: D24, F23, O50, O14.

Keywords: Foreign ownership, Firm-level efficiency, Vertical spillovers, Investment climate, Developing Countries.

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1. INTRODUCTION

Differences in productivity among countries and regions partly explain differences in countries' income levels (Klenow and Rodriguez-Clare, 1997; Hall and Jones, 1999; Easterly and Levine, 2001). These differences arise in part because of technological disparities (Howitt, 2000; Klenow and Rodriguez-Clare, 2005). In developing countries, investment climate factors such as infrastructure, finance, human capital, institutions, and regulatory policies are also important sources of differences in productivity.

A business-friendly environment is important for productivity. Skilled human capital improves firm productivity by allowing companies to make better use of current technologies and to acquire new ones (Acemoglu and Shimer, 1999; Bresnahan, Brynjolfsson, and Hitt, 2002). Financial development is also an important aspect of the business environment. It increases firm productivity by stimulating profitable investments through better selection and allocation of resources to the most profitable projects (Levine, 1997). Transport and telecommunication failures or unreliable electricity supply increase the cost for suppliers to connect with their clients and the cost of doing business generally (World Bank, 1994). Bribes to public officials to obtain advantages in the application of government laws and regulations increase economic distortions that reduce firm productivity. Inefficiency in delivering public services and the time managers spend dealing with government regulations (customs, licenses, and registrations) also affect firms by increasing their allocative inefficiency (Acemoglu, Johnson, and Robinson, 2001; Easterly and Levine, 2003; Dollar, Hallward-Driemeier, and Mengistae, 2005, 2006).

Beyond the potential of foreign investments to finance saving gaps, policy makers often seek to attract foreign firms to benefit from higher productivity and positive spillovers to local firms. Local firms indeed benefit from the presence of foreign companies through transfers of new technologies, management methods, products, and production processes. Positive spillovers will occur, however, only if foreign firms are more productive or have more technological knowledge than local companies. Domestic firms could thus learn from foreign companies by observation, by doing business with them, or through labor turnover. Foreign companies either directly or as shareholders in domestic firms are potentially correlated with more efficient productive practices. They benefit from new technologies, management practices, and opportunities for financing from their parent companies. For instance, by using foreign expertise and finance—rarely available to domestic firms—foreign companies may more easily update their production processes when facing local constraints like an unreliable supply of electricity.

However, foreign firms could also be less efficient than local companies because they may not understand the specifics of local markets. For instance, where there are high administrative burdens and the economy is not sufficiently market-oriented, foreign ownership may have little effect on firm productivity. Empirical results are mixed about the impact of foreign ownership on firm productivity. Khawar (2003) finds that foreign firms are more productive than local enterprises in Mexico, but in a study of Bulgaria, Hungary, and Poland, Angelucci et al. (2001) find that foreign firms are more productive than local firms only in Poland.

This paper uses manufacturing firm data from World Bank surveys in five developing countries (Brazil, Morocco, Pakistan, South Africa, and Vietnam) in the mid-2000s. It tests for the first time whether a better investment climate for foreign firms can explain their higher productivity than local companies. The paper also introduces an innovative way of measuring vertical spillovers at firm level by using the share of each firm's sales to multinationals located in the country.

The next section reviews recent evidence on productivity spillovers from foreign firms to local companies. Section 3 describes the one-step stochastic frontier model. Section 4 presents the enterprise survey data, and Section 5 analyzes the empirical results. Section 6 concludes.

2. FOREIGN FIRMS AND PRODUCTIVITY SPILLOVERS

The literature distinguishes horizontal from vertical spillover. Horizontal spillover refers to the increase in the aggregate productivity of a sector because of the entry of foreign firms whose productivity is higher. This entry acts as an incentive for other firms to increase their productivity because the environment is more competitive. Higher productivity due to horizontal spillover also results from copying new technologies and production processes or by hiring trained workers and managers from foreign firms. Local firms with the lowest productivity that cannot catch up with higher performers in the sector could be crowded out of the market.

Vertical spillover refers to increasing productivity by doing business with foreign companies. Such spillovers affect domestic firms that supply goods and services to foreign firms or are clients of the foreign firms. Foreign firms may require higher standards—product quality or delivery time—from their local suppliers, pushing up their productivity. Productivity could also rise when foreign firms provide their domestic clients with good-quality products. Multinational firms have incentives to transfer knowledge to firms upstream. These knowledge transfers could improve the performance of their local suppliers.

Empirical analyses of spillovers from foreign firms use an input-output matrix to derive sector-based indicators of spillovers. For horizontal spillovers, the indicator is the share of sector output produced by affiliates of foreign companies. Vertical spillovers can be grouped in backward and forward linkages. Backward linkages measure the spillovers from the presence of foreign firms downstream. They are captured by the weighted share of foreign capital from all the sectors that are supplied by the sector under consideration. Forward linkages measure the spillovers from the presence of foreign firms upstream. They are captured by the weighted share of foreign capital of all sectors supplying the subject sector. The weights in backward and forward linkages are the share of subject sector output used as intermediate inputs by another sector.

Empirical studies have produced rather mixed results. Early analyses of spillovers that focus on intra-industry (horizontal) spillovers find a positive correlation between foreign presence and firm performance. However, evidence of horizontal spillovers from firm-level studies is much less clear. For developing countries[2], Khawar (2003) finds no evidence of positive spillovers from foreign to domestic firms in Mexico. Using panel data for manufacturing industries in China, Liu (2002) finds a positive

effect of foreign direct investment (FDI) on domestic firms. But Haddad and Harrison (1993) find negative spillovers associated with FDI in Morocco and Aitken and Harrison (1999) reach a similar conclusion for Venezuela. According to the latter, the negative spillovers are caused by competition from foreign firms that force local firms to produce less at higher cost, which offsets the positive impact of technology transfers from FDI. Although evidence on spillovers, particularly horizontal, is mixed, recent firm-level studies show that local firms supplying sectors in which foreign firms operate (vertical spillovers) are more productive. Lui (2008) finds positive vertical spillovers with backward and forward linkages between industries in China. Javorcik (2004) casts doubt on positive horizontal spillovers from foreign firms in Lithuania but underlines the existence of vertical spillovers from upstream. Javorcik and Spatareanu (2008) illustrate the importance of local participation to vertical and horizontal spillovers in Romania. Blalock and Gertler (2004) confirm the importance of vertical spillovers in Indonesia.

The recent studies use firm-level data for estimating productivity. However, variables capturing spillovers are still defined by sector. Sector information could hide significant heterogeneity between firms within the sector. Indeed, interactions between foreign firms and local companies might be limited to the biggest, which are on average the most productive, local firms in the sector. Instead of using sector information to assess the importance of business between foreign and local firms, this paper uses for the first time information on the share of a firm's sales to multinational companies within the country to capture backward linkages.

3. A ONE-STEP STOCHASTIC FRONTIER MODEL

The one-step stochastic frontier model simultaneously estimates the production function, the determinants of firm inefficiency, and a composite error term with two uncorrelated elements. The first element (v) is a random variable capturing external shocks affecting firms. These shocks are independently and identically distributed, and follow a normal distribution with zero mean and σ^2 standard deviation. The second element (u), which represents technical inefficiency, has a truncated normal distribution.[3] The mean of the truncated inefficiency depends on exogenous variables, such as those related to the investment climate. The one-step stochastic frontier model does not suffer from the omitted variables bias the way the two-step procedure does.[4] Indeed, production frontier inputs are probably influenced by factors similar to those affecting technical efficiency (Marschak and Andrews, 1944; Griliches and Mairesse, 1995). Estimating the stochastic production frontier with the two-step approach is thus biased because explanatory variables are omitted in the first step.

The one-step stochastic frontier model can be written as follows:

$$\ln Y_{csit} = \ln f(L_{csit}, K_{csit}, D_c, D_s, D_t, \beta) + V_{csit} - U_{csit} \qquad (1)$$

Y_{csit} is the output of the firm i in country c and sector s during year t. L_{csit} and K_{csit} represent labor and capital. D_c, D_s, and D_t respectively reflect dummies for country, sector, and years.[5] β is the vector of unknown parameters to be estimated. The technical inefficiency term, $U_{csit,}$, be can defined as:

$$U_{csit} = Z_{csi}^{'}\delta + \eta_{csit} \qquad (2)$$

Z_{csit} includes investment climate variables; firm-specific characteristics such as foreign ownership, size, and age; and the variable capturing spillovers from foreign to local firms. δ is a vector of unknown coefficients to be estimated. η_{csit} is a random variable defined by the truncation of the normal distribution with zero mean and σ^2 variance.

Incorporating equation 2 into equation 1 leads to the following one-step production frontier model:

$$\ln Y_{csit} = \ln f(L_{csit}, K_{csit}, D_c, D_s, D_t, \beta) + V_{csit} - (Z_{csi}^{'}\delta + \eta_{csit}) \qquad (3)$$

The parameters of the stochastic frontier and the model explaining technical inefficiency are simultaneously estimated with the maximum likelihood method. The technical efficiency function derived from the stochastic frontier model is as follows:

$$TE_{csit} = \exp(-U_{csit}) = \exp(-z_{csi}\delta - \eta_{csit}) \qquad (4)$$

A predictor of the technical efficiency for the *i-th* firm in country *c* and sector *s* at the *t-th* observation is defined by equation 5:

$$TE_i = E\left[\exp\{-u_i\} \mid (v_i - u_i)\right] = \left[\exp\left\{-\mu_{*i} + \frac{1}{2}\sigma_*^2\right\}\right] \times \left[\frac{\Phi\left[\left(\mu_{*i}/\sigma_*\right)\right] - \sigma_*}{\Phi\left(\mu_{*i}/\sigma_*\right)}\right] \qquad (5)$$

where $\mu_{*i} = \dfrac{\sigma_v^2\left(\gamma^{'} z_i\right) - \sigma_u^2\left(\varepsilon_i\right)}{\sigma_v^2 + \sigma_u^2}$, $\sigma_*^2 = \dfrac{\sigma_v^2\sigma_u^2}{\sigma_v^2 + \sigma_u^2}$, and $\gamma = \dfrac{\sigma_u^2}{\sigma_u^2 + \sigma_v^2}$

and $\Phi(.)$ represents the distribution function of the standard Gaussian random variable.

4. DATA

World Bank enterprise surveys collect data on input, output, investment climate, and various firm characteristics (ownership, age, etc.). The surveys cover such areas as public regulation, governance, and access to finance or infrastructure.

In this paper, investment climate is captured by four indicators: infrastructure, institutions, human capital, and finance. The indicators were selected based on their availability, objectivity, and capacity to capture key dimensions of the investment climate. Infrastructure is captured by electricity problems that lead firms to use generators to produce their own electricity. This infrastructure variable thus captures both the electricity problem and firm responses to it. Indeed, where electricity is insufficient and unreliable, more capitalistic and productive firms may rely more on their own generators. Human capital is captured by the percentage of the workforce with secondary education. Financing problems are represented by limits to access to

formal finance, such as an overdraft facility; the share of informal sources of finance (friends, family, etc.) in firm working capital captures this. Institutions are captured by labor regulation, property rights protection, and the share of senior managers' time spent in dealing with government regulation.

The analysis covers five sectors: textiles, wearing apparel, and leather; food, beverages, and tobacco; wood and wood products, including furniture; chemicals and plastic products; and manufacture of fabricated metal products, machinery, and equipment. It covers 4,510 firms from five developing countries for 2000–2005: Brazil (2003), Morocco (2004), Pakistan (2002), South Africa (2003), and Vietnam (2005).[6]

Enterprise surveys contain production function data for the surveyed year and two years before. However, investment climate indicators refer only to the current year. Kernel distribution graphs show some stability in productivity distribution across three consecutive years (Appendix 3). Combining firms, sectors, and countries allows us to control (through country and sector dummies) for time-invariant factors that are common to all firms in a specific sector and country.

While firm production function could vary slightly over three years, investment climate is a more structural factor that is constant over such a short period (Dollar et al., 2005). Consequently, there are three alternative ways to estimate and explain firms' productivity:

- Consider production function and investment climate variables for the year surveyed.
- Estimate the production function for the three years and explain productivity averages for the period by investment climate variables. This method is not relevant here because it refers to a two-step procedure.
- Consider investment climate variables as constant for the three consecutive years and allow some variability in the production function (Dollar et al., 2005). This is the method used here.

Investment climate variables can be captured by both objective information and firm perceptions[7] of investment climate constraints. Subjective variables could be more affected by measurement errors. Indeed, more productive firms may have less concern about investment climate constraints than less productive firms. As a consequence, the same investment climate could be assessed differently depending on firm performance. That is why this analysis retains only objective variables that are not subject to subjective judgments. Although using objective variables reduces the endogeneity arising from measurement errors, simultaneity bias could remain. Regional-sector averages of investment climate indicators are used to reduce this bias (Dollar et al., 2005; Commander and Svejnar, 2008).

5. RESULTS

Before the stochastic frontier method is applied, nonparametric total factor productivity (TFP) is estimated. Table 1 presents firm-level TFP by sector, on the assumption that sector-based technology leads to more homogenous production functions.

Table 1: Mean and median of firm total factor productivity

	Period t		Period t-1		Period t-2	
	Mean	**Median**	**Mean**	**Median**	**Mean**	**Median**
Food and Beverage						
Brazil	0,90	0,93	0,85	0,96	0,83	0,91
Morocco	0,64	0,68	0,30	0,42	0,43	0,57
Pakistan	0,59	0,44	0,46	0,42	0,44	0,38
South Africa	1,10	1,23	1,06	1,11	0,83	1,03
Vietnam	0,22	0,26	0,15	0,22	0,29	0,34
Textile and W. Apparel						
Brazil	1,02	0,98	1,08	1,07	1,09	1,08
Morocco	0,77	0,72	0,75	0,72	0,71	0,68
Pakistan	0,81	0,65	0,63	0,52	0,50	0,36
South Africa	1,18	1,06	1,17	1,00	1,12	1,08
Vietnam	0,23	0,29	0,22	0,25	0,10	0,19
Wood incl. furniture						
Brazil	0,92	0,89	0,98	0,96	1,00	1,01
Morocco	0,22	0,26	1,20	0,67	-0,02	-0,33
South Africa	1,13	1,02	1,06	1,06	1,06	0,91
Vietnam	0,47	0,44	0,39	0,38	0,38	0,32
Chemicals and plastic products						
Brazil	1,10	1,11	0,92	0,92	0,92	0,78
Morocco	0,80	0,60	0,74	0,63	0,71	0,52
Pakistan	0,67	0,55	0,52	0,50	0,34	0,34
South Africa	1,10	1,04	1,26	1,19	1,24	1,16
Vietnam	0,25	0,28	0,20	0,27	0,22	0,23
Machinery and Equipment						
Brazil	0,94	0,91	0,97	0,91	0,93	0,86
Morocco	0,90	0,64	0,81	0,70	0,97	0,86
Pakistan	0,76	0,77	0,64	0,61	0,60	0,52
South Africa	1,03	0,95	1,02	0,88	0,97	0,88
Vietnam	0,31	0,39	0,43	0,44	0,35	0,44

In all industries and periods South Africa has the most firms performing well, followed closely by Brazil. Vietnam ranks at the bottom, except in the wood and furniture sector, and Morocco and Pakistan are in the middle. Differences in productivity track differences in country income. Except for Morocco in the wood and furniture sector, TFP is relatively constant across the three years observed.

a) Foreign ownership and firm efficiency

The Cobb-Douglas functional form describes the production technology. Alternative functional forms such as translog did not reveal significant differences.[8] While country and sector dummies are significant, year dummies are not, which supports equality of

productivity distribution across three consecutive years. The standard error of the inefficiency component (σ_u) is significant, confirming the relevance of the stochastic frontier hypothesis against the OLS model, which considers error terms as normally distributed.

This section analyzes investment climate as a potential transmission channel through which foreign ownership could affect firm productivity. The hypothesis is that foreign firms could benefit more from a better investment climate than local firms, leading to higher productivity. When investment climate variables are introduced in the regressions, the foreign firm coefficient is significantly reduced, indicating that a better investment climate for foreign firms is one transmission channel of the positive effect of foreign ownership on firm productivity (Table 2).

This paper thus proposes an alternative way to analyze why foreign firms[9] are more productive than local firms. Beyond the usual argument of access to better technologies and management practices, we suggest that foreign firms could be more productive because they benefit from a better investment climate when doing business than local firms do. The investment climate, which might be assumed to be similar for all firms operating in the same area, could in fact be different for foreign firms—or at least affect them differently. In fact, foreign firms may resist degradation of the investment climate more, or may influence it positively. Foreign firms could also locate in areas where the investment climate is more favorable (Kinda, 2008, 2010).

Table 2: Foreign ownership, investment climate, and firm inefficiency

	Dependent Variable: ln(Value added)			
	(1)	(2)	(3)	(4)
Production Function				
Ln(Capital)	0.184	0.178	0.175	0.175
	(31.30)***	(30.25)***	(29.55)***	(29.50)***
Ln(Labor)	0.744	0.736	0.733	0.734
	(73.02)***	(69.05)***	(68.91)***	(66.17)***
Constant	1.751	2.210	2.232	2.242
	(13.88)***	(12.28)***	(13.75)***	(8.53)***
Investment Climate *(Investment climate variables are regressed on firm inefficiency)*				
Size	-0.158	-0.134	-0.138	-0.134
	(8.64)***	(7.48)***	(8.06)***	(6.84)***
Age	-0.001	-0.001	-0.001	-0.001
	(1.45)	(0.98)	(1.39)	(1.50)
Foreign Firm	-0.287		-0.153	-0.149
	(4.90)***		(3.68)***	(3.55)***
Export (% of sales)				0.000
				(0.92)
Informal Finance		0.002	0.002	0.002
		(3.17)***	(3.12)***	(3.19)***
Electricity Problems		0.222	0.211	0.220
		(4.20)***	(3.88)***	(4.18)***
Workforce Education		-0.010	-0.009	-0.009
		(7.99)***	(8.26)***	(7.02)***
Property Rights Protection		-0.034	-0.029	-0.029
		(2.17)**	(1.86)*	(1.88)*
Regulation Management		0.006	0.007	0.006
		(2.63)***	(2.88)***	(2.94)***
Constant	1.169	1.117	1.142	1.191
	(9.39)***	(6.31)***	(6.42)***	(5.29)***
Observations	8272	8051	8036	8008
sigma_u	*0.23*	*0.26*	*0.26*	*0.26*
	[0.17]	*[0.15]*	*[0.15]*	*[0.16]*
sigma_v	*0.68*	*0.66*	*0.66*	*0.66*
	[0.15]	*[0.15]*	*[0.15]*	*[0.16]*
Wald chi2	19323.41	17106.39	16522.23	15873.94
Prob > chi2	0.00	0.00	0.00	0.00

Absolute value of z-statistics in parentheses. Numbers in brackets for sigma_u and sigma_v are standard errors.
* significant at 10%; ** significant at 5%; *** significant at 1%
All regressions include year, country, and sector dummies.
All investment climate variables are industry-region averages by size and capital ownership except informal finance variable, which is firm-level information.

To reduce the potential endogeneity bias of investment climate variables, we use as investment climate variables city-sector averages by size and foreign ownership status.[10] Regional averages and firm-level information are used as variables for financing constraints. The results are robust to both definitions, and the rest of the analysis retains firm-level information.

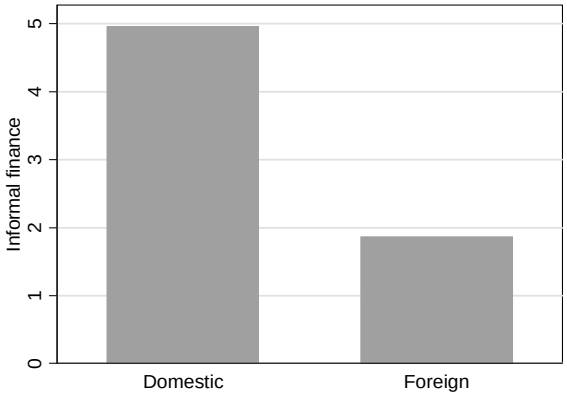
Other results show that bigger firms are more productive. Except for labor regulation, all investment climate variables are significant. Firms with better access to credit, electricity, and skilled workers are more efficient. These firms are, for instance, better able to handle technologies, old and new, because they have more skilled workers. They also benefit from better access to raw materials and intermediate consumption through their access to credit. By reducing transaction costs, secure property rights and lower regulatory constraints create a business-friendly environment, which stimulates firm performance.

Figure 1 confirms that foreign firms have a better investment climate. Financing constraints and an unskilled workforce are particularly problems for domestic firms. Foreign firms rely more on their own generators to produce electricity when unreliable electricity forces firms to adopt the more costly alternative. Given their higher financing constraints, which limits their ability to buy generators, domestic firms thus suffer more from electricity problems than foreign firms. Most institutional problems affect local and foreign firms about equally, but property rights are more secure for foreign firms.

Figure 1: Major investment climate variables and capital ownership

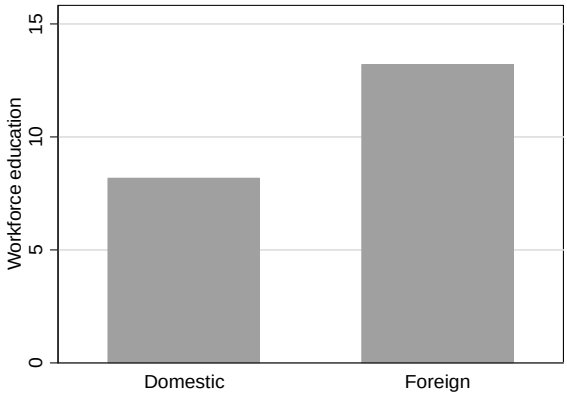
Financing constraint and capital ownership

(Financing counstraint: % of firms working capital from informal source)



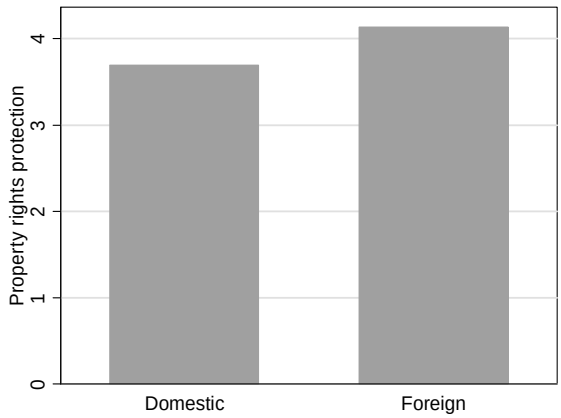
Workforce education and capital ownership

(Workforce education: % of workorce with secondary education)



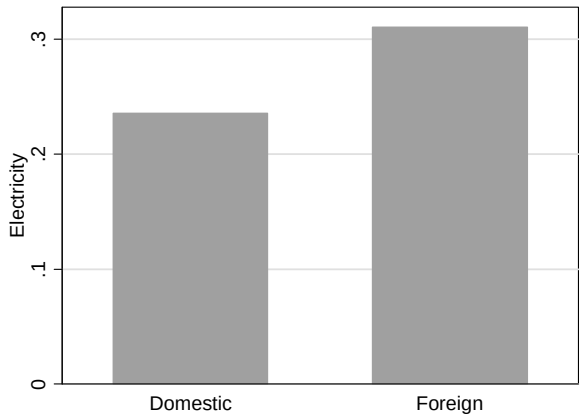
Property rights protection and capital ownership

(Property rights protection: Protection of property rights by the judicial system: scale from one to six)



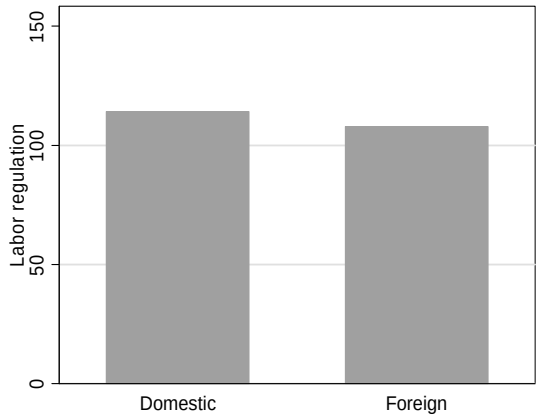
Electricity and capital ownership

(Electricity: % of firms that own or share a generator)



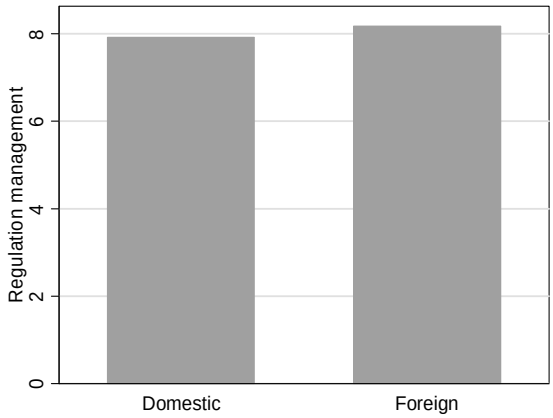
Labor regulation and capital ownership

(Labor regulation: % of optimal level of employment compared to current level)



Regulation management and capital ownership

(Regulation management: % of senior management's time dealing with government regulations)



However, for institutional factors the argument could go either way: Since foreign firms do not know the local context as well as local firms, they might have more difficulties in dealing with official regulations. On the other hand, policy makers, particularly in developing countries, often seek to attract FDI with such incentives as tax breaks, lower administrative burdens, and better protection of property rights. These incentives could lower the administrative cost of doing business and offer a better institutional framework to foreign firms than local ones.

We use multivariate analysis to test whether these insights are correct. The following section uses cross-terms between investment climate and foreign ownership variables to assess whether foreign ownership is effective in helping firms to dampen the negative effect of investment climate constraints on their productivity (see Table 3).

Table 3: Foreign ownership, investment climate, and firm inefficiency

	Dependent Variable: ln(Value added)		
	(1)	(2)	(3)
Production Function			
Ln(Capital)	0.175	0.174	0.174
	(29.54)***	(29.51)***	(29.48)***
Ln(Labor)	0.732	0.732	0.732
	(68.96)***	(67.59)***	(67.89)***
Constant	2.206	2.337	2.323
	(14.18)***	(10.70)***	(10.86)***
Investment Climate *(Investment climate variables are regressed on firm inefficiency)*			
Size	-0.136	-0.128	-0.129
	(7.93)***	(7.18)***	(7.15)***
Age	-0.001	-0.001	-0.001
	(1.33)	(1.55)	(1.47)
Foreign Firm	0.150	0.173	0.050
	(0.54)	(0.92)	(0.20)
Informal Finance	0.002	0.002	0.002
	(3.00)***	(3.17)***	(3.08)***
Electricity Problems	0.252	0.273	0.262
	(4.21)***	(4.76)***	(4.52)***
Workforce Education	-0.010	-0.009	-0.009
	(8.16)***	(8.28)***	(8.14)***
Property Rights Protection	-0.030		-0.028
	(1.72)*		(1.67)*
Regulation Management		0.001	0.001
		(0.23)	(0.29)
*Informal Finance*Foreign Firm*	*0.001*	*-0.001*	*-0.001*
	(0.15)	*(0.42)*	*(0.40)*
*Electricity Problems*Foreign Firm*	*-0.223*	*-0.257*	*-0.248*
	*(1.86)**	*(2.43)***	*(2.30)***
*Workforce Education*Foreign Firm*	*-0.001*	*0.000*	*0.000*
	(0.26)	*(0.03)*	*(0.04)*
*Property Rights Protection*Foreign Firm*	*0.019*		*0.026*
	(0.46)		*(0.66)*
*Regulation Management*Foreign Firm*		*0.013*	*0.013*
		*(3.08)****	*(3.03)****
Constant	1.086	1.008	1.132
	(5.98)***	(5.14)***	(5.57)***
Observations	8036	8036	8036
sigma_u	*0.26*	*0.25*	*0.26*
	[0.15]	*[0.16]*	*[0.16]*
sigma_v	*0.66*	*0.66*	*0.66*
	[0.15]	*[0.16]*	*[0.16]*
Wald chi2	16825.69	15922.96	15978.95
Prob > chi2	0.00	0.00	0.00

Absolute value of z statistics in parentheses. Numbers in brackets for sigma_u and sigma_v are standard errors. * significant at 10%; ** significant at 5%; *** significant at 1%. All regressions include year, country, and sector dummies. All investment climate variables are industry-region averages by size and capital ownership except informal finance variable, which is firm-level information.

The results confirm that investment climate constraints undermine firm productivity. However, except for regulation management, investment climate constraints are not significant hurdles for foreign firms. Foreign firms positively influence their own investment climate—for instance, they use their own generators to become more efficient than the average firm. Given their limited knowledge of local markets compared to domestic firms, and their better use of production time, however, foreign firms suffer more from time lost in dealing with government regulation.

Local firms have a more difficult time accessing financing, and when they do it is more expensive. They also have less power than foreign firms when lobbying policy makers to get secure property rights. Local firms also attract less-qualified workers, since qualified workers prefer the higher salaries offered by foreign firms. The capacity of local firms to compensate for deficient infrastructure is also more limited. These findings are very relevant, given the potential of local firms for job creation.

Beyond their direct effect on aggregate productivity, foreign firms could also improve country-level productivity by increasing the efficiency of local firms through spillovers from foreign to local firms.

b) Sales to multinationals and firm efficiency

In contrast to former studies using sector-level information to capture spillovers, this paper for the first time uses data on the share of each firm's sales that goes to multinational companies located in the country to capture spillovers, specifically vertical spillovers.

First, the empirical analysis is done for all firms before restricting the sample to local firms and even small local firms as a robustness check. Information on the share of firms' sales to multinationals in the country has the advantage of capturing the exact extent of cooperation between foreign and local firms. This makes it possible to control for the potential heterogeneity of spillovers within sectors. In addition, unlike other studies this paper controls for investment climate variables, capturing the effect of the business environment on spillovers. Table 4 shows the results.

Table 4: Sales to multinationals and firm inefficiency

	Dependent Variable: ln(Value added)				
	(1)	(2)	(3)	(4)	(5)
Production Function					
Ln(capital)	0.199	0.178	0.178	0.177	0.173
	(34.22)***	(29.00)***	(28.95)***	(28.85)***	(28.24)***
Ln(labor)	0.797	0.743	0.743	0.742	0.739
	(98.43)***	(67.01)***	(67.03)***	(66.75)***	(66.39)***
Constant	1.892	2.596	2.626	1.962	2.710
	(12.00)***	(12.88)***	(12.75)***	(14.05)***	(12.59)***
Investment Climate *(Investment climate variables are regressed on firm inefficiency)*					
Size	-2.535	-0.146	-0.145	-0.149	-0.146
	(5.57)***	(7.77)***	(7.74)***	(7.84)***	(8.22)***
Age	-0.045	-0.001	-0.001	-0.001	-0.001
	(1.44)	(0.98)	(0.98)	(1.07)	(1.43)
Sales to multinational	-0.078	-0.002	-0.002	-0.002	-0.002
	(2.46)**	(3.50)***	(3.51)***	(3.50)***	(3.12)***
Informal finance		0.002	0.002	0.002	0.002
		(3.35)***	(3.40)***	(3.36)***	(3.40)***
Electricity problem		0.218	0.218	0.216	0.212
		(3.55)***	(3.63)***	(3.48)***	(3.54)***
Workforce education		-0.009	-0.009	-0.009	-0.009
		(7.16)***	(7.15)***	(6.94)***	(7.34)***
Property rights protection		-0.029	-0.029	-0.030	-0.020
		(1.66)*	(1.64)	(1.68)*	(1.17)
Regulation Management			0.004	0.004	0.004
			(1.50)	(1.55)	(1.82)*
Export (% of sales)				-0.000	-0.000
				(0.71)	(0.18)
Foreign Firm					-0.176
					(3.76)***
Constant	-4.071	1.199	1.190	1.186	1.218
	(2.68)***	(6.49)***	(6.44)***	(6.34)***	(6.32)***
Observations	7622	7403	7403	7387	7375
sigma_u	*2.27*	*0.35*	*0.35*	*0.35*	*0.34*
	[0.71]	*[0.17]*	*[0.17]*	*[0.17]*	*[0.17]*
sigma_v	*0.62*	*0.62*	*0.61*	*0.61*	*0.62*
	[0.10]	*[0.15]*	*[0.16]*	*[0.15]*	*[0.16]*
Wald chi2	36050.72	14382.33	14121.22	13720.07	13507.58
Prob > chi2	0.00	0.00	0.00	0.00	0.00

Absolute value of z statistics in parentheses. Numbers in brackets for sigma_u and sigma_v are standard errors. * significant at 10%; ** significant at 5%; *** significant at 1%

All regressions include year, country, and sectoral dummies.

Sale to multinational is the percentage of firms' sales to domestic multinational in the country. All investment climate variables are industry-region averages by capital ownership except informal finance variable, which is firm-level information.

As it did in the previous section, investment climate significantly explains firm productivity. Firms selling more of their production to multinationals are more productive. The higher productivity of suppliers to foreign firms could be the consequence of the foreign firms demanding higher standards, tighter timing, and better quality. The positive relationship between firm efficiency and the percentage of their sales that goes to multinationals could thus be interpreted as implying that productivity is improved when firms do business with foreign companies.

Low-performing local firms that cannot meet the requirements of foreign firms could be crowded out of the market. Crowding-out would be problematic if market selection of firms supplying multinational companies leads to the exclusion of local or small firms. If that happens, only big and foreign firms would drive aggregate productivity improvement. Given the potential and the importance of local firms to create jobs in developing countries, crowding them out will affect local employment negatively. Baseline regressions include firm size and a foreign ownership variable to control for these two aspects. Regardless of firm size and foreign participation in their capital structure, firms selling more of their production to multinationals are more productive. Additional robustness checks based exclusively on samples of local and small-local firms confirm the results (Appendix 5).

Local firms and small-local firms that do business with multinationals located in the country are more productive. Even with the restricted sample of local and small-local firms, a selectivity problem could arise. Indeed, higher competition induced by demand from multinational companies could lead to the exit from the market of nonproductive local firms and the entry of new, more productive, local firms. This possibility highlights the potential simultaneity bias in our results. Causality direction does not matter here. Whether local firms are more productive because of technology-sharing with foreign firms or because inefficient local firms drop out and more productive ones enter, the impact of doing business with foreign firms is positive for local firms in the aggregate and for the economy at large. Finally, foreign firms could also be choosing the most productive local firms as domestic suppliers. The literature on exporter firms has showed that only the most productive firms become exporters (Bernard and Jensen, 1999; Clerides, Lach and Tybout, 1998). Local firms face higher constraints than foreign firms to access finance, reliable electricity, or skilled workers (section 5.a). Given these constraints, the potential for local firms to improve their productivity by doing business with multinationals firms (through labor turnover, employee training, or better access to local finance) is significant. The results also show that small-local firms, which are on average less productive, exhibit higher productivity when doing business with local multinationals. However, the study does not rule out the fact multinationals firms could select the most productive local firms but do suggest that those local firms (particularly small-local firms) doing business with multinationals still improve their productivity. The available data do not allow us to test these alternative possibilities. As multinationals firms prefer to develop long-term relationships with their local suppliers, testing the dynamic of a sizeable number of local firms that become multinationals suppliers during a specific time requires long-term firm-level data on local firms' interactions with multinationals.

6. CONCLUSION

By analyzing the efficiency of manufacturing firms through a one-step stochastic frontier approach, this paper has proposed that differences in the investment climate of foreign and local firms are the main factors contributing to foreign firms higher productivity. A new way to test vertical spillovers from foreign to local firms is also explored.

The results show that foreign firms' better investment climate explains their higher productivity compared to local firms. Foreign firms can positively influence the investment climate—or locate where the investment climate is better. Based on firm-level information, the paper finds evidence of vertical spillovers from foreign to local firms. Unlike previous studies that estimate spillovers at the sector level, this paper for the first time uses the share of each firm's sales to multinationals located within the country to assess spillovers. The results show that local firms and particularly small-local firms selling part of their production to multinationals are more productive. This confirms vertical spillovers through backward linkages in our sample countries.

In defining strategies to improve competitiveness, particular attention should be given to the business environment, particularly for local firms, which face more hurdles than foreign firms. Better cooperation between local and foreign firms could also magnify spillovers.

NOTES

1. Helpman, Melitz, and Yeaple (2004) have predicted in their theoretical model that only the most productive firms become multinational.

2. In developed countries, the positive impact of foreign ownership on firm performances has been highlighted by a number of authors, e.g., Piscitello and Rabbiosi (2005) and Temouri, Driffield, and Higón (2008).

3. The distribution of firm inefficiency is not sensitive to alternative statistical distributions such as exponential and half-normal (Coelli, Prasada Rao, and Battese, 1998).

4. The two-step stochastic frontier first estimates the stochastic production frontier and then explains the residuals of the first estimation (the technical efficiency) by a vector of explanatory variables.

5. Dummies pick up the effect of country -or sector- specific factors, such as natural resources endowment, national institutions, macroeconomic or political instability, and trade policy.

6. The number of firms by country is as follow: Brazil: 1,474; Morocco: 789; Pakistan: 822; South Africa: 432; and Vietnam: 993. Countries were chosen according to data availability.

7. Firms are asked to quantify their constraints on a scale going from none to very severe.

8. More flexible functional forms such as translog did not reveal any significant variation of technology coefficients and investment climate coefficients. With translog, labor elasticities are 0.75 and capital elasticities 0.18. Elasticities of labor squared are 0.06, of capital squared 0.05, and the cross term between labor and capital is -0.05. The Spearman correlation rank between Cobb-Douglas and translog efficiency is 0.98 and statistically significant at 1 percent.

9. Following the standard IMF definition of foreign direct investment, foreign ownership variable is a dummy taking one if at least 10% of firm capital is foreign and zero otherwise.

10. We ensure getting a sufficient number of firms by city, sector, size, and foreign ownership status. The results are robust to alternative way of aggregation.

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APPENDICES

Appendix 1: List of variables

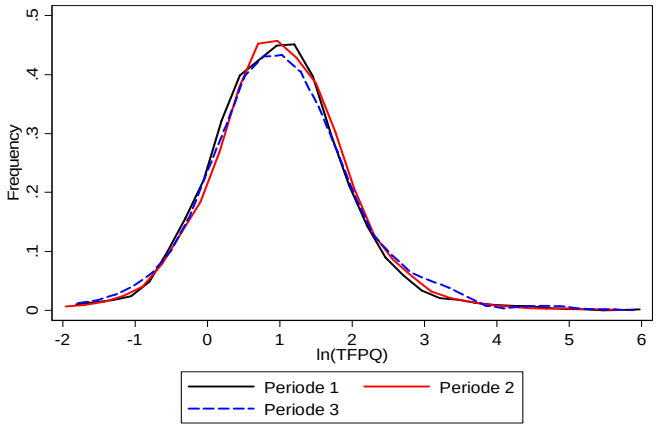
Variable	Definition
	Production Function
Ln(value added)	Logarithm of value added
Ln(capital)	Logarithm of capital
Ln(labor)	Logarithm of labor
	Firm Specific Characteristics
Sales to multinationals	Percentage of firm's sales to domestic multinational firms in the country
Size	Number of permanent workers in the firm
Age	Firm age
Export (% of sales)	Firm export as a percent of sales
Foreign firm	Dummy equal one if at least 10% of firm capital is foreign
	Investment Climate
Informal finance	Percentage of firms working capital coming from informal source (friends, family, money lenders)
Electricity problem	Percentage of firms that own or share a generator
Workforce education	Percentage of workorce with secondary education
Property rights protection	Indicator of protection of property rights by the judicial system scaled from one to six with higher scale indicating better protection
Regulation Management	Percentage of senior managers' time dealing with government regulation
Labor regulation	Percentage of the optimal level of employment compared to the current level

Appendix 2: Descriptive statistics

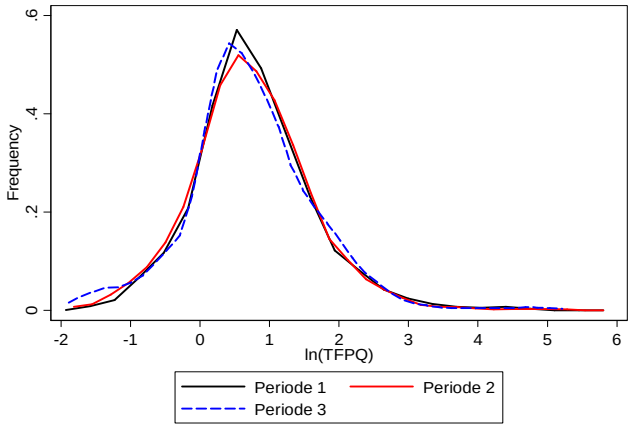
Variable	Mean	Std. Dev.	Minimum	Maximum
		Firm Specific Characteristics		
Sales to multinationals	8.1	21.1	0	100
Size	205.2	693.6	1	20503
Age	20.1	17.9	1	125
Export (% of sales)	10.4	23. 7	0	100
Foreign firm	0.1	0.3	0	1
		Investment Climate		
Informal finance	3.9	13.7	0	100
Electricity problem	0.2	0.2	0	1
Workforce education	9.7	11.0	0	100
Property rights protection	3.9	0.6	1	6
Labor regulation	117.6	30.7	50	668.9
Regulation Management	7.8	5.6	0	100

Appendix 3: Distribution of productivity across three consecutive years

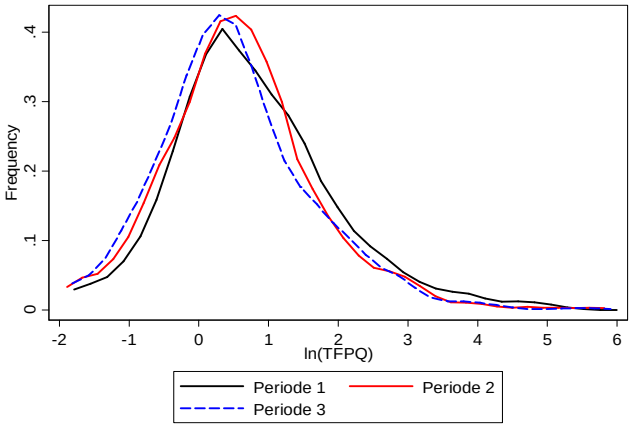
Brazil



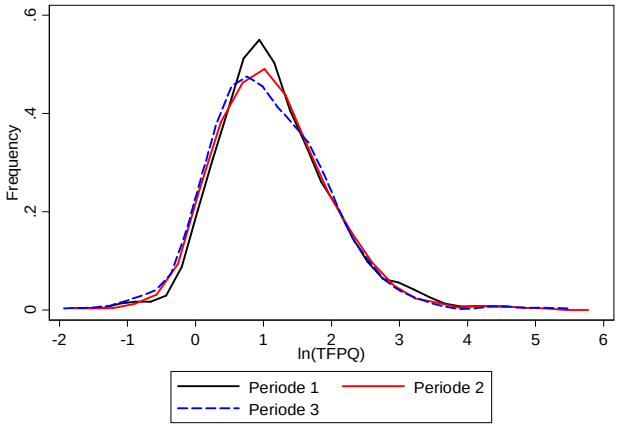
Morocco



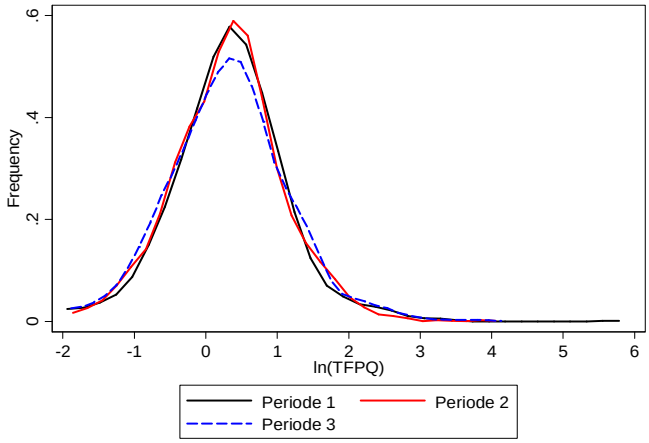
Pakistan



South Africa



Vietnam



Appendix 4: Investment climate, foreign ownership and, firm inefficiency
(No control for firms' specific characteristics)

	Dependent Variable: ln(Value added)			
	(1)	(2)	(3)	(4)
Production Function				
Ln(Capital)	0.217	0.213	0.212	0.213
	(44.18)***	(43.48)***	(43.32)***	(43.57)***
Ln(Labor)	0.777	0.775	0.775	0.767
	(126.36)***	(123.88)***	(123.62)***	(120.21)***
Constant	1.243	1.220	1.232	1.285
	(23.08)***	(22.17)***	(21.67)***	(23.01)***
Investment Climate *(Investment climate variables are regressed on firm inefficiency)*				
Foreign Firm	-6.626		-4.292	-2.967
	(4.22)***		(3.01)***	(2.18)**
Export (% of sales)				-0.063
				(4.83)***
Informal Finance		0.041	0.041	0.040
		(5.41)***	(4.82)***	(5.03)***
Electricity Problem		1.388	1.426	1.581
		(1.72)*	(1.67)*	(1.77)*
Workforce Education		-0.225	-0.214	-0.227
		(5.92)***	(4.93)***	(5.65)***
Property Rights Protection		-2.561	-2.658	-2.572
		(8.89)***	(6.82)***	(8.21)***
Regulation Management		0.042	0.043	0.043
		(2.14)**	(2.07)**	(2.07)**
Constant	-11.439	-3.098	-3.162	-3.582
	(10.78)***	(2.06)**	(1.94)*	(2.16)**
Observations	12898	12650	12635	12527
sigma_u	*2.10*	*2.03*	*2.08*	*2.15*
	[0.55]	*[0.58]*	*[0.75]*	*[0.63]*
sigma_v	*0.68*	*0.67*	*0.67*	*0.67*
	[0.10]	*[0.09]*	*[0.09]*	*[0.09]*
Wald chi2	66646.59	60685.64	59534.60	58411.08
Prob > chi2	0.00	0.00	0.00	0.00

Absolute value of z statistics in parentheses. Numbers in brackets for sigma_u and sigma_v are standard errors.
* significant at 10%; ** significant at 5%; *** significant at 1%
All regressions include year, country, and sectoral dummies.
All investment climate variables are industry-region averages by size and capital ownership except informal finance variable which, is firm-level information.

Appendix 5: Sales to multinationals and firm inefficiency
(Robustness for small and local firms)

	Dependent Variable: ln(Value added)				
	All firms			***Local Firms***	***Small-Local Firms***
	(1)	(2)	(3)	(4)	(5)
Production Function					
Ln(capital)	0.178	0.177	0.173	0.192	0.168
	(28.95)***	(28.85)***	(28.24)***	(31.03)***	(22.64)***
Ln(labor)	0.743	0.742	0.739	0.792	0.726
	(67.03)***	(66.75)***	(66.39)***	(90.92)***	(57.82)***
Constant	2.626	1.962	2.710	1.813	1.565
	(12.75)***	(14.05)***	(12.59)***	(11.20)***	(23.18)***
Investment Climate *(Investment climate variables are regressed on firm inefficiency)*					
Size	-0.145	-0.149	-0.146	-1.746	-0.197
	(7.74)***	(7.84)***	(8.22)***	(5.16)***	(6.57)***
Age	-0.001	-0.001	-0.001	-0.011	-0.000
	(0.98)	(1.07)	(1.43)	(0.53)	(0.14)
Sales to multinational	-0.002	-0.002	-0.002	-0.041	-0.005
	(3.51)***	(3.50)***	(3.12)***	(1.90)*	(2.61)***
Informal finance	0.002	0.002	0.002	0.019	0.001
	(3.40)***	(3.36)***	(3.40)***	(1.64)	(1.03)
Electricity problem	0.218	0.216	0.212	0.690	0.060
	(3.63)***	(3.48)***	(3.54)***	(0.41)	(0.50)
Workforce education	-0.009	-0.009	-0.009	-0.183	-0.017
	(7.15)***	(6.94)***	(7.34)***	(4.47)***	(6.29)***
Property rights protection	-0.029	-0.030	-0.020	-0.638	-0.087
	(1.64)	(1.68)*	(1.17)	(1.61)	(2.92)***
Regulation Management	0.004	0.004	0.004	-0.016	-0.001
	(1.50)	(1.55)	(1.82)*	(0.20)	(0.23)
Export (% of sales)		-0.000	-0.000	-0.047	-0.109
		(0.71)	(0.18)	(1.47)	(4.20)***
Foreign firm			-0.176		
			(3.76)***		
Constant	1.190	1.186	1.218	-0.366	1.422
	(6.44)***	(6.34)***	(6.32)***	(0.09)	(4.72)***
Observations	7403	7387	7375	6786	5022
sigma_u	*0.35*	*0.35*	*0.34*	*1.93*	*0.30*
	[0.17]	*[0.17]*	*[0.17]*	*[0.56]*	*[0.14]*
sigma_v	*0.61*	*0.61*	*0.62*	*0.60*	*0.65*
	[0.16]	*[0.15]*	*[0.16]*	*[0.10]*	*[0.13]*
Wald chi2	14121.22	13720.07	13507.58	29619.19	9186.57
Prob > chi2	0.00	0.00	0.00	0.00	0.00

Absolute value of z statistics in parentheses. Numbers in brackets for sigma_u and sigma_v are standard errors. * significant at 10%; ** significant at 5%; *** significant at 1%
All regressions include year, country, and sectoral dummies.
Sale to multinational is the percentage of firm sales to domestic multinational. All investment climate variables are industry-region averages by capital ownership except informal finance variable, which is firm-level information.