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Abstract

This paper uses a unique plant-level panel dataset from the Chinese manufacturing sector to measure the effects of foreign firms on the productivity of domestic firms. We find that foreign firms are more productive than domestic firms in the same industry. We find little evidence that foreign firms had any effect, either positive or negative, on the average productivity of domestic Chinese manufacturing plants. However, we also find clear evidence that this average effect masks important heterogeneity: large domestic firms appear to benefit significantly from the presence of foreign firms in the sector, while the productivity of small domestic firms is lowered by the presence of foreign firms.

1. Introduction

In recent decades, direct foreign investment (DFI) has exploded in developing countries. By some accounts, DFI accounts for more than half of all external financing in developing countries. In fact, many policy makers believe that attracting DFI is a crucial ingredient for accelerating the country's economic development. Foreign firms, the argument goes, would introduce new technologies and help upgrade technological capabilities of domestic firms. This could occur through a variety of channels. For example, workers employed by foreign firms could learn the new technologies and diffuse these technologies by starting their own firms or by moving to other domestic firms. It might be the case that foreign firms help upgrade the technologies of domestic firms by stimulating upstream and downstream linkages.

Due to these reasons, many countries have introduced a battery of tax incentives, ranging from tax holidays to the provision of utilities and other infrastructure at concessionary rates. And nowhere is this more apparent than in China, where the government has introduced a number of incentives to attract foreign investment, with remarkable success so far. In fact, China has emerged as the largest recipients of direct foreign investment in the world. Yet, there is remarkably little evidence on the effect of foreign firms on the technological capabilities of domestic firms in China. A recent important paper by Aitken and Harrison (1999) uses sophisticated econometric techniques to measure the effect of foreign firms on the productivity of domestic firms using a plant level census of firms in Venezuela. Here, Aitken and Harrison (1999) find little evidence that DFI had a positive effect on the productivity of domestic firms.

This paper will follow the approach taken by Aitken and Harrison applied to a unique panel dataset of Chinese firms. Specifically, there are two questions we seek to answer. First, do joint ventures or wholly owned foreign subsidiaries in China have higher levels of productivity than domestic firms in similar sectors? Second, does the presence of foreign firms (either joint ventures or wholly owned foreign firms) result in a technology "spillovers" to domestic firms?

We report three main findings. First, foreign firms are indeed more productive than domestic firms in the same sector. Second, the presence of foreign firms in a sector does not appear to have an effect, either positive or negative, on the productivity of an average plant in the sector. Third, foreign penetration in a sector has important effects on inequality: large domestic plants appear to be benefit from the presence of foreign firms, while small domestic plants appear to suffer.

This paper contributes to the large literature on the effects of foreign investment on the productivity of domestic firms. In addition to the papers cited above, other representative papers from this literature include Blomstrom (1986) for Mexican manufacturing and Globerman (1979) for Canada. As for China, we are not aware of any paper that uses firm level data to examine the effect of foreign investment on domestic productivity. Therefore, the main contribution of the paper is to provide the first evidence of the effects of foreign capital in a country that is the largest host of foreign direct investment in the world.

The paper proceeds as follows. Section 2 describes the data that is used for the analysis. Section 3 presents the main empirical results examining the relationship between foreign investment and productivity at the plant level. Section 4 examines

whether the spillovers are local in nature. Section 5 looks for evidence that foreign capital had a differential effect for large versus small firms. Section 6 concludes.

2. Data

The data used in this paper is the firm level data from the Chinese *Annual Survey of Industries* conducted annually by China's *National Bureau of Statistics*. This is the data published in the industrial statistics chapter of the annual publication of *China's Statistical Yearbook*. We have this data from 1998 through 2004. This survey covers all state plants and all non-state plants with revenues greater than 5 million Yuan. The number of plants ranges from 200,000 to 250,000. The data also provides plant identifiers, so we are able to track plants over time. For each plant, the dataset also provides information on the plant's industry, geographic location, ownership, book value of the plants' capital stock, input cost, revenues, employment, and revenues.

The pieces of information we use from this dataset are the following. First, we define the plant's industry as a 3-digit level. There are roughly 180 3-digit industries in the data. Second, we use the plant's revenues, employment, input costs, and the book value of the capital stock to measure the plant's productivity. The use of the book value of the capital stock instead of the market value may be of concern. One way in which we tried to deal with this is to use the data on the age of the firm to construct a proxy for the market value of capital using constant growth rate assumptions and the data on the book value of the capital stock. For the results we present below, it does not make a difference whether we use the book value of the capital stock reported in the dataset or whether we

use our proxy for the market value of the capital stock (but we can obviously provide these results upon request).

Third, a key piece of information provided in the data is the ownership of the plant. Specifically, the dataset provides information on the ownership of the plant divided into state, local governments, cooperative, and foreign ownership. We use this information to construct three variables. First, we construct a variable measuring the foreign ownership share of the plant. We call this variable *Plant_DFI*. Second, we construct a variable measuring the share of foreign firms in each 3-digit industry. Specifically, we measure the foreign share in an industry as a weighted average of the employment share of each plant where the weights are the share of foreign equity in each plant. We call this variable *Sector_DFI*. Finally, we construct a variable for the importance of foreign firms in a geographic region. Specifically, we define the local region as a Chinese province, and measure the share of foreign firms as a weighted average of the employment share of each plant in the province, where the weights are the foreign equity share of each plant. We call this variable *Local_Sector_DFI*.

3. Do Domestic Firms Benefit from Foreign Firms?

To estimate the effect of foreign firms, we follow Aitken and Harrison (1999) and estimate the following log linear production function:

$$\log Y_{ijt} = \beta_1 Plant\_DFI_{ijt} + \beta_2 Sector\_DFI_{ijt} + \beta_3 Plant\_DFI_{ijt} \bullet Sector\_DFI_{ijt} + \beta_4 Controls_{ijt} + \varepsilon_{ijt} \quad (1.1)$$

Here, i indexes the plant, j indexes the sector, and t represents time. As for the variables, *Y* is gross output of the firm, *Plant_DFI* represents the share of foreign equity for the plant, *Sector_DFI* represents the employment share of foreign equity in the sector, and *Controls* denotes a vector of controls (a vector of time dummies, the cost of intermediate inputs, the employment of the plant, and the book value of the capital stock).

Table 1 presents the basic results from estimating equation (1.1) on the Chinese data. The dependent variable is the log of plant gross output, which is regressed on the measures of foreign participation, the number of workers employed in the firm, the value of intermediate inputs used by the firm, and the book value of the capital stock (the last three variables are introduced in logs). In addition, in all the regressions we include a vector of time dummies. In the first column, we also include a vector of 3-digit industry dummies (187 industries in total) to allow for fixed productivity differences across sectors. As can be seen, the coefficient on the foreign ownership of the plant (*Plant_DFI)* is positive and statistically significant. The point estimate suggests that the productivity of plant that is entirely foreign owned is 13 percentage points higher than the productivity of a plant that is entirely owned by domestic investors.

In contrast, the coefficient on the foreign ownership in the sector (*Sector_DFI*) does not appear to be statistically different from zero. This result suggests that foreign presence in a sector (as opposed to being foreign owned itself) does not appear to have any effect on the productivity of domestic firms.

The coefficient on the term interacting foreign ownership of the plant and foreign ownership in the sector (*Plant_DFI*Sector_DFI*) is *negative* and statistically significant. The negative coefficient suggests that for domestic plants, there are positive spillovers

from foreign investment, in contrast to foreign plants. Note that this result differs from what Aitken and Harrison (1999) found in their analysis of Venezuelan manufacturing plants.

The second column presents the coefficients from the same regression, but omits the industry dummies. The reason this is done is so that we can compare our results with studies that use only aggregated industry data. As can be seen, the coefficient on foreign ownership in the sector is now negative and statistically significant. The point estimate indicates that the productivity of domestic plants is 4.5 percentage points lower in an industry with 10 percentage point higher foreign share. The coefficient on *Plant_DFI* is still positive but smaller in magnitude, and the coefficient on the interaction of *Plant_DFI* and *Sector_DFI* is now rendered insignificant.

The third column includes the industry dummies but omits the factor inputs. The reason we do this is to examine the effect of foreign ownership on the *scale* of domestic plants. In the third column, the coefficient on the foreign share in the industry is large and negative (and precisely estimated). The point estimate indicates that a 10 percent increase in foreign ownership share lowers the output of domestic firms by 3.5 percent. This suggests that foreign ownership forces domestic plants to contract.

The last four columns in Table 1 examine the dynamic effect of foreign investment by taking differences of the data. Column 5 takes first differences, Column 6 takes second differences, Column 7 takes third differences, and Column 8 takes four differences of the data. The coefficient on the share of foreign firms in the sector (*Sector_DFI*) becames more negative as we move from the first difference specification to the fourth difference specification. This suggests that the negative effect of foreign

ownership on domestic productivity appears to become more pronounced over time. The coefficient on *Plant_DFI* remains small and statistically insignificant, as is the coefficient on the variable interacting *Plant_DFI* and *Sector_DFI*.

4. Are the Effects of Foreign Firms Localized?

We now explore whether foreign capital only has an effect on the productivity of local firms in the local area. So far, we have searched for the effect of foreign firms on the productivity of domestic firms in the same industry regardless of the geographic location of the foreign firm or of the domestic firm. However, given the vastness of China's geography, it seems unlikely that foreign investment in say, the textile sector in Shanghai will have much of an effect on the productivity of a domestic firm in the same textile in a far away province such as Gansu.

To examine this, we enter a variable for the share of foreign firms in a region (defined as a Chinese province) in equation (1). That is, we define a variable *Local_Sector_DFI* as the employment share of foreign firms in a given Chinese province. The natural issue with interpreting the coefficient on this variable as reflecting the effect of local spillovers of foreign firms is that foreign firms could choose to locate in provinces with characteristics that also lead to higher domestic productivity. That is, there could be an omitted variable, such as the quality of local infrastructure that affects both the decision of foreign firms to locate in a given province and the productivity of domestic firms.

We deal with this omitted variable bias in two ways. First, we control for regional GDP. These estimates are seen in the second column in Table 2. As can be seen, there seems to be clear evidence that foreign presence in a region has a large and positive effect on the productivity of domestic firms.

A second approach we take is to estimate "within" estimates by subtracting each variable from its plant specific mean over time. The idea is that this would deal the omitted fixed characteristics of each plant by only using the deviation of the variables from its mean over time. Here, the estimates provide little evidence that foreign penetration has a positive effect on the productivity of domestic firms in the province. This does not change even when provincial GDP is included on the right hand side of the regression.

5. Do the Effect of Foreign Firms Differ by Plant Size?

We now present estimates separately for large and small plants. Here, we define large plants as those with more than 125 employees. As can be seen, there is generally little difference in the own-plant effect between large and small plants. For example, the OLS estimate on *Plant_DFI* is virtually the same for small plants as in large plants. In both cases, the point estimate suggests that foreign owned plants are generally more productive than domestic plants, by roughly 14 percentage points.

However, the effect of foreign investment in a sector does seem to clearly differ between large and small plants, at least when one considers the OLS estimates. For small plants, foreign presence in the sector appears to be associated with lower productivity.

For large plants, the converse is true. Specifically, for small domestic plants, a 10 percentage point increase in the employment share of foreign firms in the sector is associated with a 1.2 percentage point decline in productivity. For large domestic plants, a similar increase in the share of foreign firms in the sector is associated with a 1 percentage point *increase* in productivity. This finding is important in understanding the previous finding that foreign presence in a sector does not appear to have an effect on domestic firm productivity. What we were measuring before was the aggregate effect, but it clearly masked important heterogeneity in the impact of foreign capital between large and small plants.

6. Conclusion

In this paper, we have exploited a unique panel dataset of Chinese firms in the manufacturing sector to get at the perennial question of the effect of foreign direct investment on the productivity of domestic firms. Clearly, this is a topic of major relevance for policy. Many countries have viewed the attraction of foreign capital as central to their development strategy, and China has certainly been a major player in this.

This paper follows the approach taken by Aitken and Harrison (1999) to examine the effect of foreign capital in China. Our findings suggest that foreign firms are indeed more productive than domestic firms. When we examine the average productivity of domestic plants in the same sector, we find little evidence that foreign presence had a positive effect. However, when we unpack this effect, we find clear evidence that foreign

presence in a sector had a large and positive effect on large domestic plants, but had a negative effect on small domestic plants.

References:

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Table 1—Impact of Foreign Ownership on Total Factor Productivity:
Regressing Log Output at the Plant Level on Inputs and Foreign Ownership at the Plant and Sector Levels

	Impact of DFI on productivity		Impact of DFI on output	Impact of DFI on change in productivity			
	OLS with industry dummies (1)	OLS without industry dummies (2)	OLS with industry dummies and no factor inputs (4)	First differences (5)	Second differences (6)	Third differences (7)	Fourth differences (8)
Plant_DFI	0.128***	0.087***	0.841***	0.004	-0.001	0.002	-0.001
	(0.002)	(0.002)	(0.006)	(0.007)	(0.007)	(0.008)	(0.010)
Sector_DFI	-0.011	-0.045***	-0.358***	-0.023**	-0.030***	-0.053***	-0.059***
	(0.014)	(0.003)	(0.039)	(0.010)	(0.011)	(0.012)	(0.015)
*Plant_DFI*Sector_DFI*	-0.113***	-0.003	-0.255***	0.029**	0.035**	0.020	0.007
	(0.006)	(0.006)	(0.017)	(0.014)	(0.015)	(0.016)	(0.019)
Number of Plants	458,595	458,595	458,595				
Number of observations	1,260,420	1,260,420	1,260,420	776,402	519,207	338,901	210,948
R^2	0.8912	0.8867	0.1354	0.4500	0.5566	0.6156	0.6585

Notes:
a. All specifications include annual time dummies. All standard errors (denoted in parentheses) are corrected for heteroskedasticity. Unless otherwise specified, other independent variables (not reported here) include log inputs, log labor, and log capital stock (book value). *Plant_DFI* is a dummy indicating foreign ownership. *Sector_DFI* is employment ratio of foreign owned firms at the three-digit level.
b. Industry dummies defined at the three-digit level (187 industries in total).

Table 2—Effects of Foreign Ownership in the Region on Total Factor Productivity:
Regressing Log output at the Plant Level on Inputs and the Share of Foreign Ownership at the Plant Level, the Sector Level, and the Local Level

	OLS with industry dummies		Within estimates	
	No region controls	With region controls	No region controls	With region controls
	(1)	(2)	(3)	(4)
Plant_DFI	0.128***	0.111***	-0.001	-0.002
	(0.002)	(0.002)	(0.007)	(0.007)
Local_Sector_DFI	0.221***	0.125***	0.030**	0.034***
	(0.004)	(0.004)	(0.010)	(0.010)
*Plant_DFI*Local_Sector_DFI*	-0.144***	-0.088***	0.014	0.013
	(0.006)	(0.006)	(0.014)	(0.014)
Sector_DFI	-0.168***	-0.172***	-0.063***	-0.063***
	(0.014)	(0.014)	(0.011)	(0.011)
*Plant_DFI*Sector_DFI*	-0.022**	-0.039***	0.017	0.021
	(0.007)	(0.007)	(0.016)	(0.016)
Number of Plants	458,595	458,595		
Number of observations	1,260,420	1,260,420	1260131	1260131
R^2	0.8916	0.8922	0.5877	0.5877

Notes:
a. All specifications include annual time dummies. All standard errors (denoted in parentheses) are corrected for heteroskedasticity. Unless otherwise specified, other independent variables (not reported here) include log inputs, log labor, and log capital stock (book value). *Plant_DFI* is a dummy indicating foreign ownership. *Sector_DFI* is employment ratio of foreign owned firms at the three-digit level.
b. Industry dummies defined at the three-digit level (187 industries in total).
c. Regional controls include the provincial GDP per capita.

Table 3—Impact of Foreign Ownership by Plant Size:
Regressing Log Ouput at the Plant Level on Inputs and the Share of Foreign Ownership at the Plant Level, the Sector Level, and the Local Level

	Small plants (less than or equal to 125 employees)				Large plants (greater than 125 employees)			
	OLS (1)	Within (2)	OLS (3)	Within (4)	OLS (5)	Within (6)	OLS (7)	Within (8)
Plant_DFI	0.136***	-0.008	0.123***	-0.013	0.137***	0.015	0.118***	0.013
	(0.003)	(0.012)	(0.003)	(0.012)	(0.003)	(0.008)	(0.003)	(0.009)
Local_Sector_DFI	—	—	0.127***	0.012	—	—	0.130***	0.032*
			(0.005)	(0.015)			(0.005)	(0.014)
*Plant_DFI*Local_Sector_DFI*	—	—	-0.118***	0.039	—	—	-0.078***	0.001
			(0.009)	(0.024)			(0.008)	(0.019)
Sector_DFI	-0.116***	-0.057***	-0.262***	-0.063***	0.097***	-0.027*	-0.079***	-0.041*
	(0.021)	(0.016)	(0.022)	(0.019)	(0.019)	(0.014)	(0.019)	(0.016)
*Plant_DFI*Sector_DFI*	-0.119***	0.048	-0.019	0.021	-0.131***	-0.023	-0.068***	-0.021
	(0.010)	(0.026)	(0.012)	(0.031)	(0.007)	(0.017)	(0.009)	(0.022)
Number of observations	619766	619678	619766	619678	640654	640453	640654	640453
R^2	0.8422	0.5189	0.8435	0.5189	0.8912	0.5995	0.8923	0.5996

a. Industry dummies included in all OLS specifications. All specifications include annual time dummies. All standard errors (denoted in parentheses) are corrected for heteroskedasticity. Unless otherwise specified, other independent variables (not reported here) include log inputs, log labor, and log capital stock (book value). *Plant_DFI* is a dummy indicating foreign ownership. *Sector_DFI* is employment ratio of foreign owned firms at the three-digit level.
b. Industry dummies defined at the three-digit level (187 industries in total).
c. Regional controls include the provincial GDP per capita.