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Foreign direct investment and indigenous technological efforts: Evidence from China ☆

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Abstract

What impact does foreign direct investment (FDI) have on indigenous technological efforts? Despite that the question is both academically interesting and practically important, systematic empirical studies are scarce. This study attempts to help fill this gap by conducting an empirical investigation of the effects of FDI on indigenous technological effort using a firm-level survey dataset in China.

JEL classification: F21; F23; O32; O33

1. Introduction

It is widely recognized that lack of access to modern technology is one of the main reasons why poor countries remain poor. Developing economies are often advised to narrow their technological gap with developed countries by attracting foreign direct investment (FDI). Such investment often results in technological spillover and technology transfer to their domestic firms, and ultimately improves their productivity. Recently, important contributions have been made in modeling and quantifying the impacts of

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FDI on domestic productivity, technological transfers, and easing domestic financing constraints based on detailed firm-level data.[1]

However, while there are positive aspects of foreign investments, some policy-makers and economists are concerned about the impacts of FDI on indigenous technological creation in developing countries, since technological transfer through FDI may substitute domestic technologies in production.[2] Also, a firm's investment in R&D can not only improve its own technology, but also enhance a country's technological infrastructure and benefit its economy in both the short and long terms. An economy is likely to receive more (free) technological transfers when it is relatively poor, but its further technological development has to depend more and more on its own technological creation when an economy develops. Moreover, many developing countries are reluctant to depend heavily on foreign technology because of the political leverage such dependence gives to the supplying country.

Despite its theoretical interest for economists and practical importance for policymakers, systematic empirical studies on the impact of FDI on indigenous effort in R&D are scarce, particularly with firm-level data. The current paper attempts to help fill this gap by conducting an empirical investigation on the effects of FDI on indigenous R&D effort based on a World Bank survey for 998 Chinese firms from 1998 to 2000. Our empirical analysis yields two findings. First, a firm's expenditure on research and development (R&D) decreases with the amount of FDI it receives. Second, sector-level FDI has a greater positive impact on the R&D effort for the firms with more foreign presence.

2. Data and empirical methodology

The dataset was derived from a World Bank firm-level survey from 1998 to 2000. The sample included 998 Chinese manufacturing firms randomly selected in five major cities over the period 1998–2000. These cities include the capital city (Beijing), the municipalities in the fast-growing eastern coastal belt (Shanghai, Tianjin and Guangzhou) and the western region (Chengdu). The firms were spread among 14 different economic sectors, as defined according to the 3-digit international standard industrial classification (ISIC). We then complemented the firm-level data with the aggregate foreign direct investment at the sector level in order to examine the macro effect of capital inflow on firms' R&D decisions.

We attempt to examine three empirical questions: (1) What is the impact of a firm's foreign presence on its R&D effort? (2) What is the impact of an increase in foreign direct investment in an industry on firms' spending on R&D? (3) Does the interaction between firm-level FDI and sector-level FDI affect indigenous technological effort? These questions can be incorporated in the following general specification:[3]

$$\begin{aligned} Y_{ijt} = {} & \alpha_0 + \alpha_1 \mathrm{FDIFirm}_{it} + \alpha_2 \mathrm{FDISector}_{jt} + \alpha_3 \mathrm{FDIFirm}_{it} * \mathrm{FDISector}_{jt} + \alpha_4 X_{it} + \alpha_5 \mathrm{CityD} \\ & + \alpha_5 \mathrm{YearD} + \alpha_7 \mathrm{SectorD} + \varepsilon_{ijt} \end{aligned} \tag{1}$$

where i, j and t represent firm i, sector j and time t respectively. Y is the logistic value of R&D efforts. FDI_Firm and FDI_Sector are the logistic values of foreign direct investment in firm i and in sector j respectively, and (FDI_Firm * FDI_Sector) is the interactive term. X is a vector of variables for firm

[1] See, among others, Aitken and Harrison (1999), Eaton and Kortum (1999), and Harrison, Love and McMillan (2004).

[2] For example, see Kim (1991) and Lall (1993, 2001).

[3] Our model specification is similar to that by Aitken and Harrison (1999) except that our dependent variable is firm R&D efforts while theirs is firm productivity. Moreover, we use the logistic value of FDI in the regression analysis, while Aitken and Harrison (1999) use the ratio between the value of FDI and the total capital stock. Thus, our study complements Aitken and Harrison (1999).

characteristics such as fixed assets, age and SOE dummy in our case. CityD, YearD and SectorD are respectively the city, year and sector dummies to control for variation across cities, over years and across sectors. ε is the standard error term.

We estimated Eq. (1) by robust OLS, which down-weights the sample outliers to make the estimation less sensitive to the measurement errors. We also used White-corrected standard errors to deal with potential heterskedasticity in all models.

An estimation issue we may face is the potential endogeneity of firm level FDI, since the selection of foreign participation might not be random. We dealt with this issue by two methods. First, we apply the firm-specific effect in the regressions to control for the unobserved firm heterogeneity. Second, given the limitation of the dataset in obtaining good instrument variables, we therefore used the one-year lagged firm FDI and its interactive term with sector FDI, since the pre-determined firm FDI is highly correlated to its current value but is unaffected by the current R&D efforts.

3. Empirical results

Table 1 provides the robust OLS regression results on the relationship between FDI and indigenous technological efforts. Two important findings stood out. First, foreign direct investment at firm level had a

Table 1
Robust OLS Regression on the relationship between R&D Efforts and FDI

Dependent variables	Ln (R&D expenditure)	Ln (R&D expenditure/ employee)	Ln (R&D expenditure/ sales)	Ln (R&D staff)	Ln (R&D staff/ employee)	Ln (R&D expenditure on labor/ R&D staff)
	(1)	(2)	(3)	(4)	(5)	(6)
Ln (FDI_Firm)	−0.638***	−0.663***	−0.776***	−0.236***	−0.242***	−0.213**
	(0.128)	(0.137)	(0.134)	(0.061)	(0.067)	(0.100)
Ln (FDI_Sector)	−0.087	−0.182	−0.126	−0.035	−0.097	0.033
	(0.194)	(0.208)	(0.200)	(0.106)	(0.106)	(0.153)
Ln (FDI_Firm * FDI_Sector)	0.034***	0.037***	0.041***	0.012***	0.014***	0.011*
	(0.008)	(0.009)	(0.008)	(0.004)	(0.004)	(0.006)
Ln (firm size)	0.700***	0.202***	0.058*	0.333***	−0.160***	0.146***
	(0.034)	(0.033)	(0.032)	(0.016)	(0.017)	(0.024)
Ln (age)	−0.264***	−0.348***	−0.148**	−0.113***	−0.181***	−0.067
	(0.072)	(0.072)	(0.073)	(0.034)	(0.035)	(0.052)
SOE dummy	−0.160	−0.439**	0.350**	0.236**	−0.072	−0.45***
	(0.175)	(0.175)	(0.167)	(0.093)	(0.095)	(0.126)
Sector dummies			Yes			
City Dummies			Yes			
Year dummies			Yes			
Constant	−3.057	−2.617	−6.402**	−1.697	−1.858	−1.187
	(2.970)	(3.176)	(3.054)	(1.625)	(1.622)	(2.336)
Observations	2811	2799	2792	2723	2712	2723
Adjusted *R*-squared	0.33	0.22	0.18	0.32	0.26	0.06

1) ***, ** and * denote 1%, 5% and 10% significant level respectively.
2) The numbers in the brackets are standard white-corrected errors.

Table 2
Firm-specific fixed effect regression on R&D efforts and FDI

Dependent variables	Ln (R&D expenditure)	Ln (R&D expenditure/ employee)	Ln (R&D expenditure/ sales)	Ln (R&D staff)	Ln (R&D staff/ employee)	Ln (R&D spending on labor/ R&D staff)
	(1)	(2)	(3)	(4)	(5)	(6)
Ln (lag FDI_Firm)	−0.583***	−0.628***	−0.557***	−0.297***	−0.341***	−0.322**
	(0.190)	(0.199)	(0.208)	(0.065)	(0.075)	(0.146)
Ln (FDI_Sector)	0.062	0.033	0.063	−0.046	−0.074*	−0.046
	(0.098)	(0.101)	(0.106)	(0.033)	(0.037)	(0.074)
Ln (lag FDI_Firm * FDI_Sector)	0.037***	0.039***	0.032***	0.020***	0.022***	0.025***
	(0.011)	(0.012)	(0.012)	(0.004)	(0.004)	(0.009)
Ln (firm size)	0.283**	0.173	0.066	0.147***	0.037	−0.016
	(0.140)	(0.143)	(0.151)	(0.047)	(0.053)	(0.106)
Ln (age)	1.379***	1.192***	0.412	0.394***	0.208	0.226
	(0.371)	(0.377)	(0.404)	(0.124)	(0.139)	(0.281)
Constant	−3.880*	−7.424***	−9.506***	−0.232	−3.821***	0.818
	(2.063)	(2.104)	(2.237)	(0.697)	(0.778)	(1.576)
Observations	1927	1923	1918	1867	1863	1867
Adjusted *R*-squared	0.08	0.07	0.03	0.10	0.05	0.04

1) ***, ** and * denote 1%, 5% and 10% significant level respectively.
2) The numbers in the brackets are standard errors.

significantly negative effect on a firm's R&D input in all models. In other words, firms with more foreign participation tended to devote less resource to research and development. This is probably because foreign investors generally possess better technology than domestic firms. The greater the foreign presence in a firm, the more technological transfer it is likely to receive from its foreign partners, which reduces the need for its own technological creation. Furthermore, as the technologies suitable for use with China's relatively unskilled labor force are usually relatively simple, firms may decide that it is not worth investing in R&D after receiving significant technological transfers from their foreign partners. It is also possible that some firms with foreign investment may be deterred from investing in R&D because their foreign partners believe such investment could be too risky, given that R&D requires long-term and large capital input as well as intellectual property protection is weak in developing countries.

Second, the interactive term of FDI_Firm and FDI_Sector was significantly positive, while the (direct) effect of the sectorial FDI is not statistically significant. In other words, sector-level FDI had a greater positive impact on the R&D effort of firms with more foreign presence/participation. We may interpret this result as follows. The presence of a large number of foreign involved firms provides a potential source of learning through technological spillover for every firm of the home country. However, the effectiveness of learning from firm to firm may differ greatly. If a firm receives a large amount of FDI, its foreign partners might be able to facilitate technological spillovers from other firms. This is because foreign partners possess more general skills for learning foreign knowledge and they are more efficient in interacting with other foreign firms due to their cultural and language proximity. In turn, this significant technological spillover from sectoral-level FDI due to a large foreign presence at the firm level enhances the efficiency of the firm's R&D in generating new technologies and increasing its profits, which induces the firm to increase its expenditure on R&D. By contrast, if a domestic firm receives little or no help from

Table 3
Robust check: robust OLS and firm-specific fixed effect regressions on the relationship between productivity and FDI

Dependent variables	Robust OLS		Firm-specific fixed effect	
	Ln (TFP) (1)	Ln (sales/employee) (2)	Ln (TFP) (3)	Ln (sales/employee) (4)
Ln (FDI_Firm)	0.383	0.141****	0.156	0.113*
	(0.043)	(0.045)	(0.135)	(0.064)
Ln (FDI_Sector)	0.415	0.009	0.001	−0.014
	(0.063)	(0.071)	(0.046)	(0.041)
Ln (FDI_Firm * FDI_Sector)	0.0004	0.005*	0.002	0.003
	(0.003)	(0.002)	(0.005)	(0.005)
Ln (firm size)	−0.016	0.140	−0.149	0.137
	(0.014)	(0.012)	(0.067)	(0.049)
Ln (age)	−0.108	−0.199	0.385	0.497
	(0.032)	(0.032)	(0.081)	(0.065)
SOE dummy	−0.633	−0.756		
	(0.080)	(0.074)		
Sector dummies	Yes			
City dummies	Yes			
Year dummies	Yes			
Constant	−0.684	2.821*	−0.129	1.696**
	(0.974)	(1.097)	(0.860)	(0.748)
Observations	2390	2781	2390	2781
Adjusted *R*-squared	0.23	0.37	0.05	0.09

1) ***, ** and * denote 1%, 5% and 10% significant level respectively.
2) The numbers in the brackets are standard errors.

its foreign partner due to the lack of foreign presence in the firm, the firm may benefit little from the presence of foreign firms in its R&D due to its difficulty of communicating with foreign firms and/or its lack of ability to digest foreign technology.

To examine the net effect of FDI at firm and sector levels on R&D, we took the first derivative of the equation of estimation in Eq. (1), which yielded

$$\frac{d(Y_{ijt})}{d(\mathrm{FDIFirm}_{it})} = \alpha_1 + \alpha_3 \mathrm{FDISector}_{jt} \tag{2}$$

Note that our regression results showed that $\alpha_1 < 0$, $\alpha_3 > 0$, it is clear that the negative impact of firm-level FDI on a firm's R&D was counterbalanced by sectorial FDI. Hence, the net effect of foreign presence needed to be estimated by substituting α_1, α_3 and FDI_Sector into Eq. (2). Based on our results in Table 1, we found that Eq. (2) remained negative for all models. In other words, foreign participation in a firm discouraged its R&D activities overall, although the negative effect might be smaller in an industry with high foreign concentration.

In terms of the control variables, it was shown that a firm's investment in R&D increased with its size. This result is consistent with the findings of the existing literature (For example, see the survey by Cohen and Levinthal, 1989). We also observed that R&D expenditure decreased with a firm's age.

We further ran firm-specific fixed effect regressions with the one-period lagged firm FDI and reported the results in Table 2. We again found that firm FDI is significantly and negatively associated with R&D efforts while the interactive term is significantly positive, and the net effects of FDI on R&D efforts were significantly negative. It suggested our results were robust.

The main purpose of this paper is analyzing the relationship between FDI and indigenous technological effort. However, we note that most of the related literature has focused on the impacts of FDI on productivity.[4] Thus, we now follow the received literature by studying the relationship between FDI and productivity in China. A firm's productivity is estimated in two ways: (1) total factor productivity (TFP), which is measured as the difference between the actual output and the estimated output regressed in the firm-specific fixed effect Cobb–Douglas production function; and (2) labor productivity, which is measured as sales revenue per employee. We re-ran regressions in Eq. (1) using productivity as the dependent variables and reported results in Table 3.

As shown in the table, labor productivity is significantly higher for the foreign involved firms in models (2) and (4), although FDI appears to have no significantly impact on total factor productivity. These results imply that FDI has some positive impacts on the productivity growth for Chinese firms, and they are consistent with the findings of much received literature that foreign investments enhance productivity for developing countries.

4. Conclusion

Our empirical study yields the following findings. First, a firm's expenditure on research and development (R&D) decreases with the amount of FDI it receives. Second, sector-level FDI has a greater positive impact on the R&D effort for the firms with more foreign presence. Combining these two effects together, we find that the net effect of FDI on indigenous R&D effort is negative. We also find that FDI has some positive impacts on the productivity growth for Chinese firms. In future research, it will be an interesting topic to examine the net impacts of FDI considering both its positive and negative roles.

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[4] Simply speaking, productivity is a good indicator that measures a firm's efficiency at a given point of time, while a firm's R&D effort has more long-term and strategic impacts for developing countries. Thus, the current paper complements the received literature.