

Will Foreign Direct Investment Affect the Productivity of Enterprises? ——Based on PSM+DID Method

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Abstract. Is OFDI able to improve the productivity of enterprises? This paper uses the data of Industrial Enterprise Database from 2000 to 2007 to conduct empirical tests. Based on the theory of Propensity Score Matching (PSM) and Double-Differences (DID), this paper constructs an econometric model and explores the impact of OFDI on the productivity of Chinese industrial enterprise based on overcoming endogenous problems. The results show that OFDI has a positive effect on the productivity of enterprises. On the basis of the basic regression, the paper also obtained the control group samples at the ratio of 1:2, 1:3, 1:4 and 1:5 to obtain the control sample, which proved the robustness of the conclusion. These findings provide a new dimension of interpretation for verifying the need for China to implement the “going-out” policy and enhancing the competitiveness of Chinese enterprises under the new economic normal.

1. Introduction

Since the “reform and open-up” policy, Chinese enterprises have followed the implementation of China's “going-out” strategy and gradually integrated into the production of global value chains. According to the “World Investment Report 2018”, China's foreign direct investment flow reached 124.63 billion dollars in 2017, ranking third in the world; foreign direct investment stock was 148.02 billion dollars, ranking eighth in the world. The current scale of foreign investment far exceeds the level of developed countries in the same period. The proposal and development of the “Belt and Road” Initiative also provided a new opportunity for Chinese enterprises to go out. For a better position in the global value chain, the research and development of new products and the improvement of technology are particularly important. Under the background that the country's foreign direct investment can produce technology spillover effects, does the same “productivity effect” exist for enterprises to invest abroad? Therefore, this paper adopts the method of DID+PSM to explore whether OFDI can promote the productivity of enterprises.

2. Econometric Models and Variables

2.1 Econometric Models

This paper aims to study the impact of OFDI on firm productivity. In such research, mixed and selectivity bias often interfere with the estimation results. When inferring the causal relationship between two variables, we believe that a random experiment using control covariates is ideal. Specifically, we can achieve this by studying the differences in the productivities between the firms with OFDI or not. However, it is impossible to observe the productivity of firms after the period of OFDI if they are not. Therefore, this paper will adopt the Propensity Score Matching Method (PSM), according to De Loecker (2007), to formulate a matching criterion to make a control group for companies that have never made outward direct foreign investment during the sample period, reflecting the productivity of the OFDI company when it is not investing. At the same time, we used the DID method to eliminate the deviation of the results that may be caused by some unobservable factors.

Based on the idea of the difference-in-difference method, we regard the OFDI enterprises as the experimental group, and the enterprises that have never made investment as the control group. At the same time, we also constructed two binary virtual variables, OFDI and t . t indicates whether the company conducts outward foreign direct investment. $t=1$ indicates that the company has made and the company has never made if $t=0$. OFDI is a time binary dummy variable. OFDI=1 indicates the period after the company making outward foreign direct investment and OFDI=0 indicates the period before the company making foreign direct investment.

We selected variables such as the rate of return on assets (roa), cash flow (cr), subsidy (lsub), size of firm(size), age of enterprise(age), wages (lwage), and capital intensity (lklratio) as matching variables, building the following logit model:

$$\text{logit}(t = 1) = \Phi(\text{roa}_{it}, \text{cr}_{it}, \text{lsub}_{it}, \text{size}_{it}, \text{age}_{it}, \text{lwage}_{it}, \text{lklratio}_{it}) \quad (1)$$

The samples after PSM were estimated by the difference-in-difference method. The "net effect" of the experiment was obtained by subtracting the change of the dependent variable before and after the experimental period between the experimental group and the control group. Therefore, we draw on the research of Lu and Yu (2015), Liu and Qiu (2016) to construct a multiplication model:

$$tfp_lp_{it} = \alpha + \beta_1 OFDI_t_{it} + X_{it} + \mu_t + \gamma_i + \varepsilon_{it} \quad (2)$$

Where, tfp_lp_{it} is the total factor productivity of the enterprise. $OFDI_t_{it}$ is the interaction term of t and OFDI. X_{it} is the control variable collection of this article, including the matching variables mentioned above. μ_t is time fixed effect and γ_i is individual (national) random effects. ε_{it} is the error term.

2.2 Variable Selection

As for the measurement of total factor productivity(tfp_lp), this paper adopts the LP method of Levinsohn, J, A Petrin, (2003) and uses the intermediate input as the proxy variable so that the sample is fully retained while the total factor productivity is fully accurately measured.

The rate of return on assets (roa) is divided corporate income after tax by total assets. This paper draws on Zhang Jie (2012) to use the sum of corporate net profit and current year's depreciation, divided by the total assets to reflect the level of corporate cash flow (cr). Then, we use the logarithm of subsidy and product sales revenue in the Industrial Enterprise Database to represent the subsidy(lsub) and the scale of an enterprise(size). The year in which the enterprise appears in the industrial enterprise database is subtracted from the opening year of the enterprise, and then one is added to obtain the "age" of an enterprise(age). We first use the total amount of wages payable in the industrial enterprise database plus the total amount of welfare payable this year, dividing the total number of employees and finally takes the logarithm of the obtained value to obtain the average salary of an enterprise(lwage). Capital intensity (lklratio) is divided net fixed assets by number of employees.

3. The Analysis of the Measurement Results

3.1 The results of PSM

In the end, the enterprises were divided into OFDI enterprises and non-OFDI enterprises. The results of the t-test rejected the original assumption that there is no difference between OFDI enterprises and non-OFDI enterprises. After the Propensity Score Matching, the standardization deviation of all variables is less than 10%, and the results of t-test cannot reject the null hypothesis that there is no systematic difference between the OFDI enterprises and non-OFDI enterprises, and the standard deviation after the matching is greatly reduced. Therefore, the matching variables and matching methods selected in this paper are valid, and the estimation results are also reliable. The statistical description of each variable after matching is shown in Table 1:

Table 1 Description of variable statistical characteristics

Name	Observation	Mean	Bias	Min	Max
Tfp_lp	9710	3.392233	1.324709	-4.752407	8.788692
OFDI	9710			0	1
roa	9710	.0619261	.1391779	-1.509234	6.326674
cr	9710	.0892339	.1429658	-1.484234	6.371201
lsub	9710	.4431119	1.406351	-4.628586	9.044269
size	9710	5.818453	1.397	1.098612	11.96536
age	9710	10.524	9.893125	1	59
lwage	9710	-1.926918	.6275362	-6.231379	1.276522
lklratio	9710	5.020844	2.056923	-2.926412	13.22416

3.2 Regression result

Based on the theory of difference-in-difference, this section performs the regression on samples after propensity score matching. The results are shown in Table 2. Table 2 shows the results of random effects and fixed-effect panel regressions, respectively without controlling any other factors and adding control variables. The core explanatory variable of this paper is the interactive term “OFDI_t”, which passes the 1% significance level test regardless of whether the control variable is added or not. The coefficient is significantly positive, indicating that foreign direct investment has a significant positive impact on the productivity of enterprises.

Table 2 Regression result

VARIABLES	tfp_lp	tfp_lp	tfp_lp	tfp_lp
OFDI_t	0.292***	0.0622***	0.292***	0.131***
	(0.0219)	(0.0183)	(0.0226)	(0.0207)
roa		2.995***		1.814***
		(0.459)		(0.461)
cr		-1.252***		-0.472
		(0.335)		(0.371)
lsub		0.0357***		0.0209***
		(0.00600)		(0.00743)
size		0.451***		0.344***
		(0.0133)		(0.0303)
age		-0.00483***		0.00231
		(0.00124)		(0.00295)
lwage		0.477***		0.334***
		(0.0204)		(0.0317)
lklratio		0.109***		-0.00194
		(0.0103)		(0.0226)
Constant	3.299***	1.049***	3.332***	1.916***
	(0.0174)	(0.0718)	(0.00467)	(0.158)
fixed effect	N	N	Y	Y

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

In terms of control variables, the rate of return on assets (roa) and the size of the firm (size) are positive at the 1% significance level both in the random effect model and the fixed effect model. This shows that the scale effect of expanding the scale of the enterprise makes the production cost decrease. Subsidy (lsub) and average wage (lwage) were also tested at a 1% significance level with a positive coefficient. Government subsidies have indeed achieved the desired policy effects, which can reduce the production costs of enterprises and increase the innovation of new products, promoting the productivity of enterprises. Similarly, the higher human capital quality of higher enterprises represented by higher wages is conducive to continuous research and development and innovation. The coefficient of corporate cash flow(cr) is negative, which proves that the excessive idle funds of

the enterprise is not conducive to the productivity increase. the "age" of an enterprise(age) and capital intensity (lklratio) are not in line with expectations, and may have a certain “U”-type relationship due to the impact of operation time and capital intensity. Therefore, the total effect is unknown.

3.3 Robustness test

The above samples all matched the samples according to the matching ratio of 1:1. We learned from Qun Bao et al. (2011) to match according to the ratios of 1:2, 1:3, 1:4 and 1:5. The test results are shown in Table 3. It can be seen that the cross-term coefficient is still significant and has little difference with the benchmark regression coefficient, so the estimation result of this paper is relatively stable.

Table 3 Roustness test

	1:2	1:3	1:4	1:5
VARIABLES	tfp_lp	tfp_lp	tfp_lp	tfp_lp
OFDI_t	0.133*** (0.0203)	0.127*** (0.0203)	0.121*** (0.0203)	0.118*** (0.0201)
Constant	1.891*** (0.157)	1.789*** (0.157)	1.750*** (0.154)	1.725*** (0.147)
Control Variables	Y	Y	Y	Y
Individual	Y	Y	Y	Y

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

4. Conclusions and policy recommendations

With the acceleration of China’s “going-out” policy, the amount of foreign direct investment is increasing. At the same time, China’s international status is rising. Productivity is an important manifestation of improving the international competitiveness of enterprises. Under this background, this paper uses the Industrial Enterprise Database from 2000 to 2007, using PSM+DID method to explore the impact of foreign direct investment on the productivity of industrial enterprises on the basis of overcoming endogeneity. Our study found that the interaction term is significantly positive at the 1% significance level. It is to say that foreign direct investment can significantly improve the productivity of the enterprise, compared to the enterprise without foreign direct investment. The research in this paper proposes that the productivity of manufacturing enterprises will leap to a certain extent by promoting the foreign direct investment of enterprises, and it can provide feasible solutions and theoretical support for realizing the strategic concept of “ Chinese manufacturing 2025”. Therefore, accelerating the construction of a new open economic system, promoting the efficient allocation of resources globally, increasing the foreign direct investment of enterprises, and further promoting the "going-out" policy of Chinese enterprises to finally achieve the smooth transition of China's economic transformation.

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