

The Impact of Privatization on TFP: a Quasi-Experiment in China

Xiaohua Wang

China Economics and Management Academy at Central University of Finance and Economics

E-mail: fridman_wxh@163.com

Zhi Luo *

*Economic Development Research Center of Wuhan University
Economics and Management School at Wuhan University*

E-mail: luozhi@whu.edu.cn

Tianyi Wang

School of Banking and Finance at University of International Business and Economics

E-mail: tianyiwang@uibe.edu.cn

and

Zhuo Huang

National School of Development at Peking University

E-mail: zhuohuang@nsd.pku.edu.cn

Using the data of SOEs and Non-SOEs in industrial sector of China from 1998 to 2007, we investigate the impact of privatization on TFP. We construct a difference in difference model and use propensity score method to avoid the selection bias. We use the type of enterprises registration to identify the SOEs and define the privatization. The regress results show, privatization of SOEs can improve the efficiency of enterprises significantly. Some characteristics of firms will affect the effect of privatization. Our results are robust even if we use another classification criterion of types of firms.

Key Words: Privatization; TFP; SOE.

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1. INTRODUCTION

The total factor productivity (TFP) is an important index for measuring the efficiency of firms. Many researchers have studied the impact of trade (e.g., Biesebroeck, 2005; Eiichi, 2007; Kasahara and Rodrigue, 2008; Nataraj, 2011), R&D (Hall and Mairesseb, 1995), foreign direct investment (Benfratello and Sembenelli, 2006; Fernandes and Paunov, 2012), entry or exit (Aw et al., 2001; Brandt et al., 2012) and other factors on TFP. In this paper, we try to investigate the relationship between the ownership and TFP. In the early 1990s, Groves et al., (1994), Jefferson and Rawski (1994) have already found that there was obvious difference in the productivity efficiency in SOEs and Non-SOEs. We calculate TFP in firm level using Annual Surveys of Industrial Firm conducted by National Bureau of Statistics of China. The result indicates that TFP (log) in SOEs is lowest in all kinds of enterprises too. In 1998-2007, the average of TFP in SOEs is 1.61, while the number is 2.36 in collective enterprise, 2.42 in private enterprises, 3.14 in foreign founded enterprises, and 2.97 in Hong Kong, Macao and Taiwan founded enterprises. Furthermore, this phenomenon does not only exist in China. Netter and Megginson (2001) have studied the privatization in the former Soviet Union, Eastern and Central Europe. They found that the productivity was higher in private firms than in SOEs. Derek and Mygind (2002), Pohl et al. (1997) also got the similar results in the research of Russia, Estonia, Bulgaria, Czech, Hungary, Poland, Romania, Slovakia and Slovenia. Djankov and Murrell (2002) made a detail review of the empirical researches which were discussing the efficiency in different kinds of firms. Their conclusion was that the private firms were more efficient than SOEs.

Comparing to non-SOEs, there are many reasons that can lead to low efficiency in SOEs. First, the detachment of operating rights and ownership incurs so-called agency problem in SOEs. As the managers are appointed by the government, those managers' ability was called into question and they don't have to take responsibility for the bad decision. Furthermore, the managers and workers lack a long-term and effective inspiration. Their incomes don't depend on effort very much. Second, SOEs face the soft budget constrain and non-competitive market (Chun et al., 2012). SOEs can get large amount of subsidies from the government in the forms of fiscal expenditure and bank loans. Thanks to those subsidies, some of them which actually have a great deficit and should exit the market can still stay in the market. Meanwhile, as the governments control the market access, the monopoly profit in SOEs can be maintained. Third, unlike non-SOEs, SOEs are not profit maximization, they have multi-task (Bai et al., 2000).

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In most of transition countries, SOEs function as the main social welfare providers. SOEs have to offer enough jobs and provide social security such as education, medical care and pension for the employees. The principal goal of SOEs is to provide enough products and service for the country not to make profit. As to financial performance, they can depend on kinds of subsidies and the protection by the government. All these things can cause the low effort and low efficiency in SOEs.

Then how strongly could the ownership of firms affect the productivity? In order to studying this effect, most of the papers mentioned above regress the productivity on a dummy variable presenting the firm's ownership type or the share of state owned capital presenting the degree of control. Distinguished from those researches, we try to use privatization of SOEs in China as a quasi-experiment and a difference in difference model to measure the impact.

Privatization of SOEs is a part of the reform of state owned enterprises in China (Chow, 2004). From the 1980s, reform of state owned enterprises has been viewed as one of the most important means to release the energy of economic growth and improve the efficiency. Before the mid-1990s, the main objective of reform is to establish an incentive structure within SOEs by engaging the enterprise autonomy, building up the contractual management responsibility system and improving the modern enterprise system. Those reforms didn't change the ownership structure of SOEs and achieved little. From early 1995, Chinese government proposes a new strategy named "retain the large, release the small". The government allowed part of SOEs converting into non-SOEs, via various forms restructuring including reorganization, mergers and takeovers, leasing and management contracts, conversion to shareholding companies, or even outright closures. On the other hand, government retained the very large SOEs or those in the industries considered to be of national security and strategic importance. Using the Annual Surveys of Industrial Firms conducted by the National Bureau of Statistics of China from 1998 to 2007, we can found that, in Table 1, the number of SOEs in China decreased from 60825 to 14462 in 1998 to 2007, the proportion of SOEs in the sample dropped from 37% to 4%. Not all the disappeared SOEs have exited the market. Some of them still remained in the market, but their ownership has changed as they have been transformed into non-SOEs. In the same time, we observe that, the average of TFP (log) of all the enterprises with revenue from principal business over 5 million yuan was increasing every year, from 2.05 in 1998 to 3.46 in 2007. There may be several reasons for the growth of average of TFP. First is the growth of TFP in enterprises. The second one is the exit of low efficient enterprises and the entry of high efficient firms. Third, as we have mentioned above, TFP in non-SOEs is much higher than in SOEs. The privatization of SOEs may also be one of the reasons. Our

paper tries to use those samples of reformed SOEs to evaluate the effect of privatization policy on efficiency.

TABLE 1.

Average of TFP of the sample and the evolution of SOEs in China from 1998 to 2007

	TFP	number of SOEs	proportion of SOEs in the sample	Proportion of value added of SOEs in the sample
1998	2.05	60825	0.37	0.49
1999	2.17	55885	0.34	0.48
2000	2.24	48042	0.29	0.44
2001	2.47	40468	0.24	0.40
2002	2.62	35006	0.19	0.34
2003	2.81	28500	0.15	0.30
2004	2.91	28262	0.10	0.26
2005	3.08	21445	0.08	0.26
2006	3.28	19057	0.06	0.24
2007	3.46	14462	0.04	0.23

Privatization of SOEs means a SOE transforms into a non-SOE. Non-SOEs include the collective enterprises, private enterprises, foreign founded enterprises and Hong Kong, Macao and Taiwan founded enterprises. According to this definition and using the type of registration as the classification criterion, there are 11897 times of privatization. Among those times of privatization, some SOEs converted between SOEs and non-SOEs for more than once. The number of SOEs whose ownership has been changed once and only once is 7435. In the quasi-experiment, we use the SOEs whose ownership have been changed once and only once as the treatment group, and use the SOEs whose ownership have never been changed as the control group. Then we use the difference in difference model to evaluate the effect of privatization of SOEs on productivity. In order to deal with the endogenous problem induced by selection bias, we match the reformed SOEs in treatment group and non-reformed SOEs in control group using the propensity score matching method. The results show that the privatization of SOEs can obviously improve the efficiency in firm level. We also analyze the impact of heterogeneity of firms on the effect of privatization. In order to check the robust of those results, we use equity structure to define privatization again. That is, if the share of state owned capital in a firm is highest, we treated it as SOEs, otherwise the non-SOEs. We also use the propensity score matching method to match the data and difference in difference model to do the robust check. The results are very similar to the former one. And for the sake of estimating the long effect of privatization, we add the lagged item of reform in the baseline regress. We found that

the privatization increase the productivity of firms not only in the current period but also in the next period.

The structure of the paper is as follows. In Section 2, we describe the data and the regress functions. Baseline regress results is given in Section 3. In section 4 we use the propensity score matching method to match the treatment group and control group and then repeat the regress. Section 5 is the robust check. Section 6 is the dynamic effect of privatization. Section 7 is the mechanism. Section 7 is the conclusions.

2. DATA AND MODEL

2.1. Data

The sample we use in this paper is Annual Surveys of Industrial Firms conducted by the National Bureau of Statistics of China from 1998 to 2007. The surveys cover all industrial firms that are either state-owned, or are non-state firms with revenue from principal business above 5 million RMB (“above-scale” firms). Industry includes mining, manufacturing and public utilities. Using the method mentioned in Brandt et al.(2012), we clean up the data and link firms over times. And in order to make sure the data is accurate and valid, we screen the sample and delete the firms if: (1) the number of labor is less than 8; (2) the total liability is less than current liability; (3) the total assets is less than current liability; (4) the total liability is less than zero; (5) the stock of capital is less than zero; (6) the administration cost is less than zero; (7) the inventory is less than zero.

2.2. The type of ownership

For the sake of defining privatization of SOEs, we need to distinguish SOEs from non-SOEs, and then identify the privatization by the transformation of ownership from state owned to non-state owned. In China, the official classification criterion is according to the Regulation of the People’s Republic of China on the Management of Registration of Legal Enterprises. Each firm has to report its type of registration to the government when it registers and accepts annual inspection. In china, the government may continue to control a company even if it has only minority equity share, as the firm is registered as an SOE. For this sake, we use the type of registration as the main method to identify the type of ownership. Referring to the regulation, we define an enterprise as a state owned of enterprise if the type of enterprise registration is one of the following three types : (1) state-owned enterprises; (2) wholly state-owned enterprises ; (3) state-owned joint-operation enterprises. In addition, if an enterprise registered as one of the following five types: (1) state-owned and collective-owned joint-operation enterprises; (2) other joint-operation enterprises; (3) other limited liability company; (4) joint-equity cooperative enterprises ; (5) incorporated

company, and its majority share of capital is held by state, we defined it as SOEs too. We treat all the other enterprises as non-SOEs. After definition of SOEs, we can tell whether a SOE has been privatized. In order to use the difference in difference method to evaluate the policy of privatization, we have to find out the treatment group and control group. We use the reformed SOEs as the treatment group. As some of them have converted between SOEs and non-SOEs for several times, we delete such samples. So the treatment group includes the enterprises which used to be a state owned of enterprise and then converted into a non-SOE, and the transformation of ownership only happened for once. We choose the SOEs whose ownership has never been changed as the control group. There are 2224891 samples in Annual Surveys of Industrial Firms conducted by National Bureau of Statistics of China from 1998 to 2007. After filtering the sample using the method mentioned above, the treatment group and control group have 309029 samples.

2.3. Measurement of TFP

TFP is the dependent variable in our estimation. We use the method provided by Olley and Pakes (1996) to calculate it. It's a method for robust estimation of the production function allowing for endogeneity of some of the inputs, the exit of firms and unobserved permanent differences across firms. In this procedure, we need to estimate the coefficient of capital and labor. In theory, the constraint conditions are different in each firm and the technologies are not the same. It's very hard to use a uniform production function to describe all the firms' behavior. In order to reflect the technology as authentically as possible, we assume that the production functions of firms in the same industry are similar. Based on two-digit industry code, we calculate the elasticity of capital and labor in industrial level, and we use those coefficients to get the TFP in firm level. In particular, as the production functions of oil industries, mining industries, production of gas, water and power are very complicated and can't be described by C-D function, we don't calculate the TFP in those industries. So we have TFP of firm level in 29 industries.

2.4. The regress model

As the privatization of SOEs didn't happen in the same year, we construct a general difference in difference model as follow:

$$\ln(TFP_{i,t}) = \alpha + \beta \cdot T_{i,t} + \lambda_i + \varphi_t + \gamma Z_{i,t} + \varepsilon_{i,t} \quad (1)$$

Where dummy variable $T_{i,t}$ indicates whether the firm i in year t is in pre- or pro- privatization period. $T_{i,t}$ is 1 from year t to 2007 if firm i was privatized in year t , otherwise 0. λ_i is the firm fixed effect, φ_t is the year fixed effect. $Z_{i,t}$ is a series of control variables, which includes the

output (log value) of the firm (Output), the proportion of current assets in the total assets (Curasset), the proportion of total liability in total assets (Liability), the profit ratio of production (Profitability), the capital labor ratio (Capdens). $Z_{i,t}$ is used to control for the characters of the firms such as the scale of the firm, the asset structural, the debt situation, the profit and capital density. In order to avoid the two way causal relationship between the dependent variable $TFP_{i,t}$ and control variable $Z_{i,t}$, we use $Z_{i,t-1}$ as control variable in the regress. $\varepsilon_{i,t}$ is the error term. β is the key coefficient in the regress, $\beta > 0$ implies the privatization of SOEs have positive effect on TFP, otherwise the effect of privatization is negative. Table 2 gives the summary statistics of the main variables on the data. It's obvious that, TFP in those firms which have already been privatized improved a lot, and is much higher than those SOEs whose ownership have never been changed.

TABLE 2.

Sample Statistics					
Variable	Obs	Mean	Std. Dev.	Min	Max
TFP	285509	1.74	2.08	-36.36	13.35
TFP of SOEs (non privatization)	231242	1.63	2.18	-36.36	13.35
TFP of SOEs (before privatization)	26890	1.98	1.45	-32.58	10.25
TFP of SOEs (after privatization)	27377	2.47	1.38	-9.21	9.26
Output	309029	138953.9	1357331	0	1.80E+08
Curasset	302318	0.442	0.39	-1.04	136.33
Liability	302318	0.659	0.34	0	61.74
Profitability	295730	-0.32	48.77	-18000	12432
Capdens	308853	224.67	6142.52	0	2842382

As the heterogeneity of firms may affect the effect of privatization of SOEs, we add the interaction of characters of firms with the privatization into the function (1):

$$\ln(TFP_{i,t}) = \alpha + \beta \cdot T_{i,t} + \eta \cdot T_{i,t} \cdot Z_{i,t} + \lambda_i + \varphi_t + \gamma Z_{i,t} + \varepsilon_{i,t} \quad (2)$$

3. THE BASELINE RESULTS

We regress the two models using OLS with the treatment group and control group. The Table 3 gives the main results. The column (1) reports the regress result of the function (1), the columns (2) to (6) are the results of the second function. For all of those regressions, we have controlled the firm fixed effect and year fixed effect. As shown in column (1), the productivity of SOEs will increase 0.212 after the reform, while the average

TABLE 3.
The effect of privatization of SOEs on TFP

	(1)	(2)	(3)	(4)	(5)	(6)
	TFP	TFP	TFP	TFP	TFP	TFP
T	0.212*** (0.014)	0.791*** (0.101)	0.209*** (0.014)	0.189*** (0.023)	0.183*** (0.030)	0.154*** (0.013)
T*output		-0.056*** (0.010)				
T*capends			0.000 (0.000)			
T*curasset				0.048 (0.037)		
T*liability					0.042 (0.040)	
T*profitability						0.118 (0.087)
L.output	0.395*** (0.008)	0.402*** (0.008)	0.395*** (0.008)	0.395*** (0.008)	0.395*** (0.008)	0.282*** (0.006)
L.curasset	0.023 (0.016)	0.024 (0.016)	0.023 (0.016)	0.018 (0.017)	0.023 (0.016)	0.035*** (0.012)
L.liability	-0.112*** (0.020)	-0.115*** (0.020)	-0.112*** (0.020)	-0.113*** (0.020)	-0.120*** (0.021)	-0.086*** (0.016)
L.profitability	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000* (0.000)
L.capends	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	0.000 (0.000)
_cons	-1.724*** (0.077)	-1.792*** (0.079)	-1.724*** (0.077)	-1.722*** (0.077)	-1.720*** (0.077)	-0.720*** (0.060)
Year fixed effect	Y	Y	Y	Y	Y	Y
Firm fixed effect	Y	Y	Y	Y	Y	Y
N	201418	201418	201418	201418	201418	198673
adj. R^2	0.099	0.100	0.099	0.099	0.099	0.116

Notes: statistical significance is denoted by ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.10$.

TFP is 1.63 in the unreformed firms shown in Table 2. That is, the effect of privatization of SOEs on productivity is very significant. In columns (2) to (6), we try to find out whether the scale of firms, the capital density, the asset structural, the liability ratio and profitability would affect the effect of privatization. After adding those interactions, TFP increases significantly after the reform as well, but the effect is only correlated with the scale of the firm. The larger the firm, the effect of privatization on TFP is smaller. And if the scale of firm is larger than a certain value, the TFP even will

decrease after privatization. The reason is, as the company grows larger, the administration costs will increase and the flexibility will decrease. It is much more difficult to reform a bigger company than a smaller one. In the meantime, the capital density, the current asset structural, the liability ratio and profitability have nothing to do with the effect of privatization.

4. ENDOGENEITY

As the decision of privatization may be not totally exogenous or random, some factors may affect the possibility of privatization and the productivity of the firm simultaneously. For this sake, there could be endogeneity induced by the selection bias in the baseline regress. In order to solve the problem, we use the propensity score matching method. With the PSM method, we use some characters of SOEs as the observed variables to predict the probability of privatization. Then we match pairs from the treatment group and control group using the propensity score. After matching the pairs, the new treated group and control group are similar in many dimensions. The main difference between the two groups is that the SOEs in the treatment group have been privatized while the SOEs in the control group have not.

4.1. Propensity score matching

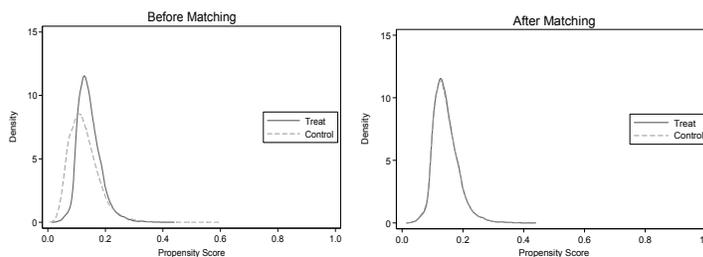
We use the rule of “nearest neighbor” provided by Rosenbaum and Rubin (1983) to do the matching. First, to estimate the propensity scores we simply have to estimate a logistic regress with the privatization indicator as the dependent and a vector of covariates to be balanced as the independent variables. Then we obtain the propensity score p_i in treatment group and p_j in control group as the predicted probabilities. After that, we get the distance indicator $C(i) = \min \|p_i - p_j\|$ and the samples in the control group with the value of p_j which is closest to p_i will be selected as the matched pair. The vector of covariates we choose include the output (log value), growth rate of sale, ratio of total liability to operation revenue, age of the firm and the square of age. We use those variables to control the scale, the growth potential, the ability to pay down the debt of firms and the age of the firm. Table 4 gives the balancing test of the matching, and it implies the listed variables are balance between the control group and treatment group. Figure 1 show the Kernel density distributions before and after the matching. It’s obvious that, after matching, the treatment group and control group are much closer to each other than before. Therefore, we can conclude that the matched control group is efficient.

4.2. Regress after matching

TABLE 4.
Balancing test after matching

	Treated mean	Control mean	P	t
Output (Log)	10.374	10.377	0.819	-0.23
Growth of sales	-0.527	-0.293	0.169	-1.37
Ratio of liability to operation revenue	69.974	96.436	0.161	-1.40
Age	27.272	27.504	0.246	-1.16
Age ²	1184.2	1369.6	0.446	-0.76

FIG. 1. The kernel density distribution before and after propensity score matching



After getting the new treatment group and control group with propensity score matching method, we repeat the regress above. Table 5 gives the main results. The column (1) is the regress result of the function (1). The result shows that, the privatization can still improve the productivity of firms significantly. But the baseline regress indeed over-estimates the effect of privatization. After matching, the effect of privatization of SOEs on TFP falls from 0.212 to 0.089. In the difference in difference estimation, the key assumption is that the time trends in the absence of the intervention are the same in treatment group and control group. Before matching, we can't promise the assumption is satisfied. After marching the sample, we get the most similar pairs and more accurate results.

The regress results of function (2) using the matched samples are summarized in columns (2) to (6) of Table 5. As shown in Table 5, the interaction of the scale of firms and privatization is negative and significant. This implies that the effect of privation is less in larger firms, the same as in Table 4. As in the baseline regress, the interaction of capital density and privatization is not significant. It means the privatization of SOEs can increase the productivity in the same degree both in capital intensive industries and labor intensive industries. And the current assets ratio and liability level don't affect the effect of privatization. Unlike the baseline regress, we find that the when profitability is higher, the effect of privatization is more

remarkable. The reason may be that, firms with higher profitability have enough profit to support the adjustment in the reform.

TABLE 5.

Results after matching

	(1)	(2)	(3)	(4)	(5)	(6)
	TFP	TFP	TFP	TFP	TFP	TFP
T	0.089*** (0.023)	0.512*** (0.150)	0.094*** (0.023)	0.073** (0.029)	0.071 (0.046)	0.083*** (0.023)
T*output		-0.041*** (0.014)				
T*capends			-0.000 (0.000)			
T*curasset				0.033 (0.038)		
T*liability					0.026 (0.062)	
T*profitability						0.322*** (0.079)
L.output	0.249*** (0.013)	0.278*** (0.016)	0.248*** (0.013)	0.248*** (0.013)	0.249*** (0.013)	0.243*** (0.013)
L.curasset	0.031 (0.021)	0.031 (0.021)	0.031 (0.021)	0.016 (0.019)	0.031 (0.021)	0.034 (0.021)
L.liability	-0.046 (0.032)	-0.049 (0.032)	-0.046 (0.032)	-0.047 (0.032)	-0.065 (0.055)	-0.050 (0.032)
L.profitability	0.012 (0.010)	0.012 (0.010)	0.012 (0.010)	0.012 (0.010)	0.012 (0.010)	0.011 (0.010)
L.capends	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
_cons	-0.389*** (0.133)	-0.688*** (0.162)	-0.393*** (0.133)	-0.381*** (0.134)	-0.377*** (0.135)	-0.336** (0.133)
Year fixed effect	Y	Y	Y	Y	Y	Y
Firm fixed effect	Y	Y	Y	Y	Y	Y
N	46351	46351	46351	46351	46351	46351
adj. R^2	0.150	0.150	0.150	0.150	0.150	0.162

Notes: statistical significance is denoted by ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.10$.

5. ROBUST TEST

In order to check the robust of the results, we use another classification criterion to define the SOEs and Non-SOEs. The SOEs are identified by the source of its investment capital. There are five sources of the capital,

that is, state owned capital, private capital, corporate capital, foreign capital, Hong Kong, Macao and Taiwan capital. If the ratio of state owned capital to the paid-up capital is highest in a firm, we identify the firm as a SOE. If the share of corporate capital is highest, we need to tell the ownership of the firm with the information of the type of registration. When the type of registration of a firm is state-owned enterprises, wholly state-owned enterprises or state-owned joint-operation enterprises and the share of corporate capital in the firm is highest, we defined the firm as SOEs too. All the other firms are treated as Non-SOEs. We use the same method mentioned in section 3 and section 4 to find the treatment group and control group and use the propensity score method to match those data. After that, we repeat the regress above using the newly matched data.

The regress result of function (1) and function (2) using the new data are summarized in Table 6. In column (1), we find that the privatization of SOEs have significant positive effect on the TFP with controlling the covariates. The transformation of ownership will improve the TFP (log value) 0.1 unit. The regress results of function (2) are presented in columns 2 to 6. As the results using the previous data, the capital density, the ratio of current asset in total asset will not affect the effect of privatization when using the new data. The effect of privatization on TFP is weaker when the scale of firm is larger. And the higher the profitability, the more successful of the reform. Comparing to the results using the previous data in Table 5, in the high liability level firms, the improvement of TFP after privatization is bigger. One potential explanation is, this type of enterprises have greater potential as the high liability level is a signal that the old system was such a low efficient one. Although there are some differences between the results using the type of registration and the source of capital as the classification criterion to identify the SOEs, all the results show that the privatization of SOEs can improve the TFP significantly.

6. THE DYNAMIC EFFECT

In this section, we try to investigate the duration of the effect of privatization of SOEs on productivity. We add the dynamic effect in the basic model. The dynamic difference in difference model is as follow:

$$\ln(TFP_{i,t}) = \alpha + \sum_{\rho=0} \beta_{\rho} \cdot TT_{i,t-\rho} + \lambda_i + \varphi_t + \gamma Z_{i,t} + \varepsilon_{i,t} \quad (3)$$

Where $TT_{i,t+\rho}$ is a dummy, if the firm i is privatized in year t , then $TT_{i,t-\rho}$ is 1 in the year $t + \rho$, otherwise 0. β_{ρ} is the effect of privatization of SOEs on productivity after the reform has been taken for ρ years. λ_i , φ_t and $Z_{i,t}$ are the same to function (1).

TABLE 6.

Robust check

	(1)	(2)	(3)	(4)	(5)	(6)
	TFP	TFP	TFP	TFP	TFP	TFP
T	0.094*** (0.021)	0.570*** (0.140)	0.094*** (0.021)	0.092** (0.037)	0.027 (0.043)	0.080*** (0.021)
T*output		-0.046*** (0.013)				
T*capends			-0.000 (0.000)			
T*curasset				0.002 (0.062)		
T*liability					0.100* (0.057)	
T*profitability						0.606*** (0.098)
L.output	0.241*** (0.012)	0.262*** (0.014)	0.241*** (0.012)	0.241*** (0.012)	0.242*** (0.012)	0.235*** (0.012)
L.curasset	0.035 (0.027)	0.037 (0.027)	0.035 (0.027)	0.033 (0.059)	0.035 (0.027)	0.039 (0.027)
L.liability	-0.050 (0.037)	-0.052 (0.037)	-0.050 (0.037)	-0.050 (0.037)	-0.125** (0.050)	-0.056* (0.033)
L.profitability	-0.009 (0.009)	-0.009 (0.009)	-0.009 (0.009)	-0.009 (0.009)	-0.010 (0.009)	-0.009 (0.009)
L.capends	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)
_cons	-0.357*** (0.123)	-0.688*** (0.147)	-0.357*** (0.123)	-0.356*** (0.125)	-0.311** (0.125)	-0.294** (0.121)
Year fixed effect	Y	Y	Y	Y	Y	Y
Firm fixed effect	Y	Y	Y	Y	Y	Y
<i>N</i>	56453	56453	56453	56453	56453	56453
adj. <i>R</i> ²	0.142	0.143	0.142	0.142	0.142	0.159

Notes: statistical significance is denoted by ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.10$.

Table 7 reports the dynamic effect of privatization. In column (1), we use all the samples to regress. In column (2), we use the matched samples selected by the propensity score matching method mentioned above. And the classification criterion to define the SOEs and Non-SOEs is the type of enterprise registration. In column (3), we use the source of its investment capital as classification criterion to define the SOEs and the same matched samples in Table 6. The result in column (1) shows, the change of ownership will not only improve TFP of SOEs in the current period, but also raise

it in the future, and the effect will not weaken. In column (2), the regress result of dynamic function using the matched sample is different from the baseline regress. Although the privatization has a persistent effect on the productivity, it last for only two periods. This is because it takes time, only one or two years, for enterprises to complete the reform. During these years, the management mode and organization structure have been improved and the productivity has increased as a result. After the reform is completed, the benefit of the privatization will vanish. Column (3) provides the robust test of column (2) using the matched data. The result is very similar to the result in column (2), the privatization of SOEs can raise the TFP in the current period and the next period.

TABLE 7.

The dynamic effect of privatization			
	(1)	(2)	(3)
TT($\rho = 0$)	0.18*** (0.02)	0.05** (0.03)	0.08*** (0.02)
TT($\rho = 1$)	0.23*** (0.02)	0.05** (0.02)	0.07*** (0.02)
TT($\rho = 2$)	0.21*** (0.02)	0.02 (0.03)	0.04 (0.02)
TT($\rho = 3$)	0.20*** (0.02)	0.002 (0.030)	0.03 (0.03)
TT($\rho = 4$)	0.22*** (0.02)	-0.02 (0.03)	0.01 (0.03)
TT($\rho = 5$)	0.20*** (0.01)	-0.05 (0.04)	-0.04 (0.03)
TT($\rho = 6$)	0.24*** (0.03)	-0.03 (0.04)	-0.05 (0.04)
TT($\rho = 7$)	0.27*** (0.04)	-0.01 (0.05)	-0.03 (0.04)
TT($\rho = 8$)	0.24* (0.06)	0.01 (0.07)	-0.03 (0.06)
Control variables	Y	Y	Y
Year fixed effect	Y	Y	Y
Firm fixed effect	Y	Y	Y
R	0.23	0.16	0.15
N	187460	40486	49975

Notes: statistical significance is denoted by ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.10$.

7. MECHANISM

As we have proved above, the privatization of SOEs has significant positive effect on the TFP. Then, what are the mechanisms? As there won't be big technology progress in the short term, the reallocation of factor inputs and management improvement may be the important reasons. Thus, in regression function (3), we try to test the effect of privatization of SOEs on factor inputs and administrative cost:

$$Y_{i,t} = \alpha + \beta \cdot T_{i,t} + \lambda_i + \varphi_t + \gamma Z_{i,t} + \varepsilon_{i,t} \quad (4)$$

Where $D_{i,t}$, $T_{i,t}$, λ_i , φ_t and $Z_{i,t}$ are the same to function 1. $Y_{i,t}$ are the variables we are interested, including the stock of capital (log value), the labor input (log value), the ratio of administration cost to output (log value) and the ratio of financial expense to output (log value). To ensure comparability between the reformed and unreformed firms, we choose the matched pairs from the treatment group and control group using the propensity score as the samples, and Table 7 presents the results.

Column (1) and (2) corresponds to the results when the dependent variables are stock of capital and labor input. The results show that, the inputs have decreased after the privatization of SOEs, either capital or labor force. This implies, the firms don't increase the investment in fixed assets and lay off the employees. Although the factor inputs have been reduced, the productivity increases. One possible reason is, there are a lot of idled capital and redundant labor in SOEs. The firms can liquidate unused assets or redundant labor through the reform and the TFP is improved as a result. In China, SOEs not only produce goods for the society, but also undertake a lot of social responsibilities such as absorbing surplus labor, providing social protection, maintaining social stability and so on (Wang et al., 2009). The extra burdens on the SOEs lead to low efficiency. The privatization of SOEs can help firms to get rid of those burdens and aim at maximizing their profits. Column (3) and (4) report the results when the dependent variables are administration cost and the financial expense. Both the administration cost and the financial expense have decreased after reform as well. This implies, the management level has been raised through the privatization of SOEs.

In Table 8, we conduct robust check of Table 7. In Table 8, we use the source of the investment capital as the classification criterion to define the SOEs and Non-SOEs as in Table 6. The results confirm that the privatization of SOEs has negative impact on the stock of capital, the labor input, the administration cost and the financial expense. That is, the TFP in reformed SOEs will increase by liquidating the unused assets, laying off the redundant employees and improving the management efficiency.

TABLE 8.

	Mechanism			
	(1)	(2)	(4)	(5)
T	-0.156*** (0.018)	-0.114*** (0.014)	-0.145*** (0.023)	-0.261*** (0.044)
L.output	0.210*** (0.009)	0.218*** (0.008)	-0.151*** (0.015)	-0.092*** (0.022)
L.curasset	-0.239** (0.094)	-0.020* (0.010)	0.001 (0.023)	-0.282*** (0.064)
L.liability	0.051 (0.024)	-0.017 (0.017)	0.012 (0.035)	0.441*** (0.068)
L.profitability	0.001 (0.013)	0.011 (0.013)	-0.008 (0.008)	-0.023* (0.013)
L.capends	0.0001*** (0.0000)	-0.000** (0.000)	0.000 (0.000)	0.000** (0.000)
_cons	8.144*** (0.100)	3.692*** (0.081)	0.326** (0.149)	-1.703*** (0.232)
Year fixed effect	Y	Y	Y	Y
Firm fixed effect	Y	Y	Y	Y
N	46334	46351	45534	38121
adj. R^2	0.079	0.156	0.033	0.060

Notes: statistical significance is denoted by ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.10$.

8. CONCLUSIONS

Using the Annual Surveys of Industrial Firms conducted by National Bureau of Statistics of China, we construct a quasi-experiment and a difference in difference model to evaluate the effect of privatization on TFP in firm level. The treatment group includes SOEs whose ownership have been transferred for once and only once, while the SOEs whose ownership have never been transferred are included in the control group. In order to deal with the endogenous problem caused by selection bias, we use the propensity score method to match the treatment group and control group. The results show that, the privatization of SOEs can improve the TFP significantly, and this effect can last for two periods. Those results are very robust even when we change the method to identify SOEs. In addition, some characters of enterprises have impact on the effect of privatization of SOEs. The scale of firm is larger, TFP increase less after privatization. And the reform would be more successful if the profitability is high in the firm. We also find out that liquidating the unused assets, laying off the redundant employees and improving the management efficiency may be the mechanism to enhance the efficiency.

TABLE 9.

	Robust check of mechanism			
	(1)	(2)	(4)	(5)
T	-0.152*** (0.016)	-0.098*** (0.012)	-0.116*** (0.020)	-0.204*** (0.039)
L.output	0.208*** (0.009)	0.213*** (0.008)	-0.145*** (0.012)	-0.058*** (0.020)
L.curasset	-0.350*** (0.033)	-0.030** (0.015)	0.078*** (0.030)	-0.213*** (0.057)
L.liability	0.037 (0.035)	-0.015 (0.015)	0.010 (0.033)	0.482*** (0.064)
L.profitability	-0.005 (0.006)	-0.008 (0.010)	0.010 (0.009)	-0.027* (0.016)
L.capends	-4.73e-08 (3.32e-08)	-0.000*** (0.000)	0.000*** (0.000)	0.000* (0.000)
_cons	8.125*** (0.097)	3.616*** (0.082)	0.193 (0.126)	-2.086*** (0.211)
Year fixed effect	Y	Y	Y	Y
Firm fixed effect	Y	Y	Y	Y
<i>N</i>	56428	56453	55546	45882
adj. <i>R</i> ²	0.075	0.130	0.029	0.060

Notes: statistical significance is denoted by ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.10$.

The Chinese data provides an interesting case to investigate the impact of ownership on the productivity. Using the quasi-experiment and DID method, we found that just the transfer of ownership from state owned to non-state owned can raise the efficiency of production of a firm very significantly while controlling other factors. That is, the SOEs are not as efficient as Non-SOEs even if they are very similar in other aspects. The results also show, although the reform of SOEs in China have obtained some achievement as the TFP in firms has raised after privatization, there could be further to go. As in the Table 1, the proportion of SOEs in the survey has decrease to 4%, but the proportion of output value of SOEs was over 23% in the survey in 2007. If some of them could be privatized or the management of operation in SOEs can be improved, the productivity would increase more in the whole country.

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