

Research on the Influence of Mixed Ownership Reform on Total Factor Productivity of China Central Enterprises

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Abstract—This paper takes 397 listed A-share central enterprises from 2010 to 2020 as a sample and uses the model of Difference-in-Differences with Multiple Time Periods to analyze the impact of mixed ownership reform on total factor productivity of central enterprises. The main findings are as follows: (1) The mixed ownership reform can effectively improve the total factor productivity of central enterprises. (2) The heterogeneity test shows that the mixed ownership reform of SRDI enterprises plays a limited role in promoting the improvement of total factor productivity of enterprises. (3) After using one-lagged explanatory variable to test, it is found that the coefficient of one-lagged Mor is significantly greater, which confirms that the effect of mixed ownership reform has the hysteresis and needs a certain time to reflect.

Keywords-Mixed Ownership Reform; Total Factor Productivity; China Central Enterprises

1. Introduction

As the national team, main force and pacesetter of the national economy, state-owned enterprises have made great contributions to the development of China's economy and society. In order to further improve the efficiency of state-owned enterprises, the Third Plenary Session of the 18th CPC Central Committee proposed that actively developing the mixed ownership economy is an inevitable requirement for deepening the reform of state-owned enterprises and improving the basic economic system. In 2014, the SASAC selected Sinopec, China National Building Material Company and Sinopharm to take the lead in carrying out the pilot project of mixed ownership reform. In September 2015, the State Council issued the Opinions on the Development of Mixed Ownership Economy in State owned Enterprises, which proposed that the development of mixed ownership economy is an important measure to deepen the reform of state-owned enterprises. It is necessary to promote the mixed ownership reform of state-owned enterprises by classification and level. In December 2016, the Central Economic Work Conference further clarified that the reform of mixed ownership is an important breakthrough in the reform of state-owned enterprises.

The reform of mixed ownership focuses on the combination of "mixing" and "reform", including not only the introduction of non-public capital and collective capital, but also the optimization of corporate governance and the transformation of operating mechanisms to promote the

high-quality development of state-owned enterprises. The reform of mixed ownership of state-owned enterprises can influence the operation and management mechanism of enterprises from many angles and aspects, such as improving equity governance, reducing insider control, reducing the policy burden of enterprises, and improving the corporate governance mechanism, especially playing a positive role in technological innovation and resource allocation efficiency. For example, Brandt et al (2013) found that the mixed ownership reform is conducive to improving the governance level of enterprises, improving the allocation efficiency of state-owned assets, and enhancing the innovation ability of enterprises^[1]. The equity structure of multiple checks and balances inhibits the behavior of large shareholders' encroachment on the interests of small shareholders and inefficient investment, reduces the self-interest behavior of large shareholders under the "decision-making of absolute controlling shareholders", urges them to make decisions on the company's operation, investment, financing and other aspects driven by "rational factors", thus improving the efficiency of enterprise technology innovation (Li et al, 2020; Aihua et al, 2021)^{[2][3]}.

In the aspect of empirical test, many scholars have studied the impact of SOE mixed ownership reform on TFP based on different samples and perspectives. For example, Liu Ye (2016), based on the database of China's industrial enterprises from 2001 to 2007, examined the impact of the mixed ownership reform of state-owned enterprises on total factor productivity, and believed that total factor productivity (TFP) had significantly improved after the reform of state-owned enterprises^[4]. Zhang (2020) found through empirical test that the mixed reform has played a positive role in the innovation input and innovation output of state-owned enterprises^[5]. However, it will have a negative impact on the total factor productivity of enterprises if the equity is too diversified or the power between heterogeneous shareholders is too balanced (Wang et al. 2021)^[6].

To sum up, many researchers have found that the mixed ownership reform of state-owned enterprises is conducive to improving their total factor productivity. However, with the convening of the Third Plenary Session of the 18th Central Committee of the Communist Party of China in 2013 and the issuance of the 2015 Opinions on the Development of Mixed Ownership Economy by State owned Enterprises, a new wave of mixed ownership reform has been formed in state-owned enterprises, especially central enterprises, since 2014. The connotation, mode and requirements of mixed ownership reform in this period have changed greatly, and only a few scholars have focused on mixed ownership reform at this stage. In particular, there is a lack of practical verification of the effect. Based on this, the main value of this paper is reflected in: (1) In terms of research objects, this paper focuses on the mixed ownership reform of state-owned enterprises and their subsidiaries during 2010-2020, especially the first to third batch of state-owned enterprise groups led by the SASAC. As the vanguard and pioneer of mixed reform, central enterprises have strong demonstration significance and research value. (2) In terms of research methods, this paper selects LP method and OP method to calculate TFP respectively, and estimates the mixed ownership reform effect based on Difference-in-Differences with Multiple Time Periods to make the estimation results more accurate.

2. Materials and Methods

2.1 Sample selection and data source

Taking 397 listed A-share central enterprises from 2010 to 2020 as a sample, the LP and OP methods were used to measure their total factor productivity. The pilot listed companies of mixed ownership reform of central enterprises were taken as the experimental group, and other enterprises were taken as the control group. Since the pilot project of mixed ownership reform includes the level of the central enterprise group and its secondary and tertiary subsidiaries, the actual controller is selected as the total sample of the SASAC and the central state-owned enterprises. The original data shall be processed with ST and * ST companies, financial companies and missing data shall be eliminated. In order to eliminate the influence of extreme values, the main continuous variables were shrunk by 1%, and finally 2166 balance panel data were obtained. The selection of hybrid enterprises is based on the pilot list published by the SASAC, the official website notification and the official website notification of the central enterprise group, and in combination with the manual comparison of the data of various parties in the WIND database, such as the hybrid concept shares, the disclosure of major restructuring issues, the company announcement, and the capital structure. Other data are mainly from the WIND financial database. The statistical analysis software used was Stata 16.0.

2.2 Model design

The model of Difference-in-Differences with Multiple Time Periods is used to analyze the impact of mixed ownership reform of central enterprises on total factor productivity. The model is as follows:

$$TFP = \alpha + \beta_0 Mor + \beta_1 Scale + \beta_2 Salary + \beta_3 Debt + \beta_4 Roic + Year + \varepsilon_{i,t}$$

The model controls effect of year to avoid the interference of macro environment related factors on the regression results.

2.3 Variable Description

2.3.1 Explained variable: Total Factor Productivity (TFP)

Total Factor Productivity, also known as Solow residual, was proposed by Robert Solo, an American economist, to measure the part of total output that cannot be explained by assets and labor factor inputs. Total factor productivity can comprehensively measure the output of the entire enterprise due to technological innovation and technical efficiency improvement. The OP method and LP method can better solve the synchronization error and selectivity error in parameter estimation. Therefore, this paper uses Olley's research for reference, uses OP method to calculate total factor productivity, and uses LP method to conduct robustness test (Olley, 1996)^[7].

2.3.2 Explanatory variable: Mixed ownership reform (Mor)

The variable of mixed ownership reform defined in this paper is 0-1 dummy variable. If an enterprise has not made mixed ownership reform during the examination period, then Mor=0; If the mixed transformation is carried out in year i, then Mor_j=1 (j>=i) or Mor_j=0 (j<i).

2.3.3 Control variable

Referring to previous literature, the control variables mainly include:

Table 1 The variables

<i>variables</i>	<i>variable symbol</i>	<i>Variable Description</i>
Explained variable	TFP	calculated by OP method
Explanatory variable	Mor	If the mixed transformation is carried out in year i , then $Mor_j=1$ ($j \geq i$) or $Mor_j=0$ ($j < i$)
Control variable	Scale	$\ln(\text{the number of contract staff})$
	Salary	$\ln(\text{total remuneration of management})$
	Debt	total liabilities/total assets
	Roic	$(\text{Net income minus tax})/\text{Total capital}$
	Year	dummy variables

3. Results & Discussion

3.1 Descriptive statistics

Descriptive statistical analysis of relevant variables is shown in the following table.

Table 2 Variable Description

<i>Variable</i>	<i>Obs</i>	<i>Mean</i>	<i>Std. Dev.</i>	<i>Min</i>	<i>Max</i>
TFP	2,166	9.840437	1.183614	6.974638	12.64647
Mor	2,166	0.0927978	0.2902159	0	1
Scale	2,166	8.559489	1.478443	4.574711	13.22277
salary	2,166	6.332446	0.6774227	3.130263	8.50593
Roic	2,166	6.12834	7.096356	-80.9718	44.8308
Debt	2,166	50.8045	20.08065	1.0269	116.535

3.2 Benchmark regression model

Table 3 shows the benchmark regression results. Model 1 is the result without control variables, and model 2 is the result with control variables. The coefficient of core explanatory variable Mor in model 1 is 0.4753, which is significantly positive at the level of 1%; Model 2 adds control variables. The results of individual and time fixed effects show that the result of core explanatory variables is 0.2188, which is also significant at the level of 1%. It can be seen that the mixed ownership reform can effectively improve the total factor productivity of enterprises.

Table 3 Benchmark regression model

<i>Variable</i>	<i>Model 1</i>	<i>Model 2</i>	<i>Model 3</i>	<i>Model 4</i>	<i>Model 5</i>	<i>Model 6</i>
Mor	0.4753** * (0.000)	0.2188*** (0.000)	0.5147*** (0.000)	0.2456*** (0.000)	0.3115** (0.046)	0.1453 (0.148)
Scale		0.3345*** (0.000)		0.2776*** (0.000)		0.6204*** (0.000)
Salary		0.3809*** (0.000)		0.3868*** (0.000)		0.3297*** (0.000)
Roic		0.0100*** (0.000)		0.0097*** (0.000)		0.0099*** (0.070)
Debt		0.0047** (0.041)		0.0057*** (0.000)		0.0009 (0.864)
Observations	2166	2166	1780	1780	384	384
R2	0.03	0.72	0.03	0.71	0.05	0.81
time fixed	YES	YES	YES	YES	YES	YES
individual fixed	YES	YES	YES	YES	YES	YES

Note: ***, ** and * are significant at the level of 1%, 5% and 10% respectively, and the data in brackets are P test values. The same below.

3.3 Heterogeneity test

According to the classification of “SRDI” (Specialized, Refined, Differential, Innovation) enterprises in the WIND database, this paper divides the samples into SRDI enterprises and non-SRDI enterprises, and studies the difference between their mixed ownership reform and total factor productivity. Model 3 and Model 4 are the results of the impact of mixed ownership reform on total factor productivity of non-SRDI enterprises. Model 3 does not include control variables, and the main explanatory variable coefficient is 0.5147, which is significant at the level of 1%. Model 4 adds control variables. At this time, the coefficient of the main explanatory variable Mor is 0.2456, which is significant at the level of 1%. It can be seen that the mixed ownership reform of non-SRDI enterprises can effectively promote the improvement of total factor productivity of enterprises. Model 5 and Model 6 are the results of the impact of mixed ownership reform on total factor productivity of SRDI enterprises. Model 5 does not include control variables, and the main explanatory variable coefficient is 0.3115, which is significant at the level of 5%; Model 6 adds control variables. At this time, the coefficient of Mor is 0.1453, which is not significant. This shows that the mixed ownership reform of SRDI enterprises plays a limited role in promoting the improvement of total factor productivity of enterprises.

The reason may be that these companies have certain advantages in R&D capability, technological content and profitability. With more business opportunities and risks, these companies do not rely on mixed ownership reform.

3.4 Robustness check

In order to test the robustness of the model, this paper uses the replacement index method to retest the model. Considering hysteresis of mixed ownership reform in the current year, the use of one-lagged Mor can better explain the long-term impact of mixed ownership reform on total factor productivity of enterprises. Model 7 and Model 8 use one-lagged Mor as the explanatory variables, Model 7 does not add control variables, and Model 8 adds control variables. From the comparison between Model 8 and Model 2, it can be seen that the coefficient of Model 8 is 0.2938, which is significant at 1% level and significantly greater than the coeffi-

cient of Model 2. It can be seen that the effect of mixed ownership reform needs a certain time to reflect. Model 9 and Model 10 are the results of the new total factor productivity measured by LP method. Use the new total factor productivity measured by the LP method to replace the explained variables. Model 9 does not add control variables, while Model 10 adds control variables.

From the test results, except for individual control variables, the regression results of core explanatory variables are basically consistent with the above, indicating that this study is robust.

Table 4 Robustness check

<i>Variable</i>	<i>Model 7</i>	<i>Model 8</i>	<i>Model 9</i>	<i>Model 10</i>
MoR	0.4458*** (0.000)	0.2938*** (0.000)	0.3523 (0.000)	0.2131*** (0.000)
Scale		0.24102*** (0.000)		0.0146 (0.769)
Salary		0.0004*** (0.000)		0.3968*** (0.000)
Roic		0.0125*** (0.000)		0.0104*** (0.000)
Debt		0.0048** (0.055)		0.0049** (0.028)
Observations	1969	1969	2166	2166
R2	0.03	0.70	0.03	0.41
Time fixed effect	YES	YES	YES	YES
individual fixed	YES	YES	YES	YES

4. Conclusions

This paper uses the model of Difference-in-Differences with Multiple Time Periods to analyze the impact of mixed ownership reform on total factor productivity of central enterprises. The main conclusions are as follows: (1) The mixed ownership reform can effectively improve the total factor productivity of central enterprises, and the results are still robust after retesting with the replacement index. (2) The heterogeneity test on whether SRDI enterprises shows that the mixed ownership reform of SRDI enterprises plays a limited role in promoting the improvement of total factor productivity of enterprises. The reason may be that these companies have certain advantages in R&D capability, technological content and profitability. Compared with large-scale central enterprises, SRDI enterprises do not rely heavily on mixed ownership. (3) The mixed ownership reform may have a certain hysteresis in improving the total factor productivity of central enterprises. After using one-lagged explanatory variable to test, it is found that the coefficient of one-lagged Mor is significantly greater than the coefficient of Mor, which confirms that the effect of mixed ownership reform needs a certain time to reflect.

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