Fixed Effect Regression Model Based on STATA Analysis to Study the Impact of R&D Expense Plus Deduction Policy on TFP

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Abstract: This paper selects the data of China's A-share listed companies from 2015 to 2021 as a sample to study the impact of R&D expenditure plus deduction on total factor productivity of enterprises. Using STATA measurement software, this paper constructs a fixed effect regression model and observes its linear regression relationship with the R&D expenditure plus deduction preference intensity as the independent variable and TFP as the dependent variable. The results show that the implementation of the R&D expenditure plus deduction policy has significantly improved the TFP level, and the policy incentive effect of non-state-owned enterprises and small-scale enterprises is more significant. Finally, based on the regression conclusion, some suggestions are put forward to improve the preferential tax policy of R&D expense deduction.

1 INTRODUCTION

In recent years, with the rapid development of computer technology, the use of computers for data analysis has been widely used. Mining valuable information from massive data to provide users with more accurate data services has achieved very significant results. STATA is a commonly used computer data analysis software. This paper uses this software technology to establish a fixed effect regression model for regression analysis, test the impact of the R&D expense plus deduction policy on TFP, analyze the data of listed companies, and provide data basis for the government to improve policies.

Most scholars believe that the R&D expense plus deduction policy has a positive impact on enterprise development. The implementation of this policy has reduced the tax expenditure of enterprises (Zhang Wenchun, 2006), enhanced the enthusiasm of enterprises for technology research and development, and can improve the R&D investment of enterprises in general (Zhou Keqing and Jingjiao, 2012). However, the heterogeneity of enterprises, including their life cycle, industry characteristics, domestic and foreign market development conditions, will affect the effect of policy (Ren Haiyun, Song Weichen, 2017). Policies can reduce enterprise operating costs and improve enterprise performance by promoting technological innovation (Hong Lianpu et al., 2019; Wang Xi and Liu Meng, 2020). The improvement of enterprise profitability guarantees investors' investment income, creates favorable conditions for enterprises to obtain external equity financing at a lower cost, and improves enterprise market value (Wang Ling et al., 2011). In terms of influencing TFP, TFP can be improved by promoting enterprises' R&D investment and improving technological innovation (Ren Cancan et al., 2021). However, the improvement effect is different due to different regions, enterprises' scale, industry competition and life cycles of enterprises (Liu Ye and Lin Chendan, 2021). In addition, tax incentives such as additional deduction of R&D expenses can also attract foreign capital, so as to improve TFP (Luosha et al., 2014). However, some scholars believe that the implementation of policies does not necessarily improve the total factor productivity of enterprises (Weinstein, 1996). Due to the existence of market failure, if the low preferential intensity is not enough to compensate for the R&D risks and externalities spillovers caused by market failure, it will have a reverse effect on the R&D investment of enterprises, and it is difficult to

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promote the improvement of TFP (Feng Haihong et al., 2015). To some extent, R&D incentive measures will induce enterprises to implement R&D manipulation, leading to a decline in the company's scientific research performance and weakening TFP (Yang Guochao et al., 2017).

2 RESEARCH HYPOTHESES

2.1 Impact of R&D Plus Deduction on TFP

Based on the theory of technological innovation, enterprises can develop new technologies and new products through technological innovation, improve production efficiency, enhance the core competitiveness of enterprises, and further reduce production costs, improve enterprise efficiency. Therefore, good technological innovation activities and achievements will bring benefits and overall improvement to enterprises, thus promoting the improvement of TFP. The R&D plus deduction policy can reduce the input cost of technological innovation, reduce the tax base, reduce the tax expenditure of enterprises, ease the financial pressure, improve the ability to resist risks, alleviate market failure, stimulate the enthusiasm of enterprises for R&D innovation, and improve TFP through technological innovation. Secondly, the R&D expense plus deduction policy is the transfer of national tax benefits, which can reduce taxable income and cash outflow. The increase of cash retention can allocate funds in other aspects, increase factor input, expand reproduction, and improve TFP. Therefore, the following assumptions are made:

H1: The R&D expense super-deduction policy can significantly increase TFP.

2.2 The Impact of the Nature of Property Rights on Policy Effects

There are differences between state-owned enterprises and non-state-owned enterprises in domestic and foreign policy environment, economic resource conditions, competition and internal governance mechanisms. State owned enterprises are heavily interfered by the government and have performance requirements for the management. Enterprise managers lack enthusiasm for reducing costs and improving production quality through technological innovation. They may give up projects with high risks and long investment periods that are conducive to the innovation and development of enterprises and instead pursue short-term goals. This greatly reduces the effect of improving TFP through policies such as R&D expense addition and deduction. For non-state-owned enterprises, the market they are facing is not constrained and supported by the government. Enterprises hope to reduce production costs, improve product quality and enhance market competitiveness through technological innovation, so as to achieve the goal of maximizing enterprise value. The policy of R&D expense addition and deduction has stimulated enterprises to carry out technological innovation activities, thus improving TFP. The following assumptions are proposed:

H2: The policy of R&D expense plus deduction has a more significant effect on the TFP improvement of non-state-owned enterprises.

2.3 The Impact if Enterprise Size on Policy Effects

The R&D strength, anti risk ability and resource acquisition ability of enterprises with different scales are different. Large scale enterprises have strong comprehensive strength, sufficient cash flow for R&D activities, strong anti risk ability, obvious advantages in resource acquisition, and low desire for external R&D incentive policies. However, small-scale enterprises are relatively short of R&D funds, lack of R&D experience, imperfect operation and management processes, and weak overall technological innovation capability. In order to enhance market competitiveness and expand enterprise scale, they are more likely to be encouraged by policies, and are willing to seize various policy opportunities to increase innovation resources, thus promoting enterprise technological progress. Therefore, the R&D expense plus deduction policy plays a more significant role in improving the overall strength of small-scale enterprises. Therefore, the following assumptions are made:

H3: The R&D expense plus deduction policy has a more significant effect on the TFP improvement of small-scale enterprises.

3 RESEARCH DESIGN

3.1 Sample Selection and Data Sources

The data of A-share listed companies from 2015 to 2021 were selected from CSMAR database, and Stata17 was used for statistical analysis. After

treatment, 3921 sample enterprises were screened, with a total of 19051 observations.

3.2 Variable Selection and Measurement

Interpreted variable: TFP. When LP method is used to estimate TFP in this paper, the production function is shown in formula (1) below.

$$\ln Y_{it}=\beta_0+\beta_k \ln K_{it}+\beta_l \ln L_{it}+\beta_m \ln M_{it}+\varepsilon_{it} \quad (1)$$

Explanatory variable: the specific calculation method for the preferential intensity of R&D expense plus deduction is:

Intensity=(R&D×Additional deduction rate×Enterprise income tax rate)/total assets at the end of the period

(2)

The selection of control variables is shown in Table (1):

Table 1: Selection of control variables.

symbol	Variable meaning	Variable definitions
Size	Enterprise size	ln (total assets).
Lev	Gearing ratio	Total liabilities / Total assets
ROE	Return on equity	Net assets / ending shareholders' equity
Cashflow	Cashflow ratio	Net cash flow from operating activities / total assets
ListAge	The listing age of the business	LN (Year of the Year -Year of Launch +1).
TobinQ	TobinQ value	TobinQ value
Mfee	Management expense rates	Administrative expenses / operating income

3.3 Empirical Model Design

With the development of computer technology and econometrics, panel data models play an increasingly important role in the research of social and economic issues. Fixed effect models are widely used in empirical tests.In order to test the impact of R&D expense plus deduction policy on TFP, establish the following fixed effect model:

$$TFP_{it}=\beta_0+\beta_1 Intensity_{it}+\alpha Controls_{it}+\eta_t+\mu_i+\delta_{it} \quad (3)$$

4 ANALYSIS OF EMPIRICAL RESULTS

4.1 Benchmark Regression Analysis

In order to study the influence of R&D Expense Plus Deduction Policy on TFP, by using the STATA software, the experimental data are analyzed by fixed effect model analysis. when other variables are controlled. The results are as follows. Model (1) does not control individual fixed effect and time fixed effect, and model (2) is added. The regression coefficients of Intensity are 17.29 and 12.12 respectively, which are significantly positive correlation at the level of 1%. The regression results show that the R&D plus deduction policy has a strong incentive effect on TFP, which verifies H 1.

Table 2: Baseline regression results.

variable	TFP	
	(1)	(2)
Intensity	17.290*** (0.951)	12.120*** (1.032)
Control variables	Significant	Significant
Enterprise fixed effects	Uncontrolled	control
Time fixation effect	Uncontrolled	control
Observations	19051	19051
R^2	0.637	0.964

4.2 Heterogeneity Analysis

In order to investigate whether the incentive effect of R&D expense deduction on TFP with different property rights is different, this paper divides the sample enterprises into two categories, namely state-owned enterprises and non-state-owned enterprises. The regression results are shown in Table 4. Under the control of individual fixed effect and time fixed effect, the intensity regression coefficients of state-owned enterprises and non-state-owned enterprises are 7.724 and 13.13, The magnitude of both coefficients indicates that the policy incentive effect of non-state-owned enterprises is more significant, which verifies H 2.

Table 3: Heterogeneity of property rights.

variable	State-owned enterprises	Non-state-owned enterprises
Intensity	7.724*** (2.264)	13.130*** (1.169)
Control variables	Significant	Significant
Enterprise fixed effects	control	control
Time fixation effect	control	control
Observations	4729	14322
R^2	0.974	0.955

In order to study the difference of policy incentive effect of heterogeneous enterprises of different sizes, this paper chooses the median of the sample of enterprise size as the dividing standard. The sample with enterprise size smaller than the median is small scale enterprises, and the others are large scale enterprises. It can be seen from Table 4 that the regression coefficients of the intensities of large-scale enterprises and small-scale enterprises are 10.98 and 14.20, which are significant at the 1% level. The magnitude of the regression coefficients indicates that the R&D expense plus deduction policy has a more significant effect on the TFP of small-scale enterprises, which verifies the H 3.

Table 4: Heterogeneity of enterprise scale.

variable	Large-scale enterprises	Small-scale businesses
Intensity	10.980*** (1.527)	14.200*** (1.438)
Control variables	Significant	Significant
Enterprise fixed effects	control	control
Time fixation effect	control	control
Observations	9501	9550
R2	0.961	0.911

4.3 Robustness Tests

In order to ensure the reliability of the empirical results, this paper conducts a robustness test, which specifically includes: (1) replacing the measurement method of the explained variable, and recalculating TFP with OP method. (2) In order to alleviate endogenous problems, the explanatory variables and control variables will be lagged for a period of robustness test. (3) The sample data from 2018 to 2021 were intercepted from the total sample and regressed again. The regression results are shown in Table 5. The sign of the correlation coefficient of Intensity is still significantly positive, proving the robustness of the regression results.

Table 5: Robustness tests.

variable	TFP_OP	Lagging one period	Shrink the sample
Intensity	3.258*** (1.072)	6.527*** (1.726)	23.500*** (1.158)
Control variables	Significant	Significant	Significant
Firm and time fixed effect	control	control	control
Observations	19051	14352	12002
R^2	0.941	0.951	0.981

5 CONCLUSIONS AND RECOMMENDATIONS

In the 21st century, computer technology has been reasonably applied to the economic field and skillfully introduced into data analysis, effectively improving the efficiency and accuracy of data analysis, realizing effective interpretation of data information, understanding the information contained in data, and finding problems through data analysis. It can be seen that computer technology has a high application value in the economic system. This paper uses STATA measurement software to conduct statistical analysis on the data of A-share listed companies from 2015 to 2021, and empirically examines the incentive effect of R&D expense plus deduction policy on TFP. The research results show that the policy of R&D expense plus deduction has significantly improved TFP, and has more significant effect on non-state-owned enterprises and small-scale enterprises.

This paper puts forward the following policy suggestions: (1) The government should actively play the role of "visible hand", make use of the advantages of computer technology to effectively analyze market data, find out policy problems, constantly improve tax preferential policies, maintain the coordination and interaction between tax policies and market mechanisms, stimulate the technological innovation vitality of enterprises, and promote the promotion of TFP. (2) The government should continue to pay

attention to the incentive role of the R&D expense plus deduction policy. It can consider expanding the 100% plus deduction proportion to all industries, while strengthening the review and supervision mechanism, standardizing the implementation of policies, giving play to the guiding function of government policies on enterprise innovation and development, and improving TFP. (3) Due to the heterogeneity of enterprises, diversified plans should be adopted when formulating policies. Appropriate preference should be made according to the characteristics of enterprises, and targeted preferential policies should be implemented, such as appropriately expanding the pre tax plus deduction preferential policies for non-state-owned enterprises and small-scale enterprises, maximizing the effectiveness of policies, and promoting the balanced growth of the overall TFP.

REFERENCES

Beason R, Weinstein D E. Growth, Economies of Scale, and Targeting in Japan (1955-1990) [J]. The Review of Economics and Statistics,1996,78 (5):286-295.

Feng Haihong, Qu Wan, Li Minglu. R&D? [J]. Studies in Science of Science,2015,33(5): 665–673

Hong Lianpu, Liu Yan, Zhang Xiang. Analysis of the Effect of Corporate R&D Tax Preferential Policy—An Empirical Study Based on China's Empirical Data[J]. Journal of Taxation and Economics, 2019, 24(1): 63–70

Liu Ye, Lin Chenyan. and TFP[J]. Studies in Science of Science, 2021, 39(10): 1790–1802

Luosha Du, Ann Harrison, Gary Jefferson. FDI Spillovers and Industrial Policy: The Role of Tariffs and Tax Holidays [J]. World Development, 2014, 64.

Ren Cancan, Guo Zeguang, Tian Zhiwen. and TFP[J]. East China Economic Management, 2021, 35(5): 119–128

Ren Haiyun, Song Weichen Enterprise Heterogeneity Factors, R&D Expense Plus Deduction and R&D Investment [J] Science of Science Research, 2017, 35 (8): 1232 – 1239

Wang Xi, Liu Meng. ance: An Empirical Analysis Based on Listed Companies in China[J]. Journal of Public Finance, 2020(11): 101–114

Wang Ling, Zhu Zhanhong. thod[J]. Science of Science and Management of Science and Technology, 2011, 32(9): 43–50

Yang Guochao, Liu Jing, Lian Peng, et al. ance[J]. Economic Research Journal, 2017, 52(8): 110–124

Zhang Wenchun. ysis[J]. Journal of Chinese Minmin University, 2006(1): 59–64

Zhou Keqing, JING Jiao. fect of preferential tax policies on R&D: A case study of ChiNext listed companies[J]. Tax Research, 2012(6): 20–24