Tax Preference, R&D and Innovation Quality: An Empirical Study Based on the Mediating Effect Model

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Abstract. This paper studies the relationship among tax preferences, R&D and innovation quality by taking the listed enterprises in Shanghai and Shenzhen from 2008 to 2017 as samples. The study finds that (1) tax preferences can affect innovation quality by R&D, there is a “partial intermediary effect” among tax preferences, R&D and innovation quality. Based on the further test of the heterogeneity of property rights, it finds that the relations among the three show obvious differences in property rights. In non-state-owned enterprises, “partial intermediary effect” is established; in state-owned enterprises, “partial intermediary effect” is not established. Further study on the impact of R&D and innovation quality on enterprise performance shows that both R&D and innovation quality can significantly promote the improvement of enterprise performance. Innovation quality plays a “partial mediating effect” in the relationship between R&D and enterprise performance, and this mediating effect is only significant in non-state-owned enterprises.

1. Introduction

In the context of the “new normal”, innovation is the key driving force for China's economy to move beyond the middle-income trap and transform from high-speed development to high-quality development. Tax policy is transparent and flexible, so it is an important policy means for the government to guide enterprises to carry out technological innovation.[1-3] Many scholars have also verified the incentive effect of tax preferences on enterprises' investment in innovation,Mansfield(1986) and Hall(1993) found that the tax cost elasticity of R&D is negative, tax incentive policies are conducive to promoting enterprises to increase R&D.[4, 5] Rao (2016) analyzed the impact of the U.S. federal R&D tax credit from 1981 to 1991, and found that the tax credit reduced the cost of R&D users by 10%.[6] Minniti and Venturini(2017) based on Schumpeter’s growth theory, found that the 10% increase in R&D tax deduction can increase the growth rate of labor productivity by 0.4% per year.[7] Guceri(2018) evaluated the effect of tax preferences on R&D investment and R&D personnel, and found that tax preferences could improve R&D expenditure at the company level, and the increase of R&D personnel brought by tax cuts would generate additional R&D effects.[8] Wu Zuguang, et al(2017)found that compared with the preferential methods of extra deduction and investment tax credit, the preferential method of tax reduction for innovative product income is more effective in encouraging enterprises to invest in innovation.[9] Cheng yao and Yan huihui (2018) compared three tax preferences by the propensity score method, and found that the incentive effect of the additional deduction of R&D expenses, the combination of the additional deduction of R&D expenses and the preferential tax rate and the preferential tax rate are decreasing successively.[3]

However, large-scale R&D does not mean high-quality innovation output. Haner (2002) believed that innovation quality is the concentrated embodiment of three different fields within an organization, including the quality of new products, processes or management modes.[10] Prajogo (2006) defined innovation quality as process quality, and believed that innovation quality is the

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embodiment of the whole process quality from product to service and operation.[11] Cai shaohong and Yu liping (2017) believed that enterprises can achieve better innovation effects only by paying attention to both the quality and quantity of innovation.[12] Huang, et al (2018) believed that the improvement of innovation quality will affect the accounting and market performance of enterprises, and having a positive effect on enterprise performance. [13] It can be seen that whether the incentive effect of tax preferences on R&D can be transferred to innovation quality, and what is the relationship between tax preferences, R&D and innovation quality is a meaningful topic. Kao (2018) studied the relationship between the preferential policy of tax credit and the quality of innovation with the sample of American enterprises from 1997 to 2007, and found that the policy of tax credit can promote the quality of innovation and improve enterprise performance.[14] However, there is still a lack of literature on tax preferences, R&D and innovation quality in China,this paper takes the innovation quality as the focus of research, and constructs a mediating effect model to deeply analyze the relationship among tax preferences, R&D and innovation quality; This paper focuses on whether R&D plays an intermediary role in the relationship between tax preferences and innovation quality, and considers the impact of the heterogeneity of property rights.at the same time, it further studies the influence of R&D and innovation quality on enterprise performance.

The main contribution of this paper:First, it has theoretical significance to broaden the research perspective of tax preference and enterprise innovation. The existing literature mainly discusses the impact of tax preferences on the R&D and innovation output of enterprises. This paper extends the innovation dimension to the innovation quality and further analyzes the relationship between tax preferences and innovation quality. Second, it enriches the research results of enterprise innovation quality. Existing researches on enterprise innovation quality mainly focus on the development of innovation quality itself, the relationship between innovation quantity and innovation quality and other micro aspects. This paper verifies the relationship between macro tax preference and micro enterprise innovation quality, realizes the connection and interaction between macro policy and micro enterprise behavior, and enriches the research field of innovation quality. Thirdly, it provides reasonable empirical basis for performance evaluation of tax incentive policies. From the perspective of innovation quality, we can have a more comprehensive understanding of the effect of macro policy tools on enterprises' micro behaviors and a more reasonable evaluation of tax incentive policies on enterprises' innovation activities,it has great significance to guide enterprises to carry out high-quality innovation activities and promote the sustainable development of enterprises.

2 Theoretical analysis and research hypotheses

2.1 How do tax preferences affect the quality of innovation?

According to the market failure theory of microeconomics, technological innovation has positive externalities, which making private benefits not equal to social benefits, the market failure in the process of technological innovation will make the input and output level of technological innovation always lower than the social optimal level.[15] According to relevant theories of public economics, macro tax policy can effectively correct the externality of technological innovation of enterprises and improve the private income and quality of technological innovation. [16] Hall and Van Reenen (2000) believed that tax incentive policies are a reflection of market orientation and will prompt enterprises to choose how to carry out R&D projects by themselves. [17] Li liqing(2007) believed that tax preferences are the main policy tool for governments to encourage enterprises to invest in research and development, and they tend to use the power of enterprises and the market to stimulate innovation.[18]

Technological innovation is a dynamic process from R&D to innovation output. R&D is the first step to carry out innovation, which directly determines the scale and quantity of innovation and is the basis for improving the quality of innovation. Innovation output, especially invention patent output, is the key factor to improve the quality of innovation. Some studies suggest that tax

preferences can encourage innovation output, Czarnitzki, et al (2011) and Cappelen, et al (2012) found that tax incentive policies can promote the output of innovations, such as new products and patented technologies.[19, 20] Lin Chen and zhu weiping (2008) found that export tax rebate and innovation subsidy policies can effectively stimulate innovation output.[21] Zhang xintong, et al (2014) found that enterprises enjoying preferential tax policies have more patents, new products and technological rewards.[22] At the same time, some studies show that R&D can affect innovation output and play an intermediary role in the relationship between tax incentives and innovation output. Cao yong, et al (2012) found that R&D was positively correlated with the number of invention patents with high quality.[23] Li weian, et al (2016) found that tax preferences can improve the innovation output of enterprises to some extent, and the R&D plays a complete intermediary role in the relationship between the two.[24] Kao (2018) found that the tax credit policy can promote the improvement of innovation quality.[14]

It can be seen that the tax preferences can not only promote the R&D of enterprises, but also promote the innovation output. R&D is the premise and foundation of innovation output, especially high-quality innovation output (such as invention patent). Based on this, the following hypotheses are proposed:

H1a: tax preferences have a significant positive incentive effect on the innovation quality of enterprises.

H1b: tax preferences have a significant positive incentive effect on enterprises' R&D.

H1c: R&D plays an intermediary role in the relationship between tax preferences and innovation quality.

2.2 Regulating effect of property right heterogeneity

The nature of property rights determines a series of corporate governance issues, such as ownership structure, principal-agent mode, decision-making mechanism, resource allocation and management mode. [25] Hao ying and liu xing (2010) found that R&D is not only sensitive to the level of marketization process, but also the difference of sensitivity is inherent in the property right characteristics of enterprises.[26] Zhang, et al (2003) studied the research and development investment status of enterprises with different property rights systems, and found that the research and development investment efficiency of state-owned enterprises was the lowest.[27] Wu yanbing (2012) believed that the private property rights of private enterprises increase their enthusiasm for enterprise innovation, while the public property rights of state-owned enterprises reduce their willingness to carry out innovation.[28] Lin, et al (2010) conducted an empirical analysis by studying the data of Chinese enterprises and confirmed that private enterprises are more willing to invest in R&D than state-owned enterprises.[29] Xiao xingzhi and Xie li (2011) found that compared with state-owned enterprises, non-state-owned enterprises have more freedom to carry out innovation, are less subject to the direct intervention of the government, and are more affected by the market environment and competition, The heterogeneity of property rights makes the innovation power and efficiency of private enterprises higher than that of state-owned enterprises.[30] The controlling shareholder of state-owned enterprises is the government, and technological innovation is largely dependent on the support of the government, and often lacks innovation incentive and institutional basis.[31]

From the perspective of the property rights of enterprises, there are obvious differences between state-owned enterprises and private enterprises in their willingness to innovate. Non-state-owned enterprises tend to have a strong willingness to innovate, and they have more internal motivation to carry out high-quality innovation activities. Based on this, the following hypotheses are proposed:

H2a: the heterogeneity of property rights has a significant moderating effect on the relationship between tax preferences, R&D and innovation quality

H2b: in non-state-owned enterprises, the intermediary effect between tax preference, R&D and innovation quality is established

H2c: in state-owned enterprises, the intermediary effect between tax preference, R&D and innovation quality is not established

3. Study design

3.1 Sample selection and data sources

In this paper, the data of a-share listed companies in Shanghai and Shenzhen from 2008 to 2017 were taken as samples, and the samples of financial industry, ST (including *ST), R&D and innovation quality data missing or other financial indicators with obvious abnormalities were excluded, and finally 7960 observed values were obtained. The data were mainly from CSMAR financial database, and stata12.0 software was used for data processing.

3.2 Model design

3.2.1 Variable definitions

This paper measures the tax preference by subtracting the difference between the income tax expense and the total profit ratio from the basic tax rate of 25%, the tax benefit intensity is proportional to this value. [32] The ratio of research and development expenditure to the main business income of an enterprise in that year is used to measure the R&D.[33] Innovation quality is a comprehensive concept, it is mainly reflected by the innovation effect. Innovation output is the most intuitive factor reflecting innovation effect, patent is one of the most important innovation output, the quality of patents can largely determine the quality of innovation. In the empirical research, many scholars measure the quality of innovation by patent-related indicators.[34][35][36][37] Liu du, et al(2016)[36] and Li Wen Jing, et al(2016)[37] argue that invention patents are high quality innovation output. So, the number of invention patent applications is used as a measure of innovation quality, In order to facilitate the empirical analysis, refer to the practice of Liu du, et al (2016) [36], take the logarithm of invention patents.

Table 1 main variable definitions.

Variable	variable name	Variable symbol	Variable description
Dependent variable	Innovation input	R&D	Innovation expenditure/main business income)*100%
	Innovation quality	Patenti	The number of invention patent applications is logarithm
	Enterprise performance	TobinQ	The value of Tobin Q
Independent variables	tax preference	tax_incentive	0.25－(income tax expense/total profit)
Regulated variable	nature of property right	Soe	The value of non-state-owned enterprises is 1, and the value of state-owned enterprises is 0
Control variables	The enterprise scale	Size	The natural logarithm of the total assets of an enterprise
	profitability	Profit	Year-end net profit/year-end total assets
	Asset-liability ratio	Lev	Total liabilities/total assets
	Fixed asset structure	PFA	Net fixed assets/total assets
	Current ratio	CR	Current assets/current liabilities
	Enterprise age	Lnage	The natural logarithm of business age
Dummy variables	Industry	Industry	According to the industry classification of CSRC in 2012, when the sample belongs to this industry, the value is 1, otherwise it is 0
	Year	Year	The annual dummy variable is 1 when the sample is of that year, otherwise it is 0

Enterprise performance is measured by TobinQ with a lag of one period.[36][38] Referring to the practice of Zhang fan and Zhang youdou(2018)[39], financial leverage, enterprise size, profitability, capital intensity, flow ratio and enterprise age are taken as control variables. The specific variable definitions are shown in Table 1.

3.2.2 Mediating effect model

Referring to the practice of BARON and KENNY(1986)[40]and Wen zhonglin,et al(2004)[41],a mediation effect model was constructed to test the relationship between tax preferences, R&D and innovation quality. The principle of the mediation effect test model is as follows:

When considering the influence of independent variable X on dependent variable Y, if independent variable X affects Y through influencing variable Z, then Z is called the mediating variable. The following equation is used to describe the relationship between the three variables.

$$Y = a_1 X + \mu_1 \quad (1)$$

$$Z = bX + \mu_2 \quad (2)$$

$$Y = a_2 X + cZ + \mu_3 \quad (3)$$

First, check whether the coefficient a_1 is significant. If a_1 is significant, it means that there is a significant correlation between X and Y, then the test of mediating effect is continued. If a_1 is not significant, it means that there is no significant correlation between X and Y, then the test of mediating effect is stopped.

Secondly, test whether b and c are significant under the premise of a_1 significance, and verify whether the variable Z plays a mediating role. If both b and c are significant, it indicates that the variable Z plays a mediating role.

Finally, the significance of a_2 was tested under the premise that both b and c were significant. If a_2 is not significant, it indicates a complete mediating effect. If a_2 is significant and the absolute value of a_2 is less than the absolute value of a1, there is partial mediating effect.

Based on the research principle of the mediating effect model and the research content of this paper, the following 7 groups of mediating effect models were constructed. In the actual regression, stepwise regression and grouping regression were combined. Model 1-1, model 1-2 and model 1-3 are used to test the relationship among tax preferences, R&D and innovation output, and carry out corresponding full sample regression and grouping test of property right heterogeneity. Model 2-1, model 2-2, model 2-3 and model 2-4 are used to further study the impact of R&D and innovation quality on enterprise performance, and to test whether innovation quality plays an intermediary role in the relationship between R&D and enterprise performance.

Model1-1

$$Patenti_{i,t} = \alpha_0 + \alpha_1 tax\_incentive_{i,t} + \alpha_j \sum_j controls + \sum Industry_i + \sum Year_i + \varepsilon_{1i} \quad (4)$$

Model1-2

$$R\&D_{i,t} = \beta_0 + \beta_1 tax\_incentive_{i,t} + \beta_j \sum_j controls + \sum Industry_i + \sum Year_i + \varepsilon_{2i} \quad (5)$$

Model1-3

$$Patenti_{i,t} = \gamma_0 + \gamma_1 tax\_incentive_{i,t} + \gamma_2 R\&D_{i,t} + \gamma_j \sum_j controls + \sum Industry_i + \sum Year_i + \varepsilon_{3i} \quad (5)$$

Model2-1

$$TobinQ_{i,t} = \eta_0 + \eta_1 R\&D_{i,t} + \eta_j \sum_j controls + \sum Industry_i + \sum Year_i + \mu_{1i} \quad (6)$$

Model2-2

$$TobinQ_{i,t} = \phi_0 + \phi_1 Patenti_{i,t} + \phi_j \sum_j controls + \sum Industry_i + \sum Year_i + \mu_{2i} \quad (7)$$

Model2-3

$$Patenti_{i,t} = \varphi_0 + \varphi_1 R\&D_{i,t} + \varphi_j \sum_j controls + \sum Industry_i + \sum Year_i + \mu_{3i} \quad (8)$$

Model2-4

$$TobinQ_{i,t} = \lambda_0 + \lambda_1 R\&D_{i,t} + \lambda_2 Patenti_{i,t} + \lambda_j \sum_j controls + \sum Industry_i + \sum Year_i + \mu_{4i} \quad (9)$$

4. Empirical results

4.1 Descriptive statistics

Table 2 is a descriptive statistical result of all variables. The average and median of tax preferences for non-state-owned enterprises are higher than those for state-owned enterprises, it indicates that the Chinese government has given more preferential policies for innovation to non-state-owned enterprises. The mean and median of R&D in state-owned enterprises are 0.048 and 0.038 respectively, both of which are significantly higher than that of state-owned enterprises,this indicates that non-state-owned enterprises are highly motivated and willing to carry out innovative activities. However, the mean and median of innovation quality in non-state-owned enterprises are slightly lower than that of state-owned enterprises, which indicates that non-state-owned enterprises still have obstacles in the transformation of innovation achievements,the property right advantage of state-owned enterprises can promote the improvement of their innovation quality.

Table 2 Descriptive statistics of the main variables.

	All samples(N=7960)			Soe=0(N=2502)			Soe=1(N=5458)		
variable	mean	Median	Std.dev	mean	Median	Std.dev	mean	Median	Std.dev
Tax_incentive	0.072	0.097	0.107	0.047	0.083	0.132	0.083	0.100	0.092
Patenti	2.680	2.640	1.430	2.930	2.890	1.570	2.560	2.560	1.340
R&D	0.044	0.036	0.043	0.036	0.031	0.041	0.048	0.038	0.044
Size	22.000	21.900	1.260	22.800	22.500	1.490	21.700	21.600	0.986
Profit	0.105	0.084	0.088	0.081	0.052	0.085	0.116	0.098	0.088
Lev	0.388	0.376	0.195	0.476	0.484	0.198	0.347	0.330	0.180
PFA	0.204	0.178	0.136	0.237	0.202	0.160	0.189	0.169	0.120
CR	2.980	1.860	3.860	2.070	1.460	2.260	3.400	2.100	4.350
Lnage	2.800	2.830	0.312	2.900	2.940	0.287	2.750	2.770	0.313

4.2 Regression results

4.2.1 Regression results of all samples

According to the regression results of model 1-1 in Table 3,innovation quality is significantly positively correlated with tax preferences,it shows that strengthening tax preferences is conducive to improve the quality of enterprise innovation, which verifies H1a. The regression results of model 1-2 are similar to the studies of Bloom et al (2002) [1]and Guceri (2018).[8] Tax incentives have a significant positive effect on R&D, H1b was verified. According to the regression results of model 1-3 in Table 3,the significant positive correlation between tax preferences and innovation quality was not affected by the addition of mediating variable R&D, and R&D has significant incentive effect on innovation quality, that is, increasing R&D can promote high-quality innovation output. However, the influence coefficient of tax preferences on the quality of innovation decreased from

0.831 to 0.812. According to the basic principle of the mediating effect model, R&D plays a partial mediating role in the relationship between tax preferences and the quality of innovation, and there is a “partial mediating effect” among the three, which verifies H1c.

According to the regression results of control variables, financial leverage, enterprise scale and profitability have significant negative, positive and negative effects on innovation quality respectively. It indicates that enterprises with low debt level, large scale and weak profitability pay more attention to improving the quality of innovation and can enhance the core competitiveness of enterprises through high-quality invention patents and seek new profit growth points. Capital intensity, flow ratio and enterprise age all have significant negative effects on innovation quality. The older and more capital-intensive an enterprise is, the less incentive it has to improve its innovation quality. The results of model 1-1 and model 1-2 show that enterprise size and profitability have opposite effects on innovation quality and R&D. Enterprises with small scale and strong profitability are more willing to invest in innovation, but the R&D of these enterprises cannot be well converted into high-quality innovation output.

Table 3 regression results of all samples.

variable	Model 1-1	Model 1-2	Model 1-3
tax_incentive	0.831*** (6.22)	0.018*** (4.33)	0.812*** (6.07)
RD			1.056*** (2.84)
Lev	-0.361*** (-3.35)	-0.005* (-1.67)	-0.355*** (-3.29)
Size	0.611*** (41.98)	-0.003*** (-6.13)	0.614*** (42.10)
Profit	-1.034*** (-5.43)	0.041*** (7.10)	-1.077*** ((-5.64))
PFA	-0.235* (-1.91)	-0.005 (-1.41)	-0.230* (-1.86)
CR	-0.015*** (-3.55)	0.002*** (17.85)	-0.018*** (-4.05)
Lnage	-0.183*** (-4.15)	-0.012*** (-8.73)	-0.170*** (-3.85)
Industry	Control	control	control
Year	Control	control	control
N	7960	7960	7960
Adj_R2	0.342	0.346	0.343

Note :() is t value, *, **, and *** are significant at the statistical level of 1%, 5% and 10% respectively. The following Table is the same.

4.2.2 Consider the heterogeneity of property rights

As shown in Table 4, the relationship among tax preferences, R&D and innovation quality shows obvious property right heterogeneity, and H2a is verified. In state-owned enterprises, although tax preferences have a significant impact on R&D and innovation quality, the results of model 1-3 show that there is no significant positive correlation between R&D and innovation quality, and the intermediary effect is not established, H2b is verified. In non-state-owned enterprises, tax preferences have a significant incentive effect on both R&D and innovation quality. By comparing the regression results of model 1-1 and model 1-3, the impact of tax preferences on enterprise innovation quality is still significant after adding the mediating variable of R&D, and the impact coefficient decreases from 0.640 to 0.614.The results of model 1-3 show that R&D has a significant positive effect on innovation quality, that is, there is a partial mediating effect between tax preferences, R&D and innovation quality. It can be seen that tax preferences play a more effective role in encouraging non-state-owned enterprises to innovate and promote high-quality innovation activities of non-state-owned enterprises.

Table 4 regression results of consider the heterogeneity of property rights.

variable	Soe=0			Soe=1		
	Model 1-1	**Model 1-2**	**Model 1-3**	**Model 1-1**	**Model 1-2**	**Model 1-3**
tax_incentive	0.951*** (4.87)	0.010* (1.84)	0.946*** (4.83)	0.640*** (3.47)	0.024*** (4.12)	0.614*** (3.33)
R&D			0.542(0.73)			1.064** (2.47)
Lev	-0.562*** (-2.91)	-0.004 (-0.71)	-0.559*** (-2.90)	-0.229* (-1.71)	-0.005 (-1.14)	-0.224* (-1.67)
Size	0.648*** (29.82)	-0.004*** (-5.92)	0.650*** (29.69)	0.572*** (26.60)	-0.003*** (-3.69)	0.575*** (26.70)
Profit	-1.185*** (-3.37)	0.021** (2.18)	-1.196*** (-3.40)	-0.815*** (-3.55)	0.048*** (6.59)	-0.866*** (-3.76)
PFA	-0.337 (-1.59)	0.004(0.75)	-0.339 (-1.60)	0.057 (0.36)	-0.008* (-1.65)	0.065 (0.41)
CR	-0.044*** (-3.16)	0.004*** (10.39)	-0.046*** (-3.25)	-0.014*** (-3.04)	0.002*** (14.70)	-0.016*** (-3.47)
Lnage	-0.328*** (-3.62)	-0.029*** (-11.90)	-0.312*** (-3.34)	-0.111** (-2.14)	-0.007*** (-4.31)	-0.103** (-1.99)
Industry	control	control	Control	control	control	control
Year	control	control	Control	control	control	control
N	2502	2502	2502	5458	5458	5458
Adj_R2	0.475	0.422	0.475	0.265	0.314	0.265

4.3 Further study

As shown in Table 5, on the whole, both R&D and innovation quality can significantly improve enterprise performance, the influence coefficients were 4.920 and 0.071, and R&D can also significantly improve the quality of innovation. The results of model 2-4 show that the positive correlation between R&D and enterprise performance remains unchanged after mediating variable innovation quality is added on the basis of model 2-1,the influence coefficient decreased from 4.920 to 4.843, indicating that innovation quality play a part of intermediary role in the relationship between enterprise performance and R&D.

As shown in Table 6, the relationship between R&D, innovation quality and enterprise performance has obvious differences in property rights. In state-owned enterprises, innovation quality has no significant effect on enterprise performance, and the increase of R&D cannot significantly promote the improvement of innovation quality. In non-state-owned enterprises, both R&D and innovation quality can significantly promote the improvement of enterprise performance, and innovation quality can play a partial intermediary role in the relationship between R&D and enterprise performance. It shows that the R&D of state-owned enterprises cannot be effectively transformed into high-quality innovation activities, and the enterprise performance cannot be promoted by carrying out high-quality innovation. The R&D of non-state-owned enterprises can be more effectively transformed into high-quality innovation output, thus promoting the improvement of enterprise performance.

Table 5 R&D, innovation quality and enterprise performance -- All samples.

variable	Model 2-1	Model 2-2	Model 2-3	Model 2-4
RD	4.920*** (9.46)		1.166*** (3.13)	4.843*** (9.31)
Patenti		0.071*** (4.52)		0.066*** (4.21)
Control variables	control	Control	control	control
Dummy variables	control	Control	control	control
N	7960	7960	7960	7960
Adj_R2	0.426	0.421	0.340	0.427

Note: Due to the limitation of space, the specific regression results of control variables should be reserved for future reference

Table 6 R&D, innovation quality and enterprise performance -- considering the heterogeneity of property rights.

Variable	Soe=0			Soe=1			
	Model 2-1	Model 2-2	Model 2-3	Model 2-1	Model 2-2	Model 2-3	Model 2-4
RD	3.790*** (4.62)		0.676 (0.91)	5.284*** (8.38)		1.144*** (2.66)	5.191*** (8.24)
Patenti		0.031 (1.39)			0.087*** (4.35)		0.081*** (4.08)
Control variable	control	control	control	control	control	control	control
Dummy variable	control	control	control	control	control	control	control
N	2502	2502	2502	5458	5458	5458	5458
Adj_R2	0.394	0.389	0.470	0.340	0.421	0.264	0.428

Note: Due to the limitation of space, the specific regression results of control variables should be reserved for future reference

4.4 Robustness checks

In order to test the stability of the research results and enhance the credibility of the research conclusions. This paper adopts the method of variable substitution to test the robustness of the relationship among tax preference, R&D and innovation quality,taking the effective corporate income tax rate as the substitution variable of tax preference, the higher the value is, the less the tax preference will be. After the variable substitution, the mediating effect test was conducted on the whole sample and the grouped sample based on the moderating effect of the heterogeneity of property rights, and the results were basically consistent. Considering the impact of the financial crisis on the macro economy in 2008, the robustness test of the relationship between R&D, innovation quality and enterprise performance is conducted without the data in 2008, and the results are basically consistent. Due to limited space, the robustness test results are omitted here for future reference.

5. Conclusions

This paper takes a-share listed companies in Shanghai and Shenzhen from 2008 to 2017 as samples, the mediating effect model is constructed to empirically test the relationship among tax preference, R&D and innovation quality,and further studies the impact of R&D and innovation quality on enterprise performance, meanwhile considers the impact of the heterogeneity of property rights. The results show that: (1) tax preferences can affect innovation quality by influencing R&D, that is, there is a “partial intermediary effect” among tax preferences, R&D and innovation quality. (2) Based on the further test of the heterogeneity of property rights, it is found that the relations among the three show obvious differences in property rights, in non-state-owned enterprises, “partial intermediary effect” is established, in state-owned enterprises, “partial intermediary effect” is not established. To further study the impact of R&D and innovation quality on enterprise performance,it is found that both R&D and innovation quality can significantly promote the improvement of enterprise performance, and innovation quality plays a “partial mediating effect” in the relationship between R&D and enterprise performance, and this mediating effect is mainly manifested in non-state-owned enterprises.

The main limitations of this study are as follows. First, due to the limitation of data collection, the innovation quality is measured mainly from the perspective of the number of high-quality

invention patents. Second, only the mediating effects of the heterogeneity of property rights be considered. Further research considers measuring the quality of innovation from multiple perspectives, we can from the structural optimization and other aspects to study the improvement of innovation quality, and the moderating effect of the external market factors and the enterprise's own attributes should be fully considered.

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References

[1] Bloom N, Griffith R, Van Reenen J. 2002. Do R&D tax credits work? Evidence from a panel of countries 1979–1997[J]. Journal of Public Economics, 85(01): 1-31.

[2] Finley, Andrew R.; Lusch, Stephen J.; Cook, Kirsten A.2015. The Effectiveness of the R&D Tax Credit: Evidence from the Alternative Simplified Credit [J]. The Journal of the American Taxation Association, 37(01): 157-181.

[3] Cheng Yao, Yan Hui Hui. 2018. Policy effect of tax incentives on enterprises' R&D investment [J]. Quantitative economic and technological economic research, 35(02): 116-130. (in Chinese)

[4] Mansfield E. 1986. The R&D Tax Credit and Other Technology Policy Issues [J]. American Economic Review, 76(02): 190-194.

[5] Hall, Bronwyn H. 1993. R&D Tax Policy During the 1980s: Success or Failure?[J]. Tax Policy and the Economy, 07: 1-35.

[6] Rao, Nirupama. 2016. Do tax credits stimulate R&D spending? The effect of the R&D tax credit in its first decade[J]. Journal of Public Economics, 140: 1-12.

[7] Minniti, Antonio; Venturini, Francesco. 2017. The long-run growth effects of R&D policy[J]. Research Policy, 46(01): 316-326.

[8] Guceri, Irem. 2018. Will the real R&D employees please stand up? Effects of tax breaks on firm-level outcomes[J]. International Tax and Public Finance, 25(01): 1-63.

[9] Wu Zu Guang, Wan Di Fang, Wang Wen Hu. 2017. Experimental study on the incentive effect of tax incentives on R&D investment [J]. Systems engineering theory and practice, 37(12): 3025-3039. (in Chinese)

[10] Haner U. 2002.Innovation quality-a conceptual framework [J]. International Journal of Production Economics, 80(01): 31-37.

[11] Prajogo, DI; Sohal, AS. 2006. The integration of TQM and technology/R&D management in determining quality and innovation performance [J]. Omega-International Journal of Management Science, 34(03): 296-312.

[12] Cai Shao Hong, Yu Li Ping. 2017. Innovation quantity, innovation quality and enterprise benefit -- empirical study from high-tech industry [J]. China soft science, (05): 30-37. (in Chinese)

[13] Huang, Shaio Yan; Chiu, An-An; Lin, Chi-Chen. 2018. The relationship between corporate innovation and performance[J]. Total Quality Management & Business Excellence, 29(03-04):441-452.

[14] Kao Wei-Chuan. 2018. Innovation quality of firms with the research and development tax credit[J]. Review of Quantitative Finance and Accounting, 51(01): 43-78.

[15] Delong, Lawrence. 1991. Equipment Investment and Economic Growth [J]. Quarterly Journal

of Economics, 106(02):445-502.

[16] Cheng Xi, Cai Xiu Yun. The incentive effect of tax policy on technological innovation of enterprises -- an empirical analysis based on heterogeneous enterprises [J]. Journal of Zhong Nan University of economics and law, 06: 94-102. (in Chinese)

[17] Hall, B; Van Reenen, J. 2000. How effective are fiscal incentives for R&D? A review of the evidence[J]. Research Policy, 29(04-05): 449-469.

[18] Li Li Qing. 2007. Research on the effectiveness of current R&D tax incentives in China [J]. China soft science, 07: 115-120. (in Chinese)

[19] Czarnitzki D, Hanel P, Rosa J M. 2011. Evaluating the impact of R&D tax credits on innovation: A microeconometric study on Canadian firms[J]. Research Policy, 40(02): 217-229.

[20] Cappelen Å, Raknerud A, Rybalka M. 2012. The effects of R&D tax credits on patenting and innovations[J]. Research Policy, 41(02): 334-345.

[21] Chen Lin, Zhu Wei Ping. 2008. Effect of export tax rebate and innovation subsidy policy [J]. Economic research, 43(11): 74-87. (in Chinese)

[22] Zhang Xin Dong, He Ya Nan, Ma Xiao Mei. 2014. Analysis on the incentive effect of R&D tax incentive policies on enterprise innovation output -- based on the research of national enterprise technology center [J]. Contemporary finance and economics, (11): 35-45. (in Chinese)

[23] Cao Yong, Su Feng Jiao. 2012. Empirical study on the impact of technological innovation input on innovation performance in high-tech industries -- based on the comparative analysis of panel data of the whole industry and its five subordinate industries [J]. Scientific research management, 33(09): 22-31. (in Chinese)

[24] Li Wei An, Li Hao Bo, Li Hui Cong. 2016. Innovation incentive or tax shield? Research on tax incentives for high-tech enterprises [J]. Scientific research management, 37(11): 61-70. (in Chinese)

[25] Meckling M C J H. 1976. Theory of the firm: Managerial behavior, agency costs and ownership structure[J]. Journal of Financial Economics, 03: 305-360.

[26] Hao Ying, Liu Xing. 2010. Marketization process and R&D investment of listed companies: from the perspective of property rights characteristics [J]. Scientific research management, 31(04): 81-90. (in Chinese)

[27] Zhang, AM; Zhang, YM; Zhao, R. 2003. A study of the R&D efficiency and productivity of Chinese firms[J]. Journal of Comparative Economics, 31(03): 444-464.

[28] Wu Yan Bing. 2015. Restudy of double efficiency loss of state-owned enterprises [J]. Contemporary economic science, 37(01): 1-10.

[29] Lin, Chen; Lin, Ping; Song, Frank. 2010. Property rights protection and corporate R&D: Evidence from China [J]. Journal of Development Economics, 93(01): 49-62.

[30] Xiao Xing Zhi, Xie li. 2011. Empirical analysis on innovation efficiency of China's strategic emerging industries [J]. Economic management, 33(11): 26-35. (in Chinese)

[31] Zhu Yong Ming, Jia Ming-e. 2017. Marketization process, financing constraints and enterprise technology innovation -- based on the analysis of data of Chinese high-tech enterprises from 2010 to 2014 [J]. Business research, (01): 49-56. (in Chinese)

[32] Cheng Xi, Cai Xiu Yun. 2017. The incentive effect of tax policy on technological innovation of enterprises -- an empirical analysis based on heterogeneous enterprises [J]. Journal of zhongnan university of economics and law, (06): 94-102. (in Chinese)

[33] Huang Jun, He Guo Liang. 2017. Corporate social responsibility, technological innovation and

enterprise value [J]. Soft science, 31(07): 93-97. (in Chinese)

[34]Tseng, Chun-Yao; Wu, Lei-Yu.2007. Innovation quality in the automobile industry: Measurement indicators and performance implications [J]. International Journal of Technology Management, 37(01): 162-177.

[35]Comino, Stefano; Graziano, Clara. 2015. How many patents does it take to signal innovation quality? [J]. International Journal of Industrial Organization, 43: 66-79.

[36] Li Wen Jing, Zheng Man Ni. 2016. Substantive innovation or strategic innovation? -- impact of macro-industrial policies on micro-enterprise innovation [J]. Economic research, 51(04): 60-73. (in Chinese)

[37]Liu du, wan di fang, Wu zuguang. 2016. Can China's gem identify innovation quality? [J]. scientific research management, 37(12):46-54. (in Chinese)

[38] Wu, Wenfeng; Wu, Chongfeng; Zhou, Chunyang. 2012. Political connections, tax benefits and firm performance: Evidence from China[J]. Journal of Accounting and Public Policy, 31(03): 277-300.

[39] Zhang Fan, Zhang You Dou. 2018. Influence of fiscal subsidies and tax incentives in competitive fields on business performance of enterprises [J]. Finance and trade research, 29(03): 80-89. (in Chinese)

[40]Baron, RM; Kenny, DA.1986. The Moderator-Mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic, and Statistical Considerations [J]. Journal of Personality and Social Psychology, 51(06): 1173-1182.

[41] Wen Zhong Lin, Zhang lei, Hou Jie Tai, et al. 2004. Mediating effect test procedure and its application [J]. Journal of psychology, 36(05): 614-620. (in Chinese)