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A study of the impact of government subsidies and tax incentives on the effectiveness of dual innovation in enterprises—Based on data from listed companies

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Abstract: Dual innovation is an important ability for enterprises to adapt to the changing external environment. Taking listed companies as the object of study, this paper examines the impact of government subsidies and tax incentives on the effectiveness of dual innovation in enterprises. The findings show that dual innovation is actively promoted by government policies, and government subsidies play a more prominent role in promoting developmental innovation, while tax incentives do the opposite; for state-owned listed companies and non-state-owned companies, the impact of government policies on dual innovation is also different. Based on this, this paper puts forward a series of policy recommendations.

1. Introduction

Innovation is the primary driving force. Faced with a complex and changing international environment, China needs to think forward about the future path of scientific and technological innovation and constantly explore the innovation theory with Chinese characteristics when it continues to explore the frontier areas of science and technology. In 2022, US President Joe Biden signed the Chip Act, whose provisions also include exclusive policies for the Chinese chip industry. In order to promote technological innovation of enterprises, the government has implemented a series of inclusive policies to enhance the impetus for innovation of enterprises. In this study, listed companies on the A-share main board and the Science and Technology Innovation Board are selected as research objects to explore the impact of government incentive policies on dual innovation.

2. Literature Review, Theoretical Analysis and Research Hypotheses

2.1. Literature Review

2.1.1. Literature on government grants and innovation

Some scholars advocate that government subsidies have not effectively stimulated the

development of innovative inputs. Li Wanfu (2017) found through empirical research that due to the existence of government subsidies mostly replacing the phenomenon of internal own funds of enterprises, this substitution effect will instead inhibit the independent investment in the dual innovation of enterprises[1].However, most researchers agree that there is a facilitating effect between the two. Song Jian (2022) used a two-way fixed model to analyze a research sample of Chinese A-share listed companies from 2011-2019 and found that financial subsidies significantly promoted corporate innovation[2].Zhang Jianshun (2022) used the double-difference method to examine the impact of competitive fiscal subsidy allocation methods on corporate innovation, and the results showed that competitive fiscal subsidy allocation methods are more capable of stimulating corporate innovation than traditional fiscal subsidy allocation methods[3].

2.1.2. Literature related to tax incentives and innovation

Some scholars advocate that tax incentives do not provide a substantial boost to innovation inputs. Zhang Jijian and Zhang Xiang (2010) conducted a questionnaire survey on a sample of 95 enterprises selected from the registered high-tech enterprises in China and found that the implementation of tax incentives did not promote R&D investment in dual innovation[4]. However, most researchers believe that there is a positive correlation between the two. Song Qing (2021) selected in the panel data of GEM listed companies from 2009-2019 and found that tax preferences have an incentive effect on the performance of dual innovation with regional variability[5]. Ghazinoory and Zahra (2021) selected data from Iranian high-tech firms to study the effects of tax incentives and direct financial inputs on innovation and found that for small and medium-sized enterprises (SMEs), tax incentives have a significant effect on R&D investment, but direct financial support is more effective for large firms[6].

2.1.3. Literature on Dualistic Innovation

March (1991) proposed the dual innovation for the first time, and it was later applied by scholars in the field of innovation. Exploratory innovation is a way of in-depth exploration of new fields and cutting-edge technologies, and exploratory innovation is a process of development and application based on existing technologies. There is an interdependent relationship between exploratory and exploitative innovation, which will rob the resources of the enterprise, so that the enterprise can not achieve effective balance in resource allocation. Li Wei (2015) argued that exploratory innovation focuses on long-term development[7], while Hu Chaoying and Jin Zhongkun (2017) argued that exploitative innovation focuses on short-term gains[8].Through sorting out, it is found that the essence of exploratory innovation is the exploration and attempt of unknown fields, while exploitative innovation is the expansion and extension of established fields.

2.2. Theoretical analysis and research hypotheses

2.2.1. The impact of government subsidies and tax incentives on dual innovation

Whether government policy is an enabler or a stumbling block to corporate dual innovation, different scholars have different conclusions due to the heterogeneity of research samples and different research methods. Most scholars believe that tax incentives have a positive effect on both R&D investment and related performance, as do government subsidies. Li Wanfu, Du Jing, and Zhang Huai (2017) argued that because innovation subsidies partially crowded out enterprises' own R&D investment, enterprises' independent investment in innovation decreased with the increase of government innovation subsidies[10].The existence of opposing views may be caused by the use of data too far back and insufficient research samples. According to the existing studies and the objects

studied in this paper, it is believed that government policies represented by tax incentives and government subsidies have a positive effect on the dual innovation of enterprises, so the following assumptions are made:

H1: Government incentive policies have a positive effect on enterprise dual innovation.

H1a: Through government subsidy policy, it promotes enterprises to realize dual innovation.

H1b: Through the tax incentive policy, it promotes enterprises to realize dual innovation.

2.2.2. Differences in the effects of government policies between state-owned and non-state-owned enterprises

Due to the state-owned enterprises and private enterprises in the nature, management style, mode of operation, access to government subsidies or access to tax incentives and many other aspects there are large differences. Chen Hao Yang (2021) believes that when the intensity of the subsidy is certain, the promotion effect of government subsidies on dual innovation of non-state-owned high-tech enterprises is more significant than that of state-owned enterprises[10].Due to the difference in the natural nature of state-owned listed firms and private listed firms, this paper divides the research object into state-owned and Non-State-owned listed firms to study the difference between the role of government subsidies and tax incentives on firms' dual innovation.

H2: Government incentives have a positive effect on dual innovation in state-owned listed firms.

H3: Government incentives for non-state-owned listed firms have a driving effect on dual innovation.

3. Research design

3.1. Model design

Chen Haoyang (2021) used a univariate linear regression model in studying the effect of government subsidies on the dual innovation input of high-tech enterprises[10]. Li Meiling, Zhang Lijie, Zhang Zhuangzhuang(2022) used a linear regression model when studying the policy evaluation of government subsidies and tax incentives on exploratory and developmental innovation from a dual perspective[11].Therefore, combining the research process of scholars, this paper adopts the following model:

$$ln(RDExpenses) = \alpha_1 lnsub + \gamma_1 X + \varepsilon_1$$

$$ln(RDInvest) = \alpha_2 lnsub + \gamma_2 X + \varepsilon_2$$

$$ln(RDExpenses) = \beta_1 tax + \gamma_3 X + \varepsilon_3$$

$$ln(RDInvest) = \beta_2 tax + \gamma_4 X + \varepsilon_4$$

Where, ln(RDExpenes) refers to exploratory innovation, ln(RDInvest) refers to developmental innovation, lnsub is the logarithm of the government subsidies, tax is the tax incentives, X is the other control variables, and ε is the random perturbation term.

3.2. Indicator selection and variable design

3.2.1. Explanatory variables

Regarding tax incentives, in the past studies, most scholars use the various tax rebates received/(various tax rebates received + various taxes paid), in which the tax rebates received reflect the rebates received by the enterprise to return the value-added tax, income tax, consumption

tax and education tax surcharge, etc.; the various taxes paid refer to the taxes that the enterprise incurs and pays in the current period, the current payment of taxes and fees incurred in the previous periods as well as the taxes and fees paid in advance[11]. This measure is used in this paper. The tax benefit data can be obtained through the disclosure in the cash flow statement of the database and processed using excel.

Regarding government subsidies, Li Meiling (2022) takes the total amount of government subsidies received by enterprises each year as a measure of government subsidies[11]. Based on the research experience of previous scholars, this paper obtains the amount of government subsidies through the government subsidy items disclosed in the financial statements of companies in the Cathay Pacific database. For the convenience of empirical evidence, the logarithm is taken for government grants.

3.2.2. Explained variables

Dual innovation mainly includes both exploratory innovation and exploitative innovation.

According to Li Meiling (2022) and other studies, exploratory innovation is more risky and faces many uncertainties in the process of research and development, and thus its related costs and expenditures are counted as expensed expenditures; whereas, developmental innovation is a capital investment in which the enterprise has already had a clear direction of research and development after the uncertainties have been greatly reduced, and the related costs and expenditures are counted as capitalized expenditures[11]. Therefore, exploratory and exploitative innovations in this study are measured as expensed and capitalized expenditures, respectively, with expensed expenditures under the line item Income Statement - R&D Expenses and capitalized expenditures under the line item Balance Sheet - Development Expenses, which are available through the databases are available. For empirical purposes, logarithms are taken for both.

3.3. Data Selection and Screening

This research selects A-share main board and Kechuang board listed companies from 2012 to 2021 as the research object, excluding all ST listed companies and companies in the financial industry. The samples with missing core data and containing outliers are excluded, and finally 180 companies with 1717 sets of data are obtained as an unbalanced panel to start the study. In addition, a series of indicators are selected as control variables, including company size, gearing ratio, net profit margin of total assets, return on net assets, and so on. All data are obtained from the Cathay Pacific database (csmar) and the Warde database (wind) and are indented. The tools used mainly include stata 15 and excel 2016.

4. Empirical results and analyses

4.1. Descriptive statistics

Through descriptive statistics, the data obtained can be broadly dissected and understood.

As shown in Table 1, all expensed expenditures, capitalized expenditures and government subsidies are logarithmic for the convenience of recording descriptive statistics. The logarithmic standard deviation of expensed expenditure and capitalized expenditure of each enterprise is large, there is an overall fluctuation range, and the difference between the minimum, maximum and average value is significant. In addition, the subsidies and tax incentives given by the government vary greatly among different enterprises. The difference of enterprise size is obvious, mainly manifested in the large gap between the minimum, maximum and average value of enterprise size,

and the relatively large standard deviation. The difference between the maximum value and the minimum value of other control variables is large, and the size of standard deviation is different, which may have a certain impact on the dual innovation of enterprises. It also strengthens the confidence of this paper to study the effect of government policies on the dual innovation of enterprises in different situations. Table 1 shows the descriptive statistical results.

Table 1: Descriptive statistical table

variable name	number of observation	mean	standard deviation	minimum	median	maximum
lnRDExpenses	1717	18.169	2.073	8.479	18.226	23.934
lnRDInvest	1717	16.657	2.167	6.494	16.721	22.985
lnsub	1717	16.267	2.354	6.298	16.548	22.107
tax	1717	0.119	0.162	0.000	0.043	0.825
size	1717	23.059	2.294	0.000	22.952	28.267
top1	1717	38.163	15.804	0.000	36.700	89.090
roa	1717	0.030	0.056	-0.553	0.028	0.311
roe	1717	0.011	1.615	-66.535	0.063	0.924
growth	1717	0.074	0.337	-4.454	0.087	4.334

4.2. Benchmark regression

Using the econometric tool Stata for analysis, ordinary least squares (OLS) regression is applied for regression to explore the role of government subsidies on dual innovation.

Table 2: The role of government grants on dual innovation

	(1)	(2)
	lnRDExpenses	lnRDInvest
lnsub	0.102***	0.116***
	(3.87)	(4.25)
size	0.292***	0.209***
	(4.24)	(3.78)
top1	0.007**	-0.007**
	(2.14)	(-1.96)
roa	3.738***	2.164**
	(4.11)	(2.21)
roe	-0.051***	-0.055***
	(-7.87)	(-8.14)
growth	0.266**	-0.021
	(2.20)	(-0.13)
_cons	9.371***	10.165***
	(7.17)	(9.46)
N	1717	1717
R^2	0.163	0.078
Adj. R^2	0.16	0.07

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.001$

As shown in Table 2, according to the regression results, the regression coefficient of the logarithm of the government subsidy and the expensed expenditures is 0.102, while the regression coefficient of the logarithm of the government subsidy and the capitalized expenditures is 0.116,

which are all significant at 1% significance level, indicating that there is a significant positive effect of both the government subsidy and the tax incentives on the exploratory innovation. Since the regression coefficient of exploratory innovation is slightly smaller than that of exploitative innovation, the use of government subsidies has a more obvious effect on exploitative innovation.

Table 3: The effect of tax incentives on dual innovation

	(1)	(2)
	lnRDExpenses	lnRDInvest
tax	1.695***	1.643***
	(6.57)	(5.45)
size	0.316***	0.236***
	(4.53)	(4.12)
top1	0.011***	-0.003
	(2.88)	(-0.89)
roa	4.361***	2.791***
	(4.90)	(2.93)
roe	-0.052***	-0.055***
	(-7.75)	(-8.50)
growth	0.226**	-0.063
	(1.99)	(-0.41)
_cons	10.119***	11.061***
	(6.55)	(8.72)
N	1717	1717
R^2	0.168	0.078
Adj. R^2	0.17	0.08

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.001$

As shown in Table 3, according to the regression results, the regression coefficient between the logarithm of tax incentives and expensed expenditures is 1.695, which is significant at 1% significance level, indicating that there is a significant positive relationship between tax incentives and exploratory innovation. Meanwhile, the regression coefficient of the logarithm of tax incentives on capitalized expenditures is 1.643, which is significant at 1% level of significance, indicating that there is a significant positive relationship between tax incentives on exploratory innovations. Since the regression coefficient of exploratory innovation is slightly larger than that of exploitative innovation, the use of tax incentives is more effective for exploratory innovation.

According to the results of the two experiments, it can be seen that the regression coefficient of tax incentives on dual innovation is significantly larger than the regression coefficient of government subsidies, on the other hand, government subsidies are more effective for exploitative innovations, while tax incentives are more effective for exploratory innovations. Therefore, more attention should be paid to appropriately increasing the regulation of government subsidies and tax incentives when using government policies, and further incentivizing exploratory and exploitative innovations through vigorous government policies.

4.3. Heterogeneity analysis

Due to the differences in nature, operation mode and management mode, the implementation of incentive policies for state-owned enterprises and non-state-owned enterprises will produce large differences.

Table 4: State-owned listed enterprises: the impact of government policies on dual innovation

	(1)	(2)	(3)	(4)
	lnRDExpenses	lnRDInvest	lnRDExpenses	lnRDInvest
lnsub	0.101***	0.088***		
	(4.00)	(3.20)		
tax			1.392***	0.965**
			(3.54)	(2.27)
size	0.342***	0.249***	0.369***	0.271***
	(12.47)	(8.37)	(13.83)	(9.40)
top1	0.004	-0.014***	0.007	-0.012***
	(0.99)	(-3.17)	(1.64)	(-2.69)
roa	2.771**	3.616***	3.341***	4.040***
	(2.33)	(2.81)	(2.79)	(3.12)
roe	-0.047	-0.057*	-0.047	-0.056*
	(-1.53)	(-1.70)	(-1.53)	(-1.69)
growth	0.427*	-0.311	0.422*	-0.312
	(1.93)	(-1.30)	(1.91)	(-1.30)
_cons	8.363***	9.931***	9.142***	10.637***
	(12.73)	(13.98)	(14.89)	(16.00)
N	1162	1162	1162	1162
R^2	0.178	0.087	0.175	0.083
Adj. R^2	0.17	0.08	0.17	0.08

As shown in Table 4, for state-owned listed companies, the regression coefficient of the logarithm of government grants and expensed expenditures is 0.101, while the regression coefficient of the logarithm of government grants and capitalized expenditures is 0.088, which is a significant regression result for both government grants and tax incentives, indicating that both of them have a significant positive correlation for exploratory innovation. Since the regression coefficient of exploratory innovation is larger than that of exploitative innovation, the use of government subsidies has a more obvious effect on exploratory innovation.

Meanwhile, the regression coefficient of the logarithm of tax incentives on expensed expenditures is 1.392, which shows that tax incentives have a significant positive relationship with exploratory innovation. Meanwhile, the regression coefficient of the logarithm of government grants and capitalized expenditure is 0.965, and there is a significant positive association between tax incentives and exploratory innovation. Since the regression coefficient of exploratory innovation is larger than that of exploitative innovation, the use of tax incentives has a more obvious effect on exploratory innovation.

As shown in Table 5, for Non-State-owned Listed Enterprises, the regression coefficient of the logarithm of government grants on expensed expenditures is 0.092, and there is a significant positive association of government grants on exploratory innovation. Meanwhile, the regression coefficient of the logarithm of government grants and capitalized expenditure is 0.187, and there is also a significant positive association between government grants and exploratory innovation. Since the regression coefficient of developmental innovation is larger than that of exploratory innovation, the use of government subsidies has a more significant effect on developmental innovation.

Meanwhile, the regression coefficient of the logarithm of tax incentives on expensed expenditures is 2.251, and there is a significant positive association between tax incentives and exploratory innovations. Meanwhile the regression coefficient of the logarithm of government grants versus capitalized expenditure is 2.594, and there is a significant positive relationship

between tax incentives and exploratory innovation. Since the regression coefficient of developmental innovation is greater than that of exploratory innovation, the use of tax incentives is more effective for developmental innovation.

Table 5: Non-State-owned Listed Enterprises: the effect of government policies on dual innovation

	(1)	(2)	(3)	(4)
	lnRDExpenses	lnRDInvest	lnRDExpenses	lnRDInvest
lnsub	0.092***	0.187***		
	(2.70)	(4.85)		
tax			2.251***	2.594***
			(5.84)	(5.84)
size	0.194***	0.157***	0.202***	0.181***
	(5.84)	(4.16)	(6.34)	(4.95)
top1	0.011**	0.007	0.014***	0.012**
	(2.11)	(1.29)	(2.80)	(2.18)
roa	5.066**	0.201	5.249**	0.180
	(2.22)	(0.08)	(2.35)	(0.07)
roe	0.069	-0.323	0.532	0.379
	(0.07)	(-0.28)	(0.53)	(0.33)
growth	0.125	0.236	0.056	0.123
	(0.73)	(1.22)	(0.34)	(0.65)
_cons	11.543***	9.849***	12.382***	11.720***
	(13.71)	(10.30)	(16.83)	(13.82)
N	555	555	555	555
R^2	0.120	0.090	0.160	0.107
Adj. R^2	0.11	0.08	0.15	0.10

4.4. Robustness test

Replace the core explanatory variables and conduct the robustness test. According to the method of Li Meiling (2022), the number of patents applied for by enterprises in the year and granted in the sample period is used as the explanatory variables, i.e., the number of inventions is used for exploratory innovation, and the number of non-inventions (utility models and designs) is used for exploitative innovation. [10] According to this method, it is found that although the coefficient changes, significant results can still be obtained, which proves that the initial hypothesis is correct.

5. Conclusion and Policy Implications

5.1. Research Conclusion

Starting from the perspective of dual innovation and using theoretical analysis to propose research hypotheses, the relationship between government policies and dual innovation is empirically examined using data from A-share main board and Kechuang board listed companies from 2012 to 2021 as the research samples, further exploring the relationship between government policies and dual innovation for enterprises of different natures. The main findings show that (1) The dual innovation is actively promoted by the government policy. According to the empirical conclusions, government subsidies play a more prominent role in promoting exploitative innovation, while tax incentives play a more significant role in promoting exploratory innovation. (2) For

state-owned listed firms, the effect of government subsidies and tax incentives on exploratory innovation is more obvious. For Non-State-owned Listed Enterprises, the opposite is true: government subsidies and tax incentives play a more significant role in exploratory innovation.

5.2. Policy Recommendations

5.2.1. Insist on the implementation of government policies to further promote dual innovation in enterprises

Although China's economic and social development is currently facing bottlenecks, the fundamentals of stable and long-term economic growth have not changed, and scientific and technological innovation will remain the pillar of future development. The current government policy can effectively encourage dual innovation, but the quality of innovation is not good enough, so enterprises must focus on dual innovation, pay attention to dual innovation, and constantly increase and adjust the proportion of investment in exploratory innovation and development innovation. At the same time, we should give play to the role of government policies, adhere to the implementation of government policies, make better use of state subsidies and tax incentives, and promote the coordination of key projects and the integration of research and development activities.

5.2.2. Improve the relevance of government policies

To create a guarantee system that accurately promotes dual innovation, it is necessary to give full play to the role of government policies in guiding ex ante and incentivizing ex post. The empirical results found that developmental innovation is effectively supported by government subsidies and tax incentives. Exploratory innovation is also effectively supported by tax incentives. This indicates that government subsidies and tax incentives are obviously goal-oriented. The government should continue to formulate targeted incentive policies for exploratory and developmental innovations. Since exploratory innovation is the root of scientific and technological innovation, the government can further strengthen the development of tax incentives. At the same time, it should improve the monitoring mechanism for the implementation of policies. As exploratory innovation is the root of S&T innovation, the government can further strengthen the formulation of tax incentives, and also coordinate the corresponding government subsidies to be issued to positively promote dual innovation and negatively push back dual innovation.

5.2.3. Formulate and implement differentiated government policies

According to the empirical conclusion, state-owned listed companies play a key role in exploratory innovation, while non-state-owned enterprises prefer to carry out exploratory innovation. The research conclusion indicates that state-owned listed companies play a crucial role in exploratory innovation, while non-state-owned enterprises tend to engage more in exploratory innovation. Therefore, it is necessary to further develop differentiated corporate policies for both state-owned and non-state-owned enterprises. At present, the reform of state-owned enterprises has made major breakthroughs, and we should rely on strong policy support, make good use of their own advantages, and promote dual innovation and exploratory innovation. For non-state-owned enterprises, the biggest challenge on the road of innovation and development is the frustration of core technology research and development, we must further rationally formulate government subsidies and tax and fee reduction policies, increase the intensity of exploratory innovation incentive policies, promote joint innovation between state-owned enterprises and non-state-owned enterprises, and create new driving forces for innovation and development.

5.3. Research Prospects and Shortcomings

Through empirical analyses, this paper explores the impact of government subsidies and tax incentives on dual innovation and provides relevant policy recommendations. Next, it can further study what factors play a mediating role between government subsidies, tax incentives and dual innovation, and the further impact of dual innovation on enterprise business performance. There are also some shortcomings in this paper's research. There is room for optimization in model selection, and there may be a negative correlation between the explanatory variables and the explanatory variables after exceeding a certain interval; further optimization can be carried out in data selection and measurement.

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