Research on the Impact of Government Subsidies on the Innovation Performance of High-tech Enterprises

--Based on the Mediating Role of R&D Investment

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Abstract. The article selects 2016-2022 high-tech enterprises as the research sample, and empirically tests the influence effect of government subsidies on the innovation performance of enterprises and the mediating role of R&D investment by constructing a mediating effect model. It is found that (1) government subsidies have a promoting effect on the innovation performance of both high-tech enterprises. (2) Government subsidies can increase the R&D investment of high-tech enterprises, and (3) government subsidies can enhance the innovation performance of enterprises by increasing their R&D investment.

Keywords: government subsidies, innovation performance, R&D investment, high-tech enterprises.

1 Introduction

Innovation as a key factor for the country to enhance its international status as well as for enterprises to gain competitive advantages has become the focus of common debate between the state and enterprises. As the main force of national competitiveness, high-tech enterprises are highly valued by the government. In order to promote the process of enterprise innovation and stimulate the enthusiasm of enterprise innovation, the government has introduced a series of innovation promotion policies, and government subsidies are an important way for the government to influence the innovation activities of enterprises. Domestic and foreign scholars have been debating whether government subsidies have a "pie" or "trap" effect on firms' innovation performance for a long time and the debate continues to ferment. It has been shown that government subsidies can increase the likelihood of patent applications, and are more suitable than tax incentives for supporting innovation activities during the growth period. Some scholars have found that government subsidies hinder innovation activities, generate adverse selection, and information asymmetry between government and enterprises leads to over-investment, which not only reduces the effect of support, but also disrupts the market order. On the other hand, in the research on R&D investment on innovation performance, most of the literature has confirmed that the increase of R&D investment is conducive to technological innovation, which can directly have a positive effect on the

innovation performance of enterprises. While it is true that government subsidies can improve firms' innovation performance, they may cause firms to rely excessively on government subsidies, or some firms may use government subsidies for other activities, which may have a crowding-out effect on firms' innovation performance. Therefore, the real role effect of government subsidies needs to be further explored. Based on this, this paper takes high-tech enterprises in 2016-2022 as a research sample to explore the relationship between government subsidies, R&D investment and innovation performance, and at the same time conducts a robustness test.

2   Theoretical Analysis and Research Hypotheses

2.1   Government Subsidies and Enterprise Innovation Performance

Technological innovation activities of enterprises are high-risk investment behaviours, while government financial subsidies are conducive to correcting market failures caused by technological innovation, and have an obvious leveraging effect on the innovative activities of enterprises. Government financial subsidies and tax exemptions are important conditions to promote the rise of high-tech enterprises. Chen L[1]compared the innovation output of enterprises with access to government subsidies with that of enterprises without government subsidies, and found that the number of patent applications of the former is much higher than that of the latter, thus its conclusion that government subsidies can significantly promote the innovation output of enterprises. Gao W[2]found that the output of technological and commercial innovations gained by government-supported enterprises is significantly higher than non-government-supported firms. Others showed that firms with higher levels of government subsidies have higher patent output and significantly higher levels of R&D than firms that are not subsidised by the government. This shows that government subsidies help enterprises to carry out innovative activities and the generation of innovative results. Based on this, hypothesis H1 is proposed: government subsidies have a facilitating effect on the innovation performance of high-tech enterprises.

2.2   Government Subsidies and R&D Investment

The positive externality, high risk and uncertainty of innovation lead to the insufficient willingness of enterprises to invest in R&D under the mechanism of market competition and the low level of R&D in the society as a whole. Blankand Stigler found that there are both crowding-in and crowding-out effects of government subsidies. Hussinger, by analysing the manufacturing enterprises in Germany, concluded that public subsidies have a positive impact on the R&D expenditures of enterprises. Through the analysis of Japanese high-tech startups, SUN Yi found that there is a complementary relationship between public R&D subsidies and R&D investment of startups [3]. Jun W takes new energy enterprises as the research object and analyses the impact of government subsidies on R&D investment of small and medium-sized enterprises, and the empirical

results show that government R&D subsidies significantly promote the R&D investment of enterprises[4]. Based on this, hypothesis H2 is proposed: government subsidies can increase R&D investment of high-tech enterprises.

2.3   Mediating Role of R&D Inputs

The way of government subsidies on the innovation performance of enterprises generally includes direct and indirect effects. Ren Chang believes that the increase of R&D investment can promote the improvement of enterprise innovation performance level, the higher the enthusiasm of enterprise R&D investment, the more money invested, the more obvious the improvement of enterprise innovation performance level[5].Others showed found that government subsidies have a significant positive impact on both enterprise R&D investment and technological innovation performance, while R&D investment plays a partially mediating role in this study of government subsidies and technological innovation performance. Others showed that companies as the research object and concluded that financial subsidies play a positive incentive role on R&D investment and innovation performance, and R&D investment has a significant positive impact on enterprise innovation performance. Therefore, government subsidies achieve the role of promoting the innovation performance of enterprises through R&D investment to a certain extent, so the hypothesis H3: government subsidies enhance the innovation performance of enterprises by increasing their R&D investment.

3   Research Design

3.1   Data Source and Sample Selection

This paper selects 2016-2022 high-tech enterprises as the initial research sample, the relevant data are from the database of CSMAR, and the enterprise patent application data are from CNRDS.

3.2   Model Design

In order to test hypothesis 1, hypothesis 2, hypothesis 3 this paper constructs the following multiple regression model. Where App is the explanatory variable for firms' innovation performance, Gov is the explanatory variable for government subsidies, RD is the mediator variable for the total amount of firms' R&D investment, ε is the random disturbance term, and the other variables are control variables.

$$App_{i,t}=\alpha_0+\alpha_1 Gov_{i,t}+\alpha_2 Size_{i,t}+\alpha_3 EC_{i,t}+\alpha_4 Cash_{i,t}+\alpha_5 Lev_{i,t}+\alpha_6 Growth_{i,t}+\alpha_7 TBO_{i,t}+\epsilon_{i,t} \quad (1)$$

$$RD_{i,t}=\beta_0+\beta_1 Gov_{i,t}+\beta_2 Size_{i,t}+\beta_3 EC_{i,t}+\beta_4 Cash_{i,t}+\beta_5 Lev_{i,t}+\beta_6 Growth_{i,t}+\beta_7 TBO_{i,t}\epsilon_{i,t} \quad (2)$$

$$App_{i,t}=\theta_0+\theta_1 Gov_{i,t}+\theta_2 Size_{i,t}+\theta_3 EC_{i,t}+\theta_4 Cash_{i,t}+\theta_5 Lev_{i,t}+\theta_6 Growth_{i,t}+\theta_7 TBO_{i,t}+\epsilon_{i,t} \quad (3)$$

3.3 Definition of Variables

The explanatory variable is the innovation performance (Innovation), this paper adopts the enterprise patent applications to express the innovation performance of enterprises, using the total number of invention-type patents, utility model patents and design-type patents applied for three kinds of patents, and taking the natural logarithm of (1+the total number of patents applied for) to measure the innovation performance. The explanatory variable is government subsidy (Gov), which is measured by the logarithm of the amount of government subsidy received by the enterprise in the year. The mediating variable is research and development investment (RD), which is measured by taking the logarithm of the annual amount of R&D investment of the enterprise. Meanwhile, this paper controls for gearing ratio (Lev), cash holding ratio (Cash), Tobin's Q (TBQ), equity concentration (EC), and firm size (Size).

4 Empirical Results and Analyses

4.1 Descriptive Statistics

Table 1. Descriptive statistics

VARIABLES	N	mean	sd	min	max
App	7,232	3.940	1.488	0	7.993
gov	7,232	17.22	1.430	13.64	21.01
rd	7,232	18.86	1.348	15.81	22.90
size	7,232	22.77	1.247	20.58	26.40
EC	7,232	0.307	0.138	0.0863	0.695
Cash	7,232	0.0470	0.0587	-0.117	0.218
Lev	7,232	0.482	0.163	0.137	0.874
TBQ	7,232	1.754	0.935	0.816	6.097

Note: stata data collation

As shown in Table 1, the standard deviation of innovation performance (App) is 1.488, the mean value is 3.940, the maximum value is 7.993, and the minimum value is 0, which indicates that the innovation performance of each high-tech enterprise has a large difference but the overall level is high. The mean value of government subsidy is 17.22, the minimum value is 13.64, and the maximum value is 21.01, indicating that the government subsidy of China's high-tech enterprises is not much, and there are differences in government subsidies to different enterprises. The mean value of enterprise R&D investment intensity is 18.86, the minimum value is 15.81, and the maximum value is 22.90, which indicates that there are differences in the investment of different enterprises in R&D, and most of the enterprises have low investment in enterprise R&D.

4.2   Regression Results Test

Table 2. Baseline results

VARIABLES	(1) App	(2) rd	(3) App
gov	0.344***	0.318***	0.171***
	(0.0144)	(0.00985)	(0.0143)
rd			0.544***
			(0.0160)
size	0.387***	0.597***	0.0621***
	(0.0182)	(0.0124)	(0.0194)
EC	-0.131	-0.403***	0.0887
	(0.103)	(0.0705)	(0.0962)
Cash	-0.165	0.503***	-0.439*
	(0.251)	(0.171)	(0.233)
Lev	0.203**	-0.297***	0.364***
	(0.0972)	(0.0663)	(0.0903)
TBQ	0.0512***	0.155***	-0.0332**
	(0.0161)	(0.0110)	(0.0152)
Constant	-10.94***	-0.238	-10.80***
	(0.284)	(0.194)	(0.264)
Observations	7,232	7,230	7,230
R-squared	0.371	0.643	0.457

Robust standard errors in parentheses *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Columns (1), (2) and (3) of Table 2 represent Model I, Model II and Model III respectively. Column (1) shows that the coefficient of government subsidy is 0.344, and it is significant at 1% level, which indicates that government subsidy is significantly positively correlated with innovation performance, i.e., government subsidy has a promotional effect on the innovation performance of high and new technology enterprises, and the hypothesis 1 is verified; column (2) shows that the coefficient of government subsidy is 0.318 and it is significant at 1% level, which indicates that there exists a stronger correlation between the government subsidy and the R & D inputs, and as the government subsidies, R&D investment also increases accordingly, government subsidies can increase the R&D investment of high-tech enterprises, hypothesis 2 is established; the third column is the regression of the mediating effect of R&D investment, the regression results show that the coefficients of the government subsidies and R&D investment are 0.171 and 0.544 respectively, and they are all significant at the level of 1 per cent. It is proved that government subsidies enhance corporate innovation performance by increasing corporate R&D investment, i.e., R&D investment plays a partly mediating role between corporate ESG performance and innovation performance, and Hypothesis 2 is verified.

4.3   Robustness Tests

In order to ensure the reliability of the research results, this paper draws on the research of Hu Ding et al. to adopt the method of replacing the explanatory variables, using (1 + the number of patents granted) to take the natural logarithm to replace the original measure of corporate innovation performance, and regress the original model respectively. The test results under the premise of replacing the explanatory variables are consistent with the previous paper, also significant at the 1% level, indicating that the empirical results of this paper are robust.

5   Conclusions and Recommendations

5.1   Conclusions

Government subsidies have a promotional effect on the innovation performance of high-tech enterprises, and government subsidies can fully mobilise the enthusiasm of high-tech enterprises for technological R&D and innovation, and guide them to increase their investment in R&D and innovation. Government subsidies can increase the R&D investment of high-tech enterprises, i.e., government subsidies can alleviate the financial pressure of enterprises, so as to achieve the role of stimulating the R&D investment of enterprises. Government subsidies can enhance the innovation performance of enterprises by increasing their R&D investment, and R&D investment plays a partly intermediary role.

5.2   Recommendations

The government should increase the subsidy for high-tech enterprises, improve the subsidy policy, and establish a sound innovation performance evaluation system. To improve the subsidy policy, it can not only make reasonable subsidies from the various processes of technological R&D and innovation activities, but also adopt differentiated subsidy policies for different industries, so as to guide high-tech enterprises to develop along the correct direction of innovation. High-tech enterprises should endeavour to improve their R&D capabilities, introduce more scientific and technological talents, strengthen the innovation drive, and carry out R&D and innovation activities more actively. The R&D capability of enterprises plays a key role in successfully transforming government subsidies into innovative achievements in order to achieve the improvement of enterprise innovation performance.

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