

Research on the Effect of Government R&D Subsidies on Innovation Performance and Behavior of Enterprises

Dandan Li

Business School, Northwest University of Political Science and Law, Xi'an 710122, China

**Corresponding author e-mail:happydans@163.com*

ABSTRACT. *Based on the two aspects of government R&D subsidies on innovation performance and behavior, this paper analyzes the influence mechanism of R&D subsidies on enterprise innovation and illustrates the different mechanism of incentive effect, crowding out and signal effect, and analyzes the enterprise scale and ownership to influence the effectiveness of the government R&D subsidies. It is found that government R&D subsidies can promote and inhibit the innovation activities of enterprises, but the influence mechanisms are different. Meanwhile, differences in enterprise size and ownership nature will affect the effect of government R&D subsidies. Therefore, in order to reasonably plan the allocation of government R&D subsidies and maximize the effect, government can formulate targeted funding methods from the aspects of setting reasonable subsidy intensity and attaching importance to innovation behaviors of non-state-owned enterprises.*

KEYWORDS: *government R&D subsidies; innovation performance; innovation behavior; impact mechanism; influencing factor*

1. Introduction

Innovation leads development. In the 14th five-year Plan of the CPC, it is emphasized that scientific and technological innovation is needed to generate new growth drivers and enhance the capacity of independent innovation to build a new pattern of development in China. It is the fundamental way to improve the competitiveness of enterprises to break through the key core technology and speed up the technological breakthrough. In order to realize the strategic goal of being an innovation-oriented country in China, local governments pay more and more attention to the role of innovation in economic development, and continuously increase the economic policy of carrying out R&D subsidies to enterprises. According to the R&D database of China National Tai 'an Listed Companies, the government's R&D subsidies for Shanghai and Shenzhen A-share listed companies increased from 127 billion yuan in 2010 to 525.8 billion yuan in 2019, with an average annual growth rate of 15.7 percent. In Schumpeter's innovation theory,

however, innovation activities with a sudden and characteristics of discontinuity and innovation output by an integral sex, uncertainty, such problems as "public goods" characteristics, the influence of many enterprises in the "free rider" behavior in the innovation activities, which makes the enterprise's innovation investment is far greater than its earnings, brings the new challenges to the innovation main body and hindered the enthusiasm of independent innovation and research and development, the R&D resource configuration is lower than the social optimum. Therefore, the government needs to carry out necessary intervention and regulation to optimize the efficiency of R&D resource allocation.

Among the government's policy tools to encourage enterprises to innovate, R&D subsidy policy is more helpful for enterprises to improve the marginal rate of return on investment. It not only encourages enterprises to carry out basic and positive external R&D activities, and forms internationally competitive patented technologies, but also improves the efficiency of innovation activities in the whole society. However, from the system point of view of innovation process, R&D innovation is more complex and professional than other innovations, and information asymmetry will affect the policy effect of R&D subsidy. Government R&D subsidy will not only stimulate the innovation activities of enterprises, but also generate crowding out effect due to the influence of other factors. In addition, behavior additionality will also change the behavior of other actors towards enterprises. For example, it may change the behavior of banks towards enterprises [1]. Therefore, the effect of government R&D subsidy is not only limited to enterprises' direct reduction of R&D cost and improvement of industrialization level of innovation achievements, but also a positive signal of enterprises' good prospect of obtaining subsidies from external investors.

A large number of scholars at home and abroad have studied the impact of government R&D subsidies on enterprise innovation. In general, the research conclusions include three categories: incentive effect, crowding out effect and mixed effect of government R&D subsidies on enterprise innovation. According to the research supporting incentive effect, government R&D subsidy will promote enterprises to invest more in R&D activities, which has incentive effect on enterprises' innovation performance [2-3]. For example, Sabrina (2017) [4] believes that due to the non-competitive and non-exclusive nature of R&D, the availability of the enterprise's own R&D output is not perfect. This positive spillover effect makes the private income far lower than the social income, and the private investment is at the social sub-optimal level. R&D subsidy will make up the loss caused by technology spillover, improve enterprise R&D efficiency and promote R&D input. Bronzini and Piselli (2016) [5] measured enterprise innovation through patent behavior, and investigated the impact of R&D subsidies in northern Italy on enterprises. The results found that the government R&D subsidy program had a positive impact on the number of patents filed by the funded companies, and that the impact was much greater for small companies than for large companies, with targeted public subsidies increasing private R&D spending. Scholars who support the crowding out effect believe that enterprises are easy to establish rent-seeking relationship with the government without moral constraints, which makes the

government intervention crowd out the innovation input of enterprises[6]. Wu Hong and Yanan Zhu (2019) [7], Kai Zhao and Hongyuan Wang (2018) [8] believe that due to the existence of information asymmetry and the existence of self-interested selection procedures in government agencies, enterprises will send false information to defraud subsidies, which is not conducive to the improvement of enterprise innovation performance. In addition, the research supporting the mixed effect believes that enterprise R&D investment will be affected by many factors, and government R&D subsidy has a non-linear effect on enterprise innovation. For example, Boeing (2016) [9] studied the distribution of R&D subsidies for listed companies in China from 2001 to 2006 and the impact on the R&D investment of enterprises. The study found that R&D subsidies offset enterprises' R&D input in the short term, but were neutral in the later period. Crowding out is not common among companies that repeatedly receive R&D subsidies, high-tech companies and state-owned enterprises of ethnic minorities. Qilin Mao, Jiayun Xu (2015) [10], Yahong Zhou et al. (2015) [11] found that the effect of government subsidies was related to the scale of industrial development. In the early stage of industrial development, government subsidies could effectively promote enterprises' R&D investment, but after the expansion of industrial scale, such a positive promotion relationship was weakened.

It can be seen that existing literature confirms the existence of specific effects of government R&D subsidies on enterprise innovation. However, due to different countries, time periods and methods adopted, relevant research results have not been conclusive. Most of the researches mainly focus on the empirical test of the direct impact of R&D subsidy on enterprise innovation, while there are few researches on the internal influence mechanism of government R&D subsidy on enterprise innovation behavior and performance. At the same time, due to the different enterprise size and ownership nature, different enterprises will absorb the government's R&D subsidy effect is also different. Therefore, the main contribution of this paper is to analyze the different action mechanism of government subsidies on the innovation performance and behavior of enterprises, and further analyze the influence of the micro differences of enterprises on the effectiveness of government subsidies from the perspective of enterprise size and ownership nature. This is not only conducive to the effective arrangement of R&D subsidy policies by the government and the rational planning of the allocation of government R&D subsidy funds, but also can take targeted strategies according to the different characteristics of enterprises to maximize the effect of government subsidies, which is of great significance to the construction of an innovative country in China.

2. Analysis of impact mechanism

2.1 Impact mechanism of R&D subsidy on enterprise innovation performance

The core competitiveness of enterprises is to improve their own technical ability, and R&D innovation is the basis for enterprises to improve their technical ability. Increasing innovation investment is an important basis for enterprises to

improve the success rate of R&D projects. However, under the environment of imperfect market mechanism, enterprises are faced with difficulties such as higher risks, more uncertainties, higher input costs and insufficient protection of the property rights of R&D achievements. If there is not enough incentive or definite expectation, enterprises will have insufficient R&D investment and reduced enthusiasm, while insufficient innovation will hinder the technological progress and productivity improvement of enterprises. Government R&D subsidy plays an important role in promoting enterprise innovation and improving their technological innovation ability. Government R&D subsidy is the most effective means to correct market failure, which can stimulate enterprise innovation and make innovation R&D reach the optimal state of society. On the one hand, the government can promote enterprises to improve the patent output and the utilization efficiency of innovation resources through R&D subsidies. On the other hand, the government helps enterprises meet the demand of sufficient research and development funds, so that enterprises can improve the output value of new products.

The Impact mechanism of government R&D subsidy on enterprise innovation performance includes three kinds. First, the government directly subsidizes R&D funds to encourage enterprises to increase R&D investment, so as to improve their technological innovation ability and R&D efficiency. Enterprises need adequate financial support for R&D and innovation, while imperfect market capital and high risk limit their investment in R&D and innovation. Therefore, obtaining government R&D funds can ensure and improve enterprises' R&D funds and reduce the risks and financing costs of R&D and innovation. Through flexible use of funds, enterprises can not only optimize the R&D foundation and increase the number of R&D personnel, but also conduct cooperation and learning of external technologies, so that more high-quality resources can be injected, so as to improve the technological innovation ability of enterprises and improve the success probability of innovative projects. Second, the government shares the risks of enterprises' innovation activities through targeted procurement of new products developed by enterprises. In the early stage of R&D and innovation, enterprises will face a lot of uncertainty, which not only requires high input cost, but also takes a long time to obtain expected earnings, which increases the pressure on enterprises to carry out R&D and innovation. Government procurement of new products improves the income and enthusiasm of enterprises' R&D activities, expands the market demand for new products, and can bring about the effect of promoting enterprises' innovation output and sales revenue increase. Finally, companies receiving government R&D subsidies are required to meet specified assessment targets, which encourages them to file more patents. To some extent, this means that enterprises need to be more active in R&D projects. Through cooperation with universities and research institutes, enterprises can be encouraged to absorb new technologies and improve their ability of technology transformation, as shown in Figure 1.

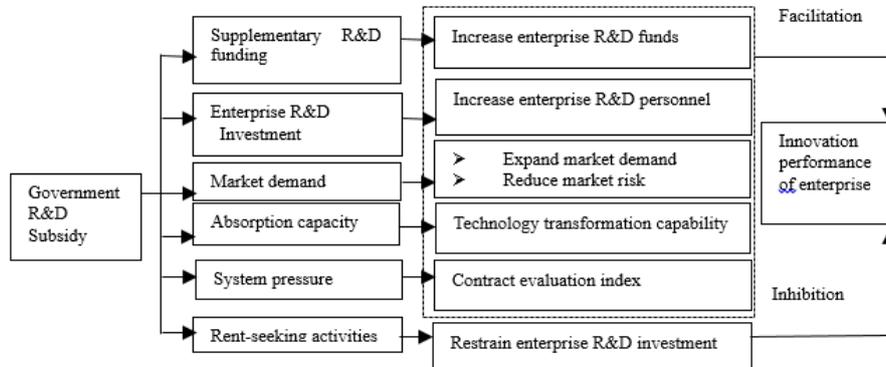


Figure. 1 Mechanism of government R&D subsidy's influence on innovation performance of enterprises

In addition, the government's R&D subsidies can also inhibit the innovation performance of enterprises. Due to the financing constraints faced by enterprises in reality, when it is easier to apply for R&D subsidies than in the capital market, there will be rent-seeking behaviors between enterprises and local governments. When the government does not have more constraints on financial expenditure, the government tends to choose the enterprises with rent-seeking relationship with the local government to grant subsidies, and determine the amount of subsidies according to the size of the rent-seeking relationship, rather than completely depending on the actual business performance and development planning of the enterprise, which has a crowding out effect on the innovation behavior and performance of enterprises to a certain extent. Min Shao and Qun Bao (2012) [12] believe that the motivation of rent-seeking behavior of enterprises will increase with the increase of government subsidies. This is because, on the one hand, the rent-seeking cost of an enterprise is directly proportional to the amount of subsidy that the enterprise wants to obtain, and the main source of rent-seeking cost is non-productive expenditure. When a higher rent-seeking cost occurs, it will crowd out the entity investment such as innovation and R&D investment of the enterprise. On the other hand, when the rent-seeking cost of enterprises is far lower than the high amount of government subsidies, enterprises can benefit from subsidies, which will induce enterprises to invest in the next round of rent-seeking behavior rather than through R&D innovation and technical level improvement to obtain excess profits. It weakens the innovation power of enterprises.

2.2 Impact mechanism of R&D subsidies on enterprise innovation behavior

Enterprises need continuous investment in innovation activities. The innovation behavior of enterprises is complex. Whether the innovation activities can bring expected benefits is facing great uncertainty. Therefore, enterprises need the

government's incentive and guidance to realize the expected innovation benefits, so that the revenue is greater than the input cost. The most direct effect of government subsidies on enterprise R&D projects is to share the R&D cost of enterprises and reduce the market risk. Especially for small and medium-sized enterprises, R&D funds need to be spent in limited funds, so they are extremely risk averse, which largely inhibits the innovation enthusiasm. Through the government R&D subsidies, the R&D cost of enterprises will be reduced, and the gap between private benefits and social benefits will be reduced. It will increase the expected rate of return of enterprises and encourage enterprises to carry out more R&D innovation. At the same time, in order to achieve the evaluation objectives of the government and continue to obtain funding, enterprises tend to choose projects with short R&D cycle and low risk, which improves the efficiency of R&D, and then increases the innovation investment of enterprises.

In recent years, scholars gradually pay attention to another role of R&D subsidies, and prove that government R&D subsidies can provide external investors with selection criteria for R&D projects, and promote subsidized enterprises to attract more external investment. There is information asymmetry among different innovation subjects, and R&D projects generally have high risks. Investors should be cautious in R&D investment. Due to the limitation of professional knowledge, it is difficult for external investors to evaluate the strengths, weaknesses and expected returns of R&D projects. Even if the borrower has promised a high expected return, the existence of asymmetric information will lead to potential lenders' internal risk of R&D, which limits their financial support for R&D projects. On the other hand, for R&D intensive enterprises, due to the positive externality of R&D activities, R&D activities involve many technical details and core secrets. For the purpose of self-protection, enterprises will not disclose a large amount of R&D information, which further leads to information asymmetry between enterprises and investors. At this time, R&D subsidies can play an important role in verifying the quality and technical advantages of the company's R&D projects. The government is equivalent to the signal sender in the market, that is, R&D subsidy can obtain subsidies from external investors for enterprises with good prospects as a positive signal. Signal effects generally work in two ways. First, in order to make the subsidy have a positive impact on the project, the government will strictly review and evaluate the innovation project, and send the government quality certification signal to the external market. A perfect R&D project identification standard system can transmit the evaluation results of the government to external investors in the form of R&D subsidies. The government has a greater incentive to review projects than market-based fundraisers, because private fundraisers have different target functions and may have free riding problems. Experts in the government have considerable insight into which companies and technologies are most promising, while external investors have limited value for traditional financial statement analysis. Therefore, in high-tech industries or emerging markets, when projects are difficult to evaluate, government R&D subsidies are more important to ensure private funding. Secondly, because the government does not directly compete with enterprises, enterprises are more willing to provide relevant R&D information to the government rather than external investors. The government has an information advantage over private

financiers because they receive a lot of subsidy applications from enterprises, which contain more information about enterprises than they are published to the public. Enterprises must provide a lot of first-hand information about R&D projects before they can apply for R&D subsidies. R&D information from enterprises can not only help enterprises obtain government subsidies, but also avoid the leakage of private capital in the process of social financing, thus reducing information asymmetry, as shown in Figure 2.

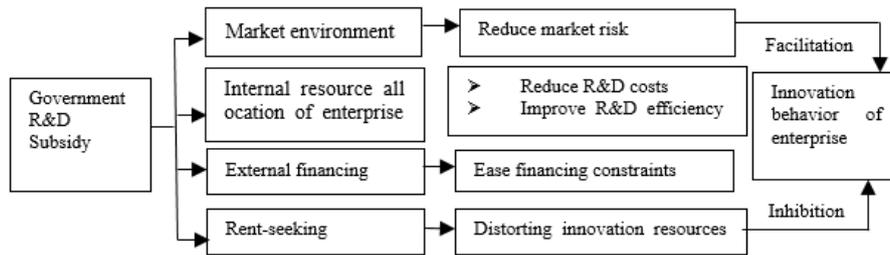


Figure 2 The influence mechanism of Government R & D subsidy on enterprise innovation behavior

Therefore, obtaining the certification of government R&D subsidies has a positive effect on enterprise innovation behavior. The evaluation of institutions is related to the commercialization potential, private investors will think that the winning projects are more valuable, and the government's choice of R&D projects is considered more accurate and fair, which can provide valuable investment signals for external investors. The signal effect of government R&D subsidies reduces the degree of information asymmetry between enterprises and investors. It is believed that enterprises with government R&D subsidies have higher R&D prospects and management capabilities, which can alleviate the financing constraints of enterprises. In addition, due to the selectivity of R&D subsidies to enterprises, it will induce rent-seeking behavior and distort innovation resources.

3. Factors affecting the effectiveness of government R&D subsidies

3.1 Enterprise scale

According to Schumpeter's innovation theory, large-scale enterprises have obvious resource advantages compared with small enterprises. On the one hand, benefiting from the economies of scale and scope, large enterprises are more efficient in engaging in high-risk and high investment R&D activities, and have the ability to adopt more active technology innovation strategies, which makes the R&D spillover effect between different departments more obvious. On the other hand, after large enterprises obtain R&D funding, the financing constraints are alleviated. By investing innovation resources into new innovation fields, private R&D

investment of enterprises can be promoted. Therefore, the size of enterprises is positively related to government R&D effect[13].

3.2 Nature of ownership

With the development of market-oriented reform and the common development of various ownership economies, due to the differences in the nature of enterprise ownership, enterprises have different resources, objectives and financial constraints, resulting in different effects of R&D subsidies. Among them, state-owned enterprises and private enterprises dominate the national economic development and are in a common competitive position in the industry. There are differences in the resource mechanism and signal transmission of R&D subsidies between the two types of enterprises.

In terms of the resource mechanism for obtaining R&D subsidies, state-owned enterprises have obvious advantages over private enterprises in terms of resource endowment. On the one hand, state-owned enterprises are usually controlled or operated by the local government. when they face losses, they often obtain various government subsidies, and there are many channels for obtaining resources. After obtaining the government's R&D subsidies, it is easy to cause the problem of resource redundancy. Meanwhile, state-owned enterprises lack of effective supervision mechanism, and there are some problems such as distorted objectives, imperfect incentive mechanism and restraint mechanism of management. It will lead to state-owned enterprises to obtain compensation through rent-seeking. R&D subsidies play a weak driving role, and even inhibit the innovation incentive effect of subsidies. On the contrary, for private enterprises, due to their own resource disadvantages, obtaining subsidies means that the enterprises have obtained the recognition of the government and the market. Most of the private enterprises are facing the problems of lack of resources and financing difficulties. Therefore, once the R&D subsidies are obtained, the private enterprises will treat the R&D subsidies carefully, actively improve the innovation performance of enterprises, and expect to continue to receive government subsidies. They have greater autonomy and flexibility in the implementation of innovation activities and strategies, which can effectively promote the transformation of existing innovation resources into innovation output.

In terms of signal transmission, compared with private enterprises, the signal effect of R&D subsidies is not so urgent. The state-owned enterprises can maintain the control, development and direct investment of strategic industries and undertake some goals of the government, such as resource protection, maintenance of important industries, property rights distribution of national resources, etc. Therefore, in this respect, the government has more motivation to support state-owned enterprises. In addition, state owned enterprises may exaggerate R&D investment to obtain government subsidies by taking advantage of information advantages, so as to induce more R&D subsidies. In terms of power allocation, in order to develop local economy, local governments also have the motivation to obtain more resources from the central government. Therefore, R&D subsidy policy tends to favor state-owned

enterprises. For private enterprises, because the market is competitive market, obtaining government subsidies can represent the recognition of the government and the market. Private enterprises can change their competitive strategy through sufficient innovation resources, and more actively participate in innovation activities to improve innovation performance. Therefore, for private enterprises, the signal effect of government subsidies will be further amplified, and the growth of innovation performance will be faster.

4. Research conclusions and policy implications

In the process of implementing innovative strategy in China, the R&D subsidies issued by the government are increasing day by day. How to reasonably plan the allocation of government R&D subsidies and make effective use of R&D resources are of great significance to enhance the international competitiveness of enterprises. From two aspects of the impact of government R&D subsidies on enterprise innovation performance and innovation behavior, this paper deeply analyzes the different influence mechanisms of government R&D subsidy effect, clarifies the different mechanism of incentive effect, crowding out effect and signal effect, and analyzes the influence of enterprise scale and ownership on the effectiveness of R&D subsidy. The results show that the impact mechanism of R&D subsidies on innovation performance and behavior of enterprises are different. At the same time, the effect of R&D subsidies will be affected due to the differences in technology experience reserve and the ability to transform experience technology into innovation activities. Compared with the state-owned enterprises, government subsidies play a more important role in promoting the innovation performance of private enterprises.

Based on the above conclusions, the policy implications of this paper include: 1. In order to effectively utilize the effect of R&D subsidies, it is necessary to set appropriate government subsidy intensity, so as to effectively stimulate enterprise innovation. The government can evaluate the enterprises according to the situation of enterprises as the basis of subsidies, regulate the qualification evaluation mechanism of subsidies to reduce the rent-seeking behavior of enterprises, and introduce dynamic subsidy adjustment mechanism to determine the subsidy intensity. 2. The government needs to make R&D subsidies more inclusive and explore various channels of financial support policies, and formulate more targeted incentive policies according to the size of enterprises, demand and sensitivity to policies. 3. The subsidy policy should be inclined to the non-state-owned enterprises with strong R&D strength and efficiency. The government should implement certain tax relief and subsidy policies for high-quality non-state-owned R&D projects, and guide universities, scientific research institutions and other social resources to gather in non-state-owned enterprises, so as to improve the effectiveness of government subsidies.

Acknowledgements

This work was supported by special project of humanities and social sciences in Shaanxi Province "Research on interactive integration of producer service industry and manufacturing industry in Shaanxi Province" (20JK0402) ; Soft science project of Xi'an Science and Technology Bureau "Research on the impact of government R&D subsidies on innovation behavior and performance of enterprises" (20RKX0048) .

References

- [1] M.Meuleman,W.D. Maeseneire(2012).Do R&D subsidies affect SME's: access to external financing. *Research Policy*, vol.41, no.3, p. 580-591.
- [2] F.B.Zhang, H.Z.Wang Huizong(2019). R&D enterprise investment, government funding and innovation performance from the perspective of heterogeneity: An Empirical Study Based on micro panel counting model. *Economic and management review*, vol.35, no.2, p.80-92.
- [3] D.X.Wang, X.Li (2017). Government subsidies, political connections and enterprise innovation investment. *Financial research*, vol.35, no.40, p.79-89.
- [4] H.T. Sabrina(2017). Financing Innovation: Evidence from R&D Grants. *American Economic Review*, vol.107, no.4, p. 1136-1164.
- [5] R.P.Bronzini(2016). The impact of R&D subsidies on firm innovation.*Research Policy*, vol.45, no.1, p. 442-457.
- [6] P.David P ,B.Hall ,A.A. Toole(2019).Is Public R&D a Complement or Substitute for Private R&D? A Review of the Econometric Evidence.*Research Policy*, vol.29, no.1, p.497-529.
- [7] H.W.Qiao, Y.N.Zhu(2019). Can tax sharing incentive promote the innovation of listed companies? *Economic and management review*, vol.35, no.1, p.83-94.
- [8] K.Zhao, H.Y.Wang(2018). Bidirectional dynamic coupling and nonlinear relationship between Government R&D subsidy policy and enterprise innovation decision .*Economic theory and economic management*, vol.329, no.5, p. 45-58..
- [9] B.Philipp(2016). The allocation and effectiveness of China's R&D subsidies -Evidence from listed firms. *Research Policy*, vol.45, no.5, p.1774-1789.
- [10] Q.L.Mao, J.Y.Xu(2015). The impact of government subsidies on enterprise new product innovation: Based on the perspective of "moderate range" of subsidy intensity. *China industrial economy*, vol.35, no.6, p.94-107
- [11] Y.H.Zhou,Y.L.Pu,S.Y. Chen (2015). Government support and new industrial development - Taking new energy as an example .*Economic research*, vol.50, no.6, p.147-161.
- [12] M.Shao, Q.Bao (2012). Government subsidies and enterprise productivity: An Empirical Analysis Based on China's industrial enterprises. *China industrial economy*, vol.25, no.7, p.70-82.
- [13] M.Hirschey,H.Skiba ,M.B.Wintoki(2012).The size,concentration and evolution of corporate R&D spending in US firms from 1976to 2010: Evidence and implications. *Journal of Corporate Finance*,vol.18, no.3, p.496-518.