Economics
2024, Vol. 13, No. 1, pp. 22-31
https://doi.org/10.11648/j.eco.20241301.13

Research Article

Government R&D Subsidies and Firms' Innovation Performance: Empirical Evidence Based on Listed Companies in the New Energy Industry

Deng Wenyi*

School of Accountancy, Hunan University of Technology and Business, Changsha, China

Abstract

At present, China is actively changing the original energy consumption structure, reducing the use of traditional fossil energy and vigorously promoting the green development of new energy. To stimulate technological innovation and promote economic growth is the direction and principle of the current industrial policy, and to increase the investment of R&D funds and enhance the independent innovation ability is the way to accelerate the construction of China's core competitive strength, so it is necessary to scientifically assess the impact of government R&D subsidies on the innovation performance of enterprises. The government's investment of R&D funds also plays an important role in the new energy industry, which is characterized by technological innovation, government R&D funding also plays an important role in the new energy industry characterized by technological innovation. In this paper, we select the panel data of listed companies in the new energy industry from 2006 to 2020 as the research object to empirically analyze the relationship between government R&D subsidies and corporate innovation performance. Based on the results of benchmark regression in this paper, the overall results show that government R&D subsidies are conducive to the improvement of corporate innovation performance in the new energy industry. This study aims to explore the effect of government R&D subsidies on enterprise innovation performance and put forward feasible suggestions to understand the role of government subsidies in the process of enterprise R&D and innovation activities from a deeper perspective.

Keywords

Government R&D Subsidies, Corporate Innovation Performance, New Energy Industry

1. Introduction

Nowadays, countries around the world are in a new period of rapid development of economic globalization, with fierce competition in both domestic and foreign markets. Influenced by the new round of scientific and technological revolution and industrial change, China's economic model is striding towards the direction of high-quality development, and the industrial development model continues to be transformed and upgraded from "Made in China" to "Created in China", and technological innovation has gradually evolved into a strategic issue for the realization of industrial civilization in the process of China's industrial development. Technological innovation has gradually evolved into a strategic

*Corresponding author: 943856011@qq.com (Deng Wenyi)

Received: 27 February 2024; **Accepted:** 21 March 2024; **Published:** 25 March 2024

issue for the realization of industrial civilization in the process of China's industrial development [1]. As an important way to promote high-quality development and build a new development pattern in China, innovation can effectively alleviate the series of problems such as optimization of economic structure and replacement of growth momentum that need to be solved in the process of transformation. As a new driving force for development and a new competitive advantage in the future, strategic emerging industries have naturally attracted much attention, and the new energy industry, a typical representative of which, has become a high point for governments to compete in the new generation of energy technologies.

In 2016, multiple governments signed the Paris Agreement in response to the climate change crisis, which has since started a new process of actively promoting green development and low-carbon transition [2]. According to the 2023 Global Carbon Neutrality Annual Progress Report released by Tsinghua University's research team, as of September 2023, more than 150 countries around the world have put forward carbon neutrality targets and sought zero-carbon transition, covering more than 80% of the world's CO_2 emissions, GDP, and population, while 86% of the world's carbon emission intensity has shown a downward trend. As a participant and leader in responding to the cause of sustainable development and global climate change, China is actively changing its original energy consumption structure, which is characterized by high energy consumption and high emissions, reducing the use of traditional fossil energy sources, and promoting technological innovation and upgrading of the industrial structure, in order to satisfy the requirements of carbon emission limitation and reduction of carbon footprint [3]. The proposal of "dual-carbon" goal has already become the main keynote of China's future economic and social development, and is bound to have a far-reaching impact on the innovation and development of China's new energy industry.

Innovation-driven era, our government attaches great importance to the development of new energy industry, China has become the world's largest energy producer and consumer for many years. However, it is worth emphasizing that China's new energy overall scientific and technological innovation capacity compared to other energy powers in the world there is still a large gap, specifically in the enterprise R&D investment is insufficient, the key core technologies and core components rely on imports easy to encounter the "neck" problem and so on [4]. At the same time, the new energy technology research and development process is inherently risky and complex, coupled with the uncertainty of innovation activities and technology spillover and other characteristics, resulting in new energy industry usually exists in the R&D investment in endogenous power problems. Therefore, in order to make up for the market defects, our government usually chooses to promote the development of new industries by means of financial subsidies [5]. However, how to evaluate the implementation effect of the financial subsidy policy, whether the long-term subsidy will make enterprises over-dependence and form new overcapacity, how to supervise and punish fraudulent subsidy, etc. are all widely disputed and need to be solved urgently. Therefore, it is necessary to explore how to effectively play the leverage role of the government in allocating subsidized innovation resources, and it is of great theoretical and practical value to study in depth the innovation effect of the government's R&D subsidies and the role of innovation drive mechanism.

In view of this, this paper selects the panel data of listed companies in the new energy industry from 2006 to 2020 as the research object to empirically analyze the relationship between government R&D subsidies and corporate innovation performance. This study aims to explore the effect of government R&D subsidies on enterprise innovation performance and put forward feasible suggestions, to understand and appreciate the role of government subsidy behavior in the process of enterprise R&D and innovation activities from a deeper perspective.

2. Literature Review

Numerous scholars have conducted a series of studies on the impact of government R&D subsidies on firms' innovation performance, but the views held are divergent.

Most foreign scholars agree with the view that government R&D subsidies can enhance the innovation performance of enterprises, and they believe that government R&D subsidies can achieve the effect of supporting the innovation activities of enterprises and reducing the burden of capital turnover, and the enterprises can use the subsidies to adjust the scale of their own production and operation, and they can also use the subsidies to carry out R&D and innovation activities, and update the technology of the enterprise, so as to achieve the ultimate goal of improving the efficiency of production and operation. amp; Roper Through a study of manufacturing plants in Northern Ireland, it was found that government subsidies can increase the added value of products [6]. Tello Studying the results of Peru's 2004 Science, Technology, and Innovation (STI) survey showed that large firms are more likely to invest in STI projects, that the size of the firm is associated with the likelihood of technological and non-technological innovations occurring, and that the STI investment intensity and government R&D subsidies both incentivize the likelihood of firms to innovate and increase their investment [7]. Cin et al. find, through extensive research, that government-issued subsidies can lead to productivity gains for small and medium-sized manufacturing firms in South Korea [8]. Minford and Meenagh find that R&D subsidies can incentivize innovation while also promoting productivity Even if R&D subsidies were reduced, they would still have a long-term impact on UK economic growth [9].

However, in the process of research, some researchers have found that government subsidies do not enhance the

performance of enterprises in some cases. Bergstrom takes the data of Swedish companies as a sample, and finds that government financial subsidies have both short-term and long-term effects on the performance of enterprises. From the short-term perspective, financial subsidies can promote the rise of business capacity and also make the enterprise performance grow; but from the long-term perspective, the positive effect will not last long, and will gradually disappear or even turn negative at the later stage [10]. Le & Jaffe take the innovation output and financial subsidies of New Zealand manufacturing and service industry companies as the research object, and find that R&D subsidies significantly increase the likelihood of patenting, as evidenced by firms' patenting activities as well as the introduction of new products. However, R&D subsidies still have some limitations, i.e. the positive impact due to government R&D subsidies is not fully demonstrated in firms' trademark application process [11].

Domestic scholars hold different views on the effect of government R&D subsidies on the innovation performance of enterprises, and there are mainly the following views: the first view is supported by most scholars, that the two are positive linear relationship, and the government R&D subsidies can significantly promote the innovation performance of enterprises; the second view is that there is a linear relationship between the two, but the two are negatively correlated, and they believe that the R&D subsidies will inhibit The second view is that there is a linear relationship between the two, but they are negatively correlated, and they believe that R&D subsidies will instead inhibit the growth of enterprises' innovation performance, which is only supported by a few scholars; the third view is that there is no significant correlation between the two; and the fourth view is that the relationship between the two is non-linear, and that the relationship between the two will be different under different subsidy intensity.

Similar to the research results of foreign scholars, most scholars in China also support that government R&D subsidies have a promoting and enhancing effect on enterprise innovation performance. An Tongliang et al. analyzed and researched the R&D subsidy issue by establishing a dynamic asymmetric information game model, and the study proposed that the remuneration of professionals should be increased to solve the problems of false signals released by enterprises and adverse selection [12]. Fan Qi and Han Minchun analyzed the relationship between the two by using panel data from various provinces, and the results showed that government R&D subsidies can greatly improve the country's innovation performance [13]. Zhou Haitao and Zhang Zhengang showed that direct subsidies, such as cash subsidies, can lead to a more rapid improvement in the innovation performance of enterprises than other forms of subsidies. At the same time, the sensitivity of enterprises to subsidies varies according to their size and stage of development, with enterprises in the growth stage being more sensitive to direct subsidies, and large companies being more susceptible to indirect subsidies such as tax incentives [14]. Gao Xiuping and Peng Yuelan selected the disclosure data of new energy automobile listed companies to analyze whether the government tax policy affects the performance of enterprises, and the results show that the preferential policy can improve the enterprise solvency and independent innovation level, but can not improve the profitability of the enterprise in a relatively short period of time [15].

In China, some scholars are skeptical about the ability of government R&D subsidies to promote enterprise innovation performance. They believe that the process of subsidization will generate problems such as information asymmetry and adverse selection, which are very likely to hinder the development of enterprise performance. Meanwhile, in the actual operation process, there are a few enterprises that rely excessively on government subsidies and divert R&D subsidies to make up for their own losses, which in the long run leads to a lack of intrinsic motivation for enterprise development, and a few enterprises that cheat subsidies by forging projects. Peng Yi and Hu Jianfeng take the comprehensive performance score as the predicted variable, and the conclusion shows that the current government subsidy support does not have a significant contribution to performance, but rather has a negative impact [16]. Zhou Fangzao et al. used total factor productivity as an evaluation index to further study the production efficiency of enterprises, and found that the government's use of direct subsidies hinders the improvement of enterprise production efficiency [17].

With the depth of research, some scholars found that the two are not simply linear, but also affected by multiple factors such as political connections, firm size, and firm attributes. Yu Minggui et al. and Wu Chengsong et al. both further analyzed the relationship between government subsidies and innovation performance from the perspective of political connections, and found that firms with connections to the government could obtain more subsidies, but the subsidies did not bring actual performance improvement to the firms, on the contrary, firms with no political connections had a significant increase in firm performance after obtaining subsidies [18, 19]. Zhu Zhili et al. found through research that the government's act of granting subsidies inadvertently produces a guiding effect of information transfer to investors, and this guiding effect can to a certain extent solve the problem of information asymmetry between investors and firms. Although the effect of government R&D subsidies on the innovation performance of enterprises can not be clearly reflected in the short term, the government's initiative of targeted subsidies, the guidance effect on investors can also incentivize enterprises to innovate [20].

3. Research Design

3.1. Sample Selection and Data Sources

Considering that there are significant changes in the treatment of R&D expenses in the 2006 enterprise accounting standards, and only after that China's listed enterprises disclose relevant data in a more systematic way, while controlling the impact of the equity separation reform on the enterprises, the selection of the samples in this paper begins in 2006. This paper selects the data samples of listed companies in new energy enterprises from 2006 to 2020, mainly to study the link between innovation performance and government R&D subsidies in new energy enterprises. In order to ensure the accuracy and authenticity of this study, the data selected in this paper have been excluded from the sample of disorder or abnormality, ST and S companies, and enterprises with serious missing data such as R&D expenses. The data of government R&D subsidy expenses in this paper mainly come from the annual reports presented by relevant enterprises, the database of Cathay Pacific and Flush, etc.; the data of patents applied by innovation performance companies mainly come from the national intellectual property website. This paper utilizes STATA and EXCEL software to process the data.

3.2. Selection and Definition of Variables

This paper investigates the impact of the relationship between government R&D subsidies and firms' innovation performance, with government R&D subsidies as an explanatory variable and firms' innovation performance as an explanatory variable. The description of the variables is as follows:

3.2.1. Explained Variables

Through reviewing the literature, we found that previous scholars chose to use market performance indicators, enterprise product sales revenue, and the number of patent applications as indicators reflecting the innovation performance of enterprises. This paper draws on the practices of Wen Jun and Feng Genfu and Jiang Xuanyu to measure the innovation performance of enterprises with two standards, one is to enter from the perspective of innovation input, selecting the R&D intensity of enterprises to measure the innovation input of enterprises, and using the percentage of R&D expenses to operating revenue as the research data; the other is to enter from the perspective of innovation output, using the number of invention patent applications (Invention patent) to measure the innovation performance of enterprises; the other is to enter from the perspective of innovation output, using the number of invention patent applications to measure the innovation performance of enterprises [21, 22]. The other is from the perspective of innovation output, using the number of invention patent applications (Invention patent) to measure the output of enterprise innovation, the data of this index is the natural logarithm of the number of invention patent applications. In China, the identification of invention patents is very strict, and the novelty and practicality of patents will be strictly evaluated, so the number of patent applications can reliably reflect the innovation performance of enterprises.

3.2.2. Explanatory Variables

The explanatory variable is Government R&D Subsidy (GRDS). Government subsidies for enterprise R&D activities are mainly in the form of direct subsidies, usually through direct financial allocations, tax incentives and other means, to provide material support for the development and production of new products. This paper draws on the research methods of Yu Minggui et al. and Guo Yue, and organizes the data of "non-operating income - government subsidies" and related subsidies in the financial statements of new energy enterprises in the income statement [18, 23].

3.2.3. Control Variables

Based on other studies in the literature on the relationship between government R&D subsidies and firms' innovation performance, this paper selects several other factors that may affect the results as control variables.

(1) Enterprise Size. Most of the large-scale enterprises have strong financial strength and material background, with a certain ability to bear the risks arising from R&D activities, and secondly, the advantage of enterprise economies of scale can win more government R&D subsidies. However, there is also a disadvantage of large-scale enterprises, the proportion of R&D expenses to the total expenses of the enterprise is low, which will have a negative effect on the enterprise's R&D investment. Smaller firms have a simple structural hierarchy and are more likely to carry out R&D activities if they have sufficient R&D investment. This paper uses the natural logarithm of the firm's total assets as the measure.

(2) Nature of enterprise ownership (SOE). Enterprises of different natures have different motivations when dealing with government-issued R&D subsidies, and there are also differences in the direction of interests pursued by state-owned enterprises and private enterprises. The government prefers to invest subsidies in enterprises with high relevance to its own development, so as to realize the long-term development of the economy driven by policies. This paper adopts a dummy variable to measure, that is, when the enterprise is a state-owned enterprise, SOE takes the value of 1, and when it is a non-state-owned enterprise, SOE takes the value of 0.

(3) Age of the business. The economic situation and the problems faced by a business vary according to its age. If the enterprise was established earlier and has good business conditions, it is in the growth or maturity period. This type of enterprise, with rich accumulation

of market resources, has a better ability to prevent risks than other enterprises, and can effectively use subsidies to carry out innovative activities. In this paper, we use the natural logarithm of the current year minus the year of establishment plus one.

(4) Gearing ratio (Lever). The gearing ratio is an important indicator for assessing the financial risk of an enterprise, and is a key reference for the Government in selecting the recipients of subsidies. It is usually considered that maintaining the gearing ratio at 50% is most conducive to an enterprise's development. If the gearing ratio of the selected enterprise is too high, it indicates that the enterprise is under great pressure of debt, and the use of funds is severely restricted, which inhibits its R&D activities and makes it difficult for the government to see the effect even if it invests in subsidies. This paper uses the ratio of total liabilities to total assets of the company to measure.

(5) Employee wages (Wage). The lack of high-tech talents in the new energy industry leads to an increase in the employment cost of enterprises, while enterprises may choose to reduce R&D activities or move subsidies to other sectors in order to maximize profits. This operation will weaken the effect of the government's policy of subsidizing innovative activities. In this paper, we use the natural logarithm of the compensation payable by firms.

3.3. Econometric Modeling

This paper builds the following econometric model to examine the impact of government R&D subsidies of new energy firms on their corporate innovation performance by drawing on the setting methods of Wanfu Li et al. and Yue Guo [23, 24]:

$$\text{R\&Dintensity}_{it} = \alpha_1 + \alpha_2 \text{GRDS}_{ct} + \delta \text{Control}_{it} + \lambda_i + \omega_t + \mu_{it} \quad (1)$$

$$\text{Invention\_patent}_{it} = \beta_1 + \beta_2 \text{GRDS}_{ct} + \delta \text{Control}_{ijct} + \lambda_i + \omega_t + \mu_{it} \quad (2)$$

Where "i" represents "enterprise", and "t" represents "year"; R&Dintensity denotes the intensity of R&D investment, which represents the innovation input of the enterprise; Invention patent denotes the number of invention patent applications, which represents the innovation output of the enterprise; GRDS is the governmental R&D subsidy; Control is the control variable at the enterprise level, which includes the enterprise size, the nature of ownership (SOE), the age of the enterprise (Age), the gearing ratio (Lever), and the wages payable (Wage); λ and ω are the enterprise and year fixed effects respectively; μ Control is the firm-level control variables, which include firm size (Size), nature of ownership (SOE), age of the firm (Age), gearing ratio (Lever), and wages payable by the firm (Wage); λ_i and ω_t are the fixed effects of the firms and the year, respectively; and μ_{it} is the random error term.

3.4. Descriptive Statistics

Table 1 demonstrates the descriptive statistics of the main variables in this paper. As can be seen from Table 1, the mean value of R&D intensity is 0.0293, and the standard deviation is 0.0233, indicating that R&D intensity has a large difference among new energy listed companies. The mean value of Invention patent is 2.7709, the median is 1.9459, and the standard deviation is 1.5768, indicating that invention patent also has a large difference among new energy listed companies. The mean value of Invention patent is 2.7709, the median is 1.9459, and the standard deviation is 1.5768, indicating that the invention patent has a big difference among new energy listed companies.

Table 1. *Descriptive statistics of major variables.*

variable	N	mean	median	sd	min	max
R&Dintensity	661	0.0293	0.0314	0.0233	0.0000	0.1516
Invention patent	636	2.7709	1.9459	1.5768	0.0000	7.1562
GRDS	727	9.2613	7.2110	3.7164	2.9134	21.5685
Size	757	22.6188	21.7818	1.0604	20.1015	25.9941
SOE	757	0.4663	0	0.4992	0	1
Age	661	2.7698	2.7081	0.2891	1.6094	3.2958
Lever	757	0.5210	0.3970	0.1718	0.0827	0.9560
Wage	733	7.7503	7.1602	2.0077	-1.1409	12.7597

4. Analysis of Empirical Results

4.1. Analysis of Baseline Regression Results

In order to verify the relationship between government R&D subsidies and corporate innovation performance of new energy enterprises, this paper conducted a regression analysis of Eq. (1) and Eq. (2) using a two-way fixed effects model. The regression results are reported in Table 2, where the explanatory variables are R&Dintensity and invention patent, columns (1) and (2) are the estimation results without adding control variables but controlling for individual firm fixed effects and year fixed effects; columns (3) and (4) are the estimation results with adding other control variables and controlling for individual firm fixed effects and year fixed effects; columns (3) and (4) are the estimation results with adding other control variables and controlling for individual firm fixed effects and year fixed effects. (1) and (2) are the estimation results without control variables but controlling for firm individual fixed effects and year fixed effects; columns (3) and (4) are the estimation results with other control variables and controlling for firm individual fixed effects and year fixed effects. As can be seen from the estimation results in Table 2, the estimated coefficients of GRDS, which is the focus of this paper, are significantly positive in all regression results, indicating that the increase of government R&D subsidies for new energy enterprises significantly promotes the R&D intensity and invention patent applications of enterprises, i.e., improves the innovation performance of enterprises, under the condition of controlling other variables unchanged, and that the empirical results are not changed due to the fact of whether or not to control other variables, indicating that the estimation results are robust and robust. change, indicating that the estimation results are robust. In this paper, the most rigorous estimation results in columns (3) and (4) are analyzed as the benchmark regression results, from which it can be seen that new energy enterprises can significantly improve their R&D investment intensity and the number of invention patent applications after obtaining government R&D subsidies, from the size of the estimated coefficients of GRDS, for every 1% increase in government R&D subsidies obtained by new energy enterprises, their R&D investment intensity significantly increases by 0.27%, while the number of its invention patent applications significantly increases by about 9.62%, which can indicate that the government R&D subsidy promotes the increase of innovation investment of new energy enterprises while also improves the output of substantive innovation achievements of enterprises. In conclusion, based on the results of the benchmark regression, the overall results show that the government R&D subsidies for new energy enterprises can promote the improvement of their innovation performance.

Table 2. *Benchmark regression results.*

variant	(1)	(2)	(3)	(4)
	R&Dintensity	***Invention patent***	***R&Dintensity***	***Invention patent***
GRDS	0.0024***	0.1071***	0.0027***	0.0962**
	(0.0006)	(0.0358)	(0.0006)	(0.0397)
Size			-0.0054*** (0.0019)	0.0092 (0.1427)
SOE			0.0017	-0.6428**
			(0.0040)	(0.2799)
Age			-0.0185	-1.3138
			(0.0125)	(0.9456)
Lever			-0.0125**	1.0237**
			(0.0063)	(0.4513)
Wage			-0.0008**	0.0246
			(0.0004)	(0.0283)
constant term (math.)	0.0112**	1.8437***	0.1934***	5.0345
	(0.0045)	(0.3234)	(0.0544)	(4.0547)
firm fixed effect	containment	containment	containment	containment
time fixed effect	containment	containment	containment	containment

variant	(1)	(2)	(3)	(4)
	R&Dintensity	***Invention patent***	***R&Dintensity***	***Invention patent***
sample size	631	622	610	545
adj. R^2	0.725	0.782	0.755	0.760

Note: Robust standard errors are in parentheses in the table; *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

4.2. Robustness Analysis

In order to verify the robustness and reliability of the benchmark regression results, this paper also conducts the following robustness tests.

First, the proxies for the explanatory variables are replaced. In this paper, the natural logarithm of R&D expenditures (R&D_exp) is used as a proxy for the explanatory variables to regress the benchmark model. Column (1) of Table 2 shows the above regression results, and it can be found that the estimated coefficient of government R&D subsidy (GRDS) is still positive and significant at the 10% statistical level, which is consistent with the previous benchmark regression results. Second, the estimation method is replaced. As the number of invention patent applications used in this paper is a non-negative integer before the natural logarithm, in order to improve the accuracy of the estimation results, this paper adopts the Poisson model to estimate the invention patent application variable without the natural logarithm; further considering that the variance of the number of invention patent applications without the logarithm is larger than the mean, and there may be over-discrete problems, so it is estimated by the use of the negative binomial model. Columns (2) and (3) of Table 3 report the above regression results, and it can be found that the estimated coefficients of government R&D subsidies (GRDS) are still significantly positive, which indicates that the findings results and conclusions of this paper will not change due to the change of the estimation method, and proves the robustness of the results. Third, the core explanatory variables are replaced. In order to prevent the endogenous bias in the estimation results due to the measurement error of the core explanatory variables, because this paper adopts the ratio of government R&D subsidies to total assets (GRDS_ratio) to serve as a proxy for the core variables, and re-estimates empirically, and the regression results are reported in Columns (4) and (5) of Table 3, which show that, regardless of whether the explanatory variables are the R&D intensity or the invention patent application number, the estimated coefficients of GRDS_ratio are significantly positive, which is consistent with the benchmark results and proves that the research findings are very robust.

Table 3. *Robustness test results.*

variant	**Replacement of explanatory variables**	**Replacement of estimation methodology**		**Replacement of explanatory variables**	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
	R&D_exp	**Poisson regression (physics)**	**negative binomial regression (NBR)**	**R&Dintensity**	**Invention patent**
GRDS	0.0553*	0.1765***	0.1825***		
	(0.0317)	(0.0342)	(0.0374)		
GRDS_ratio				0.1024***	10.2860***
				(0.0296)	(1.9274)
constant term (math.)	-11.5799***	-1.9308*	-2.6015**	0.1523***	3.1831
	(1.7996)	(1.0468)	(1.3088)	(0.0542)	(3.8863)
control variable	containment	containment	containment	containment	containment
firm fixed effect	containment	containment	containment	containment	containment

	Replacement of explanatory variables	Replacement of estimation methodology		Replacement of explanatory variables	
variant	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
	R&D_exp	**Poisson regression (physics)**	**negative binomial regression (NBR)**	**R&Dintensity**	**Invention patent**
time fixed effect	containment	containment	containment	containment	containment
sample size	610	608	608	610	545
adj. R2	0.838	-	-	0.750	0.770

Note: Robust standard errors are in parentheses in the table; *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

5. Conclusions of the Study

Many scholars at home and abroad have carried out research on the relationship between government R&D subsidies and corporate innovation performance, here this paper draws on the theoretical research ideas of relevant scholars, selects the panel data of listed companies in the new energy industry from 2006 to 2020 as the object of research, and through a series of research, mainly draws the following conclusions:

First, government R&D subsidies can promote the increase in the number of patents of enterprises, and government R&D subsidies are positively correlated with the innovation performance of enterprises. From the data of this paper, it can be seen that new energy enterprises can significantly increase the intensity of R&D investment and the number of invention patent applications after obtaining government R&D subsidies. And the relevant data show that government R&D subsidies not only promote the increase of innovation investment of new energy enterprises, but also improve the output of substantive innovation achievements of enterprises.

Second, there is a positive correlation between government R&D subsidies, enterprises' actual R&D investment and enterprises' innovation performance, and the three can promote each other. At the same time, there is a certain lag in the impact of government R&D subsidies on the actual R&D investment of enterprises and in stimulating the actual innovation performance of enterprises.

Thirdly, in the new energy industry, private enterprises with short years of experience, small scale and low human resource costs reflect the most significant effect of government R&D subsidies. However, in reality, the government has its own preference in granting R&D subsidies, so such enterprises often cannot get more subsidy support and their R&D activities are restricted.

6. Policy Recommendations

In response to the conclusions drawn from the data in this paper, it can be seen that in the new energy industry, R&D subsidies granted by the government have a positive incentive effect on the innovation performance of enterprises. This incentive is affected by a variety of factors such as enterprise size, nature and age. This paper proposes the following policy recommendations with regard to the problems shown by the theoretical data and the actual situation:

First, the government appropriately increases financial input and reasonably allocates the share of R&D subsidies. At present, in the world, the shortage of fossil energy as well as a series of pollution problems, so that people are more deeply aware of the development of new energy is the development of production of a long-term solution. Compared with the data of previous years, in recent years, China's government for the new energy industry, the total amount of financial subsidies has increased significantly, but compared to other developed countries, the gap is still large. Enterprise innovation is the main driving force to promote technological development, subsidies are an important basis to ensure the ability to innovate. Therefore, according to the data analysis: the government should follow the trend of the times to appropriately increase the investment of funds, and a reasonable allocation of the share of subsidies, focusing on enterprise R&D departments to set up a "special" subsidy program, so as to further mobilize the enthusiasm of enterprise R&D and innovation.

Second, enterprises to strengthen R&D capital investment efforts, focusing on the efficiency of capital use. As an important part of the costs of emerging enterprises, R&D costs are an important cornerstone for innovative activities. Firstly, enterprises themselves should strive to enhance their awareness of innovation and deeply realize that the investment of R&D funds can effectively promote their innovative activities, thus enabling them to have long-term profitability as well as to occupy the relevant advantages in market competi-

tion. Secondly, it is necessary to pay attention to the efficiency of the use of subsidized expenses. Enterprises need to regularly review and supervise the use of special funds in place and thoroughness, can focus on the use of funds and the use of the scope of the destination, to ensure that the government R&D subsidies on the existence of enterprise innovation performance to promote the positive development.

Thirdly, the government increases the monitoring of capital investment and pays attention to the feedback of enterprise performance. To truly enhance the innovation performance of enterprises in China's new energy industry, it is not enough to increase subsidy funds for industry companies. When the government studies the issuance of enterprise subsidy projects, it should assess the overall decision-making from multiple factors such as the age of the enterprise and the size of the enterprise, urge the enterprise to report the progress of the project in a timely manner, and publicize the use of funds on a regular basis. At the same time, substantial rewards can be taken for enterprises with good feedback on innovation performance, and the amount of subsidies can be increased in the next stage of subsidies according to the needs of enterprises. With regard to the output of enterprises' innovation performance, it is not only necessary to assess the increase in the number of patents, but also to select indicators to measure the quality of patents, so as to further systematically test the patent output effect of the government subsidies and the intrinsic influence mechanism.

Fourth, the government improves and perfects the penalty mechanism, and strictly disposes of the enterprise's fraudulent subsidy behavior. The face of the new energy industry frequently appear "subsidy" fraud, should cause the relevant departments of vigilance. The current market lacks the corresponding penalty mechanism is the main reason for the existence of corporate fraud. The government to increase supervision, improve the penalty mechanism is to ensure that the R&D subsidies are not diverted by enterprises for other important protection. Sound penalty mechanism includes the following aspects: first, the government departments to delineate the scope of violations and illegal factors, improve the violation of the penalty regulations; second, in the issuance of subsidies, the relevant departments should be clearly informed of fraudulent subsidies to enterprises in serious violation of China's laws and regulations, and will be subject to substantial penalties if violated. Finally, the illegal enterprises in strict accordance with the law, the degree of punishment should be appropriate to the degree of violation.

Abbreviations

R&D: Research and Development
GRDS: Government R&D Subsidy
SOE: Nature of enterprise ownership

Author Contributions

Deng Wenyi is the sole author. The author read and approved the final manuscript.

Conflict of Interest

The authors declare no conflicts of interest.

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