The Influence of Government Subsidies on the Development of New Energy Vehicle Industry

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Abstract Accelerating the cultivation and development of new energy vehicles will not only effectively alleviate the energy and environmental pressures, but also foster new economic growth points and international competitive advantages of China's automobile industry. This paper makes a quantitative analysis of the economic performance and growth ability of new energy vehicle listed companies, and draws a conclusion. The government subsidy has a significant negative correlation with enterprise economic performance and enterprise growth ability, indicating that there are problems in China's subsidy system. Government in support of listed companies, at the same time, also should help them to improve the core competitiveness. Improving the regulatory mechanism, transforming the mode of subsidies and promoting the ability of the independent research and development of enterprises can also help enterprises to achieve economies of scale.

Keywords Subsidy · New energy vehicle · Enterprise · Economic performance · Enterprise growth ability

1 Introduction

Since the 21st century, the security of oil and gas resources has become a major hidden danger for China's economic development. In 2015, China's oil consumption external dependence reached 60.6%. The development of new energy has a strong strategic significance for China. New energy vehicles use unconventional vehicle fuel as their power source, or use conventional vehicle fuel, but the use of new vehicle power device, advanced technical principle, with new structure, new technology of the car.

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Most consumers hold a wait-and-see attitude towards new energy vehicles. There are three reasons. First, the price of new energy vehicles after subsidies will still be more than 50,000 yuan higher than that of traditional cars with the same configuration. Second, the charging infrastructure is not perfect, and incomplete charging facilities or long charging time will also affect consumers' purchasing behavior. Third, the current battery has a shorter range. New energy vehicles are a rare field in which Chinese cars can surpass developed countries, and China may make up for or even surpass the gap with powerful countries. Government subsidy support is of great significance to new energy vehicles, but the government's choice of subsidy intensity and form remains to be explored.

China's new energy vehicle subsidy policy can be divided into two stages. From 2009 to 2012, it is a heavily subsidized stage to implement demand-based policies; after 2012, a supply policy has been implemented to gradually reduce subsidies. Through quantitative analysis, this paper empirically analyzes the data of 19 new energy vehicle listed companies from 2009 to 2016, and discusses the impact of government subsidies on the two aspects of enterprise economic performance and enterprise growth ability. It provides reference for the government to adjust subsidy intensity, improve subsidy forms and allocate resources efficiently. It also avoids the unilateral conclusion that the subsidy policy of new energy vehicles is "effective" or "invalid".

2 Literature Review

There is still disagreement over whether the government should subsidies the new energy and car industry, and scholars have not agreed on the choice of subsidies, and the review of the following literature and abroad is mainly discussed in terms of the necessity and subsidy of subsidies.

2.1 The Need for Government Subsidies for the New Energy Vehicle Industry

Through qualitative interview and quantitative research, McKinsey & Company believes that subsidy policy can promote the growth of new energy vehicle sales. Li and Wang [1] believe that scientific and reasonable subsidy policies can effectively stimulate enterprises, enable the government and enterprises to complete resource integration, and enhance the core competitiveness of China's new energy automobile industry. Gu [2] believes that the research and development and promotion of new energy vehicles are of great significance for promoting economic development and protecting the ecological environment, and government subsidies are very necessary. Peneder [3] pointed out that subsidies would effectively stimulate

enterprise R&D investment, thus promoting the growth of economic benefits of enterprises. Liang [4] believes that the concept of Chinese consumers is far behind the development speed of the industry in the field of new energy vehicles. Government subsidies can promote the purchase of consumers and realize the transition from the new energy vehicle industry to the mature stage.

2.2 Subsidy Method for New Energy Vehicles

The innovation ability of Chinese new energy enterprises is generally low, and the role of government subsidies in promoting the innovation activities of new energy enterprises has not been effectively played. According to Wang [5], there is a problem that the subsidy targets are not comprehensive. There is no capital subsidy or allocation for the enterprises producing spare parts, and there are few subsidies for subsequent corresponding links. Gillian [6] found that short-term government subsidy policies are able to promote the improvement of new energy vehicle technology, and the promotion effect of subsidy policies on vehicle technology gradually weakens with time. Liao [7] proposed that the threshold of subsidies should be raised to strengthen the management and supervision of the mode and actual utilization of subsidies. Zhang and other scholars [8] believe that the dynamic subsidy mechanism will be better than the static subsidy mechanism, and the government should start from the field of market demand and attach importance to enterprises with excellent performance.

To sum up, it is still controversial whether government subsidies can promote the development of new energy automobile enterprises. Current research mainly focuses on the theoretical aspects, lacking of in-depth study on the new energy vehicle subsidy policy, and has not yet formed a complete theoretical system.

3 Theoretical Analysis and Research Hypothesis

3.1 Theoretical Analysis

The new energy automobile industry is a strategic emerging industry, the core of development is technological innovation, and the new technology benefits the society far more than the individual benefits, but the enterprise will have a technical spilt in the production and development, and the positive externalities will be generated, causing market failures. The effective measures to solve externalities are government subsidies, which make up for the marginal private income less than the marginal social income, and realize the maximization and scale effect of social welfare. This is based on the theory of financial subsidies for new energy cars, but government subsidies can lead to crowding out and discourage companies from technological innovation.

3.2 Research Hypothesis

Under the background of China's special economic system, wind power industry, photovoltaic industry and other new energy industries have seen explosive growth in recent years, and new energy vehicle industry is no exception. From 2010 to 2015, the total amount of government subsidies received by listed new energy vehicle enterprises in China reached 51.568 billion yuan. As a result of the government's strong subsidies, enterprises rushed to obtain subsidies regardless of the actual effect of subsidies. Some enterprises even made use of loopholes in the current policies to make false declarations and other "cheat subsidies". Therefore, the government's heavy subsidies are likely to lead to enterprises' pursuit of short-term interests and blind production without technological innovation, resulting in a large number of homogenization overcapacity in the new energy vehicle industry. From the original data of the sample enterprises, the economic performance of each enterprise is not ideal, and it is preliminarily judged that the huge subsidy has not played its due role. This paper attempts to deeply explore whether the government's active intervention in the new energy vehicle industry promotes the economic performance and scale expansion of enterprises, so the following hypotheses are proposed:

H_{1a}: Government subsidies are significantly negatively correlated with the economic performance of new energy vehicle enterprises.
H_{1b}: Government subsidies are significantly negatively correlated with the growth capacity of new energy vehicle enterprises.

According to the externality theory, government subsidies can solve the externality problem of enterprises, so enterprises will have enough enthusiasm to carry out scientific and technological innovation, and technological innovation can help enterprises reduce costs, thus achieving scale effect. As a technology-intensive industry, new energy vehicle industry will lose its core competitiveness if it fails to take the lead in the technology field. By comparing and analyzing whether government subsidies have a more significant promoting effect on the return on assets and scale expansion ability of enterprises with strong R&D ability, this paper further explores the influence of government subsidies on the economic performance and growth ability of enterprises, and puts forward the following hypotheses:

H_{2a}: Government subsidies are significantly positively correlated with the economic performance of enterprises with strong R&D capabilities.
H_{2b}: There is a significant positive correlation between government subsidies and the growth capacity of enterprises with strong R&D capacity.

The research framework of the paper is shown in Fig. 1.

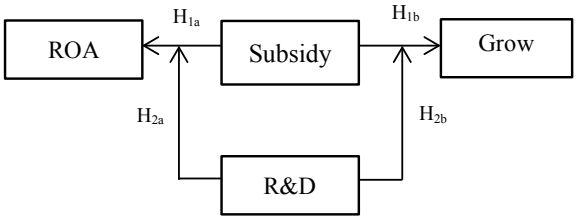

Fig. 1 The research framework

4 Empirical Analysis

4.1 Sample Selection and Data Sources

The sample enterprises in this paper are selected from the list of complete vehicle manufacturing enterprises of new energy vehicles in stock markets of Shanghai and Shenzhen. Based on the main business income of each enterprise and the new energy vehicle model catalog issued by the state, 19 sample enterprises are selected according to the availability of data to analyze the relevant data from 2009 to 2016. The situation of sample enterprises is shown in Table 1.

The selection of listed enterprises as research objects in this paper depends on their financial situation, the openness of enterprise information, and the accuracy of data. Data Total assets, total liabilities, development expenditure, operating income and net profit are all selected from the annual reports of the listed companies of the Securities Star. Some enterprises are listed late, and the main financial data are compiled according to the annual reports and financial statements of the official website of the company.

Table 1 Basic information of sample enterprises

CODE	Operating income in 2016	CODE	Operating income in 2016
000559	10,785,821,704.5	600066	35,850,442,042.7
000625	78,542,441,757.2	600104	746,236,741,228.6
000800	22,709,984,165.5	600166	46,532,069,535.5
000868	4,757,326,623.7	600213	3,395,743,970.3
000967	9,257,190,233.1	600303	3,736,692,124.8
002594	103,469,997,000.0	600418	52,490,556,761.3
600686	21,827,961,681.6	601238	49,417,676,151.0
000550	26,633,948,551.0	000572	13,890,070,950.7
000980	1,693,500,373.8	600006	16,018,020,957.6
601633	98,443,665,116.0		

[a] The data source: The database of CSMAR

4.2 Definition of Indicator

Explained variable: refer to the index selection method of Liu Jibing [9], This paper uses return on total assets (ROA) to represent the economic performance of enterprises. The growth ability of an enterprise (Grow) refers to the future development trend and development speed of the enterprise, and the ability of the enterprise to expand its operation. This article uses the expansion of the enterprise scale to express it.

Explanatory variable: subsidy, including subsidies directly allocated by the central and local governments. Research and Development Costs (R&D) is the part that can be capitalized in the development of intangible assets.

Control variable: This paper mainly controls the characteristic variables at the enterprise level, Including the age of the business, the scale of the enterprise, based on the enterprise division method issued by the Ministry of Industry and Information Technology, measures the scale of the enterprise by operating income (Size); financial leverage, this paper takes the ratio of total annual liabilities to total assets (Lev) as a measure (Table 2).

4.3 Model Building

According to the above research assumptions and variable Settings, the following regression model is established in this paper:

$$ROA_{it} = \alpha_0 + \beta_1 Subsidy_{it} + \lambda_1 Age_{it} + \lambda_2 Size_{it} + \lambda_3 Lev_{it} + \varepsilon_{it} \quad (1)$$

Table 2 Variable declaration

Variable	Index definition
Explained Variable:	
ROA	Corporate return on total assets
Grow	(Total current operating income-Total revenue of the previous period) /Total revenue of the previous period
Explaining variable:	
Subsidy	Central and local subsidies
R&D	The research and development cost
Control variable:	
Age	The establishment period of the enterprise
Size	Operating income
Lev	Asset-liability ratio

$$ROA_{it} = \alpha_0 + \beta_1 Subsidy_{it} + \beta_2 R\&D_{it} + \lambda_1 Age_{it} + \lambda_2 Size_{it} + \lambda_3 Lev_{it} + \varepsilon_{it} \quad (2)$$

$$Grow_{it} = \alpha_0 + \beta_1 Subsidy_{it} + \beta_2 R\&D_{it} + \lambda_1 Age_{it} + \lambda_2 Size_{it} + \lambda_3 Lev_{it} + \varepsilon_{it} \quad (3)$$

$$Grow_{it} = \alpha_0 + \beta_1 Subsidy_{it} + \beta_2 R\&D_{it} + \lambda_1 Age_{it} + \lambda_2 Size_{it} + \lambda_3 Lev_{it} + \varepsilon_{it} \quad (4)$$

In (1) to (4), I represented enterprise, t represented time. It is the random disturbance term. Considering the problem that some index values are too large or the units are not uniform, this paper takes the logarithm of the data corresponding to explanatory variables and control variables, so the above four models are all semi-logarithmic models. Model 1 is used to test H_{1a}; Model 3 is used to test H_{1a}; Model 2 was used to test H_{2a}; Model 4 is used to test H_{2b}.

4.4 Data Description

The minimum value of ROA is −0.13, the maximum is 0.18, and the 75th quantile is 0.08, so there is a big gap in the economic performance of each company. The standard deviation of grow is 0.25, which is relatively stable. The 75-digit quantile is 0.32, and the maximum value is 1.25, indicating that the growth capacity of new energy auto companies is generally low, and the gap between strong companies and other companies is too large. The profit of some companies is negative, which may be caused by poor sales in the current period. In terms of control variables, there is a large difference between the minimum and maximum values of Age and Lev, indicating that the control variables have large changes in time or space, but the fluctuations are not significant. The standard deviation of size data is large, indicating that the scale difference between new energy auto companies is obvious.

The mean value of ROA of enterprises with development expenditure is the same as the general situation, and the standard deviation is 0.04. Compared with the general situation, the fluctuation is smaller, but its minimum value is larger. The average grow value is 0.19, which is larger than the average grow value (0.17), indicating that the new energy automobile enterprises attach importance to R&D and innovation ability have stronger overall economic performance and growth ability. The standard deviation of enterprise development expenditure data is 1.61, with the maximum value of 21.86 and the minimum value of 14.69, indicating that there is a huge gap between enterprises in development expenditure (Fig. 2).

It is basically possible to exclude outliers and calculation errors, and these data can be used for subsequent analysis. In addition, this study further gives a scatter plot of the correlation of these variables. We can only see that the size of the firm has a positive correlation with the age of the enterprise and the subsidies. There is

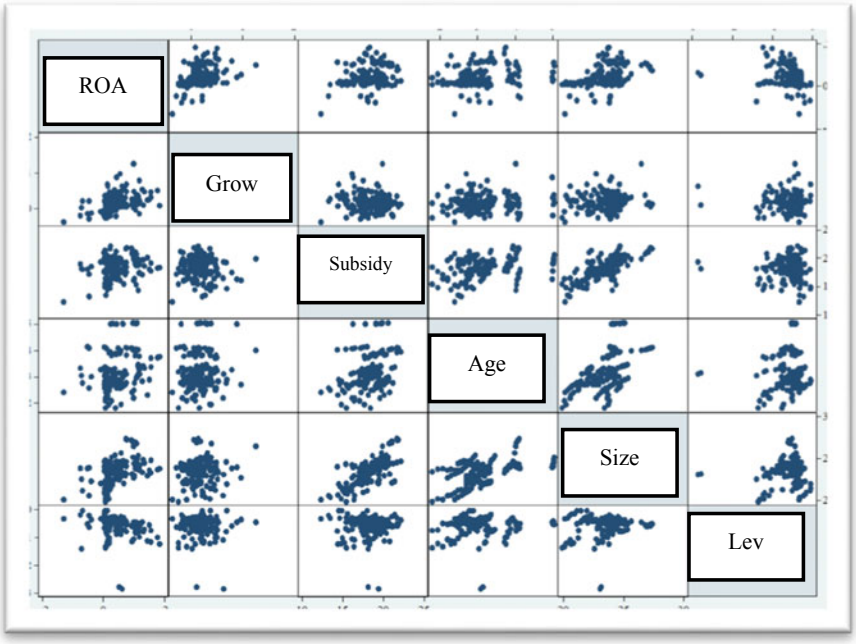

Fig. 2 Scatter plots of all variable correlations

not a clear correlation between subsidies and the economic performance of enterprises or the ability of enterprises to grow, which indicates that government subsidies have not significantly promoted the economic performance of enterprises and the Growth of enterprises. The preliminary judgment assumes that hypothesis H_{1a} and H_{1b} are established.

5 Analysis Method and Empirical Test

5.1 Analytical Method

In order to test the influence of government subsidies on the economic performance and growth capacity of enterprises, this paper selected relevant panel data from 2009 to 2016 for analysis. Panel data have two dimensions of cross section and time, which can solve the problem of missing variables. The missing variables are often caused by unobservable individual differences or "heterogeneity". The regression analysis of panel data is mainly divided into fixed effect model and random effect model. If the intercept term representing individual heterogeneity is related to an explanatory variable, it is called a "fixed effect model"; if it is not related to all explanatory variables, it is called a "random effect model". In this

paper, Hausman test is used to select the appropriate model. The null hypothesis of Hausman test is that there is no fixed effect, and the estimation result of random effect should be used. The fixed-effect model is consistent whether the null hypothesis is true or not. If the null hypothesis is not true, the random-effect model is inconsistent. If the null hypothesis is true, the random-effect model is more effective than the fixed-effect model. In addition, in this paper, the method of IPS is used to conduct the unit root test on the data. The hypothesis of IPS test is that the unit root exists in H_0. If the p value is greater than 0.05, the null hypothesis cannot be rejected and the data is non-stationary.

5.2 *Test Ideas*

In Table 3, model 1 does not include any control variables, enterprise age is added to model 2, and enterprise size is added to model 3. Model 4 further introduces financial leverage as a control variable. Model 5 introduces the explanatory variables R&D based on the relevant data of some enterprises with development expenditures, thus testing the impact of government subsidies on the economic performance of enterprises with strong R&D capabilities, and also analyzing the effect of development expenditures on economic performance of enterprises. The analysis of the growth ability of enterprises in Table 4 is the same.

Table 3 Empirical results of enterprise economic performance

Explained variable	ROA				
Variable	(1)	(2)	(3)	(4)	(5)
Subsidy	−0.00435*	−0.0027*	−0.00636***	−0.00809***	−0.00808**
	(0.00236)	(0.00255)	(0.00237)	(0.00227)	(0.00368)
Age		−0.035	−0.100***	−0.0231*	−0.249***
		(0.0214)	(0.0222)	(0.0127)	(0.0489)
Size			0.0437***	0.0320***	0.0672***
			(0.00756)	(0.00559)	(0.0121)
Lev				−0.0395***	−0.0277**
				(0.0104)	(0.0123)
R&D					0.00866***
					(0.00309)
Constant	0.126***	0.207***	−0.542***	−0.506***	−0.752***
	(0.043)	(0.0655)	(0.142)	(0.106)	(0.235)
IPS	−1.16365	−15.7726***	−13.6555***	−12.2191***	−14.1582***
Hausman	7.38**	10.13**	14.22***	10.52*	22.62****
Remark	FE	FE	FE	RE	FE

[b.] *Note:* (1) ***, **, *are significant at the level of 1, 5 and 10%, respectively. (2) Hausman represents the statistic of Hausman test, FE and RE represents the fixed effect and the random effect. (3) IPS test showed that the data was stable

Table 4 Empirical results of enterprise growth capability

Explained variable	Grow				
Variable	(1)	(2)	(3)	(4)	(5)
Subsidy	−0.0516***	−0.0232*	−0.0596***	−0.0609***	−0.0704**
	0.0177	0.0127	0.0161	(0.0162)	(0.0284)
Age		0.0466	−0.0174	−0.0150	−0.0128
		0.0367	0.0421	(0.0432)	(0.0567)
Size			0.0867***	0.0888***	0.139***
			0.0253	(0.0257)	(0.0515)
Lev				−0.0468	−0.147
				(0.0607)	(0.0934)
R&D					0.0400*
					(0.0238)
Constant	1.12***	0.45**	−0.715*	−0.777*	−2.70**
	0.324	0.224	0.415	(0.427)	(1.24)
IPS	−4.8287***	−18,778***	−16.2536***	−14.5445***	−15.4200***
Hausman	6.39**	5.66	8.94*	8.79	10.65*
Remark	FE	RE	RE	RE	RE

[c.] *Note:* (1) ***, **, *are significant at the level of 1, 5 and 10%, respectively (2) Hausman represents the statistic of Hausman test, FE and RE represents the fixed effect and the random effect (3) IPS test showed that the data was stable

5.3 *Empirical Test*

In Table 3, the results of Models (1)–(5) show that the coefficient of government subsidies are all negative, and both are significant at different levels of 1%–10%, indicating that the government has made a large amount of financial subsidies for listed companies of new energy vehicles. However, it did not achieve good results. Taking Model 4 as an example, government subsidies are significantly negatively correlated with the economic performance of new energy auto companies at the level of 1%, with a coefficient of −0.00809, because the model is a semi-logarithmic model, and the explanatory variable changes when the relative variable is interpreted. Absolute quantity, so for every 1% increase in government subsidies, the economic performance of enterprises will fall by 0.0000809 units. Explain that the government subsidies obtained by new energy auto companies have reduced corporate performance and confirmed the hypothesis H_{1a}.

In terms of control variables, the enterprise age coefficient is significantly negatively correlated with the enterprise economic performance at the level of 10%, while the enterprise size is significantly positively correlated with the enterprise economic performance at the level of 1%. In line with the theory of scale economy, the improvement of production efficiency brought by the expansion of production

scale can achieve the purpose of reducing average cost, increasing profit space and improving the economic performance of enterprises. In terms of financial leverage, the asset-liability ratio is significantly negatively correlated with the economic performance of new energy automobile enterprises at the level of 1%, with a coefficient of −0.0395.

In model 5, the government subsidy coefficient is negative and significant at 5%, indicating that there is a significant negative correlation between government subsidies and economic performance of companies with strong R&D capabilities. However, government subsidies have not produced positive effects, but have adversely affected the technological innovation of enterprises.

In Table 4, the coefficient of government subsidies in Models 1–5 are all negative, both of which are significant at different levels of 1%–10%, further indicating that the government's huge subsidies for listed companies of new energy vehicles have not achieved the desired results. Similarly, in the model 4 cases, the coefficient of government subsidy (−0.0609) is significantly negatively correlated with the growth capacity of enterprises at 1%, indicating that for every 1% increase in government subsidies, the growth capacity of enterprises will decrease by 0.000609 units, indicating that new energy vehicles The government subsidies obtained by the enterprises hindered the expansion of the scale of production and confirmed the hypothesis H_{1b}.

The samples in model 5 are enterprises with development expenditure, and government subsidies are significantly negatively correlated with the growth ability of enterprises. However, the coefficient of government subsidies is very small different from that in model 2, which further indicates that government subsidies do not play their due role in the growth ability of new energy automobile enterprises with strong development ability. Development expenditure plays a significant role in promoting the growth ability of enterprises, with a coefficient of 0.04, indicating that enterprises can enhance their competitiveness through increasing R&D and technological innovation. There is a significant positive correlation between the size of an enterprise and its growth capacity at the level of 1%, and the coefficient is 0.0888, indicating that larger enterprises have stronger growth capacity, and the improvement of production efficiency brought by the expansion of production scale can achieve the purpose of reducing the average cost, thus improving the profit level and helping enterprises to achieve the scale effect.

5.4 Empirical Result

Based on the empirical analysis of relevant data of listed new energy enterprises, this paper studies the impact of government subsidies on the economic performance and growth capacity of enterprises. The empirical results are summarized as follows:

Firstly, government subsidies do not contribute to the development of new energy vehicle enterprises, but have an inhibitory effect, which confirms the

hypothesis H_{1a} and H_{1b} and exposes the drawbacks and deficiencies of China's new energy vehicle subsidy system.

Secondly, the age of the company is significantly negatively correlating with economic performance. The reason may be that the long-established enterprise management model is backward and cannot adapt to market changes quickly, resulting in poor management. There is no significant correlation between the age of the enterprise and the growth ability of the enterprise. It may be that the development of the enterprise tends to be stable, and the influence of the age of the enterprise on the expansion of the scale of the enterprise gradually disappears. The size of the firm has a positive effect on economic performance and growth ability, in line with the theory of scale effect. The lower the asset-liability ratio of a company, the smaller the financial risk is, which is more conducive to the growth of the company's economic performance, and the company can use government subsidies more effectively.

Thirdly, R&D can promote the improvement of enterprise economic performance and the expansion of enterprise scale. Government subsidies are also significantly negatively correlated with the economic performance and growth capacity of enterprises with strong R&D capacity, which is inconsistent with hypothesis H_{2a} and hypothesis H_{2b}. The inconsistency between the effect of government subsidies and the expected results is probably due to the fact that subsidies crowd out the investment of private capital in R&D activities, which verifies the results obtained from the theory of crowding out effect in the above theoretical analysis, and indicates that there are problems in the selection of objects of government subsidies.

6 Conclusions and Policy Recommendations

Based on the current research results, this paper analyzes the impact of government subsidies on the economic performance and growth capacity of enterprises, and conducts an empirical test, and draws the following conclusions and Suggestions:

Firstly, although government subsidies can stimulate to some extent, "all-inclusive" subsidy system [4] and imperfect regulatory mechanism will cause enterprises to slack in operation and management and trigger a large number of "cheat subsidy" behaviors [10]. China's current subsidy system is not reasonable, and enterprises often adopt low-price and homogeneous competition to obtain subsidies [11], which eventually leads to enterprises' neglect of long-term interests and loss of sustainable development ability. Government subsidies are prone to low efficiency and other problems. Lax supervision will lead to dependence of some enterprises and insufficient motivation for subsequent development.

Secondly, the new energy vehicle industry is a technology-intensive industry, and the enterprise's early-stage research and development investment cost is very large. Government subsidies have no positive impact on the operation of enterprises with strong research and development ability, indicating that the subsidies do not

provide targeted effective incentives to enterprises. The ways and targets of subsidies still need to be improved, and the maintenance of intellectual property rights should be paid attention to, and special subsidy funds should be given to key technology research and development areas.

Thirdly, the empirical results show that the enterprise scale effect has played. The significant negative correlation between the age of enterprises and the economic performance of enterprises indicates that some enterprises with long years of establishment are likely to have problems such as backward management modes. Enterprises also need to carry out management mode reform to adapt to the current market environment, strengthen the research and development of cutting-edge technologies, and improve their core competitiveness.

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