The Impact of Financial Support on Innovation Efficiency of Government Subsidies From the Perspective of DEA-Tobit——An Empirical Study Based on Chinese New Energy Vehicle Enterprises

Sha Zhang
Central South University of Forestry and Technology
Fang Chen (1506333599@qq.com)
Central South University of Forestry and Technology

Research Article

Keywords: Financial support, DEA-Tobit perspective, Government subsidies, Innovation efficiency, New energy vehicle enterprises

Posted Date: September 27th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-829271/v1

The impact of financial support on innovation efficiency of government subsidies from the perspective of DEA-Tobit ——An Empirical Study Based on Chinese New Energy Vehicle Enterprises

Sha Zhang, Fang Chen

The first author:

Sha Zhang School of Economics, Central South University of Forestry and Technology

E-mail:1506333599@qq.com

Corresponding author:

Fang Chen School of Economics, Central South University of Forestry and Technology

E-mail:18373216563@163.com

Abstract: The new energy vehicle enterprises is a strategic emerging industry in China, so more and more government subsidies to promote innovative development are being accepted by new energy vehicle enterprises. What is the innovation efficiency of new energy vehicle enterprises receiving government subsidies? With the acceleration of the process of global economic financialization, whether financial support can promote the innovation efficiency of government subsidies and how enterprises should allocate financial assets have become issues that need to be deeply considered. Based on the annual report data of China's domestic listed new energy vehicle enterprises from 2015 to 2020, the relationship between government subsidies and enterprise innovation efficiency is empirically tested, and the impact of financial support on enterprise R&D innovation efficiency is investigated. The empirical results show that government subsidies are wasteful and fail to effectively promote R&D innovation, and the innovation efficiency of government subsidies is positively influenced by firm nature and firm age, while the total asset turnover ratio, operating cycle and firm size have a negative impact on innovation efficiency. Further research found that there is an inverted U-shaped relationship between financial support and the innovation efficiency of government subsidies. A certain degree of financial support has a positive impact on the innovation efficiency of government subsidies, but excessive financial support has a negative impact on the innovation efficiency of government subsidies. The conclusion provides empirical evidence for the Chinese government to improve the subsidy policy and standardize the development of new energy vehicle enterprises, and has a certain reference value for guiding new energy vehicle enterprises to reasonably allocate financial support.

Keywords: Financial support; DEA-Tobit perspective; Government subsidies; Innovation efficiency; New energy vehicle enterprises

1 Introduction

With the intensification of global energy supply tension and environmental pollution, China's output of fossil energy such as oil and natural gas is insufficient, and the development and utilization of new energy is imminent. At the same time, with the improvement of economic level, the use frequency of vehicles increases and the pollution to the environment increases. The traditional vehicle exhaust pollution has become a worldwide public hazard, and its proportion to the increase of greenhouse gas concentration cannot be ignored. Therefore, the new energy vehicle industry is gradually raised to a strategic height. New energy has the advantages of pollution-free and renewable. The vehicle fueled by new energy is in line with the development trend of "carbon neutralization" in China. Its concept of green, low-carbon and energy saving has also been favored by more and more consumers in the world.

As a strategic emerging industry in China, the development of new energy vehicles is the key to the transformation and upgrading of China's automobile industry. In order to promote the high-quality development of new energy vehicle industry, the general office of the State Council issued the development plan for new energy vehicle industry (2021-2035) on November 2, 2020. The government promotes the development of new energy vehicle industry, first, to improve the increasingly serious environmental problems, second, to solve the problem of resource shortage, and third, to promote the technology of pillar industries such as automobiles to reach the international leading level. In this context, the government uses a variety of policies to stimulate the development of new energy vehicle industry. Due to the policy support, the development speed of China's new energy vehicle industry is amazing, and the new energy vehicle industry has become one of China's sunrise industries.

However, at present, China's new energy vehicle industry is still facing some problems, such as the core technology is not advanced enough, the quality assurance is not perfect enough, the infrastructure is not comprehensive enough, and the market competitiveness is not large enough. Innovation is the first driving force leading the development of science and technology. Esther and Desiderio (Esther and Desiderio 2016) believed that the key for high-tech enterprises to realize transformation and upgrading is to master core technology and seek long-term competitive advantage through innovation. Innovation is also the core source for countries and enterprises to improve their competitiveness. Because of its strategic height, the importance of innovation is becoming more and more prominent. Guo (Guo 2018) said that for enterprises with immature technology, R&D activities are risky, requiring high R&D expenses and high-level R&D risks. Moreover, some scholars (Baker et al. 2005; Hannu and Janne 2015) also believes that immature enterprises have high uncertainty and information asymmetry, and it is more difficult for them to obtain external financing than ordinary enterprises, and government subsidies help to solve the market failure caused by the positive external effects of innovation, improve the innovation enthusiasm of new enterprises and alleviate the problem of lack of resources. As the existing academic research has not reached a consistent conclusion on the effect of government subsidies, it is necessary to further explore the impact mechanism of government subsidies on the innovation output efficiency of new energy vehicle enterprises.

In addition, with the acceleration of the process of global economic financialization, the development of new energy vehicle enterprises is affected by the financial market. Du (Du et al. 2017) believes that financial support has two sides for new energy vehicle enterprises, one is the "reservoir" effect of financial support, and the other is the crowding out effect of financial support. "Reservoir" effect means that new energy vehicle enterprises can alleviate the current situation of capital shortage by increasing financing channels and improving financing capacity. Crowding out effect means that too much financial support will reduce the funds used for production investment, which is unfavorable to the R&D and innovation of new energy vehicle enterprises. Financial support can provide more possibilities for the financing of new energy vehicle enterprises, but there are few studies on the impact of corporate financial support on the R&D efficiency of new energy vehicle enterprises under the government subsidy policy. With the deepening of financial support, new energy vehicle enterprises need to consider how to reasonably allocate and make use of financial support in the process of innovation and development, so as to make government subsidies play a better role. At present, there are too few studies on the role of financial support on new energy vehicle enterprises, and we cannot accurately understand the impact of financial support on government subsidies. Therefore, it is necessary to explore the impact of financial support on the innovation R&D efficiency of government subsidies for new energy vehicle enterprises.

2 Literature summarize

2.1. Research on the effect of government subsidies on new energy vehicle enterprises

R&D activities have risks and externalities, and there is also the possibility of market failure, but R&D activities are the most direct source of technological innovation, which provides theoretical support for government subsidies to promote enterprises to carry out R&D. The purpose of government subsidies is to solve the capital problem of enterprises by providing subsidies or reducing taxes, so as to promote enterprises to carry out independent R&D activities without worries, and drive the technological innovation of the whole industry. In recent years, with the increase of government subsidies and enterprise R&D investment, the relationship between government subsidies and enterprise R&D investment has become a hot topic in academic circles. On the one hand, the government subsidy policy can effectively make up for the lack of funds and increase the R&D investment of enterprises, so as to improve the innovation of enterprises and increase the R&D output of enterprises; On the other hand, the biased selection of government subsidy objects makes enterprises squeeze out the original R&D investment, resulting in rent-seeking, arbitrage and other behaviors.

Zhao and Xie believes (Zhao and Xie 2017) that government R&D subsidies solve the problem of enterprise funds. Coupled with the orientation of the use of government subsidy funds, enterprises are bound to increase R&D expenditure. Scholars (Yu et al. 2019; Bronzini and Piselli 2016) believe that government subsidies not only improve the innovation quality and efficiency of enterprises as a whole, but also subsidized enterprises can launch more new products and even apply for more patents. Early researchers (Almus and Czarnitzki 2003) also accurately calculated through the model: in the case of government subsidies, the innovation activities of enterprises increased by about 4 percentage points. Peng and Mao (Peng and Mao 2017) found that government R&D subsidies can promote the growth of industry scale and the growth of upstream and downstream industries by promoting enterprise innovation and increasing the technological competitiveness among enterprises.

However, some scholars (Qin 2017; Liu et al. 2019; Xiao and Lin 2014; Zhang and Sun 2018; Xia 2020) believe that in practice, government subsidy investment is ineffective in promoting R&D activities of some enterprises, even contrary to the expected effect-Government R&D subsidy has a negative impact on enterprise technological innovation efficiency, that is, crowding out effect. Wallsten and other scholars (Wallsten 1999; Catozzella and Vivarelli 2016; Bond et al. 2003; Lach 2002; Levy 1990; Garcia 2004) have studied the United States, Italy, Britain, Israel and OECD and found that government R&D subsidies have a significant inhibitory effect on enterprises' R&D activities. At the beginning of government subsidy investment, it really made up for the lack of funds of enterprises. However, Zhang and Chen (Zhang and Chen 2016) believe that once enterprises accept excessive government R&D subsidies, the further increase of government subsidies will not increase the R&D investment of enterprises, but will squeeze out other capital investment for R&D, which cannot promote enterprise innovation, and even lead to excessive investment, increase employee redundancy and the formation of arbitrage space. Dai and Cheng (Dai and Cheng 2015) found that subsidies may also induce excessive purchase behavior of enterprises. The purchase cost of subsidized enterprises is higher than that of non-subsidized enterprises. The higher the subsidy intensity, the higher the purchase cost. In addition, scholars (Yu and Li 2016; Xiao and Xie 2011) have found that unreasonable subsidy policies lead to frequent "subsidy fraud" and weaken the competitiveness of China's new energy vehicle industry, and although government subsidies improve the efficiency of enterprise innovation and R&D, they also help listed companies whitewash their performance. Some scholars (Zhou et al. 2015; Zhang and Yan 2020) believe that there is an inverted U-shaped relationship between Government R&D subsidies and enterprise R&D activities. At the initial stage of industrial development, government subsidies can bring profit advantages to emerging industries, but after industrial expansion, government support is difficult to effectively encourage enterprises to increase R&D investment, indicating that the relationship between Government R&D subsidies and enterprise R&D investment may be promoted first and then restrained.

2.2. Impact of financial support on R&D Efficiency

On the one hand, non-financial enterprises can alleviate financing constraints and reduce business risks through financial support; On the other hand, the return on investment of financial assets gradually exceeds the profit margin of entity operation, resulting in non-financial enterprises more and more inclined to invest funds in financial assets rather than R&D and fixed assets, which makes the virtual economy that should serve the real economy focus on the opposite, and the inversion of the principal and the end will inevitably inhibit the innovative development of the real economy. Therefore, enterprise financial support has two aspects: reservoir effect and crowding out effect.

The "reservoir" effect can play a "pull effect" on the technological innovation input and technological innovation output of enterprises (Xu and Liu 2019). Financial support helps to ease the financing constraints faced by enterprises, so as to promote the R&D and innovation activities of enterprises (Ju et al. 2013). Financial support can obtain income in the short term and enrich the endogenous cash flow of the enterprise (Denis and Sibilkov 2009), so it can prevent the shortage of funds for main business to a certain extent (Baud and Durand 2011). Financial support can enrich enterprise financing channels, enhance risk resistance (Cato and Matsumura 2013), and solve the problems of information asymmetry and lack of funds faced by enterprises (Soener 2015).

However, financial support has a certain crowding out effect on enterprise innovation. Allocating more financial assets means reducing enterprise R&D innovation. Financial support largely reflects the excessive capitalization of real production, which will lead to the transformation of economic operation from production and consumption market to speculative and profitable market (Zhang et al. 2014), slow down the economic growth rate and possibly increase the unemployment rate (Ignacio and Hector 2014). Although holding financial support can help enterprises avoid risks, it may also bring additional risks (Song and Lu 2015). This is reflected in the high return of financial support, which will promote enterprises to allocate more financial support, play a substitute role for the main business investment of non-financial enterprises (Orhangazi 2008), crowd out funds for physical investment and R&D innovation, inhibit enterprises' industrial investment and hinder the development of enterprises' main business (Tori and Onaran 2018). Especially when the profitability of the enterprise's main business is insufficient, financial support is easier to exert a crowding effect on the enterprise's innovation investment. Moreover, the stronger the market arbitrage motivation of non-financial enterprises to improve the level of financial support, the more likely it is to inhibit the driving force of enterprise technological innovation (Wang et al. 2017).

2.3 Literature review

By combing the relevant literature on the relationship between government subsidies, financial support and enterprise innovation and R&D efficiency and the research on the development effect of government policies on new energy vehicle enterprises, there are mainly four research deficiencies in terms of the actual needs and theoretical research of new energy vehicle enterprises: First, there are disputes about the promotion effect of Government R&D subsidies. There are three existing conclusions: first, government R&D subsidies promote enterprise innovation R&D efficiency, second, government R&D subsidies inhibit enterprise innovation R&D efficiency, and third, there is an optimal amount between Government R&D subsidies and enterprise innovation R&D efficiency; Second, the existing research mainly analyzes the impact of Government R&D subsidies on the efficiency of enterprise R&D activities from the overall analysis of the whole listed manufacturing enterprises. There is less research on accurately positioning new energy vehicles. The innovation efficiency of Government R&D subsidies for new energy enterprises is still a direction that needs in-depth research; Third, in the existing research, scholars mainly take enterprise R&D expenses as the measurement standard, while ignoring government subsidies will increase the proportion of enterprise R&D personnel, and the expansion of R&D team will increase the efficiency of innovation output; Fourth, the impact of financial support on the relationship between government subsidies and innovation R&D efficiency of new energy vehicle enterprises is uncertain.

Based on the above analysis, the research object of this paper selects the data of new energy vehicle enterprises disclosed on official websites such as Shenzhen Stock Exchange and Shanghai Stock Exchange from 2015 to 2020, discusses the efficiency of Government R&D subsidies on the innovation of new energy vehicle enterprises, and reveals the impact of financial support on the innovation efficiency of Government R&D subsidies. The research conclusion is helpful for new energy vehicle enterprises to reasonably allocate assets with government subsidies; At the same time, it helps to enrich the theoretical research on the impact mechanism of government subsidies on the innovation and R&D efficiency of new energy vehicle enterprises; It can also provide enlightenment for the formulation of government subsidy policies and the innovation practice of new energy vehicle enterprises.

3 Research design

3.1 Data sources

The research object of this paper is the new energy vehicle enterprises that disclosed financial data on the official websites of Shenzhen Stock Exchange and Shanghai Stock Exchange from 2015 to 2020. Panel data on Government R&D subsidies, enterprise R&D expenditure, number of enterprise R&D personnel, financial support, main business income and other research objects were collected through the wind database, and the practical patent applications of each enterprise from 2015 to 2020 were manually collected through the State Intellectual Property Office. The data are processed as follows: (1) due to the lack of data of some enterprises, in order to ensure the accuracy of the research results, enterprises lacking some age data and enterprises listed after 2015 are deleted. (2) Since some enterprises do not carry out R & D activities themselves, enterprises without R & D personnel, R & D expenditure and patent applications are deleted. (3) Due to the continuous loss of some enterprises and the risk of delisting, ST and ST * enterprises are deleted. Thus, 45 enterprises were collected.

3.2 Select measurement model

3.2.1 Data envelopment analysis

Data envelopment analysis was proposed by A. charnel and W. W. Cooper in 1978. This method is based on the concept of relative efficiency and has strong objectivity. It is widely used in the study of efficiency in various situations. There are many models in DEA, and BBC is one of the classical models. BCC model analyzes the efficiency of decision-making unit under the condition of variable return to scale, and decomposes the overall comprehensive technical efficiency value into pure technical efficiency and scale efficiency. There is the following relationship between the three: comprehensive technical efficiency is equal to pure technical efficiency multiplied by scale efficiency. In this model, we can further analyze whether the non DEA efficiency is caused by improper input-output allocation or inappropriate scale of decision-making unit.

Suppose there are N decision units (DMUs). For any DMU_j (J = 1,2,..., n), m inputs X_{ij} (I = 1,2,..., m) are used to produce s outputs YRJ (r = 1,2,..., s). The DEA-CCR model can be expressed as:

$$\begin{cases} max h_{j0} = \frac{\sum_{r=1}^{s} u_r y_{r_{j0}}}{\sum_{i=1}^{m} v_i x_{ij_0}} \\ s.t. \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1, j = 1,2,\dots,n \\ \mathrm{u} \geq 0, \mathrm{v} \geq 0, \mathrm{i} = 1,2,\dots,\mathrm{m}; \quad \mathrm{r} = 1,2,\dots,\mathrm{s}; \quad \mathrm{j} = 1,2,\dots,\mathrm{n}。 \end{cases} \tag{3.1}$$

The above planning model is a fractional programming, which uses Charnes Cooper change to make:

$$t = \frac{1}{v^T x_0}, w = tv, \mu = tu \qquad\qquad t = \frac{1}{v^T x_0} \rightarrow = 1 \tag{3.2}$$

It can be transformed into the following linear programming model P:

$$
(\mathrm{P})\begin{cases} \max h_{j0} = \mu^t y_0 \\ s.t. w^t x_j - \mu^t y_j \ \geq 0,\ j = 1,2,\dots,n \\ w^t x_0 = 1 \\ w \geq 0,\ \mu \geq 0 \end{cases} \tag{3.3}
$$

The dual programming of programming p is programming D:

$$
(\mathrm{D})\begin{cases} \min\theta \\ s.t. \sum_{j=1}^{n} \lambda_j x_j \leq \theta x_o \\ \sum_{j=1}^{n} \lambda_j x_j \geq y_o \\ \lambda_j \geq 0,\ j = 1,2,\dots,n \\ \theta \ \ Unconstrained \end{cases} \tag{3.4}
$$

For the convenience of calculation and application, the relaxation variable s^+ and residual variable s^- are further introduced to change the above inequality constraints into equality constraints, which can become:

$$
(\mathrm{D})\begin{cases} \min\theta \\ s.t. \sum_{j=1}^{n} \lambda_j x_j + s^+ = \theta x_o \\ \sum_{j=1}^{n} \lambda_j x_j - s^- = \theta y_o \\ \lambda_j \geq 0,\ j = 1,2,\dots,n \\ \theta \ \ Unconstrained,\ s^+ \geq 0,\ s^- \geq 0 \end{cases} \tag{3.5}
$$

The above programming (D) is directly defined as the dual programming of programming (P).

Determine whether the BCC model is both technically effective and scale effective:

θ^*=1, and s^{*+}=0, s^{*-}=0. Then the decision-making unit j_0 is DEA effective, and the economic activities of the decision-making unit are both technology effective and scale effective;

θ^*=1, but at least one input or output is greater than 0. Then the decision-making unit j_0 is weak DEA efficient, and the economic activities of the decision-making unit are not the best technical efficiency and the best scale at the same time;

3) θ^*<1. The decision-making unit J0 is not DEA effective, and the economic activity is neither the best technical efficiency nor the best scale.

3.2.1 Tobit model

Tobit model refers to a kind of model in which the dependent variable is approximately continuously distributed on the positive value, but contains some observations with a positive probability of 0. For example, in any given year, a considerable number of families' medical insurance expenditure is 0. Therefore, although the overall distribution of annual family medical insurance expenditure is scattered in a large positive range, it is quite concentrated in the number 0.The classic Tobit model is a generalization of probit regression by James Tobin when analyzing the expenditure of household durable goods. Later, it was extended to a variety of situations. Amemiya summarized it into type I to type V Tobit models. The standard type I Tobit regression model is as follows:

$$
\begin{aligned}
& y^* = \beta' x_i + u_i \\
& \mathrm{y}_i^* = y_i \qquad y_i^* > 0 \qquad\qquad (3.6) \\
& \mathrm{y}_i^* = 0 \qquad y_i^* \leq 0
\end{aligned}
$$

In the above formula, y_i^* is the potential strain, which is observed when the potential variable is greater than 0, and the value is y_i, Truncate at 0 when less than or equal to 0, x_i is the independent variable vector,βis the coefficient vector, the error term u_i independent and normal distribution: $u_i \sim N(0, \delta^2)$ 。The model can also be simplified as follows:

$$y = max\ (0,\ \beta' x_i + u_i) \qquad (3.7)$$

Using the least square method to estimate the model parameters with censored data will produce deviation, and the estimators are inconsistent. Under certain assumptions, its parameters can be estimated by maximum likelihood method.

3.3. Select indicators

3.3.1 Construction of input index and output index

According to the research purpose of this paper and considering the availability of data, six consecutive years of the national Shenzhen Stock Exchange and Shanghai Stock Exchange from 2015 to 2020 are selected as the decision-making unit (DMU). Three input indicators and two output indicators are selected to measure the innovation efficiency of new energy vehicle enterprises. The relevant index data are obtained from wind database and the State Intellectual Property Office. See Table 1 for the selection of specific indicators. The reasons for the selection of indicators are as follows:

Input index: ① Government subsidy. Government subsidies can solve the financing difficulties of new energy vehicle enterprises. Sufficient funds can promote enterprises to pay more attention to the improvement of technology, accelerate the innovative development of enterprises and increase the innovative output. ②Proportion of R&D expenses in operating revenue. The input of R&D funds is the basic premise for enterprises to carry out innovation activities and obtain innovation output. R&D expenses most intuitively reflect the amount of R&D investment of an enterprise, and R&D expenditure will be affected by the amount of enterprise profits. Through the proportion of R&D expenditure in operating revenue, we can see the R&D intensity of an enterprise from the opposite side. ③Ratio of R & D personnel to total employees. The proportion of scientific research personnel is regarded as one of the important indicators in the identification standards of high-tech enterprises in China. For example, in the qualification identification of high-tech enterprises, it is stipulated that the proportion of scientific and technological personnel with college degree or above in the total number of employees of enterprises shall be greater than or equal to 30%, and the proportion of R&D personnel to the total number of employees of enterprises shall be greater than or equal to 10%. Therefore, the investment of R&D personnel of enterprises shall be analyzed from the perspective of relativity.

Output index: ①Operating revenue. Operating revenue is the source of funds for enterprises to compensate production and operation expenses. The realization of operating revenue is related to the normal progress of enterprise reproduction activities. Strengthening operating revenue management can reasonably compensate various expenses of enterprises, which is conducive to the smooth progress of reproduction activities. Operating revenue is an important guarantee for enterprises to obtain profits. The acquisition of profits is the guarantee for enterprises to carry out R&D activities.②Number of practical patent applications. Patents are divided into three categories: invention, utility model and design. Design does not promote technological progress and does not belong to the core technology of the enterprise. Therefore, the sum of invention and utility model patents is selected as the number of practical patent applications. Patents are the most direct result of enterprise technological innovation.

Table 1 Input and output indicators of DEA innovation efficiency

Index type	Index code	Index definition
Input index	X1	Government subsidies (million yuan)
	X2	Proportion of total R&D expenditure to operating revenue
	X3	Proportion of R&D personnel in total employees
Output index	Y1	Operating revenue (million yuan)
	Y2	Number of practical patent applications

3.3.2 Description of regression model variables

The explanatory variable is innovation efficiency (IE). Three efficiency values are obtained through DEA model, and the comprehensive technical efficiency value is selected as the explained variable.

The explanatory variable is enterprise annual financial support (Fa). By referring to other literature (He et al. 2021), this paper defines the financial support allocated by enterprises as the sum of trading financial assets, derivative financial assets, net loans and advances, net financial assets available for sale, net held to maturity investment and net investment real estate. Considering the nonlinear and complex impact of financial support on the innovation efficiency of new energy vehicle enterprises under government subsidies, this paper also includes the square item of annual financial support.

Control variables: after referring to the literature of relevant scholars at home and abroad, the following control variables are selected: annual salary of management, enterprise nature, enterprise scale, enterprise age, total asset turnover rate, business cycle, equity concentration and profit margin.

(1) Annual salary of management (AMS). The decisions made by senior executives have a significant impact on the development of listed companies. Senior executives, that is, senior managers of enterprises, hold the management and decision-making power of enterprises. Therefore, the governance of enterprise senior management team has become the basis of corporate governance, and enterprise growth is the most direct and effective reflection of the level of corporate governance. Therefore, in order to improve the sustainable growth ability of enterprises and attract more investors, Enterprises need to formulate a reasonable executive compensation incentive mechanism. Therefore, the per capita annual salary of management is selected to measure the impact of enterprise management on enterprise innovation efficiency.

(2) The nature of the enterprise (Owner). Different nature of enterprises will lead to different governance efficiency, resulting in differences in business performance. Therefore, enterprises of different nature have different degrees of investment in innovative R&D activities. The actual controllers of enterprises of different nature are different. The actual controllers of state-owned enterprises are generally the government, and the actual controllers of private listed enterprises are mostly natural persons or families. Therefore, they will have different decisions on enterprise strategy. The nature of the enterprise is a virtual variable. The central state-owned enterprises and local state-owned enterprises are taken as 1, and other types of enterprises are taken as 0.

(3) Enterprise size (lnSize). Enterprises need to spend a lot of human and material resources to master core technologies for innovation, and enterprises of different sizes have different enthusiasm. Large enterprises have resource advantages, capital and team. They also hope to improve their competitiveness by mastering core technologies. Their R&D enthusiasm is higher than that of small-scale enterprises. Therefore, the enterprise scale is measured by the natural logarithm of total assets.

(4) Enterprise age (Age). Enterprise R&D activities cannot be completed overnight, which often takes a lot of time. Small and medium-sized enterprises are often established for a short period of time and lack of experience. Therefore, such enterprises may invest funds in the capital market to make up for the lack of funds. The age of the enterprise is expressed by the year of the enterprise minus the year of establishment of the company.

(5) Total asset turnover (TAT). The total asset turnover rate is the ratio of net sales revenue to average total assets. The higher the ratio, the stronger the enterprise's sales capacity and the better the benefit of asset investment, reflecting the management quality and utilization efficiency of all assets of the enterprise. The total asset turnover rate can reflect the operation efficiency and changes of the total assets of the enterprise in this year and previous years, find the gap in asset utilization between the enterprise and similar enterprises, and promote the enterprise to tap the potential, actively generate income, improve the product market share and improve the asset utilization efficiency. Therefore, the total asset turnover rate is selected as one of the control variables.

(6) Operating cycle (lnOC). The operating cycle refers to the period from the payment obligation of outsourcing to the recovery of accounts receivable arising from the sale of goods or the provision of services. The operating cycle is the sum of inventory turnover days and accounts receivable turnover days. The length of operating cycle is an important factor determining the company's current asset demand. The short operating cycle indicates the effective management of accounts receivable and inventory. Generally, the operating cycle is short, which means that the capital turnover is fast and there is sufficient capital for R&D. The long operating cycle indicates that the capital turnover speed is slow. It is necessary to reserve funds to maintain the operation of the enterprise, which will naturally reduce the R&D investment of the enterprise. Therefore, the logarithm of the operating cycle is taken as the surrogate variable to eliminate the differences caused by different operating cycles.

(7) Equity concentration (Top1). Ownership concentration is not only the main indicator to measure the ownership distribution status of the company, but also an important indicator to measure the stability of the company, but also an important indicator to measure the company structure. The degree of equity concentration will affect the judgment of enterprise owners on the future development direction of the enterprise. In order to eliminate the influence of heteroscedasticity, the equity concentration is measured by the proportion of the shares held by the largest shareholder in the total shares of the company.

(8) Profit margin (ROA). Profit margin shows the ability of an enterprise to earn profits. The ultimate goal of an enterprise is to have a better profit margin. The higher the profit margin, the higher the return to shareholders and the greater the enterprise value. At the same time, the higher the profit margin, the more cash flow and the faster the cash return, the greater the amount

of R&D investment. Therefore, the ratio of total profit to operating income is taken as the surrogate variable of profit margin for control.

Table 2 List of variables

Variable	Variable name	Variable symbol	Variable definition
Explained variable	Innovation efficiency	IE	Innovation efficiency measured by DEA method
Explanatory variable	Financial support	Fa	Sum of financial assets of various enterprises
	Square of financial support	Fa__sq	Square of the sum of financial assets of various enterprises
Controlled Variable	Annual salary of management	AMS	Per capita annual salary of management
	The nature of the enterprise	Owner	Dummy variable, 1 for state-owned enterprises and 0 for others
	Enterprise size	lnSize	Natural logarithm of total assets
	Enterprise age	Age	Year of study minus year of establishment
	Total asset turnover	TAT	Ratio of net sales revenue to average total assets
	Operating cycle	LnOC	Inventory turnover days plus accounts receivable turnover days
	Equity concentration	Top1	Shareholding proportion of the largest shareholder
	Profit margin	ROA	Ratio of total profit to operating income

4 Empirical results and analysis

4.1 DEA results and analysis

Using deap2.1 software, calculate the comprehensive technical efficiency value (crste), pure technical efficiency value (vrste) and scale efficiency value (scale) of the upgrading of new energy vehicle listed enterprises from 2015 to 2020. In DEA evaluation, if the efficiency is 1, it means that the production of the enterprise is efficient, and if it is 0, it is invalid; An efficiency value close to 1 is more effective. The specific efficiency value is shown in Table 3, and the average enterprise efficiency value is shown in Figure 1.

Table 3 Efficiency values of 45 listed new energy vehicle enterprises from 2015 to 2020

DUM	2015			2016			2017		
	crste	vrste	scale	crste	vrste	scale	crste	vrste	scale
1	0.271	0.28	0.965	0.57	1	0.57	0.339	0.342	0.994
2	0.022	0.141	0.158	0.153	0.184	0.83	0.321	0.321	1
3	0.065	0.194	0.335	0.234	0.246	0.953	0.083	0.175	0.473
4	1	1	1	1	1	1	0.895	1	0.895
5	0.304	0.805	0.377	0.553	0.667	0.829	0.884	1	0.884

6	0.049	0.148	0.33	0.039	0.171	0.225	0.028	0.154	0.183
7	0.067	0.089	0.759	0.271	0.32	0.845	0.185	0.209	0.885
8	0.122	0.249	0.49	0.602	0.66	0.912	0.184	1	0.184
9	1	1	1	0.469	1	0.469	0.239	0.406	0.589
10	1	1	1	1	1	1	1	1	1
11	0.042	1	0.042	0.264	0.28	0.942	0.335	0.405	0.827
12	0.127	0.329	0.385	0.132	0.227	0.583	0.177	0.228	0.778
13	0.301	0.59	0.511	1	1	1	1	1	1
14	0.094	0.099	0.949	0.398	0.427	0.934	0.283	0.311	0.908
15	0.126	0.14	0.898	0.28	0.374	0.75	0.106	0.255	0.416
16	0.144	0.458	0.315	0.274	0.345	0.794	0.039	0.511	0.077
17	0.043	0.19	0.226	0.167	0.174	0.959	0.276	0.285	0.966
18	0.03	0.422	0.07	0.214	0.272	0.785	0.333	0.624	0.533
19	0.123	0.131	0.939	0.089	0.094	0.947	0.145	0.323	0.448
20	0.274	0.765	0.358	0.934	0.943	0.991	0.029	0.598	0.049
21	0.224	0.913	0.245	1	1	1	0.96	1	0.96
22	0.334	0.339	0.984	0.074	0.434	0.17	0.288	0.443	0.651
23	1	1	1	1	1	1	1	1	1
24	0.311	0.312	0.998	0.165	0.305	0.541	0.088	0.1	0.875
25	0.166	0.21	0.791	0.183	0.516	0.355	0.363	1	0.363
26	1	1	1	0.437	0.498	0.877	0.571	0.706	0.809
27	0.21	0.36	0.582	0.123	0.346	0.355	0.222	0.689	0.322
28	0.156	0.388	0.402	0.179	0.212	0.845	0.182	0.184	0.99
29	0.012	0.23	0.054	0.072	0.246	0.293	0.043	0.157	0.273
30	0.209	0.293	0.715	0.213	0.454	0.468	0.551	1	0.551
31	1	1	1	0.323	0.41	0.787	1	1	1
32	1	1	1	0.254	0.57	0.446	0.237	0.746	0.317
33	0.15	0.476	0.314	0.405	0.801	0.506	0.336	0.417	0.806
34	0.64	0.68	0.941	0.281	0.5	0.563	0.701	0.737	0.95
35	0.481	1	0.481	0.243	0.255	0.954	0.033	0.188	0.177
36	0.008	0.27	0.031	0.067	0.201	0.331	0.212	0.545	0.388
37	1	1	1	1	1	1	1	1	1
38	0.187	0.189	0.989	0.136	0.156	0.874	0.305	0.329	0.93
39	0.325	0.524	0.62	0.647	0.832	0.778	0.466	0.686	0.679
40	1	1	1	1	1	1	1	1	1
41	0.465	0.71	0.655	0.072	0.228	0.315	0.069	0.191	0.361
42	0.118	0.185	0.636	0.742	0.823	0.902	1	1	1
43	0.531	0.731	0.726	1	1	1	1	1	1
44	1	1	1	0.56	1	0.56	0.044	0.339	0.131
45	0.155	0.18	0.861	0.094	0.23	0.408	0.309	0.519	0.596
DUM	2018			2019			2020		

	crste	vrste	scale	crste	vrste	scale	crste	vrste	scale
1	0.226	0.439	0.514	0.402	0.447	0.899	0.394	1	0.394
2	0.148	0.248	0.598	0.548	0.599	0.915	0.381	0.729	0.523
3	0.106	0.211	0.499	0.231	0.291	0.792	0.444	0.807	0.551
4	0.33	0.939	0.352	0.959	1	0.959	0.678	1	0.678
5	0.191	0.409	0.467	0.203	0.258	0.784	0.091	0.273	0.333
6	0.191	0.415	0.461	0.082	0.287	0.285	0.378	0.496	0.762
7	0.058	0.147	0.397	0.257	0.264	0.972	0.188	0.192	0.98
8	1	1	1	1	1	1	0.403	0.429	0.941
9	1	1	1	1	1	1	0.502	1	0.502
10	1	1	1	1	1	1	1	1	1
11	0.077	0.089	0.865	0.681	1	0.681	0.467	0.792	0.59
12	0.225	0.389	0.578	0.536	0.554	0.966	0.919	0.936	0.981
13	1	1	1	0.347	0.532	0.653	0.936	1	0.936
14	1	1	1	1	1	1	1	1	1
15	0.411	0.603	0.682	0.163	0.228	0.715	0.326	1	0.326
16	0.043	0.804	0.053	0.333	0.428	0.778	0.249	0.658	0.379
17	0.337	0.386	0.874	0.177	0.315	0.561	0.085	0.296	0.287
18	0.426	0.728	0.585	0.232	0.389	0.595	0.182	0.517	0.353
19	0.006	0.032	0.179	0.113	0.113	0.999	0.104	0.105	0.997
20	0.039	0.451	0.087	0.829	1	0.829	0.666	0.787	0.846
21	0.545	1	0.545	1	1	1	1	1	1
22	0.024	0.535	0.045	0.301	0.39	0.771	0.262	0.491	0.535
23	1	1	1	1	1	1	1	1	1
24	0.195	0.197	0.99	0.067	0.158	0.422	0.149	0.286	0.523
25	0.136	0.65	0.21	0.29	0.317	0.915	1	1	1
26	0.328	0.706	0.465	0.473	0.532	0.89	0.178	0.537	0.332
27	0.062	0.522	0.12	0.176	0.644	0.274	0.712	0.835	0.852
28	0.157	0.176	0.894	0.119	0.313	0.379	0.555	0.562	0.986
29	0.117	0.572	0.205	0.217	0.261	0.831	0.142	0.247	0.574
30	0.184	0.386	0.477	0.247	0.298	0.829	0.059	0.213	0.277
31	0.112	0.497	0.226	0.294	0.48	0.614	1	1	1
32	0.394	1	0.394	0.454	1	0.454	0.229	0.954	0.24
33	0.323	0.559	0.578	0.337	0.344	0.979	0.113	0.338	0.335
34	0.352	0.74	0.475	0.375	0.423	0.886	0.573	0.653	0.878
35	0.174	0.369	0.471	0.048	0.205	0.234	0.03	0.229	0.132
36	0.488	0.561	0.87	0.256	0.339	0.755	0.354	0.604	0.586
37	0.235	0.641	0.367	0.957	0.971	0.986	0.421	1	0.421
38	0.186	0.192	0.969	0.102	0.152	0.668	0.205	0.254	0.807
39	0.063	0.664	0.094	0.251	0.729	0.344	0.379	0.933	0.406
40	1	1	1	1	1	1	1	1	1

41	0.091	0.19	0.478	0.227	0.283	0.803	0.233	0.234	0.993
42	0.56	1	0.56	1	1	1	1	1	1
43	1	1	1	0.014	0.313	0.045	0.925	0.926	0.999
44	0.042	0.399	0.105	0.646	0.751	0.86	0.226	1	0.226
45	0.37	0.407	0.908	0.788	0.913	0.864	0.23	0.821	0.281

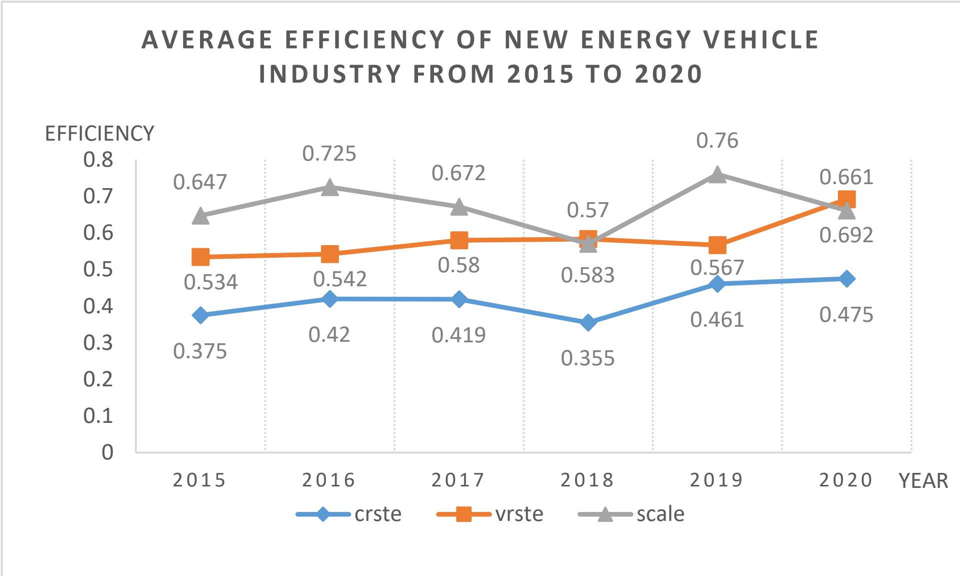

FIG 1 Average efficiency of new energy vehicle industry from 2015 to 2020

Comprehensive technical efficiency value is the product of pure technical efficiency value and scale efficiency value. It can be seen from table 3 that in addition to the comprehensive technical efficiency value, pure technical efficiency value and scale efficiency value of ten enterprises in 2015, only eight enterprises in the other five years are fully effective. Within six years, only the 10th, 23rd and 40th enterprises have maintained production efficiency, which indicates that the effective investment performance level of the other 42 listed new energy vehicle enterprises is unstable from 2015 to 2020. It can also be seen from table 3 that the scale efficiency is slightly higher than the pure technical efficiency, and the comprehensive technical efficiency is lower than 0.5, indicating that the overall efficiency of the new energy vehicle industry is low and there is much room for improvement. From the perspective of comprehensive technical efficiency, the rising trend of efficiency is basically maintained, and only decreased in 2018, which is caused by the sharp decline of scale efficiency. With the support of policies, a large amount of capital will flow into the new energy vehicle industry by 2018. Excessive development leads to certain problems in the industry, low industry concentration, and the problem of "small, scattered and chaotic" cannot be ignored. Before that, the phenomenon of "cheating compensation" by enterprises occurred frequently, which greatly damaged the market's trust in new energy vehicles. The fundamental reason for the reduction of comprehensive technical efficiency in 2018 lies in the implementation of two policies. First, on February 13, 2018, the Ministry of finance, the Ministry of industry and information technology, the Ministry of science and technology and the national development and Reform Commission jointly issued the notice on improving the financial subsidy policy for the promotion and application of new energy vehicles. In a word, the new subsidy policy is to subsidize and increase the endurance of new energy vehicles increased battery density. Second, the "double points" policy for passenger cars was officially launched in July 2018. The so-called double points, in short, means that for automobile companies with sales of more than 30000 vehicles, both fuel vehicles and new energy vehicles will generate response points. The lower the fuel consumption of fuel vehicles, the higher the score. If the fuel consumption is very high, negative scores may be obtained. Normative policies have been introduced successively, forcing automobile enterprises to manufacture vehicles that meet consumer needs, preventing blind new enterprises and expanding production capacity, and promoting the healthy and sustainable development of new energy automobile industry. Therefore, to a certain extent, the production scale of new energy automobile enterprises has been reduced.

The DEA data analysis results will give the input and output redundancy respectively, in which the output redundancy value indicates how much less output, while the input redundancy value indicates how much more input. Deap2.1 software gives the calculation results of each decision-making unit, and gives the average value of 45 new energy vehicle listed enterprises from 2015 to 2020, as shown in Table 4. Firstly, from the overall data, it is found that the annual R&D personnel investment redundancy of 45 listed new energy vehicle enterprises is low, and there is even no redundancy in 2019, indicating that enterprises should increase the construction of R&D teams. In addition, government subsidies and R&D expenses are redundant. The redundancy of government subsidies decreased rapidly in 2018, which is in line with the impact of the implementation of the two new policies in 2018 analyzed above. From the perspective of output, there is a serious shortage of patent applications, and the operating income is relatively good, indicating that the output of new energy vehicle enterprises in patent technology R&D is insufficient. On the whole, the input is redundant, but the output is seriously insufficient, indicating that the innovation efficiency of new energy vehicle enterprises is low. The redundancy value of patent application is too high, indicating that the innovation efficiency of the enterprise is low and there are few practical patents for invention. Government subsidies occupy the original R&D funds, but the original R&D funds are invested in the real estate market and capital market. Therefore, government subsidies do not promote the improvement of enterprise innovation efficiency, but inhibit enterprise innovation efficiency.

Table 4 Average redundancy value of 45 new energy vehicle enterprises from 2015 to 2020

Year	Y1	Y2	X1	X2	X3
2015	6.138	224.105	35.315	5.546	0.194
2016	5.808	203.452	130.534	35.54	0.071
2017	17.983	134.878	48.261	12.628	0.007
2018	32.95	162.891	17.401	12.505	0.006
2019	3.357	154.62	21.73	1.955	0
2020	16.412	84.058	85.826	11.347	0.021

4.2 Regression analysis

Firstly, this paper makes a static analysis of the production efficiency of China's listed new energy vehicle enterprises from 2015 to 2020 by using DEA model, and then uses panel Tobit model to calculate whether there is a positive relationship between financial support and innovation efficiency of new energy vehicle enterprises by using stata15.0 software. Taking comprehensive technical efficiency as the explanatory variable and financial support as the explanatory variable, Tobit model is used for regression analysis. The results are shown in Table 5 and table 6.

Table 5 Tobit 1 regression results of financial support and innovation efficiency of new energy vehicle enterprises from 2015 to 2020

Variable	Coefficient	Standard error	z	P>|z|
Fa	4.11E-06	1.74E-06	2.37	0.018**
AMS	0.009189	0.00313	2.94	0.003***
Owner	0.14634	0.078385	1.87	0.062*
lnSize	-0.13076	0.036206	-3.61	0***
Age	0.011372	0.005608	2.03	0.043**
TAT	-0.27179	0.107364	-2.53	0.011**
LnOC	-0.14913	0.067998	-2.19	0.028**
Top1	0.00108	0.002302	0.47	0.639
ROA	-0.00033	0.001128	-0.29	0.768
_cons	2.265449	0.57123	3.97	0

Note: *、**、*** respectively represent the significance levels of 10%, 5% and 1%

Table 6 Tobit 2 regression results of financial support square term and innovation efficiency of new energy vehicle enterprises from 2015 to 2020

Variable	Coefficient	Standard error	z	P>|z|
Fa	0.0000139	5.51E-06	2.52	0.012**
Fa_sq	-5.64E-11	3.01E-11	-1.87	0.061*
AMS	0.0090355	0.003123	2.89	0.004***
Owner	0.1488463	0.078872	1.89	0.059*
lnSize	-0.1430846	0.036804	-3.89	0***
Age	0.0119745	0.005646	2.12	0.034**
TAT	-0.2929202	0.108238	-2.71	0.007***
LnOC	-0.1436981	0.068034	-2.11	0.035**
Top1	0.0004113	0.002343	0.18	0.861
ROA	-0.0003022	0.001119	-0.27	0.787
_cons	2.37293	0.571092	4.16	0

Note: *、**、*** respectively represent the significance levels of 10%, 5% and 1%

It can be seen from table 5 that the total asset turnover rate has a negative correlation with innovation efficiency at the level of 5%, and the correlation coefficient is -0.27, indicating that the total asset turnover rate has the most significant impact on enterprise innovation efficiency. The larger the total asset turnover rate, the faster the capital turnover rate, while the R&D activities take a long time, which will occupy a large amount of working capital and reduce the total asset turnover rate of the enterprise. Therefore, enterprises with high total asset turnover rate need to ensure sufficient funds for operation, so as to occupy the funds for R&D. therefore, the innovation efficiency of enterprises is bound to be low.

Similarly, from the perspective of business cycle, there is a negative correlation with innovation efficiency at the level of 5%, and the correlation coefficient is -0.15. The business cycle is related to the enterprise's inventory turnover days and accounts receivable turnover days. For enterprises with short business cycle, less inventory turnover days means that the enterprise has no stock, and the inventory can be quickly converted into circulating funds; Less days of accounts receivable turnover indicates that enterprises have less bad debts and fast account recovery, which can increase the expenditure of R&D funds. Therefore, there is a negative correlation between business cycle and enterprise innovation efficiency.

From the perspective of enterprise nature, the impact of the nature of state-owned enterprises on innovation efficiency is positive, and the correlation coefficient is about 0.15. State owned enterprises are easier to obtain government subsidies than private enterprises, and the innovation efficiency of state-owned enterprises is higher than that of private enterprises. R&D activities are risky. The operation of many private enterprises is unstable. Some state-owned enterprises do not use all government R&D subsidies for R&D and innovation. The proportion of R&D investment is small, and the innovation efficiency is naturally lower than that of state-owned enterprises.

The regression coefficient of enterprise scale to the innovation efficiency of new energy vehicle enterprises is -0.13, which is significant at the level of 1%. It shows that enterprise scale has a significant impact on innovation efficiency. With the increase of scale, enterprise innovation efficiency is lower. Some studies have shown that (Liu 2019), on the whole, enterprise scale has a significant inhibitory effect on the improvement of innovation quality, that is, when the enterprise scale becomes larger, the innovation efficiency does not improve synchronously. The reason may be that when the enterprise scale is large, it has certain monopoly power, loses market competition vitality and lacks innovation ability.

Enterprise age is positively correlated with innovation efficiency at the level of 5%, and the correlation coefficient is 0.01, indicating that enterprise innovation efficiency increases with the growth of enterprise age, but the impact result is not significant, indicating that enterprise age is not a key factor affecting the innovation efficiency of new energy vehicle enterprises.

The annual salary of the management is positively correlated with the innovation efficiency at the level of 1%, indicating that the annual salary of the management is helpful to improve the innovation efficiency of new energy vehicle enterprises to a certain extent. However, the correlation coefficient of this factor is only 0.009. Compared with other factors, the annual salary of management has little impact on the innovation efficiency of new energy vehicle enterprises.

There is a positive correlation between ownership concentration and innovation efficiency, and a negative correlation between profit margin and innovation efficiency. Neither ownership concentration nor profit margin has passed the significance test, indicating that ownership concentration and profit margin are not significant factors affecting enterprise innovation efficiency.

Financial support is positively correlated with innovation efficiency at the level of 5%, and innovation efficiency increases with the increase of financial support. Tobit1 in Table 5 reports the estimation results of the quadratic term variable FA sq, while tobit2 in Table 6 reports the estimation results of the quadratic term variable FA sq. It can be seen that the coefficient of the explanatory variable FA is positive at the statistical level of 5% and above, and the coefficient of the square term FA sq is negative at the statistical level of 5%. This preliminarily verifies that there is an inverted U-shaped relationship between financial support and innovation efficiency of new energy vehicle enterprises under government subsidies. This also shows that a possible logical relationship between financial support and the innovation efficiency of new energy vehicle enterprises under government subsidies is that a certain degree of financial support can indeed reduce enterprise risks and increase enterprise financing efficiency, resulting in a crowding in effect on enterprise innovation investment activities; However, when the scale of financial support funds is higher than a certain threshold, it will cause crowding out effect or substitution effect on enterprise innovation investment.

5 Main research conclusions and policy implications

5.1 Research conclusion

Using the input-output data of national new energy vehicle enterprises from 2015 to 2020, this paper studies and reveals the impact effect and internal mechanism of the innovation subsidy policy actively used by the government on the innovation investment of new energy vehicle enterprises. This paper draws the following conclusions:

First of all, on the whole, the comprehensive technical efficiency of listed enterprises of new energy vehicles is low, and the pure technical efficiency and scale efficiency are low. In the R&D process of listed new energy vehicle enterprises, technological innovation and technological reform need to be further promoted, and the improvement of technical efficiency can directly promote the improvement of comprehensive technical efficiency. The mismatch of input and output in scale or technology is the fundamental factor leading to the failure of most listed new energy vehicle enterprises to achieve effective upgrading. The results of DEA model show that the R&D personnel input redundancy of 45 listed new energy vehicle enterprises is low every year, and there is even no redundancy in 2019, indicating that enterprises should increase the construction of R&D teams. There is a serious waste of government subsidies, insufficient output, and the input is not proportional to the output.

Secondly, Tobit regression model shows that the innovation efficiency of government subsidies of new energy vehicle enterprises is positively affected by the nature of state-owned enterprises and the age of enterprises, and negatively affected by the total asset turnover rate, business cycle and enterprise scale. Too fast total asset turnover rate and too long business cycle may squeeze the R&D funds of enterprises and affect the innovation efficiency of enterprises. The large scale of enterprises may also have a negative impact on the efficiency of R&D and innovation because of the lack of competitive consciousness.

Finally, through Tobit model, this paper concludes that there is a significant inverted U-shaped relationship between financial support and innovation efficiency of new energy vehicle enterprises under government subsidies. This is an important discovery different from the existing research, which reveals the complex and nonlinear incentive effect formed by the innovation efficiency of new energy vehicle enterprises under financial support and government subsidies. The unique meaning of this nonlinear incentive effect is that, to a certain extent, financial support produces a "reservoir" effect on the innovation efficiency of new energy vehicle enterprises under government subsidies, that is, crowding in effect; When the financial support reaches a certain level, the financial support has a significant crowding out effect on the innovation efficiency of new energy vehicle enterprises under government subsidies.

5.2 Research enlightenment

The Enlightenment of this study lies in: first, a comprehensive evaluation and Reflection on the effectiveness of the government subsidy policy, and the implementation of effective adjustment and Reform for this policy system is an important step to promote the healthy and rapid development of the new energy vehicle industry. For new energy vehicle enterprises, we should gradually reduce the scale and intensity of government innovation subsidies, adjust the functions and standards of government subsidies, improve the fund use efficiency of government subsidies, and shift the government innovation policy to encourage and guide enterprises in basic research Cultivate independent innovation ability and improve innovation efficiency in applied basic research and key core technology innovation breakthroughs. Second, for new energy vehicle enterprises, attention should be paid to the negative impact of high turnover rate of total assets, long business cycle and large enterprise scale on the innovation efficiency of R&D subsidies. While paying attention to the short-term profits of enterprises, attention should be paid to the investment in R&D activities, continuously improve their R&D ability and R&D success rate, and master the core technology through R&D activities, In order to form the long-term competitive advantage of the enterprise. Third, for over financialized enterprises, government R&D subsidies should be cautious, and the subsidy should be inclined to new energy vehicle enterprises with low financial support. New energy vehicle enterprises should clarify the financial investment orientation and pay attention to innovation and development. Enterprises should position financial investment to provide more abundant endogenous funds for business activities and R&D innovation, "feed back" the main business with the help of financial activities, take the entity as the foundation, and guard against the emergence of the phenomenon from reality to emptiness.

Ethical Approval

Ethical approval is not required for this article because it does not address ethical issues.

All authors consent to participate and Publish

Authors' contributions

1. Fang Chen: Planned the research design; Revise this paper.
2. Sha Zhang: Organize and analyze data; Write this paper.

Declaration of Interest Statement

On behalf of all the authors of this paper: **The impact of financial support on the innovation efficiency of government subsidies from the perspective of DEA Tobit -- Based on the empirical research on Chinese New Energy Vehicle Enterprises** (hereinafter referred to as "this manuscript "), I solemnly declare as follows:

Author's last name: Sha Zhang, Fang Chen

All the authors of the above articles agree to contribute to International Journal of Environmental Research. The first author and responsible author, on behalf of all the authors of the above articles, undertake the following:

1. Guarantee that the content of this manuscript has not been formally published, and no two manuscripts will be submitted.

2. Ensure that there are no political errors or leaks of political, military, scientific and technological information in the articles. In case of any of the above problems, the author and his unit shall take all responsibilities.

3. Guarantee that the authorship and ranking of all authors are undisputed, and there are no intellectual property disputes. In the course of revising the manuscript, if there is an increase or decrease of the author or change of the signature unit, the consent of all the authors, the first signature unit and the responsible author shall be issued a certificate.

4. The first author of the manuscript (or the corresponding author shall designate the person in charge when submitting the paper) shall be responsible for the revision, answering questions, proofreading, payment of the manuscript review and other publishing fees, handling of single copy and remuneration and other matters related to the manuscript.

5. Self-conceit. In case of any discrepancy with item 1~4, the author shall assume all responsibilities and compensate for the loss of the editorial department.

6. After the manuscript is published, the author shall transfer all publishing rights of the manuscript (including paper publishing rights, reproduction, distribution rights, and publishing rights of electronic media such as CD-ROM and Internet) to the Editorial department of Journal of Cleaner Production.

7. The first author and responsible author must carefully read the full text and pay attention to political errors such as borderless, correct academic views and text expression, standard terminology, and correct statistical processing.

8. Deliver the editorial department of Journal of Cleaner Production to collect the publication

fee of the article at that time

Please read the agreement carefully and sign it.

Corresponding author: Fang Chen

The first author: Sha Zhangu

September 13, 2021

Funding Project

1. One belt, one road project: the 2020 annual Hunan provincial social science achievement evaluation committee project: "the research on the construction of green mineral resources corridors along the belt and road" and the mechanism of interest sharing. The project number is XSP20YBC223;
2. 2018 Hunan philosophy and Social Science Foundation Project "Research on safety evaluation and management policy of China's metal resources under the new normal" (18ybq136);
3. Key project of youth fund of Central South University of forestry and technology in 2016: "Research on supply side structural reform and optimization mechanism of metal resources industrial structure in Hunan Province".
4. Project of Hunan social science achievement evaluation committee "Research on green development evaluation and policy optimization of mining industry in Hunan Province" (Project No.: xsp20ybz173).

Availability of data and materials

Data sets used or analyzed in the current study are available from corresponding authors upon reasonable request.

Compliance with Ethical Standards

1. There is no potential conflict of interest in this article.

   The author did not receive any organization's support for the submitted work.

   No funds were received to assist in the preparation of the manuscript.

   No funds were received for this study.

   No funds, grants or other support were received.
2. This paper does not cover studies of human participants, human data or human tissues.
3. The author shall be responsible for misrepresentation or failure to comply with the above standards.

Reference

Almus. M., Czarnitzki. D. The effects of public R&D subsidies on firms' innovation activities: the case of Eastern Germany [J]. Bus. Econ. Stat, 2003,(21) 226–236.

Baud C.,Durand C.. Financialization，Globalization and the Making of Profits by Leading Retailers[J]. Socio-Economic Review.2011,10:241-266.

Beck T.,Demirgüç-Kunt A., Maksimovic V. Financial and Legal Constraints to Growth：Does Firm Size Matter? [J]. The Journal of Finance,2005(60):137-177.

Bond S, Harhoff D, Van Reenen J. Investment, R&D and financial constraints in Britain and Germany[J]. Centre for Economic Performance Discussion Paper, 2003,0595.

Bronzini, R., Piselli, P.. The impact of r&d subsidies on firm innovation [J]. Res. Policy, 2016,45 (2), 442–457.

Cato S,Matsumura T. Merger and entry-license tax[J]. E-conomics Letters,2013,119(1):11-13.

Catozzella A，Vivarelli M. The possible adverse impact of innovation subsidies：Some evidence from Italy[J]. International Entrepreneurship and Management Journal, 2016, (12): 351-368.

Dai X, Cheng L. The effect of public subsidies on corporate R&D investment: An application of the generalized propensity score[J]. Technological Forecasting and Social Change, 2015, 90(2): 410-419.

Denis D.J., Sibilkov V. Financial Constraints，Investment，and the Value of Cash Holdings[J]. The Review of Finan-cial Studies.2009,23:247-992.

Du Yong, Zhang Huan, Chen Jianying. Impact of financial support on the future main business development of real enterprises: promotion or inhibition [J]. China industrial economy, 2017 (12): 113-131.

Esther Hormiga,Desiderio Juan García-Almeida. Accumulated knowledge and innovation as antecedents of reputation in new ventures[J]. Journal of Small Business and Enterprise Development,2016,23(2).

Garcia-Quevedo. J. Do public subsidies complement business R&D? A meta-analysis of the econometric evidence, Kyklos 57 (2004) 87–102.

Guo Yue. Signal transmission mechanism of government innovation subsidy and enterprise innovation [J]. China's industrial economy,2018(09):98-116.

Hannu Karhunen,Janne Huovari. R&D subsidies and productivity in SMEs[J]. Small Business Economics,2015,45(4).

He Lifen, Zhang Dan, Wang Qiaoyi. Enterprise financial support and earnings sustainability -- Also on innovation and institutional investor effect [J]. Monthly journal of Finance and accounting, 2021 (13): 28-35.

Ignacio Gonz á lez,Hector Sala. Investment Crowding - Out and Labor Market Effects of Financialization in the US[J]. Scottish Journal of Political Economy,2014,61(5):589-613.

Ju Xiaosheng, Lu Di, Yu Yihua. Financing constraints, working capital management and enterprise innovation sustainability [J]. Economic research, 2013,48 (01): 4-16.

Lach, S. Do R&D subsidies stimulate or displace private R&D? Evidence from Israel [J]. The Journal of Industrial Economics, 2002,4: 369–390.

Levy D M. Estimating the Impact of Government R&D[J]. Economics Letters, 1990, 32(2): 169-173.

Liu Jinru, Zeng Xianfeng, Zeng Qian. Impact of environmental regulation and government innovation subsidies on enterprise green product innovation [J]. Economic and management research, 2019,40 (06): 106-118.

Liu Qiuming. Research on the impact of government subsidies on innovation quality from the perspective of enterprise scale [D]. Northeast University of Finance and economics, 2019.

Orhangazi Ö. Financialisation and Capital Accumulation in the Non-Financial Corporate Sector:A Theoretical and Em-pirical Investigation on the US Economy:1973-2003[J].2008,32:863-886.

Peng Hongxing, Mao Xinshu. Government innovation subsidies, company executives' background and R & D Investment -- Empirical Evidence from China's high-tech industry [J]. Finance and trade economics, 2017,38 (03): 147-161.

Qin Zixing. Analysis of government subsidy strategy for strategic emerging industries under innovation driven mode [J]. Operations research and management, 2017,26 (10): 173-180.

Soener Matthew. Why do firms financialize? Meso-level evidence from the US apparel and footwear industry, 1991–2005[J]. Socio-Economic Review,2015,13(3):549-573.

Song Jun, Lu min. U-shaped relationship between non monetary financial support and operating return -- evidence of financial support from listed non-financial companies in China [J]. Financial research, 2015 (06): 111-127.

Tori D., Onaran O. The Effects of Financialization on Investment:Evidence From Firm-Level Data for the UK[J].Cambridge Journal of Economics, 2018,42:1393-1416.

Wallsten S J. Do government-industry R&D pro-grams increase private R&D? The case of the small business innovation research program[M].Palo Alto: Stanford University Press, 1999: 82-100.

Wang Hongjian, Cao Yuqiang, Yang Qing, Yang Zheng. Does financial support of real enterprises promote or inhibit enterprise innovation -- a study based on the experience of Listed Companies in China's manufacturing industry [J]. Nankai management review, 2017,20 (01): 155-166.

Xia Ling. The impact of government subsidies on Enterprise R & D Investment -- An Empirical Analysis Based on strategic emerging industries [J]. Friends of accounting, 2020 (24): 132-137.

Xiao Xingzhi, Xie Li. Empirical analysis on innovation efficiency of China's strategic emerging industries [J]. Economic management, 2011,33 (11): 26-35.

Xiao Wen, Lin gaobang. Government support, R & D management and technological innovation efficiency: An Empirical Analysis Based on China's industrial industry [J]. Management world, 2014 (4): 71-80.

Xu Shan, Liu Duchi. Empirical Study on the impact of enterprise financial support on technological innovation [J]. Scientific research management, 2019,40 (10): 240-249.

Yu Bai,Siyi Song,Jianling Jiao,Ranran Yang. The impacts of government R&D subsidies on green innovation: Evidence from Chinese energy-intensive firms[J]. Journal of Cleaner Production,2019,233.

Yu Zuo, Li Xiang. We should speed up the fair competition review of subsidy policies for new energy vehicles [J]. China price regulation and antitrust, 2016 (09): 29-31.

Zhang Caijiang, Chen Lu. Is the more government subsidies for enterprise innovation the better [J]. Science of science and technology management, 2016 (11): 11-19.

Zhang Chengsi, Liu Zehao, Luo Yu. China's commodity financial support stratification and inflation driving mechanism [J]. Economic research, 2014,49 (01): 140-154.

Zhang Fan, Sun Wei. Micro mechanism of government innovation subsidy efficiency: superposition effect of incentive effect and crowding out effect: theoretical explanation and test [J]. Financial research, 2018 (4): 48-60.

Zhang Yong'an, Yan Jiaxin. Dynamic relationship between Government R & D funding, enterprise R & D investment and innovation performance [J]. Research on science and technology management, 2020,40 (02): 1-10.

Zhao Kangsheng, Xie Shiyu. The impact of Government R & D subsidies on Enterprise R & D Investment -- An Empirical Study Based on Chinese Listed Companies [J]. World economic journal, 2017 (02): 87-104.

Zhou Yahong, Pu Yulu, Chen Shiyi, Fang Fang. Government support and new industrial development -- Taking new energy as an example [J]. Economic research, 2015,50 (06): 147-161.