# Analysis on the Influence of Government Subsidy on Foton Automobile Technology Innovation Efficiency under the Background of Dual Carbon

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**Abstract: The new energy industry is an emerging industry; the rise of the emerging industry is inseparable from the national macro-control. In recent years, new energy automotive industry as the mainstay of carbon reduction, more and more to receive government subsidies. Based on the DEA-Malmquist model, this paper takes Foton Automobile as the research object to explore whether enterprises can rationally use government subsidies to promote technology innovation under the dual-carbon background. It is found that government subsidies have a certain incentive effect on Foton automobile technology innovation. The static efficiency score shows that after the two-carbon goal is proposed, the government subsidies continue to increase and the innovation efficiency of the enterprise reaches the best state. The dynamic efficiency score shows that the input-output of Foton Automobile has not reached the optimal scale, and Foton Automobile still needs to adjust the production scale of the enterprise and improve the innovation efficiency. Finally, the government should strengthen the supervision of the use of government subsidies, enterprises should speed up the transformation of technological achievements, pay attention to the rational distribution of input and output suggestions and countermeasures.**

**Keywords: Dual Carbon Target; Foton Motor; Government Subsidies; Technological Innovation Efficiency**

## 1. Introduction

In 2020, The State Council issued the "New Energy Automobile Industry Development Plan (2021-2035)", which proposed that new energy vehicles adhere to electric, networked, intelligent, and promote hydrogen fuel as the development and innovation direction. The new energy automobile industry is a Technology intensive industry, and its development requires the government to provide a series of support projects, of which government subsidies are representative projects. In recent years, enterprises have received more and more government subsidies. In 2022 and 2023, the Ministry of Finance issued a budget of 38.5 billion yuan and 19.9 billion yuan for new energy conservation and emission reduction subsidies, but whether the enterprise is really used properly is the government's "wishful thinking" or the enterprise's "two-way rush".

Beiqi Foton Automobile Co., LTD. (referred to as Foton Automobile), as the earliest domestic layout and the earliest investment in new energy research and development enterprises, was rated as "China's top ten enterprises in the industry of independent innovation ability". In recent years, the amount of government subsidies obtained by Foton Automobile is relatively stable, and the amount of subsidies obtained is relatively high compared with other new energy vehicles. In 2021, Foton Motor has developed nearly 100 lightweight projects, achieved full coverage of pure electric products, and achieved energy saving of 3,667 tons of standard coal and carbon reduction of 7,957 tons. This paper constructs a new energy vehicle technology innovation evaluation index system. Based on the DEA-Malmquist model, this paper constructs the technological innovation evaluation index system of new energy vehicles, evaluates Foton Automobile as the research object, and analyzes whether the enterprise can reasonably use government subsidies to promote technology innovation under the dual-carbon

 

background from static and dynamic perspectives.

## 2. Literature Review

### 2.1 The Impact of Government Subsidies on Technology Innovation

As for the research on the impact of government subsidies on the technology innovation of enterprises, experts and scholars have not unified views. At present, they can be roughly divided into two kinds of views: one is that government subsidies will promote the increase of technology innovation investment; the second is that government subsidies will inhibit the increase of technology innovation investment; Government subsidies have a significant promoting effect on the innovation investment of BYD's new energy enterprises [1]. The intensity of government subsidies is positively correlated with the intensity of technological innovation [2]. Enterprises need to bear high risk costs for innovation in new fields, and government subsidies can help enterprises share part of the innovation risk costs and improve their enthusiasm for innovation [3]. However, there are some scholars believe that the government subsidies has inhibitory effect on technology innovation investment. Government subsidies have a negative correlation with R&D and innovation input of new energy vehicle enterprises [4].

### 2.2 Research on the Efficiency of Technology Innovation Indicators

DEA method is used to measure and analyze the technology innovation efficiency of small and medium-sized enterprises in Guangdong province [5]. DEA model is used to build a five-indicator enterprise innovation performance indicator system from two aspects of innovation input and innovation output, and evaluate the specific impact of government subsidies on the innovation performance of Changan Automobile [6].

## 3. Construction of Evaluation System for Technological Innovation Efficiency of Foton Automobile with Government Subsidy

It is an important content of this study to construct the evaluation system of government subsidy to Foton automobile technology innovation efficiency. The selection of input-output index reflects the objective and content of evaluation. This paper summarizes the indicators selected by other scholars in related research, as shown in Table 1 below.

**Table 1. Input-Output Index Selection**

| Author, Year | Input indicator | Output indicator |
|---|---|---|
| (Yang, 2022)[7] | R&D expenditure, R&D personnel | The number of patents and the proportion of internally formed intangible assets |
| (Shen,2020)[1] | R&D intensity, R&D personnel | Intangible assets, proportion of intangible assets, number of patents |
| (Li,2022a)[8] | R&D funds, R&D personnel | Internal research and development of intangible assets, the number of patents, results sales revenue |
| (Li,2022b)[9] | R&D expenditure, R&D personnel | The proportion of intangible assets and patent applications |

The innovation input index reflects the willingness and input strength of enterprises to carry out innovation activities. From Table 1, the input indicators selected by most scholars are human resources and R&D input. Human resource refers to the number of core personnel in technological innovation, which reflects the knowledge power invested by enterprises in technological innovation. R&D investment is the material premise for enterprises to carry out innovative research activities, and reflects the recognition of enterprises' financial resources for technology innovation activities. The index of innovation output reflects the technology innovation achievements and economic benefits of enterprises. In the context of dual carbon, achieving carbon emission reduction requires a higher level of innovative technological achievements. The number of patents granted is the result of examination and approval by the State Intellectual Property Office. The proportion of internal R&D intangible assets in the total intangible assets to a certain extent represents the amount of innovation output. Product sales revenue reflects whether the products produced by an enterprise through technological innovation are competitive in the market, and reflects the final economic output

 

of an enterprise's R & D and innovation results.

In principle, all inputs and outputs of an enterprise in the process of technological innovation should be regarded as variables. However, considering the difficulty, objectivity and accuracy of data collection, and combining the representativeness and scientificity of indicators, this paper constructs a technological innovation evaluation index system with 2 input indicators and 3 output indicators, as shown in Table 2 below.

**Table 2 Selection of Technical Innovation Efficiency Index of Foton Automobile**

| Item | Index | Definition |
|---|---|---|
| Input indicator | R&d investment | R&d investment |
| | R&d personnel input | Number of R&D personnel |
| Output indicator | Product sales revenue | Operating income |
| | Number of patents granted | Number of new patents granted in China |
| | Proportion of intangible assets formed by internal R&D | The proportion of intangible assets formed by internal R&D in intangible assets |

## 4. Descriptive Analysis of the Influence of Government Subsidies on Foton Automobile's Technology Innovation

### 4.1 Descriptive Analysis of the Impact of Government Subsidies on Enterprise Innovation Input

4.1.1 R&D investment

Before the two-carbon goal was proposed, the government has begun to attach importance to the development of the new energy industry. From Figure 1, in 2017, the government subsidized Foton Motor up to 372 million yuan. From 2018 to 2019, due to the impact of the social "fraud" problem, the government reduced subsidies to enterprises, and the amount of government subsidies obtained by Foton Motor also decreased correspondingly, and the amount of research and development investment also declined. After the "dual carbon goal" was proposed in 2020, the amount of government subsidies received by Foton Automobile increased significantly compared with the previous two years, and the amount of research and development investment increased accordingly. Overall, Foton motor research and development investment scale on government subsidies are highly dependent.

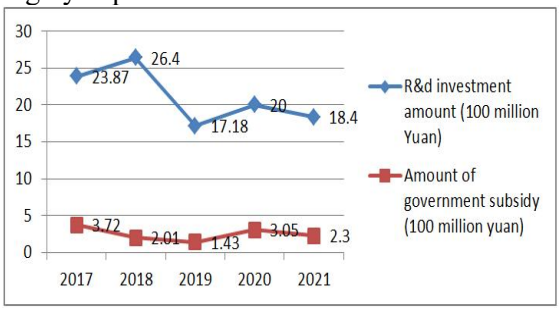


**Figure 1. The Change Trend of Government Subsidies and R&D Investment**

New energy vehicles break through the technical bottlenecks of intelligent networked vehicles and hydrogen fuel cell vehicles, and play an important role in promoting the realization of the "dual carbon goal". From Table 3, after 2020, government will provide new subsidies for Foton's research and development projects of vehicle networking and hydrogen fuel cell key technologies. The increase in research and development subsidies of key technologies will help Foton improve its innovation in intelligence, electrification and fuel cells improve the transportation efficiency of new energy vehicles and reduce carbon emissions.

4.1.2 Number of R&D personnel

As shown in Figure 2, nearly five years, the number of R&D personnel of Foton Automobile has shown a fluctuating trend, which is basically consistent with the change trend of government subsidy amount. In 2017-2019, the number of research and development personnel also decreased due to the decrease in supplementary government assistance year by year. In 2020, although the amount of government subsidies has increased, due to the impact of the novel coronavirus epidemic, the company has optimized its organizational structure and reduced the number of research and development personnel. Government subsidies will fall in 2021, and the number of R&D staff will also decrease. Overall, government subsidies have a certain impact on the number of research and development personnel at Foton.

 

**Table 3. Breakdown of Major Projects of Government Subsidies for R&D Expenditures(**Unit: 100 million yuan)

| Item | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|
| Multi-functional vehicle factory government subsidy construction funds | 0.31 | 0.31 | 0.31 | 0.31 | 0.24 |
| New energy vehicle projects support research and development funds | 0.55 | 0.25 | 0.25 | 0.25 | 0.25 |
| Automobile industry achievement transformation project subsidy funds | 0.08 | 0.08 | 0.08 | 0.08 | 0 |
| Car connected application project grant | 0 | 0 | 0 | 0.9 | 0.4 |
| Hydrogen fuel cell bus key technology research and development grants | 0 | 0 | 0 | 0.19 | 0 |

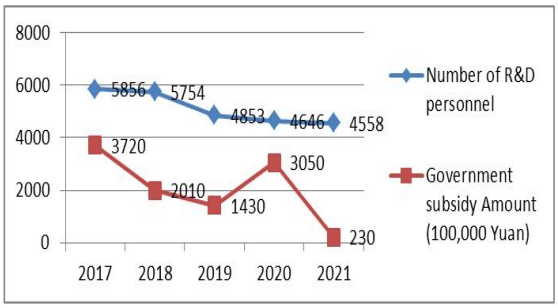


**Figure 2. Changes in Government Subsidies and the Number of R&D Personnel**

### 4.2 Descriptive Analysis of the Impact of Government Subsidies on Enterprise Innovation Output

4.2.1 Sales revenue of new energy vehicles

As can be seen from Table 4, from 2017 to 2018, Foton Motor's sales revenue decreased with the reduction of government subsidies. In 2020, intelligent and hydrogen fuel electrification have become the key development goals of new energy vehicles, the amount of government subsidies has surged, and the sales revenue of enterprises has also increased significantly. In 2021, the amount of government subsidies dropped to 230 million, coupled with the impact of macroeconomic growth slowed down, the new blue plate regulations and other factors, Foton Motor's heavy truck and commercial vehicle sales have declined significantly, resulting in a significant reduction in new energy vehicle sales revenue. It can be seen that the scale of government subsidies and the new energy vehicle sales volume of Foton Motor show the same direction.

4.2.2 Proportion of intangible assets formed by internal research and development

Figure 3 shows that from 2017 to 2021, the changing trend of the proportion of intangible assets formed by Foton Motor's internal R&D basically changes in the same direction as the amount of government subsidies. From 2017 to 2019, the proportion of intangible assets formed by internal research and development declined with the amount of government subsidies. From 2020 to 2021, with the support of the "double carbon target" policy requirements and government subsidies, new energy vehicles will increase the technological innovation of intelligent electrification and hydrogen fuel electric batteries, Intangible assets independently developed by enterprises increased year by year. Government subsidies encourage enterprise R&D and promote the output of innovation results, reflecting the dependence of enterprise R&D output on government subsidies.

**Table 4. Change Trend of Government Subsidies and Sales Revenue of New Energy Vehicles**

| Item | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|
| Sales revenue of new energy vehicles (100 million yuan) | 77.73 | 16.74 | 61.51 | 43.09 | 31.83 |
| Amount of government subsidy (100 million yuan) | 3.72 | 2.01 | 1.43 | 3.05 | 2.3 |

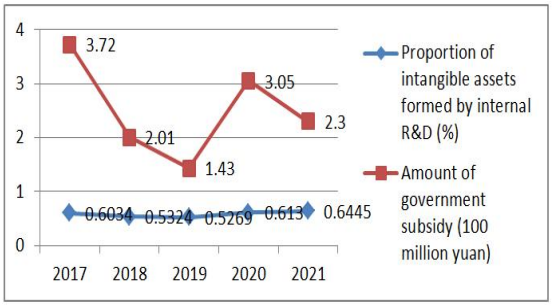


**Figure 3. The Changing Trend of the Proportion of Intangible Assets Formed by Government Subsidies and Internal R&D**

4.2.3 Number of patents granted

Before 2009, there were no government subsidies, and Foton's total authorized patents were only 197, a small number of authorized patents. In the deepening of the government subsidy policy, the average annual number of

 

patents granted by Foton Automobile has reached more than 300.

As can be seen from Figure 4, although the number of patent grants of Foton Motor shows a trend of decreasing first and then remaining flat from 2017 to 2021, there is not a complete correlation with government subsidies. The main reason is that patent development and authorization take a long time, and the R&D investment of the enterprise may not be able to form corresponding technological innovation results in that year. Government subsidies have a delayed effect on the promotion of technology innovation.

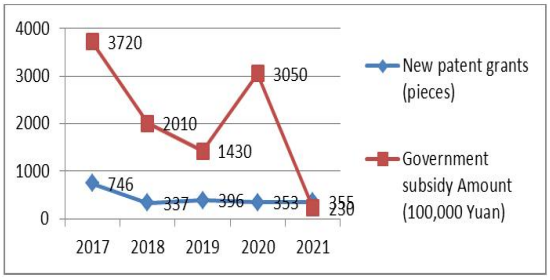


**Figure 4. Trends of Government Grants and Patent Grants**

## 5. Analysis of Technological Innovation Efficiency of Foton Automobile Based on Government Subsidy Based on DEA-Malmquist Model

Next, taking JAC Automobile, the pioneer of domestic new energy vehicles, which receives stable government subsidies every year, as a reference enterprise, based on the DEA-Malmquist model, the influence of government subsidies on the technology innovation efficiency of Foton Automobile is discussed from the static and dynamic perspectives.

### 5.1 Analysis of Innovation Efficiency of Foton Automobile Based on DEA-BCC Model

Using DEAP 2.1 analysis software, the comprehensive efficiency, pure technical efficiency and scale efficiency of the two enterprises from 2017 to 2021 can be obtained, as shown in Table 5 below.

Comprehensive efficiency reflects the ~~overall~~ innovation performance level of the enterprise. When it reaches 1, it means that the overall innovation performance level of the enterprise has reached the best. From Table 5, the average innovation comprehensive efficiency of Foton enterprise is 0.933, which is better than 0.922 of the reference enterprise. In 2017, 2020 and 2021, Foton's comprehensive efficiency has reached the optimal level of 1. After the "double carbon target" was put forward, government subsidies continued to increase, Foton Automobile research and development investment increased, innovation output to maximize, although Jianghuai Automobile government subsidies, but its comprehensive innovation efficiency is slightly lower than Foton Automobile, indicating that Foton Automobile can make full use of government subsidies, the output of efficient innovation results. In 2018 and 2019, the comprehensive efficiency of Foton Automobile was less than 1, which indicates that Foton Automobile has unreasonable resource allocation.

Pure technical efficiency reflects whether an enterprise can effectively use innovation resources at the technical and management level. When it is equal to 1, it indicates that the enterprise has high resource utilization efficiency. From Table 5, the average pure technical efficiency of Foton automobile is slightly higher than that of JAC Automobile. In addition to 2018, in other years, Foton Motor's pure technical efficiency has reached 1, especially after 2020, Foton Motor's government subsidies have increased, the company has increased the scale of research and development investment and the number of research and development personnel, and the company's pure technical efficiency has been strengthened. Although JAC has obtained more government subsidies and technological innovation investment than Foton, its average pure technical efficiency is lower than Foton, which shows that Foton can make reasonable use of resources for technological innovation and development.

Scale efficiency mainly measures whether the ratio of input and output is reasonable and whether it is at the best scale. If it is equal to 1, it means that its input and output are at the best scale. As can be seen from Table 5, the average scale efficiency of Foton Automobile is lower than that of JAC Automobile. In 2017, 2020 and 2021, Foton's scale efficiency reached 1, and the scale efficiency in 2019 was also close to the optimal level, which indicates that Foton's innovation input-output ratio reached the optimal scale in these years. The big

 

difference with Jianghuai Automobile is that in 2018, Foton Automobile's return to scale in this year is also in a decreasing state. This shows that Foton's innovation input-output is unreasonable, and the production scale should be adjusted to achieve the optimal input-output.

**Table 5. Comparison of Technological Innovation Efficiency between Foton Automobile and Jianghuai Automobile**

| Year | corporation | Overall efficiency | Pure technical efficiency | Scale efficiency | Returns to scale |
|---|---|---|---|---|---|
| 2017 | Foton Motor | 1 | 1 | 1 | constant |
| | Jianghuai Automobile | 0.697 | 0.785 | 0.889 | decrement |
| 2018 | Foton Motor | 0.684 | 0.833 | 0.821 | decrement |
| | Jianghuai Automobile | 0.963 | 1 | 0.963 | decrement |
| 2019 | Foton Motor | 0.982 | 1 | 0.982 | increasing |
| | Jianghuai Automobile | 1 | 1 | 1 | constant |
| 2020 | Foton Motor | 1 | 1 | 1 | constant |
| | Jianghuai Automobile | 0.95 | 0.974 | 0.976 | decrement |
| 2021 | Foton Motor | 1 | 1 | 1 | constant |
| | Jianghuai Automobile | 1 | 1 | 1 | constant |
| Mean value | Foton Motor | 0.933 | 0.967 | 0.961 | |
| | Jianghuai Automobile | 0.922 | 0.952 | 0.966 | |

### 5.2 Analysis of Innovation Efficiency of Foton Automobile based on DEA-Malmquist model

The DEA-Malmquist index calculation allows a dynamic analysis of the innovation efficiency of Foton. technology innovation efficiency index is an important index reflecting the overall technology innovation efficiency change. When the value is greater than 1, it indicates that the overall innovation efficiency of the enterprise has been improved, and the technological progress index is an indicator reflecting whether the enterprise's technological capability and innovation capability have been improved. The change index of pure technical efficiency reflects whether an enterprise can effectively use resources at the technical and management level. The scale efficiency change index represents whether the enterprise is close to the optimal production scale.

As can be seen from Table 6, in recent years, the average value of technology innovation efficiency of Foton and Jianghuai Automobile is greater than 1, indicating that the overall technology innovation ability of new energy automobile enterprises is constantly increasing. The period when the change index of technology innovation efficiency of Foton automobile is less than 1 is 2017-2018 and 2020-2021, the reason is that the scale efficiency index and technological progress index decline rapidly, especially in 2020-2021, the technological progress index is only 0.314, and the pure technical efficiency is either 1 or less than 1. It shows that Foton's pure technical efficiency has not been well developed, so Foton still needs to strengthen the management level, technical level and scale.

## 6. Basic Conclusions and Suggested Countermeasures

### 6.1 Basic Conclusions

This paper uses DEA model to discuss the impact of government subsidies on technology innovation efficiency of Foton Automobile from static and dynamic perspectives, and draws the following basic conclusions:

(1) Government subsidies have a certain incentive effect on Foton's technology innovation. The input of government subsidies can promote enterprises to carry out active innovation, and the amount of government subsidies is closely related to enterprises' R & D and innovation activities.

(2) Based on the analysis results of DEA static model, especially after the two-carbon target was proposed, the government subsidy rebounded and the innovation efficiency of enterprises reached the best state, but there was also an unreasonable allocation of

 

input-output resources in some years. Based on the analysis results of DEA dynamic model, Foton Automobile's technological innovation efficiency index fluctuates greatly, and the decline is basically due to the impact of scale efficiency index and technological progress index, indicating that the input-output of the enterprise has not reached the optimal scale, and Foton Automobile still needs to strengthen the adjustment of the production scale of the enterprise to achieve the optimal ratio of input-output, so as to improve the innovation efficiency.

**Table 6. Average Malmquist Index and Decomposition of Technology Innovation Efficiency of Foton Automobile and Jianghuai Automobile**

| Year | corporation | Technical efficiency change index | Technological progress index | Pure technical efficiency index | Scale efficiency index | Technological innovation efficiency index |
|---|---|---|---|---|---|---|
| 2017-2018 | Foton Motor | 0.886 | 0.917 | 1 | 0.886 | 0.813 |
| | Jianghuai Automobile | 1.048 | 1.048 | 1 | 1.048 | 1.475 |
| 2018-2019 | Foton Motor | 1.05 | 1.225 | 0.945 | 1.111 | 1.287 |
| | Jianghuai Automobile | 1 | 1.378 | 1 | 1 | 1.378 |
| 2019-2020 | Foton Motor | 1.075 | 1.839 | 1.058 | 1.016 | 1.976 |
| | Jianghuai Automobile | 1 | 0.786 | 1 | 1 | 0.786 |
| 2020-2021 | Foton Motor | 0.974 | 0.314 | 0.995 | 0.979 | 0.306 |
| | Jianghuai Automobile | 1 | 0.976 | 1 | 1 | 0.976 |
| Mean value | Foton Motor | 0.996 | 1.074 | 1.000 | 0.998 | 1.096 |
| | Jianghuai Automobile | 1.012 | 1.047 | 1.000 | 1.012 | 1.154 |

### 6.2. Suggested Countermeasures

6.2.1 Rationally planning government subsidies and strengthening supervision of government subsidies

As an important starting point for the realization of the dual-carbon goal, the new energy automobile industry will be subsidized by the government every year to meet the standards of new energy automobile enterprises. Government should further improve the subsidy policy. At the same time, government should strengthen supervision, supervise the specific use of enterprise subsidy funds, and require enterprises to publicize the details of the use of subsidy amounts, and information is transparent. Enterprises that make reasonable use of government subsidies and produce significant technological innovation results will be rewarded, so as to stimulate more enterprises to actively carry out technology innovation and promote the realization of the dual-carbon goal.

6.2.2 Enterprises should constantly enhance the consciousness of independent innovation and improve the level of innovation

The management of enterprises should adhere to technological innovation and formulate strategic objectives for the formation of technological innovation, rather than relying on the amount of government subsidies. At the same time, incentive systems can also be adopted to evaluate different research and development projects and motivate outstanding employees who can independently research and develop results that are valuable to the innovation activities of enterprises, so as to improve the enthusiasm of employees for innovation. Let enterprises form a good atmosphere of technological innovation, so as to promote the realization of the dual carbon goal.

6.2.3 Accelerate the transformation of technological achievements and pay attention to the rational distribution of input-output

 

In terms of innovation investment, increase R&D investment in energy conservation and emission reduction, optimize the use and investment mechanism of R&D funds, do a good job in the budget of R&D investment, ensure that there is no waste or shortage of investment in the development and research stage, maximize the output of intangible assets, sales revenue of new energy vehicles, patents and other innovative achievements, improve innovation efficiency, and adjust the personnel structure. Increase the training of employees; focus on cultivating a technical team in research and development, and give play to the positive role of talents in technological innovation. In the process of technological innovation, we should not only pay attention to innovation input, but also strive to increase innovation output and promote the rapid transformation of innovative technological achievements. Enterprises can make good use of the resources of universities and scientific research institutes, and establish technological innovation alliances with them to jointly promote the transformation of technological achievements and improve the product's market competitiveness.

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