Analysis of the Impact of Fiscal Policy on the Innovation Performance of New Energy Vehicle Companies-An Empirical Analysis Based on Panel Data of Listed Companies

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Abstract. Based on the panel data of listed companies in China's new energy automobile industry from 2015 to 2019, an empirical test of the impact of government direct and indirect subsidies on corporate innovation performance is studied, and the mediating role of corporate innovation input is studied. The research results show that direct government subsidies have a positive impact on the innovation performance and investment of enterprises, and indirect government subsidies have a positive impact on the innovation performance and investment of enterprises. At the same time, corporate innovation investment plays an intermediary role in government subsidies and innovation performance. On the basis of the above conclusions, it provides a reference for the government to evaluate the effect of subsidies and adjust subsidy policies.

1. Introduction

Innovation is the primary productive force. In "Made in China 2025", China proposed the new energy automobile industry as a strategic development industry. At the same time, it is obvious that the development of new energy vehicles is the only way for China to move from a major automobile country to a powerful automobile country. Government subsidies are the most direct source of technological innovation for new energy vehicle companies, and the innovation performance brought about by their innovation activities has attracted widespread attention [1]. In recent years, there has been a lot of research on the effects of government subsidies at home and abroad, mainly focusing on the relationship between government subsidies and corporate innovation input. Few people pay attention to the impact of different subsidies in government subsidies. Research on the relationship between indirect subsidies and corporate innovation performance is even rarer.

Government subsidies can generally be divided into two basic models, namely direct subsidies based on government budget allocation and indirect subsidies based on tax incentives. Based on this idea, this article uses the data in the annual reports of listed companies in the new energy automobile industry to express the government's direct subsidies as "government subsidies" in the annual reports and the government's indirect subsidies as "tax benefit subsidies". At the same time, the concept of "government subsidies-innovation input-innovation performance" was proposed, and the mediation path of enterprise innovation input to innovation performance under the two cases of government direct subsidies and indirect subsidies was discussed [2]. New energy automobile industry listing in 2015-2019 The company's panel data is an empirical test of the research samples. This study aims to reveal the government's direct and indirect subsidy mechanism for corporate innovation performance, as well as
the follow-up government’s tax and tax preference methods for new energy vehicle companies. It provides decision-making guidance for the evaluation of subsidy effect and the choice of subsidy.

2. Theoretical basis and research hypothesis

2.1. The effect of direct government subsidies

Due to its special strategic and emerging industrial attributes, the new energy automobile industry has always received high-intensity subsidies from the government. Through direct subsidies in the main form of budgetary appropriations to stimulate enterprises' technological innovation activities, it has also become a general consensus in many countries to support the development of the new energy automobile industry. Some scholars such as Duguet (2004), Cheng Hua (2008) believe that direct government subsidies can promote the innovation investment of enterprises, that is, a general incentive effect; there are also scholars such as Hussinger (2008), Liu Hong (2012). They believed that the government’s direct subsidy is an inverted U-shaped pattern that first rises and then falls for the innovation investment of enterprises. That is, when the amount of direct subsidy does not exceed the critical value, the increase in direct subsidy will promote the innovation investment of enterprises. However, once the direct subsidy is subsidized the amount exceeds the critical value, the increase in direct subsidies will inhibit the innovation input of enterprises; some scholars such as Choi and Lee (2017) have studied the Korean pharmaceutical manufacturing industry and found that direct government subsidies have a crowding-out effect on small and medium biomedical companies.

At the same time, a large number of existing studies have found that there is a positive correlation between government direct subsidies and corporate innovation performance [3]. Guo (2016) found that direct government subsidies can stimulate enterprises to make additional investment in innovation, thereby supporting enterprises to produce more high-quality products. Gao Xiuping (2018) found that direct government subsidies can improve enterprise innovation performance in many aspects, including technological innovation level. Further research by scholars such as Bizan has shown that direct government subsidies can increase the probability of success of subsidized projects and enable companies to obtain more technology patents. In summary, although domestic and foreign scholars have different conclusions on the effects of government direct subsidies. However, in China, new energy vehicle companies use direct government subsidies to enhance technological innovation activities, and then generate more innovation performance has become an important way for corporate development, so the following hypothesis is proposed.

• H1 Direct government subsidies have a positive impact on corporate innovation investment.
• H2 Direct government subsidies have a positive impact on corporate innovation performance.

2.2. Effects of indirect government subsidies

Due to the particularity of the new energy automobile industry, all enterprises are high-tech enterprises, which can enjoy a large number of preferential tax policies led by market compensation. A large number of domestic and foreign scholars, such as Zhu Pingfang (2003), Czarnitzki (2011), and Kobayashi (2014), believe that preferential tax policies can significantly stimulate the innovation investment of enterprises, which are mainly manifested in the innovative products and innovative projects of enterprises [4]. Companies that receive indirect government subsidies are often more willing to invest more in technological innovation activities. The main reason is that indirect government subsidies reduce the risk of innovative projects and increase the rate of return of the company’s innovation activities. At the same time, the company have hidden social benefits, that is, easier access to social investment and bank loan support [5]. At the same time, a large number of existing research and practical experience show that preferential tax policies can promote the sales of new products and patent growth of enterprises. my country has a stricter review process for invention patents. It takes a long time from application, publication to authorization, and is highly innovative, which can represent the innovation capabilities of enterprises. Researchs by Zhang Xindong and others have shown that the number of patent applications of listed companies that enjoy preferential tax policies is much higher than that of listed companies that
have not; Bai Xuyun and other studies have shown that preferential tax policies have a significant positive impact on corporate patent applications. Based on the above analysis, the following hypotheses are proposed:

• H3 Government's indirect subsidies have a positive impact on corporate innovation investment.
• H4 Government's indirect subsidies have a positive impact on the innovation performance of enterprises.

2.3. The mediating role of enterprise innovation input
As a knowledge-intensive industry, new energy vehicles are inseparable from technological innovation activities, which obviously means high investment and high risks. Generally speaking, technological innovation activities should be the spontaneous behaviour of enterprises, which is the main way for them to seize market share and develop rapidly. Judging from the existing experience, most new energy automobile companies can implement technological innovation strategies, and under the incentive of government subsidies, they can actively carry out innovation activities and master core technologies. However, practice has shown that government subsidies have a significant lag effect on the output of innovative projects, innovative products and patents of enterprises, and it is necessary to rely on the innovation input of enterprises themselves to produce innovation performance. This means that the innovation investment of enterprises acts as a bridge between government subsidies and innovation performance, and direct and indirect government subsidies are more to guide enterprises to make greater innovation investment. Accordingly, the following hypotheses are proposed:

• H5 The relationship between government subsidies and corporate innovation performance.

3. Research design

3.1. Data source and sample selection
This article selects new energy vehicle companies that have published annual audit reports and financial reports on the Shenzhen Stock Exchange and Shanghai Stock Exchange from 2015 to 2019 to view the panel data and process the samples as follows: In the annual report of the listed company, Delete samples lacking data on “government subsidies” and “tax incentives”; ST samples have been removed; Samples of listed companies whose main businesses are real estate, Internet and finance, and cross-border R&D of new energy vehicles are deleted [6]. In the end, this paper obtained 165 observations from 33 companies.

3.2. Variable design

3.2.1. Independent variables
Direct government subsidies (lnZFZJBT). Learning from the practice of Tang Qingquan et al. (2008), the “government subsidy” data in the notes of the listed company's annual report is recorded as a direct subsidy and the logarithmic value is taken [7].

Indirect government subsidies (lnZFJJBT). Learning from the practice of Li Miaomiao et al. (2014), the “tax refund” data in the annual report of listed companies is used as an indirect subsidy and the logarithmic value is taken.

3.2.2. Dependent variable
Innovation performance (lnpatent). Drawing lessons from Griliches, the number of patent applications is recorded as the company's innovation performance and the logarithm is taken.

3.2.3. Intermediary variables
Enterprise innovation investment (lnRD). Since different companies have different descriptions of innovation investment, the data of "R&D expenditure" or "technology R&D expenditure" is recorded as enterprise innovation investment and the logarithm is taken.
3.2.4. Control variables
Learn from the practices of Tang Qingquan (2008), Bai Junhong (2011), Albert and John. Control the following representative variables: number of employees (lnstaff), age of listing (age), asset-liability ratio (dar), total executive compensation (lnpaid) and senior management's shareholding ratio (ratio) as control variables.

See Table 1 for specific variables and descriptions.

| Variable type       | Variable name       | Variable symbol | Variable description                                      |
|---------------------|---------------------|-----------------|-----------------------------------------------------------|
| Independent variable| Direct government  | lnZFZJBT        | Log value of government direct subsidy                    |
|                     | subsidies           |                 |                                                           |
|                     | Indirect government| lnZFJJBT        | Log value of indirect government subsidies                |
|                     | subsidies           |                 |                                                           |
| Dependent variable  | Enterprise innovation| lnpatent       | The logarithm of the number of enterprise patent applications|
|                     | performance         |                 |                                                           |
| Mediating variable  | Enterprise innovation| lnRD            | Logarithmic value of enterprise R&D investment            |
|                     | investment           |                 |                                                           |
| Control variable    | Number of employees | lnstaff         | Log value of the number of employees                      |
|                     | Age of listing      | age             | Age of listing                                            |
|                     | Assets and liabilities| dar            | Measure debt solvency                                    |
|                     | Total executive compensation| lnpaid        | Log value of total executive compensation                 |
|                     | Executive shareholding ratio| ratio      | Number of executive shares/total shares                   |

4. Empirical results and analysis

4.1. Data source and sample selection
Descriptive analysis is to study the overall situation and overall level of quantitative data, usually using the average and median to describe the data. In order to eliminate the influence of outliers, this paper performs 1% reduction of the tail value processing on the data \[{8}\]. In order to eliminate the influence of model heteroscedasticity, this paper performs logarithmic processing on some data. The overall results are as follows:

| variable | N  | min | max  | mean | sd  | p50  | skewness | kurtosis |
|----------|----|-----|------|------|-----|------|----------|----------|
| lnpatent | 165| 1.386| 8.228| 4.620| 1.364| 4.466| 0.118 | 3.079 |
| lnZFZJBT | 165| 15.76 | 20.83 | 17.83 | 1.303 | 17.67 | 0.446 | 2.378 |
| lnZFJJBT | 165| 19.05 | 24.37 | 21.11 | 1.238 | 20.92 | 0.871 | 3.368 |
| lnRD    | 165| 15.80 | 22.59 | 19.37 | 1.330 | 19.27 | 0.235 | 3.227 |
| lnstaff | 165| 3.367 | 10.99 | 8.580 | 1.197 | 8.353 | -1.205 | 7.681 |
| age     | 165| 1     | 26   | 11.61 | 6.400 | 9    | 0.666 | 2.245 |
| dar     | 165| 0.188 | 0.809 | 0.494 | 0.156 | 0.483 | 0.0730 | 2.067 |
| lnpaid  | 165| 13.35 | 17.53 | 15.81 | 0.770 | 15.80 | -0.391 | 3.635 |
| ratio   | 165| 0    | 0.488 | 0.0893 | 0.143 | 0.0136 | 1.622 | 4.219 |

The absolute value of kurtosis is less than 10 and the absolute value of skewness is less than 3, which can indicate that although the data does not present a completely normal distribution, it can be basically accepted as a normal distribution.
4.2. Panel regression analysis

In order to verify the previous hypothesis, this paper uses panel regression to estimate the model. The panel model involves three models, namely the mixed POOL model, the fixed-effects FE model and the random-effects RE model. First, perform model testing to find the optimal model: First: F test is used to select and compare the FE model and the POOL model [9]. A p value less than 0.05 means that the FE model is better. Otherwise, the POOL model is used; second: BP test is used For the comparison between RE model and POOL model, a p value of less than 0.05 means that the RE model is better, otherwise, the POOL model is used; third: Hausman test is used to compare the selection of FE model and RE model, p value less than 0.05 means that the FE model is better Excellent, otherwise the RE model is used. In order to verify the above hypothesis, the specific analysis results are summarized as follows:

Table 3. Panel regression analysis table (hypothesis 2)

|       | Pool  | Fe    | Re    |
|-------|-------|-------|-------|
|       | Inpatent | Inpatent | Inpatent |
| lnZFZJBT | 0.5946*** | 0.3225*** | 0.4109*** |
|   | (8.1468) | (2.6317) | (4.4633) |
| lnstaff | 0.5213*** | 0.4345*** | 0.5395*** |
|   | (6.6592) | (2.9407) | (5.0801) |
| age | -0.0238 | -0.2020*** | -0.0329 |
|   | (-1.5944) | (-3.3957) | (-1.4197) |
| dar | -0.6105 | -0.6709 | -0.4993 |
|   | (-0.9610) | (-0.7106) | (-0.6499) |
| lnpaid | -0.0449 | 0.3622* | -0.0402 |
|   | (-0.3733) | (1.9283) | (-0.2935) |
| ratio | 0.3751 | -1.8270 | -0.1307 |
|   | (0.6333) | (-1.2626) | (-0.1513) |
| _cons | -2.9009*** | -7.7452*** | -6.0587*** |
|   | (-4.9343) | (-2.7330) | (-2.8840) |
| N | 165 | 165 | 165 |
| _cons | 0.3848 | 8.5682*** | 5.1937*** |
|   | (0.2430) | (5.3830) | (3.7127) |

According to F test, BP test, and Hausman test, the model finally chooses the FE model. The specific analysis shows that lnZFZJBT shows a significant level of 0.01 for lnpatent, and the regression coefficient is greater than 0, indicating that lnZFZJBT shows a significant positive influence relationship, that is, hypothesis 2 holds.

Table 4. Panel regression analysis table (hypothesis 1)

|       | Pool  | Fe    | Re    |
|-------|-------|-------|-------|
|       | lnRD  | lnRD  | lnRD  |
| lnZFZJBT | 0.6652*** | 0.3224*** | 0.4530*** |
|   | (10.7324) | (4.6838) | (7.1685) |
| lnstaff | 0.3116*** | -0.0958 | 0.0036 |
|   | (4.6862) | (-1.1543) | (0.0478) |
| age | 0.0085 | 0.1579*** | 0.0642*** |
|   | (0.6696) | (4.7259) | (3.1092) |
| dar | -1.7965*** | -0.0472 | -0.3228 |
|   | (-3.3299) | (-0.0889) | (-0.6296) |
| lnpaid | 0.3343*** | 0.2570** | 0.3483*** |
|   | (3.2719) | (2.4357) | (3.7939) |
| ratio | -0.4789 | 0.0372 | -0.2668 |
|   | (-0.9521) | (0.0458) | (-0.3941) |
| _cons | 0.3848 | 8.5682*** | 5.1937*** |
|   | (0.2430) | (5.3830) | (3.7127) |
| N | 165 | 165 | 165 |
According to F test, BP test, and Hausman test, the model finally chooses the FE model. The specific analysis shows that lnZFJJB T shows a significant level of 0.01 for lnRD, and the regression coefficient is greater than 0, indicating that lnZFJJB T shows a significant positive for lnRD Influence relationship, that is, hypothesis 1 holds.

Table 5. Panel regression analysis table (hypothesis 4)

| Model | DV | Pool | Fe | Re |
|-------|----|------|----|----|
|       | lnZFJJBT | lnpatent | lnpatent | lnpatent |
|       | 0.5468*** | 0.5915*** | 0.5095*** |
|       | (4.3320) | (2.3330) | (2.9101) |
| Instaff | 0.2452** | 0.1839 | 0.2814** |
|       | (2.1459) | (1.0207) | (1.9620) |
| age | 0.0044 | -0.1821*** | -0.0295 |
|       | (0.2701) | (-3.1665) | (-1.0941) |
| dar | 0.0917 | -0.3486 | -0.3030 |
|       | (0.1295) | (-0.3671) | (-0.3755) |
| lnpaid | -0.0410 | 0.2681 | -0.0241 |
|       | (-0.3002) | (1.3853) | (-1.643) |
| ratio | 0.9798 | -1.6451 | -0.0033 |
|       | (1.4413) | (-1.1314) | (-0.0033) |
| _cons | -8.5617*** | -11.2492*** | -7.6768*** |
|       | (-3.5394) | (-2.6997) | (-2.6111) |
| N | 165 | 165 | 165 |
| R2 | 0.427 | 0.2057 | 0.1533 |
| Ftest | F(32,126) = 7.51, Prob > F = 0.0000 |
| BPtest | chibar2(01) = 89.73, Prob > chibar2 = 0.0000 |
| hausman | chi2(6) = 11.44, Prob > chi2 = 0.0758 |

* p < 0.1, ** p < 0.05, *** p < 0.01, t statistics in parentheses

According to F test, BP test, and Hausman test, the model finally chooses the FE model. The specific analysis shows that lnZFJJBT is significant for lnpatent at the 0.05 level, and the regression coefficient is greater than 0, indicating that lnZFJJBT is significantly positive for lnpatent Influence relationship, that is, hypothesis 4 holds.

Table 6. Panel regression analysis table (hypothesis 3)

| Model | DV | Pool | Fe | Re |
|-------|----|------|----|----|
|       | lnZFJBT | lnRD | lnRD | lnRD |
|       | 1.0527*** | 0.4601*** | 0.7629*** |
|       | (11.3283) | (3.1117) | (6.2725) |
| Instaff | -0.2520*** | -0.2935*** | -0.3456*** |
|       | (-2.9946) | (-2.7929) | (-3.6012) |
| age | 0.0219* | 0.1912*** | 0.0732*** |
|       | (1.8452) | (5.7007) | (3.6156) |
| dar | -1.5929*** | 0.2413 | -0.0379 |
|       | (-3.0556) | (0.4358) | (-0.0715) |
| lnpaid | 0.2675*** | 0.1847 | 0.2988*** |
|       | (2.6628) | (1.6363) | (3.0712) |
| ratio | 0.6524 | 0.2122 | 0.2489 |
|       | (1.3034) | (0.2502) | (0.3563) |
| _cons | -4.4438** | 6.8985*** | 0.6567 |
|       | (-2.4951) | (2.8388) | (0.3269) |
| N | 165 | 165 | 165 |
| R2 | 0.6732 | 0.5668 | 0.5123 |
According to F test, BP test, and Hausman test, the model finally chooses the FE model. The specific analysis shows that lnZFJJBT shows a significant level of 0.01 for lnRD, and the regression coefficient is greater than 0, indicating that lnZFJJBT shows a significant positive for lnRD Influence relationship, that is, hypothesis 3 holds.

### 4.3. Test of mediation effect

| Path                      | Total effect | a          | b          | a*b intermediary effect | direct effect | conclusion       |
|---------------------------|--------------|------------|------------|-------------------------|---------------|------------------|
| lnZFJZJT => lnRD => lnpatent | 0.3225***    | 0.3224***  | 0.4081***  | 0.1315                  | 0.191         | Fully intermediary |
| lnZFJJBT => lnRD => lnpatent | 0.5915**     | 0.4601***  | 0.4352***  | 0.2002                  | 0.3913        | Fully intermediary |

* p < 0.1, ** p < 0.05, *** p < 0.01

According to the above table, it can be seen that corporate innovation input has a complete intermediary effect in the process of direct government subsidies/indirect government subsidies and corporate innovation performance, which means that Hypothesis 5 is established.

### 4.4. Robustness test

This article adopts the method of adding more control variables (ROA (total net profit margin), growth (total growth rate of assets), bsize (number of directors), pid (proportion of independent directors), top 10 (proportion of top ten shareholders) Test whether the above model is stable.

| Model DV | Fe1 lnpatent | Fe2 lnRD | Fe3 lnpatent | Fe4 lnRD | Fe5 lnpatent | Fe6 lnRD |
|----------|--------------|----------|--------------|----------|--------------|----------|
| lnZFJZJT | 0.3065**     | 0.3203***| 0.1674       | 0.4948*  | 0.4235***    | 0.2926   |
|          | (2.4767)     | (4.8177) | (1.2688)     | (1.8203) | (2.7704)     | (1.0794) |
| lnZFJJBT | 0.4948*      | 0.4601***| 0.4352***    | 0.2002   | 0.3913       |          |
|          | (1.8203)     | (2.7704) | (1.0794)     |          |              |          |
| lnRD     | 0.37060      | -2.5655  | 4.7742       |          |              |          |
| lnstaff  | 0.1413***    | -0.2426***| -0.1632**    | 0.1708***| -0.2446***   |          |
|          | (1.2091)     | (-0.2749)| (1.0794)     | (1.3915) | (-0.5017)    |          |
| age      | -0.1812***   | -0.2426***| -0.1632**    | 0.1708***| -0.2446***   |          |
|          | (-2.8937)    | (-1.8203)| (-1.8203)    | (2.7704) | (-1.0794)    |          |
| dar      | 0.1413***    | -0.2426***| -0.1632**    | 0.1708***| -0.2446***   |          |
|          | (-2.8937)    | (-1.8203)| (-1.8203)    | (2.7704) | (-1.0794)    |          |
| lnpaid   | 0.1173       | 0.4319**  | 0.2691       | -0.0646  |              |          |
|          | (1.1800)     | (3.7777)  | (1.7091)     | (-0.5157)|              |          |
| ratio    | -0.1274      | -0.2573   | -1.6526      | -1.4325  | 0.0696       | -1.4657  |
|          | (-1.941)     | (-1.3241)| (-2.6288)    | (1.0794) | (-0.5017)    |          |
| ROA      | 0.5656       | 2.5432    | 1.7015       | -0.3903  | 1.8877       |          |
|          | (2.6639)     | (4.4772)  | (1.7091)     | (-0.5157)|              |          |
| growth   | -0.1044      | -0.0421   | -0.0963      | -0.1384  | -0.0303      |          |
|          | (-0.5295)    | (-0.2170)| (-0.4826)    | (-1.0794)|              |          |
| bsize    | 0.0116       | -0.0131   | 0.0086       | -0.0148  | 0.0707       |          |
|          | (1.2907)     | (-0.6328)| (0.9272)     | (-0.9083)|              |          |
| pid      | 0.0116       | -0.0131   | 0.0086       | -0.0148  | 0.0707       |          |
|          | (1.2907)     | (-0.6328)| (0.9272)     | (-0.9083)|              |          |
| top10    | -0.0574      | -0.2736***| -0.0312      | -0.2521***| 0.0891       |          |
|          | (-0.4279)    | (-3.7936)| (-0.4428)    | (-2.279) | (-0.5017)    |          |
|          |              |          |              |          | (0.4454)     |          |
|          |              |          |              |          |              |          |
|          |              |          |              |          |              |          |

* p < 0.1, ** p < 0.05, *** p < 0.01
The conclusions drawn in the above table are consistent with previous conclusions, indicating that the model is stable.

5. Conclusion and inspiration

This paper uses the panel data of listed companies in China's new energy automobile industry from 2015 to 2019 as a research sample to conduct empirical research. The research results mainly include the following three aspects: direct government subsidies have a significant positive impact on corporate innovation performance and corporate innovation input \cite{10}. Moreover, the government’s high direct subsidies have the effect of making enterprises add to the innovation input; the government’s indirect subsidies have a positive impact on the innovation performance of enterprises and the innovation input of enterprises, and although indirect subsidies cannot directly affect innovation performance, they can promote the “quantity” of the company’s technology changes, which indirectly improves the company’s innovation performance. By comparing the impact of government direct subsidies and indirect subsidies on the company’s innovation performance, we find that direct subsidies are more targeted for companies, while indirect subsidies are due to the pertinence is not strong, and the effect is not as good as direct subsidies.

Therefore, the government should strengthen the direct subsidy for the new energy automobile industry. This is because the government's direct subsidy can effectively promote the investment of enterprises in innovative research and development, and at the same time help enterprises to obtain a good social reputation, attract more investment, and provide enterprises for research and development projects \cite{11}. Escort; and when providing indirect subsidies dominated by market forces to enterprises, the government should focus on preferential treatment of new products and technologies of enterprises, so that indirect subsidies can help enterprises more effectively; in order to better exert the effect of subsidies The government should establish a timely feedback mechanism in order to achieve the subsidy effect due to the subsidy policy.

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