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Article

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Research paper

Exploring the impact of government subsidy and R&D investment on financial competitiveness of China's new energy listed companies: An empirical study



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HIGHLIGHTS

- R&D investment intensity has a significant positive correlation with the financial competitiveness, and it has a lag effect.
- The moderating role of the government subsidies is examined.
- Factor analysis is used to explore the calculation of financial competitiveness.
- First examining the effect of government subsidies in the new energy industry in China.

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ABSTRACT

In the environment where the traditional energy industry is declining and the new energy industry is developing rapidly, we collected the data from 98 new energy companies listed in China's Shanghai and Shenzhen stock markets from 2012 to 2016 to conduct an empirical study to understand the relationship between their R&D investment intensity and their corporate financial competitiveness. In addition, we looked at an issue of how the relationship is impacted by government subsidies. The research results show that the R&D investment intensity has a significant positive correlation with the financial competitiveness of China's new energy listed companies, and it has a lag effect. The current government subsidies have no significant moderating effect on the relationship between R&D investment and financial competitiveness. Based on the empirical study conducted, we propose that China's new energy listed companies should increase R&D investment, strengthen the long-term budget management of R&D investment, and increase government support and supervision in order to enhance financial competitiveness.

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1. Introduction

Innovation is the first driving force for development and the strategic support for building a modern economic system (Xi, 2017). Since the 18th National Congress, China has vigorously implemented an innovation-driven development strategy. The 19th National Congress continued to propose strengthening the construction of the national innovation system and strengthening strategic and technological forces (Xi, 2017). Scientific and technological innovation plays a vital role in building a well-off society in China.

According to the “Statistical Bulletin on China's Science and Technology Funds”, in 2016, China invested a total of 1567.67 billion yuan in research and development (R&D) investment, which was an increase of 10.6% over 2015, and the growth rate was 1.7 percentage points higher than that in 2015. Among them, corporate expenditures accounted for 77.5% which is the main body of enterprises in research and experimentation. The 19th National Congress of the Communist Party of China proposed to establish a technological innovation system with enterprises as the mainstay, market-oriented, and deep integration of production, education and research (Xi, 2017). Due to the increasingly fierce domestic and international market competition, technological innovation capability directly affects the competitiveness of enterprises. In recent years, the Chinese government has continuously strengthened its support for small and medium enterprises' innovation and promoted transforming scientific and

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technological achievements into production. Therefore, there has been a widespread concern about whether R&D investment representing the technological innovation capability of enterprises improves the financial competitiveness of enterprises, and how government subsidies affect them.

The energy industry as a supporting industry has made an indelible contribution to China's economic development. According to the BP World Energy Statistics Yearbook, China's energy consumption accounted for 23% of global consumption in 2016 and is the world's largest energy consumer. However, with the sharp decline of fossil fuels and the increasingly serious environmental pollution, the development speed of the traditional energy industry has gradually slowed down, and the new energy industry with abundant resources and cleanliness has developed rapidly. In 2016, the world's renewable energy grew by 12% and continued to grow at the fastest rate. The new energy field has gradually become a key industry in the world for competing development.

This paper takes the listed companies in the new energy industry as the research object, empirically analyzes the impact of R&D investment on the company's financial competitiveness, and studies the role of government subsidies for this impact. Finally it offers specific countermeasures and suggestions for the new energy industry.

2. Related literature review and research hypothesis

2.1. Correlation between R&D investment and current financial competitiveness

Enterprise financial competitiveness refers to a kind of competitiveness that is based on knowledge and innovation ability, and effectively integrates the ability of the financial capability system of the enterprise to benefit the sustainable competitive advantage and then acts on the financial controllable resources of the enterprise (Zhu, 2016). In all stages of enterprise development, innovation is an important factor in maintaining a company's competitiveness (Styles and Jones, 2007). George et al. empirically studied the relationship between business-university alliances, R&D investment and financial performance of 147 biotechnology-listed Companies. They found that biotechnology companies with a background of business-university alliances had lower R&D investment, however their R&D efficiency and financial performance were higher (George et al., 2002). Lin et al. conducted the empirical research about patent and financial data of 258 US technology companies and found that the R&D intensity of technology companies has a significant impact on financial performance (Lin et al., 2006). Edwin Mansfield used the Douglas production function to derive R&D spending that has a positive impact on improving business productivity (Edwin, 1965). Oswald D R. divided the R&D investment into two categories, capitalization and cost-based, conducted empirical analysis of the relationship between capitalization and cost-based and corporate value, and found that its correlations with corporate value did not change significantly (Oswald, 2008). Ma Wencong, Hou Yu, Zhu Guilong and others found that the intensity of R&D investment in emerging industries has a significant positive impact on the innovation performance of enterprises through the comparison of different industries (Ma et al., 2013). Qiu Yunjie and Wei Wei used the tendency to assign ratios to find that corporate R&D can effectively improve their performance (Chou and Wei, 2016).

This paper believes that the innovation ability of an enterprise depends fundamentally on the strength of R&D investment, and the innovation capability is the core element of financial competitiveness. Based on the above discussion, our Hypothesis 1 is stated as follows:

H1: R&D investment is promoting the current financial competitiveness of new energy listed companies.

2.2. The lag of the impact of R&D investment on financial competitiveness

There is a certain period for research and development of any technology (Baker et al., 2015; Costa-Campi et al., 2017). Therefore, the impact of R&D investment on competitiveness will also have a lag in time (Breyer et al., 2013; Strandholm et al., 2018). Eberhart et al. conducted an empirical study based on the data of a sample of 8331 companies from 1951 to 2001 and found that since the investors' response to the increase in information on R&D was not timely and the market was gradually realizing that the increase in R&D investment was good information, which in turn lead to a lag, positive impact of increased R&D investment on financial performance (Eberhart et al., 2004). Kostopoulos et al. conducted a survey of a sample of 461 Greek companies involved in the third community innovation. Based on the result from the path analysis, they found that R&D investment had positively promoted the innovation and financial performance of the enterprise, but this positive promotion had a time lag (Kostopoulos et al., 2011). Yang Zhonghuan empirically analyzed the R&D investment and corporate value after implementing the new accounting standards, and found that R&D investment has a strong positive correlation with corporate value with a lag in time (Yang, 2013). Wang Yuchun and Guo Yuanzhen analyzed the relationship between R&D input and output in manufacturing and information technology industries, and concluded that R&D capital investment is significantly positively correlated to profitability with a lag in time (Wang and Guo, 2008).

Due to the fact that there exists a lag in time between the investment and corporate value, meaning that the current R&D investment may not show its benefits in the current period. Based on the above discussion, our Hypothesis 2 is proposed as follows:

H2: There is a time lag in the positive promotion of R&D investment on the financial competitiveness of new energy listed companies.

2.3. Moderating effects of government subsidies

The empirical findings of Meuleman and Maeseneire show that companies with higher credit ratings are more likely to receive government subsidies. And the SMEs which have obtained R&D government subsidies have more the opportunity to get long-term debt funds because the government recognizes its credit. In the context of sufficient funds, the SMEs are more willing to increase R&D investment to enhance their innovation capabilities, which in turn will help improve financial competitiveness (Meuleman and DeMaeseneire, 2012). Zhu Bin and Li Lulu analyzed the data from the ninth private enterprise survey and concluded that the government's research and development subsidy policy have an incentive effect on private enterprise R&D investment (Zhu and Li, 2014). Xu Haibo conducted an empirical analysis of Dalian high-tech enterprises as a sample, and found that government preferential policies have a restraining effect on the relationship between R&D investment and corporate performance (Xu, 2017). He Liuli took the listed companies in the manufacturing industry as the research object, and concluded that the tax preferential policies have a positive adjustment effect on the relationship between R&D investment and corporate performance (He, 2018). Xiong Heping, Yang Yijun, Zhou Wei and others quantitatively analyzed the relationship between government subsidies and R&D investment from the perspective of life cycle, and concluded that government subsidies only stimulated the R&D activities of enterprises in the recession period (Xiong et al., 2016). Zhang Xinrong and Liang Zhengwei conducted an empirical analysis on the time series of high-tech enterprises. It was found that government subsidies can have a positive mediating effect on corporate performance through R&D investment, but

Table 1
Financial competitiveness evaluation index system.

Variable	Name	Symbol	Description
Debt-paying ability	Equity ratio	Y_1	Ending shareholders' equity/total assets
	Quick ratio	Y_2	(Current Assets-Inventory)/Current Liabilities
	Cash ratio	Y_3	Ending cash and cash equivalents /current liabilities
Development capability	Rate of return on equity growth	Y_4	(Return on equity of the current period - return on equity of year-ago period)/return on equity of year-ago period
	Net profit growth rate	Y_5	(Net profit current year - net profit year-ago period)/(net profit year-ago period)
Operating capacity	Total assets turnover	Y_6	Operating income/ending balance of total assets
	Current asset turnover	Y_7	Operating income/ending balance of current assets
Profitability	Profit rate of asset	Y_8	Net profit/total assets balance
	Ratio of profits to cost	Y_9	Total profits/(operating costs + sales expenses + management expenses + financial expenses)
	Return on assets	Y_{10}	(total profits + financial expenses)/average total assets
	Operating profit margin before interest and tax	Y_{11}	(net profit + income tax + financial expenses)/(operating income)
Cash flow ability	Total operating cash current liability ratio	Y_{12}	Net cash flow from operating activities /total current liabilities
	Total operating cash liabilities ratio	Y_{13}	Net cash flow from operating activities /average balance of liabilities

there are some differences in the effects of “in-process subsidies” and “ex ante subsidies” (Zhang et al., 2016). Wu Xianyun, Chen Yan and others used strategic emerging industries as the research objects, and found that government subsidies have a moderating effect on the relationship between R&D investment and corporate value with a lag in time (Wu et al., 2017).

The state encourages technological innovation of enterprises, and also has various forms of subsidy preferential policies for enterprises with innovative capabilities (Styles and Jones, 2007; Fan and Dong, 2018). Government subsidies have no direct impact on the improvement of financial competitiveness, but government subsidies will promote the financial competitiveness of enterprises by influencing R&D investment. Based on the above discussion, our Hypothesis 3 is stated as follows:

H3: Government subsidies have an adjustment effect on the relationship between R&D investment and financial competitiveness of new energy listed companies

3. Data definitions and methodologies

3.1. Data source

This study selected the sample data from the companies in the new energy industry listed on the Shanghai Stock Exchange and the Shenzhen Stock Exchange in a period of 2012 to 2016. Through the inquiry of China New Energy Network, a total of 98 companies including photovoltaic energy, wind power, biomass energy, lithium power and new energy automobile industry were collected. The selection criteria are: (1) to avoid the incomplete data and the impact of extreme values, delete companies that are newly listed and delisted in 2012–2016; (2) delete ST (Special Treatment, which means the company's operation losses for two consecutive years. Risk warning) and *ST (The company's operation losses for three consecutive years. Delisting warning.) companies; and (3) delete companies with abnormal data. The original data came from Guotaian database, Juchao Information Network Sina Finance, etc. The data processing mainly used SPSS19.0 software and Excel.

3.2. Variable definition

3.2.1. Explanatory variables

(1) R&D investment

R&D investment includes R&D capital investment and R&D personnel input (Lee and Yang, 2018). Since the disclosure of R&D

personnel of listed companies was not comprehensive, this study selected R&D funds as explanatory variables. The R&D investment value was taken from the R&D expenditure item in the notes to the financial statements disclosed by the company. For those that were not disclosed, the development expenditure in the current balance sheet, the research expenditure in the management fee, and the sum of the transferred intangible assets were taken as the total R&D expenditure of the company in the current year (Lee et al., 2015).

$RDM = R\&D \text{ expenditure} / \text{total assets}$

(2) Government subsidies

The government subsidy value came from the notes to the financial statements disclosed by the company. The sum of direct subsidies, tax refunds and other items were used as the value of government subsidy items (Peng and Liu, 2018).

$Subs = \text{Government Subsidy} / \text{Operating Income}$

3.2.2. Interpreted variables

The interpreted variables of this research are the financial competitiveness of the company. A company's financial competitiveness evaluation system included a total of 13 indicators to reflect financial competitiveness, such as solvency, development capability, operational capability, profitability, and cash flow capability. Factor analysis was used to obtain comprehensive financial competitiveness. The basic purpose of factor analysis is to use a few factors to describe the relationship between many indicators or factors. That is, to put together several closely related variables into the same class, each type of variable becomes a factor, with a few factors reflect most of the information in the original data (Vijayakumar, 2018). The result of factor analysis of the company's financial competitiveness evaluation index system was served as interpreted variables. The detailed information of the evaluation indicators is shown in Table 1.

Then, a suitability test is performed on the factor analysis. The test results are shown in Table 2.

It can be seen from Table 2 that the KMO value is 0.604, and the approximate chi-square of the Bartlett sphericity test is 8568.951, corresponding to a p-value of 0.000, which indicates a suitable factor analysis by a significance test. Tables 3 and 4 are matrixes of total variance and component score coefficients for the interpretation of the orthogonal rotation after Kaiser normalization, respectively.

Based on the factor analysis presented in Table 3, the five factors with eigenvalues greater than 1 are extracted, and the

Table 2
KMO and Bartlett tests.

KMO test value of financial competitiveness	0.604
The approximate chi-square	8568.951
Bartlett test of financial competitiveness	78
df	
Sig.	0.000

cumulative variance contribution rate is 89.688%, and the common factor variance of all indicators is greater than 0.7, indicating that the common factor reflects the original index information well. According to Table 3, the scores of each factor can be separately obtained, and then the variance contribution rates of the five factors in Table 4 are taken as weights. After weighted aggregation, the comprehensive score function of the financial competitiveness of China's new energy listed companies is:

$$F = (25.494F_1 + 21.657F_2 + 15.095F_3 + 14.655F_4 + 12.787F_5) / 89.688$$

3.2.3. Control variables

Influencing the company's financial competitiveness and R&D expenditure also includes other factors. In order to better reflect the impact of R&D investment on the financial competitiveness of new energy listed companies, the control variables selected in this study are as follows:

(1) company size

The size of the company represents the competitiveness of the company to a certain extent (Crowder and Reganold, 2015). Under normal circumstances, the size of the company affects the financial competitiveness and the degree of R&D investment. Therefore, the company size is selected as a control variable where

$$\text{Size} = \text{Lg total assets}$$

(2) Capital structure

The asset–liability ratio represents the solvency of the company, affects the financial position of the company, and is a component of financial competitiveness. The literature has shown that the asset–liability ratio usually has a greater impact on R&D investment. Therefore, the capital structure is selected as a control variable which is expressed as:

$$\text{Les} = \text{total liabilities}/\text{total assets}$$

(3) Return on net assets in the previous period

The size of the ROE in the previous period will directly affect the strength of the company's current R&D investment. At the

Table 4
Component matrix.

	Component				
	1	2	3	4	5
Y ₁	−0.017	0.361	0.000	−0.074	0.023
Y ₂	−0.015	0.361	−0.003	−0.060	0.032
Y ₃	−0.019	0.316	−0.008	0.048	0.010
Y ₄	−0.023	−0.003	0.505	0.011	0.004
Y ₅	−0.048	−0.007	0.513	0.012	−0.008
Y ₆	−0.023	0.078	0.004	−0.083	0.574
Y ₇	0.000	−0.029	−0.007	0.034	0.508
Y ₈	0.269	0.018	−0.004	−0.007	0.063
Y ₉	0.280	−0.025	−0.023	−0.012	−0.099
Y ₁₀	0.270	−0.007	−0.008	−0.013	0.084
Y ₁₁	0.297	−0.044	−0.071	−0.026	−0.075
Y ₁₂	−0.025	−0.007	0.011	0.503	−0.017
Y ₁₃	−0.014	−0.064	0.010	0.526	−0.036

same time, selecting the ROE of the previous period as a control variable can control the endogenous problem between R&D investment and financial competitiveness:

$$\text{Roe}_{t-1} = \text{net profit after tax}/\text{owner's equity}$$

The variables involved in this study are shown in Table 5.

3.3. The model

The research model of this study is designed as follows:

$$F_{i,t} = \alpha_0 + \beta \text{RDM}_{i,t-n} + \sum_{j=1}^3 \mu_j \text{Controls}_j + \varepsilon_{i,t} \quad (1)$$

$$F_{i,t} = \alpha_0 + \beta_1 \text{RDM}_{i,t} + \beta_2 \text{Subs}_{i,t-n} + \lambda \text{RDM}_{i,t} \times \text{Sub}_{i,t-n} + \sum_{j=1}^3 \mu_j \text{Controls}_j + \varepsilon_{i,t} \quad (2)$$

$i = 1, 2, 3 \dots I$, where i denotes the i th sample company, $t = 1, 2, 3, 4, 5$, t denotes the t th year, $n = 0, 1, 2$.

$F_{i,t}$ denotes the financial competitiveness of the i th sample company in the t th year,

$\text{RDM}_{i,t,n}$ denotes the development of the i th enterprise in the n th year Input intensity, as well as other variables.

4. Empirical data analysis and discussion

4.1. Descriptive statistics

The statistical results of R&D investment of new energy listed companies in 2012–2016 are shown in Table 6. It can be seen

Table 3
Total variance explained.

Component	Initial eigenvalue			Extract sums of squared loadings			Rotation sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	3.666	28.199	28.199	3.666	28.199	28.199	3.314	25.494	25.494
2	2.772	21.321	49.520	2.772	21.321	49.520	2.815	21.657	47.151
3	1.992	15.321	64.841	1.992	15.321	64.841	1.962	15.095	62.246
4	1.765	13.574	78.415	1.765	13.574	78.415	1.905	14.655	76.900
5	1.465	11.273	89.688	1.465	11.273	89.688	1.662	12.787	89.688
6	0.598	4.602	94.289						
7	0.335	2.575	96.865						
8	0.188	1.449	98.314						
9	0.112	0.862	99.176						
10	0.052	0.400	99.576						
11	0.035	0.267	99.842						
12	0.012	0.090	99.932						
13	0.009	0.068	100.000						

Extraction method: principal component analysis.

Table 5
Variable list.

Category	Name	Symbol	Definition
Explained variable	Financial competitiveness	<i>F</i>	Factor analysis composite score
Explanatory variables	R&D investment intensity	<i>RDM</i>	R&D investment amount/total assets
	Government subsidy	<i>Subs</i>	Government subsidy/gross revenue
Controlled variable	Company size	<i>Size</i>	The natural logarithm of total assets
	Capital structure	<i>Les</i>	Total liabilities/total assets
	Return on equity	<i>Roe_{t-1}</i>	Net profit/Ending shareholders' equity

Table 6
2012–2016 R&D investment statistics.

R&D investment	Year	Mean (%)	Minimum (%)	Maximum (%)	Standard deviation(%)
RDM	2012	1.4864	0.0184	7.8192	1.4815
	2013	1.4939	0.0023	9.1206	1.4553
	2014	1.4407	0.0238	8.1180	1.3575
	2015	1.4500	0.0199	8.5387	1.4814
	2016	1.5160	0.0124	8.7911	1.4551

Table 7
Pearson correlation test.

Variable	F	RD	Sub	Size	Lev	Roe
F	1					
RDM	0.230**	1				
Subs	−0.022	0.030	1			
Size	−0.147**	−0.215**	0.007	1		
Lev	−0.630**	−0.250**	−0.059	0.377**	1	
Roa	−0.280**	0.032	−0.019	0.047	−0.186**	1

Note: * denotes significant at the $p < 5\%$ level, and ** denotes significant at the $p < 1\%$ level.

from Table 6, the proportion of R&D investment decreased slightly in 2014, and gradually increased in 2015 and 2016. It shows that under the environment of gradually declining of traditional energy industry, the new energy industry is gradually aware of the importance of technological innovation, and each company has also increased the investment in research and development.

4.2. Correlation analysis

A Pearson correlation test was performed on the variables of the sample data, and the results are shown in Table 7. R&D investment and the company's financial competitiveness are significantly positively correlated with a significance level of less than 1%, which is supporting our Hypothesis 1. However, government subsidies are not significantly related to financial competitiveness, which indicates Hypothesis 2 is not supported. In addition, through the multi-collinearity diagnosis between variables, the test results show that the VIF values of the variance expansion factors of all variables are less than 2, indicating that there is no serious multicollinearity problem between the variables in the model. The next step is to conduct regression analysis.

4.3. Regression analysis

4.3.1. Regression analysis of R&D investment and corporate financial competitiveness

The model (1) was used to analyze the R&D investment and financial competitiveness of new energy listed companies. The results are shown in Table 8. It can be seen from Table 8 that R&D investment is significantly promoting the current financial competitiveness of enterprises, our Hypothesis 1 is supported. In addition, the R&D investment is significantly positively promoting the financial competitiveness of the first phase and the second phase of the time lag, indicating that the positive promotion

Table 8
Regression analysis results.

Variable	F	F (n = 1)	F (n = 2)
RDM _{t-n}	0.106*** (2.813)	0.103*** (2.625)	0.098** (2.508)
Size	0.071* (1.787)	0.039 (0.940)	0.038 (0.906)
Les	−0.551*** (−13.494)	−0.529*** (−12.620)	−0.531*** (−12.622)
Roe _{t-1}	0.249*** (6.694)	0.261*** (6.720)	0.261*** (6.707)
Adjusted R ²	0.427	0.416	0.415
F	82.285	73.341	73.084
Sig.	0.000	0.000	0.000
N	437	408	408

Note: * denotes significant at the $p < 5\%$ level, and ** denotes significant at the $p < 1\%$ level.

Table 9
Regression analysis results.

Variable	F	F (n = 1)	F (n = 2)
RDM	0.108*** (2.680)	0.103** (2.560)	0.103*** (2.577)
Subs _{t-n}	−0.028 (−0.718)	0.021 (0.552)	0.016 (0.401)
RDM*Subs _{t-n}	0.058 (1.446)	0.070** (2.057)	0.081** (2.074)
Size	0.046 (1.103)	0.040 (0.972)	0.042 (1.109)
Les	−0.522*** (−12.348)	−0.512*** (−11.996)	−0.517*** (−12.023)
Roe	0.258*** (6.650)	0.267*** (6.881)	0.262*** (6.773)
Adjusted R ²	0.421	0.421	0.422
F	50.257	50.226	50.566
Sig.	0.000	0.000	0.000
N	408	408	408

Note: * denotes significant at the $p < 5\%$ level, and ** denotes significant at the $p < 1\%$ level.

of R&D investment on the financial competitiveness of the enterprise has a lagging impact. At the same time, the significant impact of the positive promotion of R&D investment on the financial competitiveness of the second phase of the lag is slightly reduced. So our Hypothesis 2 is supported.

4.3.2. Moderating effect of government subsidies

The model (2) was used to test the Moderating effect of government subsidies on the relationship between R&D investment and financial competitiveness. The results are shown in Table 9. It can be seen from Table 9 that government subsidies do not have a significantly positive adjustment effect on the correlation between R&D investment and financial competitiveness in the current period, but have a positive adjustment effect on the correlation between R&D investment and financial competitiveness in the lag period. Our Hypothesis 3 is supported.

Table 10
Regression analysis results.

Variable	F	F (n = 1)	F (n = 2)
RDM _{t-n}	0.079** (2.067)	0.163*** (4.117)	0.074** (2.106)
Size	0.050 (1.254)	0.025 (0.609)	0.024 (0.592)
Les	−0.593*** (−14.258)	−0.567*** (−13.600)	−0.557*** (−13.055)
Roe _{t-1}	0.247*** (6.604)	0.306*** (7.719)	−0.258*** (6.549)
Adjusted R ²	0.424	0.428	0.410
F	80.709	76.868	71.227
Sig.	0.000	0.000	0.000
N	437	408	408

Table 11
Regression analysis results.

Variable	F	F (n = 1)	F (n = 2)
RDM	0.144*** (2.882)	0.187*** (3.172)	0.208*** (4.317)
Subs _{t-n}	0.048 (0.879)	0.016 (0.342)	−0.034 (−0.744)
RDM*Subs _{t-n}	0.120* (1.845)	0.208*** (3.474)	0.264*** (4.749)
Size	0.027 (0.662)	0.026 (0.651)	0.025 (0.630)
Les	−0.553*** (−12.968)	−0.530*** (−12.422)	−0.527*** (−12.452)
Roe _{t-1}	0.266*** (6.808)	0.256*** (6.683)	0.257*** (6.781)
Adjusted R ²	0.424	0.435	0.444
F	50.627	53.003	54.962
Sig.	0.000	0.000	0.000
N	408	408	408

4.4. Robustness test

In order to test the reliability of the conclusion, this study adopted a method of replacing explanatory variables. Specifically it includes the following steps:

(1) taking the ratio of the R&D investment amount of the sample enterprise to the operating income as a substitute indicator for the R&D capital input intensity;

(2) taking the ratio of government subsidies to total assets of sample enterprises as a substitute indicator for government subsidies.

The above process was re-examined using the substitute indicators, and the specific regression results are shown in Tables 10 and 11. From Tables 10 and 11, the significance of the relationship between government subsidies, R&D investment and financial competitiveness has changed slightly, but no substantial changes have taken place. The results of the robustness test are basically consistent with the previous analysis, further supporting the conclusions previously made.

5. Conclusion and policy implications

5.1. Conclusion

This paper took the data of 2012–2016 China New Energy Listed Company as a sample, and conducted an empirical study on the impact of R&D investment on the company's financial competitiveness and the moderating role of government subsidies on this relationship. The following conclusions are drawn:

First, R&D investment has a significant positive impact on the financial competitiveness of the enterprise in the current period. R&D investment is inseparable from the independent innovation capability of the company. And financial competitiveness is a

kind of financial integration ability based on knowledge and innovation. The increase in R&D investment will inevitably enable enterprises to upgrade their R&D capabilities and innovate their own technological advantages. On this basis, enterprises fundamentally improve their financial competitiveness, and then form their own core competitiveness, to meet the market demand for new products to increase their market shares.

Second, the impact of R&D investment on the company's financial competitiveness is lagging. The ongoing cycle of R&D activities and the likelihood of successful R&D are highly uncertain. Therefore, the current R&D investment may not necessarily achieve R&D results in the current period, and the R&D results may not necessarily produce economic benefits in the current period. Only when the finished product of R&D successfully enters the market and gains the recognition of consumers, can it play its role, generate economic benefits and improve the financial competitiveness of enterprises.

Third, government subsidies have a lagging effect on the positive correlation between R&D investment and the company's financial competitiveness. Government subsidies can stimulate the enthusiasm of enterprises' technology innovation, and at the same time promote the transformation of scientific and technological achievements, and then positively adjust the correlation between R&D investment and corporate financial competitiveness. However, due to the signal transmission effect, the impact of government subsidy information in the stock market is lagging, so that government subsidies will have an impact on the economic activities of the enterprise lagged by one period. Therefore, the adjustment effect of government subsidies in the current period is not obvious since it has hysteresis.

5.2. Policy implications

According to the conclusions made from this research, combined with China's current macroeconomic environment, the following suggestions are proposed for the R&D investment and financial competitiveness of new energy listed companies:

First, based on the company's own situation, it is suggested to increase R&D investment in order to enhance innovation capabilities. Whether or not it has the core competitiveness that other companies cannot match depends largely on the company's own technological innovation capabilities. The demand for energy in the market has only increased. The traditional energy industry is facing the threat of insufficient resources, and its development is far behind the needs of society. Being an environmentally friendly industry, the new energy industry is based on renewable resources and its development has unlimited possibilities. Therefore, based on the "One Belt and One Road" (which is the abbreviation of "Silk Road Economic Belt" and "21st Century Maritime Silk Road") strategic background and the country's strengthening of the innovation system, the new energy industry in its infancy should seize this opportunity and increase investment in research and development to improve its independent research and development capabilities.

Second, it is important to strengthen the long-term budget management of R&D investment. The R&D cycle of any R&D project has great uncertainty. Long-term R&D activities mean that there is no return on capital investment in the pre-development period. This requires companies to fully measure the financial situation of the company at the beginning of the R&D project, and make a long-term budget and maintain sufficient patience. At the same time, enterprises should consider the lag of R&D activities, and do not arbitrarily interrupt or terminate to avoid unnecessary loss. Enterprises cannot reduce the quality of R&D activities for short-term benefits, but focus on the long-term and give full play to the future economic benefits of R&D projects.

Third, the Chinese government should formulate long-term special support policies for R&D activities and establish follow-up supervision mechanisms. Driven by the innovation-driven development strategy, it is inseparable from the support of the Chinese government to establish a technological innovation system that is enterprise-oriented, market-oriented, and deeply integrated with industry, academia and research. China's new energy industry is in the growth stage, and many companies will reduce their investment in technological innovation due to lack of funds. It is important to increase the support of the Chinese government's special subsidies for R&D activities for its R&D investment. Therefore, the Chinese government should formulate the long-term special support policies for R&D activities to provide timely R&D subsidies to enterprises that carry out long-term research and development projects. When there is a shortage of funds the government needs to help enterprises carry out research and development activities smoothly. At the same time, it is necessary to establish a monitoring mechanism to ensure that the Chinese government's special subsidies for R&D activities are indeed used for R&D activities of enterprises. It is also necessary for the Chinese government to guide new energy listed companies to attract innovative investments from private venture capital markets and public venture capital markets in order to expand the sources of their R&D funds. In addition, the Chinese government can design a R&D tax plan that is conducive to the innovation activities of new energy listed companies, and provide tax support for its R&D activities.

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