

# Research on the Influence of Board Governance on Enterprise Value

## - Mediating Effect based on R&D Investment of Listed Energy Companies

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**Abstract.** In order to promote energy enterprises to straighten out the board governance mechanism and ensure the standardization and modernization of enterprise management, based on the data of listed energy companies from 2013 to 2017, this paper studies the influence of board governance on enterprise value and the transmission mechanism of R&D investment from the perspective of R&D investment. The results showed that the size of the board of directors, the number of board meetings and the total annual salary of directors were significantly positively correlated with the enterprise value, while the combination of two positions, the proportion of independent directors and the shareholding of directors were significantly negatively correlated. Research and development investment show partial or complete mediating effect. Based on this, the paper puts forward some Suggestions on how to improve board governance and incentive mechanism, as well as how to coordinate R&D investment to enhance the enterprise value of listed energy companies.

**Keywords:** Energy listed companies, Board governance, R&D investment, Enterprise value, Mediating effect.

## 1. Introduction

As an important foundation of economic development, energy plays an important role in national life and national defense industry, and its contribution to economic development cannot be ignored. Faced with the new normal of economic development, the energy industry has also realized that under the background of deepening supply-side structural reform and implementing innovation-driven development strategy, technological innovation is the inexhaustible driving force for the long-term development of enterprises[1]. However, compared with other industries, the overall innovation ability of the energy industry has a big gap. How to ensure that r&d investment can be effectively converted into innovation results and promote enterprise value improvement is the concern of many enterprises that vigorously carry out technological innovation.

For listed companies in the energy industry, most of them are state-owned capital holding shares or participating in shares, and most of the board members have government participation. Therefore, the influence of the board governance on the investment in research and development has a certain practical value on the enterprise value. Therefore, through the study of the transmission mechanism of "board governance -- r&d investment -- enterprise value"[2], this paper can not only provide new ideas for enhancing enterprise value, but also promote enterprise innovation activities.

## 2. Hypothesis

Board of directors' system is an important part of modern enterprise management, and effective governance can promote the improvement of enterprise value. The integration of the two jobs has a lot to do with leadership. When you combine the two roles, it helps save communication costs, but not all chairmen are good at management. In particular, for listed energy companies, the chairman assumes more administrative responsibilities and holds the post of general manager, which may expand his/her power, manipulate the decision-making of the board of directors and bring about negative effects[3]. The larger board size can provide more business strategies, which is conducive to the increase of enterprise value. Similarly, the increase of the proportion of independent directors can

better realize effective supervision, balance power to a certain extent, avoid the hidden operation to the greatest extent, make the company's decision-making and operation more transparent, and contribute to the steady growth of enterprise value.

Throughout the listed company, the resolution formed at the board meeting is the main way for minority shareholders to understand the company's operating conditions, and the main way for the enterprise to establish a responsible and responsible image. In other words, the increase in the number of board meetings is conducive to the disclosure of corporate information and the understanding and supervision of the operation and management of the enterprise by stakeholders [4]. Here, this paper proposes the following hypothesis:

H1: two jobs in one undermines value.

H2: the larger the board of directors, the more conducive to the improvement of enterprise value.

H3: the larger the proportion of independent directors, the more conducive to the improvement of enterprise value.

H4: the more board meetings held, the more conducive to the improvement of enterprise value.

Incentive measures to promote the interests of individuals and enterprises in line with the long-term development of enterprises. Combined with the actual situation of listed energy companies in China, equity incentive is not mature enough, which may run counter to the incentive theory. As the most important and traditional incentive mechanism, compensation is usually affected by the performance level during operation. In order to obtain higher compensation, the management may pursue short-term gains and ignore the long-term development of the enterprise. But listed energy companies, where board members have a more prominent reputation in the industry, pay more attention to the long-term development of enterprise value. Based on the above analysis, this paper proposes the following hypotheses:

H5: directors' shareholding is negatively correlated with enterprise value.

H6: total annual salary of directors is positively correlated with enterprise value.

Enterprise production and management is the process of constantly pursuing excess profits, and research and development activities are indispensable to obtain excess profits. For enterprises, r & d is a risky investment, and it is basically difficult to see results in the short term. But for long-term development, r & d activities are the inevitable choice of enterprises. As the main body of research and development activities, enterprises not only respond to the call of the society, but also shape the core advantages of enterprises through innovation, maintain stable development of enterprises, and promote the increase of enterprise value. Here, this paper proposes hypothesis H7: r&d investment of enterprises is positively correlated with enterprise value.

The theory of technological innovation points out that r & d activities are the forerunner of innovation, and the level of r & d investment indicates the active degree of r & d activities. The combination of the two jobs has strengthened the chairman's authority, allowing him to make decisions quickly. But power is too centralized, board of directors contain action to reduce. For listed energy companies, the possibility of timely and effective innovation activities is even smaller. Therefore, is not conducive to enterprise research and development investment. When the board of directors is larger, directors can play a role in their areas of expertise, which can promote more comprehensive exchange of technology, experience and so on. At the same time, independent dong has no interest dispute with the enterprise, and can view the problem from an objective perspective. Therefore, guaranteeing the proportion of independent directors can theoretically promote the effective governance of the board of directors, thus strengthening the research and development activities of enterprises.

Frequent board meetings provide directors with ample opportunities to communicate and keep stakeholders informed of the latest developments in the enterprise. The directors' autonomy and external supervision are strengthened, which will make them make decisions more consistent with the sustainable development of the enterprise. Based on the above analysis, this paper proposes the following hypotheses:

H1a: the combination of the two jobs will reduce the r&d investment of enterprises.

H2a: the larger the board of directors, the greater the r&d investment.

H3a: the greater the proportion of independent directors, the greater the investment in research and development.

H4a: the more board meetings are held, the greater the investment in research and development.

The foregoing analysis points out that the equity incentive of listed energy companies in China is not mature enough and may not have the expected effect. Therefore, the promotion effect on r&d activities is not obvious, and even hinders r&d investment [5]. However, the compensation is greatly influenced by the current operating conditions of the enterprise. Management may resort to short-term speculation in order to get a higher annual salary. However, board members are mostly supervised by various parties in the industry. Their personal behaviors are closely related to the long-term development of the enterprise, and they will assume more responsibilities for the future of the enterprise and theoretically support the r&d and innovation. Based on the above analysis, the following hypotheses are proposed:

H5a: directors' shareholding hinders the increase of r&d investment.

H6a: total annual salary of directors is positively correlated with r&d investment.

Different governance of the board of directors will have different influences on the level of r&d investment of enterprises. Through enterprise operation and management, it ACTS on enterprise value. The foregoing analysis shows that board governance has various impacts on enterprise value. After r & d investment is added, it will affect the resource allocation and strategic decision of the enterprise, and further affect the enterprise value. Therefore, the following hypothesis is proposed:

H1b: R&D investment has an intermediary effect between the integration of two jobs and enterprise value.

H2b: R&D investment has a mediating effect between board size and enterprise value.

H3b: R&D investment has an intermediary effect between the proportion of independent directors and enterprise value.

H4b: R&D investment has an intermediary effect between the number of board meetings and enterprise value.

H5b: R&D investment has an intermediary effect between directors' shareholding and enterprise value.

H6b: R&D investment has an intermediary effect between the total annual salary of directors and the enterprise value.

### **3. Study Design**

#### **3.1 Sample Selection and Variable Design**

This paper takes listed Chinese energy companies as research samples from 2013 to 2017. In order to ensure the continuity and integrity of the research data, companies with ST class, suspended listing and incomplete data were excluded, and 245 sets of sample data were finally obtained. The data in this paper are all from CSMAR, Wind database and annual reports of listed companies. The calculation method and symbol representation of related variable indicators are shown in the following table:

Table 1. Calculation and Expression of Variables

Variables	Measure	Calculation	Symbols	
Explained variable	The enterprise value	Tobin Q value [6]	(market value of tradable shares + number of non-tradable shares * net assets per share + book value of liabilities)/book value of total assets	TQ
Explanatory variables	Board governance	The joining together of two job	And set it as 1, and set it as 0	JT
		Board size	Total number of board members at the end of the term	BS
		Proportion of independent directors	Number of independent directors at the end of the term/total number of directors at the end of the term	ID
		Number of board meetings	The number of board meetings held in that year	BM
		Shareholding ratio of directors	Total/total shares held by directors	MAR
		Total annual salary of directors	Total annual salary of directors	MAS
Intervening variable	R&D spending	R&D investment intensity	R&d expenditure/operating income	R&D
Control variables	The enterprise scale	Ending assets	Log of ending assets	Size

### 3.2 Empirical Model Design

The paper first examines the impact of r&d investment on governance structure. then, the influence of each variable of board governance on enterprise value and r&d investment is verified respectively, and whether r&d investment has mediating effect is tested.

(1) analysis model of the impact of r&d investment on enterprise value:

$$TQ = \alpha_0 + \alpha_1 R \& D + \alpha_2 Size + \varepsilon$$

(2) mediating effect test model: based on the above analysis, this paper constructed the test model shown in table 2 and table 3. Among them, table 2 shows the model constructed to test regression coefficients c and a in the steps of intermediary effect coefficient test.

Table 2. model construction of mediating effect test (i)

Model	Coefficient c tests the model	Model	Coefficient a tests the model
Model1	$TQ = \alpha_0 + \alpha_1 JT + \alpha_2 Size + \varepsilon$	Model1a	$R \& D = \alpha_0 + \alpha_1 JT + \alpha_2 Size + \varepsilon$
Model12	$TQ = \alpha_0 + \alpha_1 BS + \alpha_2 Size + \varepsilon$	Model2a	$R \& D = \alpha_0 + \alpha_1 BS + \alpha_2 Size + \varepsilon$
Model13	$TQ = \alpha_0 + \alpha_1 ID + \alpha_2 Size + \varepsilon$	Model3a	$R \& D = \alpha_0 + \alpha_1 ID + \alpha_2 Size + \varepsilon$
Model4	$TQ = \alpha_0 + \alpha_1 BM + \alpha_2 Size + \varepsilon$	Model4a	$R \& D = \alpha_0 + \alpha_1 BM + \alpha_2 Size + \varepsilon$
Model5	$TQ = \alpha_0 + \alpha_1 MAR + \alpha_2 Size + \varepsilon$	Model5a	$R \& D = \alpha_0 + \alpha_1 MAR + \alpha_2 Size + \varepsilon$
Model6	$TQ = \alpha_0 + \alpha_1 MAS + \alpha_2 Size + \varepsilon$	Model6a	$R \& D = \alpha_0 + \alpha_1 MAS + \alpha_2 Size + \varepsilon$

On the basis of models 1-6 and 1a-6a, the regression coefficients b and c 'in model 1b-6b are tested, as shown in table 3.

Table 3. model construction of mediating effect test (ii)

Model	Coefficient b&c' tests the model	Model	Coefficient b&c' tests the model
model1b	$TQ = \alpha_0 + \alpha_1 JT + \alpha_2 R \& D + \alpha_3 Size + \varepsilon$	Model4b	$TQ = \alpha_0 + \alpha_1 BM + \alpha_2 R \& D + \alpha_3 Size + \varepsilon$
model2b	$TQ = \alpha_0 + \alpha_1 BS + \alpha_2 R \& D + \alpha_3 Size + \varepsilon$	Model5b	$TQ = \alpha_0 + \alpha_1 MAR + \alpha_2 R \& D + \alpha_3 Size + \varepsilon$
model3b	$TQ = \alpha_0 + \alpha_1 ID + \alpha_2 R \& D + \alpha_3 Size + \varepsilon$	Model6b	$TQ = \alpha_0 + \alpha_1 MAS + \alpha_2 R \& D + \alpha_3 Size + \varepsilon$

In the above model,  $\alpha_0$  represents the constant term, I (I = 1,2,..., 12) represents the regression coefficient and  $\varepsilon$  is the residual term.

## 4. Analysis of Empirical Results

### 4.1 Correlation Analysis and Stationarity Test.

The correlation coefficients of the variables in this paper are all within 0.5, indicating that there is no serious multicollinearity problem. After the first difference, all variables are significant at the level of 5%, that is, the first order single integration. It can be seen that the sample data selected in this paper is itself stable. Therefore, further research can be done.

### 4.2 Regression Results of Influence of Board Governance on Enterprise Value.

The board of directors' constructs model1-modle4 from JT, BS, ID and BM. The F test values of the four models are 12.6976, 13.7077, 11.8279 and 11.8983 respectively, which are greater than the critical value 2.035. At the same time, LM test and Hausman test are both significant at the 1% level. Therefore, the fixed-effect model was selected. All the models were significant at the level of 1%, and the adjusted R2 was 0.7177, 0.7422, 0.7377 and 0.7136, indicating that the fitting degree of the models was good.

For Modle1, the influence of JT on enterprise value is analyzed. The results show that there is a significant negative correlation between them. That is, the chairman concurrently serves as the general manager will reduce the enterprise value, which is consistent with hypothesis 1. According to the regression coefficient, the enterprise value will decrease by 0.2933 units when the two jobs are added together. The regression coefficient between BS and enterprise value studied by Modle2 is 0.1959, which is significant at the level of 5%. Hypothesis 2 is verified. This shows that the enterprise value of China's listed energy companies will be enhanced with the increase of board size. Modle3 verifies that ID has a significant negative correlation with enterprise value, which negates hypothesis 3. The regression coefficient of this model is -7.6128, indicating that the enterprise value will decrease as the proportion of independent directors in China's listed energy companies increases. The regression coefficient of Modle4 is 0.0050 and significant at the significance level of 10%. Hypothesis 4 is verified. The existing results show that the increase of the number of board meetings is conducive to the improvement of enterprise value in China's listed energy companies.

In order to analyze the influence of incentive mechanism on enterprise value, Modle5 and Modle6 regression models were constructed from the perspectives of directors' shareholding and annual salary. The F test values were 19.7410 and 14.9458, respectively, greater than the critical value 2.035. In addition, LM test and Hausman test are significant at 1% confidence level. Therefore, the fixed effect model is adopted. In terms of fitting degree, the adjusted R2 of the two was 0.8159 and 0.7395, respectively, with good fitting degree. All were significant at the level of 1%.

The empirical results of Modle5 show that MAR is significantly negatively correlated with enterprise value (regression coefficient is -24.8903), which is consistent with hypothesis 5. It indicates that with the increase of directors' shareholding ratio, the enterprise value of China's listed energy

companies will decline. Modle6 verifies that the influence of MAS on enterprise value is significantly positively correlated, which conforms to the content of hypothesis 6. The regression coefficient was 0.1945 and was significant at the confidence level of 5%. It indicates that the increase of MAS3 will increase the enterprise value accordingly.

According to the above empirical analysis, BS, BM and MAS all contribute to the increase of enterprise value. The increase of JT, ID and MAR will reduce the enterprise value.

#### 4.3 Regression Results of the Influence of Board Governance on R&D Investment

According to the mediating effect coefficient test method, the paper will make an empirical analysis of the constructed regression equation Modle1a-Modle6a, and the specific results are shown as follows.

The influence of board structure on r&d investment starts from JT, BS, ID and BM. The F test values (1.1581, 1.1566, 1.2224 and 1.1982, respectively) of the four regression models of Modle1a-Modle4a were all lower than the critical value 2.035, and the LM test did not pass the significance test. Therefore, mixed effect model should be selected for regression analysis in these four regression models.

Modle1a reveals a significant positive correlation between JT and enterprise r&d investment, with a regression coefficient of 0.0058, which is significant at the confidence level of 10%, negating the content of hypothesis 1a. That is, the concentration of power after the chairman concurrently serves as the general manager is more likely to guarantee the development of research and development activities, so as to increase the investment in research and development. Modle2a results show that as the size of the board of directors increases, so does the r&d investment, consistent with hypothesis 2a. Modle3a showed a significant negative correlation between ID and r&d investment, assuming that 3a had not been proved. It shows that the independent director system in listed energy companies still needs to be improved, and the increase of its proportion has not effectively increased the investment in research and development. Modle4a reflects that BM has a significant promotion effect on enterprise r&d investment (regression coefficient is 0.0012), which confirms hypothesis 4a. The number of board meetings reflects the diligence of directors. At the same time, the convening of the board meeting, help to strengthen the communication between the directors, improve the efficiency of governance, help technical innovation, so that the investment in research and development has been increased.

When studying the influence of incentive mechanism on r&d investment, Modle5a and Modle6a equations are established from the perspective of directors' shareholding and total annual salary. Consistent with the above test, the F test of the two is 1.6052 and 1.0679 respectively, both smaller than the critical value 2.035, and the LM test fails the significance test. Therefore, the mixed effect model is also used to carry out research.

Modle5a shows that MAR has a significant negative correlation with r&d investment, and the r&d investment will decrease by 4.5231 units for every 1 unit reduction in management shareholding ratio, which is consistent with hypothesis 5a. It also reflects that the implementation of equity incentive does not promote the r&d investment of listed energy companies in China. The empirical results of Modle6a confirm the hypothesis 6a, that is, MAS is significantly positively correlated with the r&d investment of enterprises, and the regression coefficient is 0.0026. It shows that the increase of total annual salary of directors is conducive to the increase of r&d investment.

#### 4.4 Regression Results of R & D Investment on Enterprise Value.

Modle7 is an equation constructed for r&d investment and enterprise value. F test value 24.8039, greater than the critical value 2.035. L M test and Hausman test were both significant at the 1% level, so the fixed-effect model was selected. The results show that R&D is positively correlated with enterprise value, which is consistent with hypothesis 7. That is, r&d investment promotes the improvement of enterprise value.

### 4.5 Mediating Effect Test of r & d Investment.

In this paper, coefficient test method is used to test whether regression coefficient  $c$  is significant, as shown in figure 1. Then, the second step test was performed for the regression coefficient  $a$  and the regression coefficient  $b$  after R&D was added in model1-model6. Finally, starting with the significance level of  $a$  and  $b$ , the regression coefficient  $c'$  of 6 main effect models after r & d investment was added to them according to the appropriate situation, or Sobel test was conducted.

Combined with figure 1, JT, BS and other 6 other variables reflecting board governance, the regression coefficients of ID and MAR all passed the significance level test of 1%. The regression coefficients of JT, BS and MAS all passed the significance level test of 5%. The regression coefficient of BM is significant at the significance level of 10%.

Regression coefficients  $a$  were significant at the levels of 1%, 5% and 10% respectively, while  $b$  passed the 1% significance test, as shown in figure 2. That is, the second step of intermediary effect test is completed.

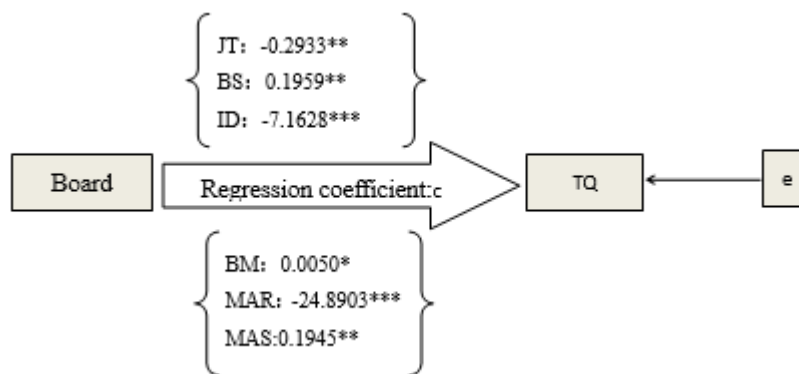


Figure 1. mediating effect test figure(i)

The third step of mediating effect test,  $c'$  in figure 2. Among them, the regression coefficients of ID and MAR are significant at the confidence level of 1%. The regression coefficient of MAS is significant at the confidence level of 5%. BS is significant at a confidence level of 10%. As can be seen, r&d investment is the mediating variable of the influence of ID, MAR, MAS and BS on enterprise value, and it is a partial mediating effect. The regression coefficients  $c'$  of JT and BM have not passed the significance level test, so the r&d investment has a complete mediating effect. Therefore, hypothesis 1b-6b is verified.

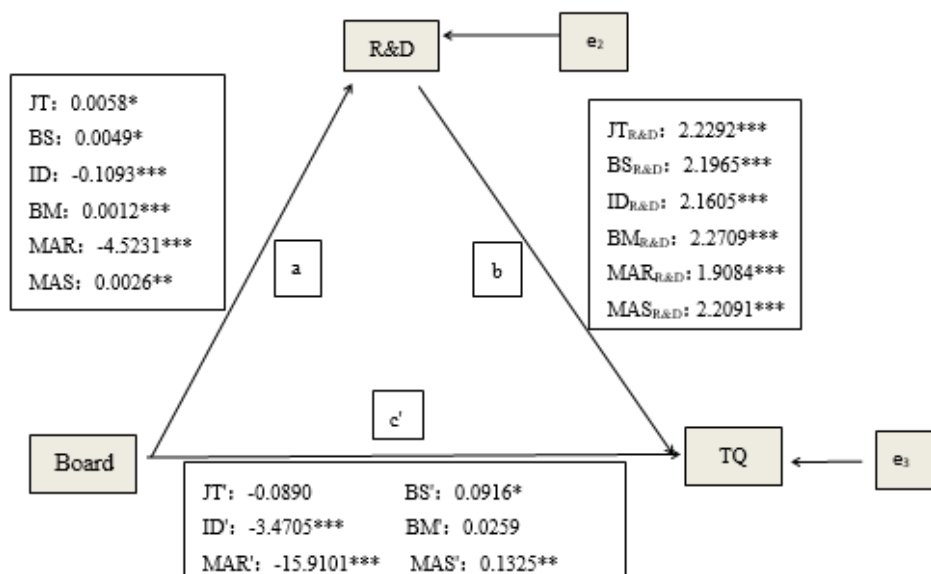


Figure 2. mediating effect test figure (ii)

Through the above analysis, the mediating effect of r & d investment on the six indicators selected in this paper exists, but there are only complete mediating effect and partial mediating effect. It shows that the effectiveness of energy listed companies to enhance enterprise value by adjusting r&d investment through board governance needs to be improved. Such empirical results show that in order to enhance the value of an enterprise, enough preliminary investigation is indispensable. Only the governance structure constructed after full demonstration can be conducive to the improvement of enterprise value. At the same time, we should attach importance to the intermediary role of r&d investment, strengthen the development of r&d investment activities, ensure the orderly progress of innovation activities, promote technological innovation, to ensure the long-term development of enterprises and enhance enterprise value.

## **5. Countermeasures and Suggestions and Implementation Strategies**

We will improve board governance and improve the effectiveness of decision-making and oversight. The empirical results show that BS and BM significantly promote enterprise value. JT and ID are negatively correlated with enterprise value. Efficient board governance mechanism can effectively sort out the power and responsibility relationship between managers and owners and minimize the agency problem. For China's listed energy companies, the existing board of directors' governance structure to formulate the corresponding system for management, enterprise decision-making and implementation supervision has a certain role in promoting the efficient operation of enterprises.

Improve the incentive mechanism to stimulate the team vitality. Empirical results show that MAR is harmful to enterprise value, while MAS is opposite. The incentive mechanism reflecting the emerging stage is not perfect enough in China's listed energy companies, especially the use of equity incentive needs to be adjusted to better stimulate team vitality and promote the steady development of the enterprise.

Establish a coordinated development mechanism between board governance and r&d investment. Board governance in the process of affecting enterprise value, r & d investment to strengthen the degree of impact. Therefore, it is necessary to take into account the coordination between board governance and r&d investment, and attach importance to r&d investment that can bring overall competitive development to enterprises. The impact of governance structure on enterprise value may not be obvious.

In a word, R&D is the mediating variable between board governance and enterprise value. Therefore, under the current economic situation, listed energy companies should not only improve board governance and incentive mechanism, but also coordinate r&d investment to increase enterprise value.

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