

The structure of the board of directors' regulating effect on the relationship between Innovation input and enterprise value

Weihong Zhang, Pai Wang ^a, Huibin Shi

School of Economics and Management, Xidian University, Xi'an 710061, China;

^a408102965@qq.com

Abstract

The paper analyzes the data of Manufacturing gem listed company during 2014 to 2016 with regression model, in order to explore The structure of the board of directors' regulating effect on the relationship between Innovation input and enterprise value. At the same time, in combination with large intrinsic value and instability of gem listed company, the paper put forward synthetic method which can help evaluate enterprise value better. Research shows that education of the board of directors, the position of chairman and general manager are separated, the ratio of independent director have positive regulating effect on the relationship Innovation input and enterprise value.

Keywords

Enterprise value; Innovation input; The structure of the board of directors; Synthesis; Regulating effect.

1. Introduction

With the principle that innovation drives development and quality is the first was been proposed by <Made in China 2025>, China has entered a new round of innovation development , based on technology innovation is increasingly fierce market competition, innovation become an important way to enhance the value of enterprise, but the effect is caused by different enterprise investment have a big difference. The factors regulating relations between Innovation input and enterprise value has become a hot topic.

There are two major omissions in previous studies. Firstly, most studies choose company shares as the core elements, ignoring the internal organizational structure of the company's role. The board of directors as a department which has function of decision making and supervisory has an important influence on the relationship between Innovation input and enterprise value. Secondly, The domestic existing research mainly explained from the aspects of theory, empirical studies only base on the motherboard market, research is lack of The gem market. To compensate for these two disadvantages, this paper choose the board of directors as perspective, gem listed companies as object to explore the structure of the board of directors' regulating effect on the relationship between Innovation input and enterprise value. Meanwhile this paper also put forward a new enterprise valuation method which is synthetic method to assess gem listed companies are mainly made up by high tech enterprises better. The paper want to provide advice for Innovation input and enterprise value, reference for further study in the future.

2. The theory and hypothesis

Innovation is the inherent power of enterprise development. According to the theory of technological innovation, the enterprise is the main innovation, technological progress is the booster of economic growth, technological progress is not easy, it is a process of accumulation and development, which requires constant investment of capital and manpower. The traditional economic growth theory suggests that technological innovation is the key to form the core competitiveness of enterprises. As the form of resources allocation, Innovation input can bring higher economic benefits. The progress of technology also promote the overall optimization process, including product, market , business

model and so on. Gem listed companies are mainly made up by high tech enterprises, technological innovation is the basis for the company, only to increase investment in innovation research and develop new technology can the enterprise value be improved. Based on the above theory, put forward the hypothesis:

Hypothesis one: The other factors remain unchanged, there is a positive correlation between Innovation input and enterprise value.

Some scholars regard the size of the board of directors as a variable to influence the relationship between enterprise Innovation input and enterprise value. For example, Wang Rengfei (2005)^[2], Xu Wei (2011)^[3] demonstrate the R&D input increases with the expansion of the size of the board, but Xu Jingfa (2002)^[4] shows that reducing the size of the board of directors appropriately is favor of R&D input. According to the scale benefit view, this paper argues that the larger board size, the more likely to have different members to supplement with each other on knowledge and information. It can develop new ideas in the exchange of ideas, consider the full range in the decision-making process, reduce decision-making errors and risk, but also increase the company's supervision. It will be conducive to improve enterprise value by innovation investment. But the small size of the board of directors can carry out the work flexibly, reduce unnecessary friction work, reduce the cost and improve the efficiency of communication. The marginal benefit is gradually decreasing, the size of the board of directors' influence on the relationship between enterprise innovation investment and the enterprise value is not a simple linear. The board is composed by the board members, taking into account the influence of scale also need to consider the characteristics of its members, He Qiang (2009)^[5], Ma Fuping (2010)^[6] have researched the age and education background of the board of directors, they show that the older the chairman and board members, the more risk averse they are. They are willing to develop according to the original mode, which leads to the mismatch between cost and benefit of innovation investment. The education is a reflection of a person's knowledge reserve and vision of openness, the better, the more likely to accept new ideas to try, having a deeper understanding of the changing world and keeping pace with the times and make a timely response. Based on the above theory, put forward the hypothesis:

Hypothesis two: The size of the board of directors regulates the relationship between Innovation input and enterprise value into an inverted U type.

Hypothesis three(a): The average age of the directors has a negative regulating effect on the relationship between Innovation input and enterprise value.

Hypothesis three(b): The education background of directors has a positive regulating effect on the relationship between Innovation input and enterprise value.

In the previous study, the most widely used variable is the duality of chairman and general manager and the ratio of independent director. For example, Zahar (2000) [1], Xu Jingfa (2002) [4] think the position of chairman and general manager are separated can bring the promotion of performance. Chen Kunyu (2010) [7], Zhao Xufeng (2011) [8] show that the high proportion of independent directors in the board of directors has a stronger influence on the value of enterprises than the enterprises with the low proportion of independent directors. According to the principal-agent theory, in the principal-agent relationship, there is a common problems that chairman and general manager have different goals. Therefore, there is a need for a strong oversight mechanism to keep the goals consistent. In the case of the duality of chairman and general manager, the general manager does not have a supervisory mechanism, the performance is difficult to control, and it is easy to make a decision error. At the same time, the board's ability to deal with information will also be limited. By contraries, the position of chairman and general manager are separated is beneficial to ensure the independence and effectiveness of the board of directors, to prevent the board of directors from being controlled by the general manager and to reduce the opportunistic behavior in the activities of innovative investment. Can carry on the innovation investment decision better and enhance the enterprise value. In the member of the board of directors, it usually includes executive directors and

independent directors, the executive director has a certain position in the enterprise, often for their own gaining more benefits to violate other small shareholders' benefits. They want to be stable and evade responsibility, could not make objective judgment for the business activities of enterprises. Independent directors have no big interest with enterprise, they are more like a kind of expert consultation, correctness of the decision may have effects on their personal value, authority and reputation, so usually can make decisions objectively, make right decision of innovation investment to enhance enterprise value. Based on the above theory, put forward the hypothesis:

Hypothesis four: the position of chairman and general manager are separated has a positive regulating effect on the relationship between Innovation input and enterprise value.

Hypothesis five: The ratio of independent directors has a positive regulating effect on the relationship between Innovation input and enterprise value.

3. Research design

3.1 Research data

The data of this paper are collected and collate from the Taian CSAMR database, the data of the 2014-2016 year manufacturing GEM listed companies were selected, in which the data samples from ST and ST* and the missing data samples were eliminated. 43 sample data in 2014, 54 sample data in 2015 and 54 sample data in 2016 were obtained. On the basis of these data, it is processed by Excel software and the regression analysis of data is carried out by using Spss software.

3.2 Research variable

This paper discuss the structure of the board of directors' regulating effect on the relationship between innovation investment and enterprise value. Enterprise value is an explanatory variable, this paper puts forward a synthetic method to evaluate the value of the enterprise into two parts. That is $V=V1+V2$, $V1$ is the value of the real asset and the $V2$ is the implied value. Using the cash flow discounting model to estimate $V1$, the concrete model is $V1 = \sum_{n=1}^{\infty} \frac{F_n}{(1-r)^n}$. Using two forked tree model to estimate $V1$, the concrete model is $V2 = e^{-r\Delta t} [p * V_U + (1 - P)V_d]$.

Innovation input is an explanatory variable, in the concrete calculation, it is expressed through the innovation input intensity. In this paper, the intensity of innovation input is expressed as the ratio of R&D investment to total assets.

The structure of the board of directors is a regulating variable, this paper refines it into following 5 indicators: board size, average age of directors, education background of director, the duality of chairman and general manager and the ratio of independent director.

The factors that affect the value of the enterprise are not only for innovation input, for the accuracy of the test results. In this paper, it choose following three factors as control variables: enterprise size, asset liability ratio and operating profit margin. The specific definition and calculation of the above variables are shown as follows.

Table 1 Variable definition and calculation description table

Type	Variable name	Code	Definition and Calculation method
Explanatory variable	Enterprise value	CV	$(V1+V2+ \text{Debt book value}) / \text{Assets book value}$
Explanatory variable	Innovation input	R&D	R&D investment / Total assets
Regulating variable	Board size	Board	The number of board of directors
	Average age	Age	Average age of members of the board of directors

	Education background	Edu	The number of bachelor degree or above / Total number
	The duality of chairman and general manager	Dua	Virtual variable.1 or 0
	The ratio of independent director	Roid	Number of independent directors / Total number
Control variables	Enterprise size	Size	Natural logarithm of the scale of total assets
	Asset liability ratio	DA	Total liabilities / Total assets
	Operating profit margin	SR	(Business income - Operating cost) / Business income

3.3 Research model

Based on the above assumptions and variable design, this paper uses regression model to explore the structure of the board of directors’ regulating effect on the relationship between Innovation input and enterprise value. The research model is shown in Figure 1. The innovation input and the structure of the board of directors are all second order variables. The concrete calculation model is as follows:

Model 1: $CV = \alpha_0 + \alpha_1 * R\&D + \alpha_2 * Size + \alpha_3 * DA + \alpha_4 * SR + \varepsilon_1$ It is used to test the relationship between innovation input and enterprise value.

Model 2: $CV = \alpha_0 + \alpha_1 * R\&D + \alpha_2 * Board + \alpha_3 * R\&D * Board + \alpha_4 * Size + \alpha_5 * DA + \alpha_6 * SR + \varepsilon_2$ It is used to test regulating effect of board size on the relationship between innovation input and enterprise value.

Model 3: $CV = \alpha_0 + \alpha_1 * R\&D + \alpha_2 * Age + \alpha_3 * R\&D * Age + \alpha_4 * Size + \alpha_5 * DA + \alpha_6 * SR + \varepsilon_3$ It is used to test regulating effect of average age of directors on the relationship between innovation input and enterprise value.

Model 4: $CV = \alpha_0 + \alpha_1 * R\&D + \alpha_2 * Edu + \alpha_3 * R\&D * Edu + \alpha_4 * Size + \alpha_5 * DA + \alpha_6 * SR + \varepsilon_4$ It is used to test regulating effect of education background of director on the relationship between innovation input and enterprise value.

Model 5: $CV = \alpha_0 + \alpha_1 * R\&D + \alpha_2 * Dua + \alpha_3 * R\&D * Dua + \alpha_4 * Size + \alpha_5 * DA + \alpha_6 * SR + \varepsilon_5$ It is used to test regulating effect of the duality of chairman and general manager on the relationship between innovation input and enterprise value.

Model 6: $CV = \alpha_0 + \alpha_1 * R\&D + \alpha_2 * ROID + \alpha_3 * R\&D * ROID + \alpha_4 * Size + \alpha_5 * DA + \alpha_6 * SR + \varepsilon_6$ It is used to test regulating effect of the ratio of independent director on the relationship between innovation input and enterprise value.

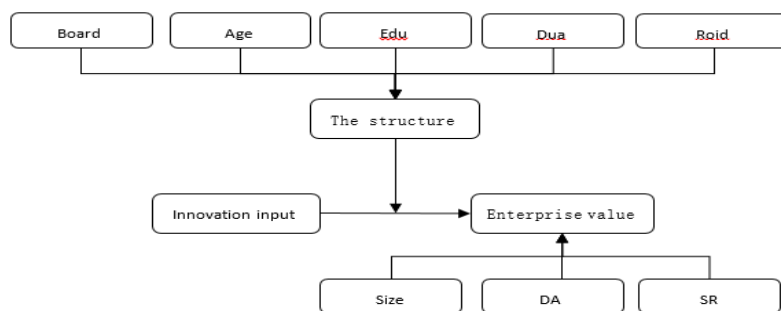


Figure 1 Regression Model of the variables

4. Result analysis

4.1 Descriptive statistical analysis

The following table 2 is a descriptive data analysis for all variables, in which the minimum value of the enterprise value is 0.19. The maximum value is 0.88. It shows that there is a large gap in the value of enterprise between Sample Firms. The average number of innovative input intensity is 0.0322. It shows that the overall innovation investment is still a little inadequate and there are differences between Sample Firms. The standard deviation of the size of the board of directors and the average age of the directors is 1.39925 and 2.81357, there are great differences. The average number of education background of director is 0.8523, it shows that most of the directors of sample enterprises have been well educated and have corresponding professional knowledge. The average number of the duality of chairman and general manager is 0.2371, it shows that the chairman and general manager of majority of the sample enterprises are separated and the decision-making power and the management right are separately exercised. In terms of control variables, the mean value of enterprise scale, asset liability ratio and operating profit rate are 21.4543, 0.2419 and 0.4533, which are basically consistent with the current situation of GEM listed companies in manufacturing industry, indicating that the sample enterprises have certain representativeness.

Table 2 Descriptive analysis results table

Variables	Sample	Min value	Max value	Average	st dev
CV	151	0.19	0.88	0.5904	0.18441
R&D	151	0.00	0.13	0.0322	0.02156
Board	151	5.00	12.00	7.9794	1.39925
Age	151	44.15	58.67	51.2065	2.81357
Edu	151	0.00	1.00	0.8523	0.21456
Dua	151	0.00	1.00	0.2371	0.42757
Roid	151	0.30	0.50	0.3839	0.05333
Size	151	19.81	23.29	21.4543	0.71796
DA	151	0.03	0.71	0.2419	0.15781
SR	151	0.02	0.96	0.4533	0.24125
Effective sample	151				

4.2 Regression test and analysis

Before the regression test the correlation between variables should be discussed in order to verify the hypothesis preliminarily. It can be obtained from table 3, the correlation coefficient between the enterprise value and the innovation input is 0.18 at 5% significant levels. It shows that the innovative input can improve the value of the enterprise. Hypothesis one is preliminarily verified. The size of the board of directors, the average age and the ratio of independent directors have no significant correlation with the value of the enterprise, their regulating effect needs to be further tested in the regression test. But there is a significant positive correlation between the degree of educational education of directors and the value of enterprise and the innovation input. Hypothesis three (b) is preliminarily verified. The correlation between innovation input and other variables is basically below 0.1, indicating that their correlation is relatively low and there is no serious collinearity problem.

Table 3 Variable correlation coefficient table

Var	CV	R&D	Board	age	Edu	Dua	ROID	Size	DA
CV	1								
R&D	0.18**	1							
Board	-0.4	-0.03	1						
age	-0.072	-0.057	0.087	1					
Edu	0.158*	0.204**	0.22**	-0.08	1				
Dua	0.204**	0.121	-0.24**	-0.04	0.22**	1			

ROID	-0.055	0.041	-0.7***	-0.03	0.052	0.33***	1		
Size	-0.23**	-0.18**	0.042	-0.14*	-0.004	0.02	0.16*	1	
DA	0.44***	0.035	0.089	-0.17*	0.23**	0.03	-0.01	0.28***	1
SR	-0.18**	0.082	0.088	0.18**	-0.01	0.14*	0.095	-0.12	-0.4***

Notes:*, **, *** Indicating significant levels of 10%, 5%, and 1%

Table 4 carries out a regression analysis between enterprise value, innovation investment and the structure of the board of directors. The following results are obtained:

Table 4 Enterprise value,innovation investment and board structure regression test

Var	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
R&D	0.099* (1.15)	0.319 (0.75)	0.042 (0.07)	-0.29* (-0.50)	0.15* (1.47)	-0.088* (-0.22)
Board		-0.01 (-0.07)				
Board*R&D		-0.22 (-0.50)				
Age			-0.03 (-0.29)			
Age*R&D			0.056 (0.089)			
Edu				-0.077* (-0.48)		
Edu*R&D				0.418* (0.673)		
Dua					0.36* (2.35)	
Dua*R&D					-0.21* (-1.29)	
ROID						-0.04* (-0.29)
ROID*R&D						0.198* (0.478)
Size	-0.37*** (-4.11)	-0.369*** (-4.06)	-0.37*** (-4.07)	-0.37*** (-4.01)	-0.37*** (-4.28)	-0.371*** (-4.03)
DA	0.53*** (5.58)	0.542*** (5.620)	0.531*** (5.487)	0.526*** (5.294)	0.52*** (5.601)	0.531*** (5.501)
SR	-0.024 (-0.26)	-0.005 (-0.05)	-0.021 (-0.22)	-0.024 (-0.27)	-0.081 (-0.88)	-0.022 (-0.24)
sample size	151	151	151	151	151	151
F-measure	12.09***	8.209***	7.908***	8.006***	9.691***	7.944***
Adj-R ²	0.316	0.311	0.30	0.305	0.352	0.303

Notes:*, **, *** Indicating significant levels of 10%, 5%, and 1%

4.2.1 The relationship between innovation input and enterprise value

From the analysis of table 4, the correlation coefficient between innovation input and enterprise value is 0.099 and the positive correlation is at 10% significant level. It shows that it is possible to increase the value of the enterprise by increasing the innovation input for the listed companies of the manufacturing enterprise. Hypothesis one gets further verification.

4.2.2 The structure of the board of directors' regulating effect

To determine whether the structure of the board of directors has a regulatory effect, the following principles are given. First, determine whether the product of the board of directors' structure and innovation investment is significant, if not doing the second test. Whether the structure of the board of directors is related to the value of the enterprise, if not going the third step. Whether the correlation coefficient between the groups is significantly different, the significant difference shows it is a regulating variable, otherwise it is not. According to the above principles, the structure of the board of directors are examined as follows:

Board size: The correlation coefficient of the product term of the board size and the innovation input is -0.22 by regression test, but it is not significant, it shows that second test is needed, the correlation coefficient of board size and enterprise value is -0.4 and is not significant through table 3, so it should go the third step, using the average value of the board size of 7.9794 as standard, dividing into a small scale and a large scale of two groups as table 5. It shows that there is no obvious difference in the coefficient of innovation input. Indicating that the board size has no regulatory effect on the relationship between innovation input and enterprise value. Hypothesis two is not verified.

Table 5 Check list for grouping board size

Var	small size	lager size
R&D	0.224 (1.480)	0.036 (0.349)
Size	0.318*** (1.947)	-0.402*** (-3.846)
DA	0.346*** (1.936)	0.653*** (6.194)
SR	0.044 (0.274)	-0.069 (-0.648)
sample size	69	82
F-measure	2.351***	14.395***
Adj-R ²	0.116	0.498

Notes:*, **, *** Indicating significant levels of 10%, 5%, and 1%

Average age of directors and education background of director: From table 4, The correlation coefficient of the product term of the average age and the innovation input is 0.056 by regression test, but it is not significant, it shows that second test is needed, the correlation coefficient of average age and enterprise value is -0.072 and is not significant through table 3, so it should go the third step, using the average value of the average age 51.2065 as standard, dividing into a low age and a high age of two groups as table 6. It shows that there is no obvious difference in the coefficient of innovation input. Indicating that the average age has no regulatory effect on the relationship between innovation input and enterprise value. Hypothesis three (a) is not verified. But the correlation coefficient of education background of director and enterprise value is 0.418 at 10% significant level. It shows that the education background of directors has a positive regulating effect on the relationship between Innovation input and enterprise value. Hypothesis three (b) gets further verification.

Table 6 Check list for grouping age of directors

Var	Low age	High age
R&D	-0.002 (-1.748)	0.233 (1.857)
Size	-0.479*** (-3.81)	-0.446*** (-3.14)
DA	0.376*** (2.783)	0.592 (4.101)
SR	-0.216* (-1.536)	0.047 (0.371)
sample size	78	73
F-measure	8.080***	6.133***
Adj-R ²	0.362	0.313

Notes:*, **, *** Indicating significant levels of 10%, 5%, and 1%

The duality of chairman and general manager: The correlation coefficient of the duality of chairman and general manager and enterprise value is -0.21 at 10% significant level. It shows that the position of chairman and general manager are separated is the better form for innovation input and enterprise value improving. Hypothesis four gets verification.

The ratio of independent director: The correlation coefficient of the ratio of independent director and general manager and enterprise value is 0.198 at 10% significant level. It shows that the ratio of independent directors has a positive regulating effect on the relationship between Innovation input and enterprise value. Hypothesis five gets verification.

5. Conclusion and revelation

This paper choose the board of directors as perspective, gem listed companies as object to explore The structure of the board of directors' regulating effect on the relationship between Innovation input and enterprise value. Getting two conclusions as following: Firstly, innovative input brings scarce resources and unique competitive advantages to produce core competence for enterprise, it can improve the value of the enterprise at a great extent, especially for gem listed company. Secondly, education background stands for knowledge, insight and courage, it plays an important role in scientific decision-making, the position of chairman and general manager are separated can overcome the contradiction of the role, exert the mutual supervision mechanism and ensure the independence and effectiveness of the board of directors, Independent directors use their own professional knowledge and objective evaluation to make up for the limitations of the internal people. All of them have a positive regulating effect on the relationship between Innovation input and enterprise value. The conclusions of this paper are benefit for grasping the ways to improve the enterprise value of gem companies, clarifying the difference between the effects of innovation input and providing a reference for further research in the future.

According to the above conclusion, the following enlightenment is put forward in this paper. First of all, the enterprise is in a new round of industrial revolution, technology development and product replacement are fast, the gem listed companies which are mainly made up by high tech enterprises want to increase market share and expand the advantages of enterprises, they need to increase input in innovation, establish the consciousness of innovation driven development. On the one hand, through differentiation strategy to form the competitive advantage. On the other hand, through technological innovation to achieve overall optimization of production links, so as to reduce their cost

and enhance enterprise value. What's more, gem companies need to take measures to improve their input and efficiency, including rational allocation of resources and commercialization of research results. On the one hand, they should invest in the number of resources that are consistent with their own strength and situation. On the other hand, they should strengthen the audit and supervision of resources, improve the efficiency of using, optimize the structure of R&D departments and improve the training mechanism of R&D talents. At the same time, strengthening the quality and ability of personnel, optimizing the structure, building a learning organization and enhancing the motivation of innovation. From the top to the bottom, the whole member study, the whole staff innovate, the knowledge share, create a continuous benign cycle, in order to improve the consciousness and level of innovation. Last but not least, the board of directors of GEM listed companies will be more independent, they need to attach importance to the influence of board of directors structure for the development of enterprises especially. Enhancing the level of knowledge, strengthening the responsibility to ensure that scientific and effective decision can be made. Strengthening the supervision, keeping the position of chairman and general manager are separated, ensuring the independence and effectiveness of the board of directors, keeping balances between the board and the managers, reducing the opportunism behavior, all of these can be favor for enterprises. At the same time, improving the system of independent directors of listed companies to increase the proportion of independent directors for encouraging active participation in corporate governance, finally to achieve the goal of improving the value of the enterprise.

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