

# Board Structure, Entrepreneurial Risk Preference and Exploratory Innovation

Based on the Empirical Data of High-end Equipment Manufacturing Industry\*

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**Abstract**—This paper, with the high-end equipment manufacturing industry listed companies in Shanghai and Shenzhen from 2009 and 2013 as the object of the research, adopting the negative binomial stochastic effect regression model, examines the relationship between board structure and exploration innovation, and the influence of entrepreneurial risk appetite. The research conclusion has some reference to how to improve the board structure of listed companies, enhance the capacity of enterprise exploration innovation, and promote the reform and innovation of high-end equipment manufacturing industry in China.

**Keywords**—board structure; entrepreneurial risk preference; exploratory innovation

## I. INTRODUCTION

The high-end equipment manufacturing industry is not only the key pillar of the transformation and upgrading of China's traditional industry, but also the key development industry for the next five years in the "13th Five-Year strategic emerging industry development plan". Compared with traditional industries, the high-end equipment manufacturing industry pays more attention to the impact of technology innovation on the development.

Exploratory innovation is the exploration of the unknown field of science and technology in addition to the basic products and research achievements of the enterprises. As a revolutionary innovation, it will completely change the existing commodities and core technologies of enterprises. The exploratory innovation can help the high-end equipment manufacturing enterprises to optimize the product structure and enhance their comprehensive strength, so as to seize the initiative in the process of industrial transformation and development.

The construction of a perfect exploratory innovation

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system depends on a good board structure, which will play a decisive role in the decision-making and strategic objectives of enterprises in exploratory innovation activities. Most of the existing research focus only on the influence of the board structure on the overall innovation technology, ignoring the concrete form of innovation and the role entrepreneur risk preference plays between the board structure and the exploratory innovation. Considering the characteristics of the high-end equipment manufacturing industry, this paper, which focuses on the exploratory innovation of the enterprise, studies the specific interaction mechanism of the board structure, and the moderating effect of the entrepreneurial risk preference in this process. The research results have some reference value for improving the innovation level of the high-end equipment manufacturing enterprises and optimizing the structure of the board of directors.

## II. THEORETICAL ANALYSIS AND RESEARCH HYPOTHESIS

### A. The Board Structure and Exploratory Innovation

The board of directors is the core leadership and legal representative of the joint-stock enterprise. Its main responsibilities include making strategic decisions and supervising the various behaviors of the management layer. It occupies a key position in the corporate governance structure and affects the formulation of various exploratory innovation decisions of the enterprise. Referring to the research results of Fei Xue (2016), Xiangyi Xu and Yeguo Tang (2013)[1], this paper studies the influence of the structure of the board of directors on the exploratory innovation from two aspects: CEO Duality and independent director ratio.

CEO Duality, that is, the chairman and the general manager are concurrently appointed by the same person. The CEO Duality is beneficial to the unification of the opinion of the board and the CEO. It will increase the decision-making autonomy of the CEO, reduce the conflict and eliminate the time cost of the information communication between the CEO and the chairman. Qinghua Huang, Xiding Chen (2017) found that the CEO Duality is beneficial to technological

innovation of enterprises[2]. Li and Tang's research (2010) proves that the CEO Duality makes it easier for the CEO to adopt high-risk decision-making[3]. The CEO Duality enable enterprises to capture innovation opportunities in the competitive market quickly, and promote the successful implementation of exploratory innovative R&D projects. Based on this, this article puts forward the following hypothesis:

H1: CEO Duality is conducive to exploratory innovation.

The independent directors ratio refers to the proportion of independent directors to all directors of the company. The independent directors are generally senior personages in a certain field, with profound professional knowledge background and rich related work experience. They can provide constructive opinions for the board of directors in the major strategic decisions of the enterprises. Junli Zhang and Hao Jin (2015) found that the independent directors ratio of enterprises has positive impacts on the investment of enterprise's scientific research funds on core technology and the innovation performance of enterprises[4]. Xiangyi Xu and Yeguo Tang (2013) found that the independent directors ratio has positive impacts on the investment of enterprises on technological innovation[1]. Independent directors can effectively supervise all kinds of speculation in the company, promote the formation of enterprise innovation atmosphere guide the company management to absorb all kinds of innovative ideas, formulate the company development strategy based on the long-term interests of the company, and thus promoting the enterprise exploratory innovation.

Based on this, this article puts forward the following hypothesis:

H2: The higher the independent directors ratio is, the more beneficial it will be for the enterprises to carry out exploratory innovation.

#### *B. Board Structure, Entrepreneurial Risk Preference and Exploratory Innovation*

Entrepreneurial risk preference is the tendencies entrepreneurs show when they take risks and face uncertain decisions. In the case of higher risk preference of entrepreneurs, the more perfect the board structure is, the more willing the enterprise will be to try to invest new technologies and products, challenge new projects with high risk, and then get high expected returns. On the contrary, the enterprises with imperfect board structure are more sensitive to the uncertainty risk caused by exploratory innovation. There will be more misgivings and disputes over the decision results, which makes it easier for enterprises to put down their feet when facing new opportunities, and even do not intend to take innovative actions.

Based on this, this article puts forward the following hypothesis:

H3: Entrepreneurial risk preference positively regulates the relationship between CEO Duality and exploratory innovation.

H4: Entrepreneurial risk preference positively regulates the relationship between the independent directors ratio and exploratory innovation.

### III. RESEARCH DESIGN

#### *A. Sample Selection and Data Source*

The initial data include 80 high-end equipment manufacturing listed companies. To guarantee the validity and unity of the data, they have been filtered according to the following principles:

Exclude ST companies, S companies and \* ST companies.

Exclude listed companies whose data is incomplete or unavailable.

Exclude listed companies whose R & D process and the final product involves state secrets.

Finally, 45 listed companies were selected as research samples.

#### *B. Variable Measurement*

1) *Dependent variable*: Drawing on the relevant research of Deming Zeng(2016), the annual number of patents in new technology fields is applied to carry out quantitative measurement of exploratory innovation[5].

Exploratory innovation: The first four digits of the patent classification number "i" in that year did not appear in the past five years, and then counted  $T_i = 1$ . Otherwise, the number was 0.

2) *Independent variables*: Referring to the related literature of Erming Xu and Zhihui Wang(2000), this paper designs two explanatory variables: CEO Duality and independent directors ratio.

3) *Moderating variables*: According to Tang Yingmei and Wang Huaiming's study(2011), financial decisions can reflect the risk preference of entrepreneurs, and the proportion of venture capital investment in the total assets can measure the entrepreneurial risk preference tendency[7]. Therefore, this article use the formula in the table below to objectively reflect the risk preference of entrepreneurs

4) *Control variables*: Last year's performance of enterprise, the growth of enterprises and enterprise Age.

TABLE I. DEFINITION AND MEASUREMENT OF VARIABLES

Type	Name	Sign	Calculation method
Dependent variable[4]	Exploratory innovation	EI	Exploratory innovation performance $= \sum T_i$
Independent variables[3]	Board structure	CD	If the chairman and general manager is held by the same person, take 1, otherwise take 0
		IDR	Number of independent directors divided by the total number of board members
Moderating variables	Entrepreneurial preference risk	ERP	(trading financial assets + accounts receivable + available for sale financial assets + holding to maturity investment + investment real estate) / total assets
Control variables	Last year's performance of enterprise	ROAt - 1	last year's return on assets
	The growth of enterprises	Growth	growth rate of sales revenue
	Enterprise Age	Age	The number of years since the company was founded

### C. Model Construction

Exploratory innovation is nonnegative counting variables. Poisson distribution model is suitable for counting type data modeling, but the variance of the variable (exploratory innovation) is greater than its mean. Therefore, referring to the research of Deming Ceng, Ming Lin and others, this paper chooses the negative binomial regression model which is a generalized Poisson model for empirical analysis.

Based on H1 and H2, build model 1, which is used to study the influence of board structure on the exploratory innovation.

Model 1:

$$EI_{i,t} = C + \beta_1 CD_{i,t} + \beta_2 IDR_{i,t} + \beta_3 ROA_{i,t-1} + \beta_4 Growth_{i,t} + \beta_5 Age_{i,t}$$

Based on H3 and H4, build model 2, which is used to study the influence of entrepreneurial risk preference on the board structure and exploratory innovation.

Model 2:

$$EI_{i,t} = C + \beta_1 CD_{i,t} + \beta_2 IDR_{i,t} + \beta_3 ROA_{i,t-1} + \beta_4 Growth_{i,t} + \beta_5 Age_{i,t} + \beta_6 IDR_{i,t} \times ERP + \beta_7 ERP$$

## IV. EMPIRICAL ANALYSIS

### A. Descriptive Statistics

According to the descriptive statistics in "Table II", we can see that the highest number of exploratory innovation patents applied by the high-end equipment manufacturing enterprises is 44, while the least is 0, and the average number of new patent applications for exploratory innovation is 7.5. It shows that China's high-end equipment manufacturing industry has attached great importance to the learning and innovation of new knowledge and technology in recent years. The mean of CEO duality shows that general manager and chairman of the company are separated in 90% of China's high-end equipment manufacturing listed companies; the lowest proportion of independent directors is 15% and the highest is 56%, but the difference between the companies is not obvious. The specific statistical data of the remaining control variables are shown in "Table II".

TABLE II. DESCRIPTIVE STATISTICS

Variables	Sample size	Mean	Standard deviation	Minimum	Maximum
EI	186	7.51	7.23	0.00	44.00
CD	186	0.11	0.32	0.00	1.00
IDR	186	0.36	0.05	0.25	0.56
ROA	186	0.05	0.04	0.06	0.18
Growth	186	0.35	0.66	0.60	4.46
Age	186	13.72	4.00	5.00	27.00
ERP	186	1.53	2.37	0.0001	17.13

### B. Regression Analysis

The results of model 1 show that the estimation coefficient of the CEO duality, which is positive, has passed the significance test ( $\beta=0.426$ ,  $p<0.05$ ). It shows that there is a significant positive effect between the CEO duality and the exploratory innovation. Therefore, H1 is supported. The results of model 2 show that the estimation coefficient of the independent directors ratio, which is positive, has passed the significance test ( $\beta=2.992$ ,  $p<0.1$ ). It shows that there is a positive effect between the independent directors ratio and the exploratory innovation. Therefore, H2 is supported.

The results of model 3 and model 4 show that the relationship between the CEO duality, independent directors ratio and exploratory innovation is significantly influenced by the entrepreneur risk preference. Therefore, the higher the entrepreneur risk preference is, the greater the influence of independent directors ratio and CEO duality innovation will be on exploratory innovation.

TABLE III. RESULTS OF THE NEGATIVE BINOMIAL RANDOM EFFECTS REGRESSION MODEL

Variables	Model 1	Model 2	Model 3	Model 4
Constant term	-2.13*** (0.829)	3.44*** (0.567)	2.54*** (0.430)	3.15*** (0.677)
ROA <sub>t-1</sub>	0.023** (0.021)	0.543** (0.019)	0.04 (0.03)	0.03** (0.03)
Growth	-0.201 (0.105)	-0.071 (1.134)	-0.10 (0.09)	-0.10 (0.11)
Age	1.110*** (0.228)	-0.053** (0.016)	-0.04 (0.03)	-0.05*** (0.02)
ERP			0.02 (0.04)	0.23** (0.09)
CD	0.389** (0.119)		0.51** (0.23)	
CD×ERP			0.17* (0.18)	
IDR		3.334* (1.897)		2.35 (1.55)
IDR×ERP				0.01** (0.01)
Log likelihood	-575.39	-588.54	-576.77	-559.89
Wald chi <sup>2</sup>	89.59***	577.65***	536.86***	597.36***

<sup>a</sup> Note: The values in parentheses are standard errors, \* indicates  $p < 0.10$ , \*\* indicates  $p < 0.05$ , \*\*\* indicates  $p < 0.01$ , the same below.

## V. CONCLUSION

Based on the theory and literature of the board structure and exploratory innovation, this paper sets up a negative binomial random effects regression model to study the relationship between the board structure and the exploratory innovation. The study found that CEO duality and independent directors can effectively improve the exploratory innovation ability of the listed companies in the high-end equipment manufacturing industry, and the entrepreneurial risk preference can significantly regulate the influence of the CEO duality and the independent directors on the exploratory innovation.

Exploratory innovation plays an irreplaceable role in the development of the listed companies in the high-end equipment manufacturing industry. It is an important force for enterprises to improve their comprehensive strength and optimize the product structure. In order to improve the innovative ability of the enterprise, we should start from the following two aspects: (1) Optimize the board structure, employ more independent directors with professional knowledge, improve the supervisory duty of independent directors, and promote the formation of the enterprise innovation atmosphere; (2) Strengthen the entrepreneurs risk preference and employ managers with higher risk preference. The higher the risk preference of entrepreneurs is, the more they will be concerned about the opportunities in the competitive market.

In a word, only by establishing a perfect board structure and enhancing the risk preference of entrepreneurs, can we effectively enhance the innovative ability of the enterprise and promote the healthy and sustained development of the high-end equipment manufacturing industry in China.

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