Research on the Pertinence Between the Identity Characteristics of Independent Directors and Enterprise Innovation

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Abstract. The independent director system has multi aspect influence on enterprises.For public corporations, the connection between the independent director system and the capacity fro innovation of businesses is on of them. Take the state-owned enterprise in Chinese A stock market in Shanghai and Shenzhen from China between 2016 and 2021 as a research sample. This paper uses the basic econometric model to find the correlation between three factors include age, education background and whether independent directors are multiple identities and enterprise innovation through studying enterprise input and output and the number of patents. According to the study, an enterprise's capacity for innovation is favorably correlated with the age of its independent directors. Additionally, the educational experience of independent administrators has a favourable impact on the innovative capacity of an organization. The ability of businesses to innovate is favorably correlated with the identities of several independent directors.

Keywords: Independent director, Enterprise innovation, Characteristics of identity.

1. Introduction

In recent years, market competition has increased, and the ability to innovate has become a critical force in promoting the long-term development of publicly traded companies. Since 2001, China has promulgated regulations on the independent director system. Whether the independent director system plays a practical role in the company has become a concern of scholars and the market, and has received different opinions. Whether the independent director system has played a practical effect in the company has become a concern of scholars and the market, and has received different opinions.

In fact, many factors affect a company's innovation ability, including enterprise capital investment, management ability and so on. However, little research exists on the correlation between independent administrators and the innovation capacity of companies in China. The objective of the system of independent directors is to put in place a mechanism for mutual restriction and supervision within the directorates. In the legal entity system of the United States, Great Britain, and other countries, the authority of the legal entity is simply the general assembly of shareholders and the Governing Council. But there is no supervisory board, independent administrators play the dual role of decision-making and control in practice. A company's innovation resources input, management ability, incentive ability and realization ability represent the degree to which a company completes innovation-related activities, which reflects its innovation ability. The main topics of this paper are whether independent directors have an impact on the innovation of an enterprise and whether the background of outside directors can make a positive contribution in the innovation ability of an enterprise. In addition, understanding the connection between the background of outside directors and the innovation ability of enterprises is of practical significance for organizations to improve their innovation ability and study the independent director system.

This paper draws on two main theories. The first principal-agent theory, which is based on information asymmetry and holds that the principal-agent relationship emerges with large-scale

production. The division of labor in the company is more specifically due to the development of productivity, while corporate managers cannot exercise their corporate power normally due to the combined influence of external and internal reasons, and catalyze professional agents to perform relevant duties. Second, the resource dependent theory illustrate that the main role of the directorates is to provide the company with the required resources as much as possible to minimize the environmental uncertainty. Therefore, some independent directors with other identities and backgrounds, who have important resources for the company will join the board. In terms of data, this article looks at sample data from Shanghai and Shenzhen listed stocks in China from 2016 to 2021 combined with the econometric basic model. Taking the input, output and professionalism of enterprise output as indicators to measure enterprise innovation, this paper determines the correlation between the multiple identities, educational background, age and scale of independent directors and enterprise innovation ability, and finally gets the results.

2. Literature Review and Hypothesis:

2.1. Independent director system

For a long time, the independent director system was expected to be a measure to protect the minority shareholders in the enterprise and make the decision of the organization's directors more efficient and reasonable. Therefore, it is discussed in many studies whether the independent director system meets the expectation of the regulator, but there is always a dispute. One conclusion is that the independent director system can supervise and promote enterprises. Liang found that not all independent directors will be bought and manipulated by major shareholders. By comparing with companies without dissident independent directors, the risk of an enterprise stock market crash with dissident independent directors is significantly lower, which proves that the supervision behavior of independent directors is helpful to alleviate agency problems, curb the bad news hoard behavior of management and thus reduce the stock price crash risk [1]. Lin believes that independent directors have a supervisory role from the perspective of strategic control of the company, which can inhibit the reckless behavior of the new general manager to reduce the performance of the company [2]. Wang made choose the issue of hollowing out by the controlling shareholder as the situation to test the supervision function of non-interested directors with professional background and draw the following conclusions: In practice, independent directors with accounting background have a stronger function of supervising controlling shareholders' evisceration beforehand and in the process, but they do not play such a role for independent directors with legal background [3]. However, other studies indicate that the independent director system does not play an expected role in the company's performance. Hu believed that independent directors were not playing their proper role in enhancing business performance and management.[4].

2.2. Independent director identity characteristics and enterprises innovation

The background of the independent director determines the degree and direction of the influence of the independent director system on the organizations. Zhong's research shows that the percentage of broad directors, salary, education level and female identity play a certain role in the process of technological innovation investment [5]. Zhou through the social network analysis method concluded that when listed companies have independent directors with technical background, the active connection between the network centrality of the company's non-interested directors and innovation performance is significantly enhanced and conducive to the improvement of enterprise innovation performance [6]. Pornsit Jiraporn using the estimation of differences shows that the independence of advice leads to a crucial increase in investment in innovation and productivity of innovation [7]. Liu found that independent directors with specific technical education background have a positive impact on enterprise innovation. In addition, the impact is more significant in state-owned, large and established enterprises [8]. Liu. M found that CEO friendliness plays a positive role in firms' ability to develop in the long term and is influenced by the degree of CSR fulfillment. In addition, executive

compensation can enhance the positive correlation between the two sides [9]. Balmseier shows that businesses are moving to an independent board of directors focused on more frequented and familiar technology fields. They requested patents, filed more claims and received more patent citations in the future [10]. However, a dependency model developed by Cuadrado-Ballesteros based on panel data from 321 agri-food companies between 2002 and 2017 suggests that independent directors are crucial in the implementation of ecological innovation and ecological design projects, but the diversity and identity of independent directors are not important factors [11]. Measured by the number of patents, Sierra-Moran found that non-interested directors have a negative impact on enterprise innovation, which is likely to be mitigated by the degree of director diversity [12]. The unique identity and background of independent directors, such as educational background, salary and gender, should be considered and paid attention to.

2.3. Proportion of independent directors and enterprise innovation

When analyzing the connection between independent director and enterprise innovation, the scale of independent director is a very essential factor. Xu proposed that the knowledge and experience of outside directors can find innovative opportunities and possibilities with development space for the family holding company, so a high proportion of outside directors can promote the innovative behavior of the family holding company [13]. Taking non-financial companies listed on the GEM before the end of 2012 as the research object, Wang pointed out that after the introduction of the outside director system, public companies can effectively prevent the management from reducing the enterprise's R&D investment for their own short-term interests, thus affecting the enterprise's long-term earnings [14]. Hu adopted the panel dual-fixed model to study that the increase of the percentage of broad directors in a firm can significantly increase the number of patents in a corporation and improve the overall scientific research and innovation level of the company [15]. Yan’s research found that the increase of independent directors can significantly promoting firms' innovation performance, indicating that independent directors alleviate agency problems, improve managers' risk taking, alleviate management conservatism, and promote management to actively choose innovative projects [16]. Lu analysed and concluded that the stability of the executive team, which can be improved by the external director system can regulate the improvement of the company's professional technology innovation [17]. Li draws the conclusion that the independent director colleague has an increasing positive impact on innovation, especially the investment intensity and innovation output by referring to the human capital theory. However, this influence only exists in non-state-owned enterprises [18]. Wu proposed that the increase of the percentage of outside directors has a positive promoting effect on the innovation output of labor-intensive and technology-intensive enterprises, and a passive inhibiting effect on the innovation output of capital-intensive enterprises, but it can promote and nurture the future innovation output of capital-intensive enterprises by reducing enterprise costs and improving enterprise profits [19]. The share of independent directors in the enterprise has a positive impact on the innovative capacity of the firms. Because the scale of independent administrators is not a defining characteristic, this article analyses the proportion of independent administrators as a control variable in empirical research.

2.4. Hypothesis formulation

Based on a comprehensive analysis of the above literature, this paper concludes that older independent directors are in a stable stage of their career, have more energy to seriously understand and participate in the management of corporate innovation, and have an open attitude towards corporate innovation activities. On the contrary, younger independent directors lack work experience and tend to specialize in a particular field such as finance, law and corporate management, and therefore pursue low-risk corporate development strategies and have a relatively negative attitude towards corporate innovation. Based on the above analysis, this paper proposes that.

Hypothesis $H_{1.1}$: The average age of independent directors is positively related to firms' innovation input; Hypothesis $H_{1.2}$: The average age of independent directors is positively related to firms'

innovation output.

The innovation areas currently involved in listed companies are often accompanied by innovations in business models or science and technology, and are characterized by a high threshold and large scale. Unlike the management of a company's day-to-day business activities, the innovative areas of a company require decision-makers to have a full and complete understanding and judgement of the industry's prospects and the company's current situation, as well as a certain level of knowledge of emerging science and technology. In this context, the paper argues that an independent board of directors with a high level of education has the advantage of specializing in the content of innovation, enabling companies to increase their innovation input and output. Independent directors with multiple identities have more mature industry experience to judge the feasibility and applicability of corporate innovation, enabling the development of a virtuous cycle of corporate innovation. Accordingly, this paper proposes that:

Hypothesis $H_{2.1}$: The average educational attainment of independent administrators is positively linked to the firm's innovation input; Hypothesis $H_{2.2}$: The average educational attainment of independent directors is positively linked to the company's innovative output. Hypothesis $H_{3.1}$: The multi-status of independent directors is positively correlated with the company's innovation input; Hypothesis $H_{3.2}$: Multiple status of independent directors is positively correlated with corporate innovation output.

3. An empirical test of independent directorship characteristics on profitability

3.1. Data sources and sample selection

This article uses a sample of Chinese A stock market in Shanghai and Shenzhen, from 2016 to 2021 for the study. Patent data, information on the identity of independent directors and corporate financial data are obtained from the Guotaian CSMAR database. In this article:

1. exclude companies such as ST and *ST, which are in abnormal financial or other conditions and are therefore not analysed; 2. exclude the sample of listed companies in the financial sector according to the 2012 industry classification, as these companies are hardly involved in R&D activities for new products or technologies and are therefore not analysed; 3. draw on Mr. Lian Yujun's winsor2 command to tailor the data to avoid the impact of extreme values on the sample. 4. the official statistics obtained on 31 December each year were chosen as the basis. After processing, 4715 listed companies were obtained, and the data were processed using Stata17 software.

3.2. Variable setting and model construction

3.2.1. Variable setting

The explanatory variable of enterprise innovation needs to be measured in terms of both inputs and outputs: the input of innovation is measured by dividing the enterprise's R&D investment by the enterprise's business revenue, and the number of patents issued obtained by the enterprise in that year plus one by taking the natural logarithm is measured by the output of innovation. Innovation inputs can represent a firm's willingness to engage in innovative activities, and innovation outputs can, to a certain extent, represent the scale and capability of a firm's innovation.

This paper focuses on the age, education and multiple status variables of independent directors, as defined and symbolically represented in Table 4.1. In addition to this, corporate innovation is also influenced by other external factors such as firm size, cash solvency and debt levels, so six control variables are introduced in this paper to drain the influence of other factors on the variables under study.

Table 1. Description of variables

Variable category	Variable name	Symbols	Meaning of variables
Explained variables	Innovation input	InIp	R&D investment/operating income
	Innovative outputs	InOp	(Number of inventions patented + 1) as natural logarithm
Explanatory variables	Age of sole director	Age	Average age of independent directors
	Solo Director Education	Edu	1=Secondary and below, 2=Junior college, 3=Bachelor's degree, 4=Master's degree, 5=PhD degree, 6=Other, 7=MBA/EMBA. The average value of the sole director's education is taken.
	Multiple identities	Mult	Average of the number of independent directors in a part-time capacity.
rol variables	Company size	Size	The total number of assets of the company is taken as the natural logarithm
	Gearing ratio	Deb	Total liabilities / Total assets
	Current ratio	Cur	Current assets / Current liabilities
	Return on net assets	Roe	Net profit/average balance of shareholders' equity
	Combined leverage	Lev	(Net profit + income tax expense + finance costs + depreciation of fixed assets, depreciation of oil and gas assets, depreciation of productive biological assets + amortization of long-term amortization of intangible assets)/(Net profit + income tax expense)
	Percentage of sole directors	Sca	Number of Independent Directors / Number of Board of Directors

3.2.2. Model construction

This document considers the impact of independent directorship characteristics on corporate innovation, based on which the least squares estimation method is used to construct the following basic econometric model.

$$InIp = \beta_0 + \beta_1 Age + \beta_2 Edu + \beta_3 Mult + \sum \mu Con + \varepsilon \text{ (model a)} \quad (1)$$

$$InOp = \beta_0 + \beta_1 Age + \beta_2 Edu + \beta_3 Mult + \sum \mu Con + \varepsilon \text{(model b)} \quad (2)$$

Where β_0 - β_3 are the correlation coefficients of the explanatory variables, Con is the control variable, μ is the correlation coefficient of the control variable and ε is the residual term.

3.3. Descriptive statistics

The descriptive statistics of the explanatory, explanatory and control variables for a sample of 4715 listed companies were carried out using Stata software and the results are presented below.

Table 2. Descriptive statistics for Model A

Variable	N	Mean	p50	SD	Min	Max
InIp	17061	5.09	3.85	7.59	0.001	727.3
Num	17061	3.185e+09	3.005e+09	2.644e+09	72016	6.890e+09
Age	17061	53.85	53.67	5.35	31.33	75.50
Edu	17061	3.89	4	0.67	2	7
Mult	17061	1.54	1.33	1.41	0	23
Cur	17061	2.76	1.85	3.11	0.11	78.51
Deb	17061	0.39	0.38	0.19	0.01	4.59
Size	17061	22.22	22.03	1.32	17.81	28.64
Roe	17061	0.11	0.09	0.13	-0.86	8.72
Lev	17061	2.45	1.43	10.48	-1.21	913.80
Sca	17061	0.18	0.18	0.039	0.036	0.40

Table 3. Descriptive statistics for Model B

Variable	N	Mean	p50	SD	Min	Max
InOp	3796	2.00	2.08	1.70	0	9.09
Num	3796	3.735e+09	3.009e+09	2.760e+09	82017	6.890e+09
Age	3796	54.13	54	5.33	38.33	75.50
Edu	3796	3.87	4	0.68	2	6
Mult	3796	1.61	1.33	1.51	0	23
Cur	3796	3.24	2.03	3.78	0.16	48.76
Deb	3796	0.37	0.35	0.19	0.02	0.99
Size	3796	22.15	21.97	1.25	19.38	27.59
Roe	3796	0.11	0.09	0.19	-0.19	8.72
Lev	3796	2.33	1.38	5.56	0	174.2

There is some variation in the sample size between the two models due to residual sample statistics. As can be seen from the descriptive statistics above, the average and median age ranges from 53-54 years old, with the youngest independent director being over 30 years old and the oldest being 75 years old, with a large gap between the maximum values. The mean level of education is around 3.85, which is closer to a master's degree, with a minimum value of 2 and a maximum value of 7. The mean value of the multiple status variable is 1.6, indicating that most independent directors do not hold different positions in many companies.

3.4. Correlation analysis

Correlation analysis was conducted using stata software on the two models to initially explore the positive and negative correlations between the two variables in Model A and Model B. The results are as follows.

Table 4. Model A correlation analysis

Variables	InIp	Age	Edu	Mult	Cur
InIp	1.000				
Age	-0.010	1.000			
Edu	0.063***	-0.093***	1.000		
Mult	0.068***	0.011	0.082***	1.000	
Cur	0.189***	-0.059***	0.025***	0.027***	1.000
Deb	-0.203***	0.081***	-0.034***	-0.025***	-0.585***
Size	-0.164***	0.214***	-0.025***	-0.011	-0.324***
Roe	-0.013*	-0.016**	0.000	0.030***	0.016**
Lev	-0.014*	0.005	-0.004	-0.012	-0.051***
Sca	0.028***	-0.039***	0.011	0.030***	0.087***
Variables	Deb	Size	Roe	Lev	Sca
Deb	1.000				
Size	0.522***	1.000			
Roe	0.004	0.012*	1.000		
Lev	0.082***	0.043***	-0.070***	1.000	
Sca	-0.175***	-0.227***	0.047***	-0.015**	1.000
*** p<0.01, ** p<0.05, * p<0.1					

Table 5. Model B correlation analysis

Variables	InOp	Age	Edu	Mult	Cur
InOp	1.000				
Age	0.033**	1.000			
Edu	0.016	-0.082***	1.000		
Mult	0.084***	0.035**	0.032**	1.000	
Cur	0.015	-0.061***	-0.011	0.109***	1.000
Deb	0.040**	0.093***	0.016	-0.119***	-0.626***
Size	0.140***	0.195***	0.000	-0.066***	-0.337***
Roe	0.027*	-0.042***	-0.023	0.008	0.007
Lev	-0.044***	0.007	-0.001	-0.045***	-0.092***
Sca	-0.015	-0.032**	-0.015	0.038**	0.054***
Variables	Deb	Size	Roe	Lev	Sca
Deb	1.000				
Size	0.568***	1.000			
Roe	0.025	-0.015	1.000		
Lev	0.169***	0.097***	-0.075***	1.000	
Sca	-0.147***	-0.179***	0.024	-0.070***	1.000
*** p<0.01, ** p<0.05, * p<0.1					

Based on the above correlation analysis, it is initially clear that the age variable is not significantly related to firm innovation input and is significant with firm innovation output at the 95% confidence level. The correlation coefficient is 0.063, and the correlation coefficient is not significant with the innovation output variable. The multiple identity variable was positively correlated with both innovation input and innovation output, with correlation coefficients of 0.068 and 0.084 respectively.

To avoid bias in the experimental results due to the interaction between the explanatory and control variables, the two models were verified for multicollinearity. The VIF value of model A was 1.22 and the VIF value of model B was 1.27 both of which were less than 5, so the problem of multicollinearity between the variables was not considered.

3.5. Multiple regression analysis

A further multiple regression analysis of the two models using stata software produced the following results.

Table 6. Results of Model A multiple regression analysis

Variables	Age	Edu	Mult	Cur	Deb
ModelA	0.037***	0.594***	0.315***	0.252***	-3.890***
Variables	Size	Roe	Lev	Sca	
	-0.500***	-0.796*	0.002	-3.664**	
Constant	12.940***	Observations	17061	R-squared	0.061
*** p< 0.01, ** p<0.05, * p<0.1					

Table 7. Results of Model B multiple regression analysis

Variables	Age	Edu	Mult	Cur	Deb
ModelB	0.001	0.0362	0.096***	0.025***	-0.054
Variables	Size	Roe	Lev	Sca	
ModelB	0.236***	0.227	-0.015***	0.209	
Constant	-3.650***	Observations	3,796	R-squared	0.0350
*** p<0.01, ** p< 0.05, * p<0.1					

According to the results of the linear regression, the regression result of the age variable with firm innovation input was significant at the 99% significance level with a coefficient of 0.037, and hypothesis H1.1 was supported; the regression result with firm innovation output was not significant and hypothesis H2.2 was not verified. The regression result of education level with firm innovation input was significant and the coefficient was 0.594, hypothesis H2.1 was supported; the regression result with firm innovation output was not significant and hypothesis H2.2 could not be supported. The multiple identity variable was significantly and positively associated with both firm innovation input and output with regression coefficients of 0.315 and 0.096 respectively, and hypothesis H3.1 and hypothesis H3.2 were both tested.

4. Conclusions, recommendations and outlook of the study

4.1. Research conclusions and recommendations

The average age of outside directors is positively related to firms' investment in innovation and not significantly related to firms' output. The regression results are somewhat in line with this paper's expectation that older independent directors have more positive attitudes towards innovation activities and increase the willingness of firms to implement innovation activities. However, such positive attitudes do not directly help firms to improve their level of innovation and innovation efficiency, and are therefore not significantly related to the innovation output variable.

The level of training of independent managers is positively linked to the company's contribution to innovation and is not significantly linked to the company's production. According to the results of the study, highly educated independent boards of directors drive corporate innovation inputs, but have very limited impact on corporate innovation outcomes. This paper suggests that this situation is likely to occur because firms invite independent directors with a greater bias towards finance, law and corporate governance. In this case, the industry expertise of the independent directors may not be involved in the area of corporate innovation at all, and therefore their contribution to innovation outcomes is minimal.

Multiple independent directorships are positively correlated with both corporate innovation inputs and outputs. According to previous literature, multiple independent directorships tend to be negatively related to various financial indicators of the firm, i.e. more work distracts the independent director and makes the firm's performance worse. The main reason why the findings of this paper differ from previous literature is that corporate innovation is different from other day-to-day operational activities and does not require the decision-maker to be involved in every step of the innovation process, but requires him/her to have extensive experience and a long-term perspective to control the overall situation. Therefore, an independent board of directors with multiple roles can be

more active and constructive in the corporate innovation process, so that corporate R&D can enter a virtuous cycle.

Based on the above findings, this paper argues that the hiring of non-interested directors by companies is a two-way selection process and that companies should be clear about the competencies of independent directors and the purpose of hiring them. If they want independent directors to participate in corporate innovation, they should focus on whether they have sufficient experience in the field i.e., multiple identities. Older and more educated independent directors can be effective in increasing a firm's willingness to innovate, but they do not significantly contribute to the firm's ability to innovate and improve its efficiency.

4.2. Research gaps and outlook

Statistics on the areas of expertise of independent directors make a great contribution in the input and output of corporate innovation. The purpose of inviting independent directors can be directly distinguished by investigating whether the independent directors themselves are engaged in ancillary areas such as finance, law, corporate management or in the main business area of the company. Due to the lack of relevant statistical variables in the current database, it is technically difficult to manually aggregate information on each independent director for each company, which is a shortcoming of this paper at present. If the industry expertise variable of the sole director could be counted, it would be possible to exclude other data and directly investigate whether independent directors engaged in their main field of business have a positive effect on corporate innovation.

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