

Potential Characteristics of Supervisory Board, Company Asset Scale and Irregularity of Listed Companies: Empirical Analysis Based on Heckman Two-Stage Model

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Abstract Based on heterogeneity extraction, this paper analyzes four potential characteristics of the supervisory board, they are Individual Heterogeneity of the Supervisory Member (*Internal Heterogeneity*), Organization Size of the Supervisory Board (*Organization Size*), Structural Characteristics of the Supervisory Board (*Structural Characteristics*) and Identity Background of the Supervisory Board (*Identity Background*); and verifies the impact and action path of the potential characteristics on irregularities. Then, systematically evaluates the micro enterprise organization construction and corporate governance behavior by using the methods of factor analysis and Heckman two-stage model. Empirical research shows that the scale of corporate assets does have an important impact on corporate irregularities and the governance of the board of supervisors. Under the regulation of the company scale, the three potential characteristics: *Organization Size*, *Identity Background* and *Structural Characteristics* have played a significant inhibitory role on irregularities, and the *Internal Heterogeneity* has no significant effect. When using *violation behavior* as an alternative variable of supervision performance, the sample selection deviation will be caused by the lack of information disclosure. This paper suggests that we should pay attention to the team of the board of supervisors scientifically and reasonably, weaken the appropriate personalized differences within the board of supervisors, and comprehensively consider the interaction between the company scale, asset quality and the performance of the board of supervisors when formulating the corporate internal management system.

Keywords heterogeneous factors; potential characteristics; company asset scale; factor analysis; Heckman two-stage model

1 Introduction and Literature Review

In recent years, the public's attention to the irregularities of listed companies has been increasing. According to the statistics of the WIND database and the information of company announcements, from 2015 to 2019, a total of 8,674 irregularities occurred in domestic A-share

companies. Among them, the largest number of irregularities occurred in 2016 that was 2562 times, which increased by 4 times compared with the previous year, and dropped sharply in 2017. The reason for the analysis may be that major events have made the capital market sensitive and fragile, such as ‘the circuit breaker mechanism’ in 2016, the enforcement of new regulations, the layered implementation plan of the New Third Board, and the opening of the Shenzhen-Hong Kong Stock Connect. At the same time, the China Securities Regulatory Commission has stepped up its supervision of market behavior, implemented the mandatory delisting mechanism, and strengthened the publicity and handling of mergers and acquisitions, information disclosure, and abnormal fluctuations of individual stocks in the secondary market. To 2018, the number of irregularities increased by 60.6% compared with the previous year, according to the analysis of *Xin Gong Consulting*^[1], the market value of the A-share market evaporated by more than ten trillion yuan in 2018, and the trading volume shrank significantly. The market dilemma has forced many companies to seek changes, and the turbulent market has increased violations and chaos, then supervision has become even slacker, push the capital market system continuously reformed to keep pace with the times.

There are many reasons for the appearance and occurrence of irregularities and violations, and the research on them is also a complex system. Current studies contribute to irregularities of listed companies have covered many factors, perspectives and levels, such as the structure of the board of directors^[2-5], independent directors^[3, 6], executive compensation structure^[7, 8], executive background characteristics^[9, 10], ownership structure^[11-13], the shareholding ratio of institutional investors^[14], external auditors^[15-17], asset quality^[18], etc.

The Board of Supervisors aims to prevent and supervise business behaviors that deviate from the normal state, restrain the moral hazard and adverse selection of executives, cut down agency costs, reduce the occurrence of violations, and ultimately ensure the healthy operation of the company. Logically, if the board of supervisors diligently performs its supervisory functions, effectively supervises the behavior of directors and senior executives in performing their duties, promptly corrects behaviors that harm the company’s interests, and conducts questions and investigations when the company operating conditions are abnormal, then the probability of irregularities and violations should be gradually reduced. On the contrary, if irregularities occur frequently and the board of supervisors remains silent, the supervisory responsibilities will not only be questioned, but may even be considered as the colluding body of the violations. This paper needs to explore and solve the problem whether there is a direct causal connection between the board of supervisors and the irregularities, or how to exclude other factors that may affect the irregularities.

Some recent papers analyzed and selected violation indicators to measure the governance performance of the board of supervisors. For example, Sun, et al.^[19] used related party transactions as the explained variable indicators, and conducted an empirical analysis on the implementation effect of the board of supervisors system. Cui and Wang^[20] found that there is a strong correlation between the annual salary of supervisors, the number of objections raised by the board of supervisors and the occurrence of violations of listed companies. Xue and Huang^[21] believed that the supervisor which owns the company equity would performs its supervisory duties more diligently, so that enhances the supervision efficiency of the board of

supervisors, and restrains the violations of the company management. Agrawal and Chadha^[22] demonstrated in their research that ‘corporate earnings management’ is not significantly related to the independence of the board of directors and the board of supervisors, but is affected by the professional background of independent directors and supervisors. However, there is still a lack of unified index selection and quantification methods in empirical research for evaluating the effectiveness of the board of supervisors, and lack further analysis and distinction on the heterogeneity of the board of supervisors as well. It is even found that the theory and practice of heterogeneity based on Western countries are not applicable to the East countries, that leading to a discussion of the appropriate mediating variables to intervene in different contexts^[23].

Compared with the existing literature, there are mainly three contribution of this paper. The first one is to select heterogeneous factors and indicators that can fully represent the characteristics of the supervisory board, hereafter using the method of factor analysis to refine and reduce the dimension of micro-data, in order to explore the impact of the potential characteristics of the board of supervisors to corporate violations, so as to put forward more reasonable and specific governance programs and policy recommendations finally. Secondly, considering that the statistics on violations of listed companies are actually based on the probability set of two events: ‘Violation of listed companies’ and ‘disclosure by regulatory authorities’, therefore, when violations occur but are not disclosed, information will be missing, resulting in sample selection bias. In this paper, the Heckman two-stage model^[24] is used to correct the problem. Thirdly, it is found that companies with larger assets will encounter more complex problems and situations, are more likely to be concerned by regulatory authorities, and increase the probability of disclosure violations. So this paper focus on the interactive effect of ‘company asset scale’ on various variables. The relationship among the potential characteristics of the supervisory board, the company asset scale and irregularities not only expands the breadth and depth of research on corporate governance, but also provides new inspiration and clues for improving corporate supervision performance.

2 Theoretical Framework and Hypotheses

2.1 Path Analysis and Hypotheses

Generally, individual characteristics not only affect personal behavior, but also affect team stability and behavior at the firm level. Such as differences in experience, skills, perceptions, and values among members may have an impact on decision-making and, consequently, on the firm’s performance^[25]. This paper selects 13 heterogeneity factors that can represent the overall average characteristics and internal differentiation characteristics of the board of supervisors, and assumes that the board of supervisors can pass through the four potential characteristics of *Internal Heterogeneity*, *Organization Scale*, *Structural Characteristics* and *Identity Background* to affects oversight performance and ultimately has an impact on irregularities.

First of all, *Internal Heterogeneity* represents a comprehensive assessment of various differences among individual supervisor, mainly including five factors: Age heterogeneity^[26], education heterogeneity^[27], professional heterogeneity^[28], salary difference^[29] and background difference^[30]. According to social identity theory^[31], internal differences will affect the communication and stability between teams to a certain extent, which will be detrimental to perfor-

mance. On the other hand, based on the information decision theory^[32], the diversification of educational backgrounds, majors and work backgrounds means that more information, knowledge, resources and ways of thinking can be obtained, at the same time, the Tournament theory^[33] also supports that the vertical gap within the team will have a certain incentive effect, thereby improving the supervision level and efficiency of the supervisory board. Therefore, when the intensity of internal heterogeneity increases, it has an impact on supervisory performance, which in turn affects corporate irregularities. Based on the above analysis, the following competing hypotheses are proposed:

H1a: The internal heterogeneity of the board of supervisors has a positive impact on corporate irregularities.

H1b: The internal heterogeneity of the supervisory board has a negative impact on corporate irregularities.

Second, *organization scale* includes not only the static number of personnel, but also the dynamic personnel flow, mainly including the number of personnel and the frequency of personnel replacement. Generally speaking, a supervisory board with a larger number can cover more diverse expertise and information^[34], on the other hand, it also means more complex internal relationships, increased agency costs, and reduced stability, which lead to a decrease in internal performance, also meet the threshold effect theory^[35]. In addition, the higher the personnel replacement frequency, means inputting the continuous and fresh blood, breaking the inherent interest system, closing regulatory loopholes and improving supervisory performance^[36]. However, replacement frequency also leads to instability, which reduces work performance and correspondingly increases the probability of violations^[37]. Based on the above analysis, the following competing hypotheses are proposed:

H2a: The organizational size of the supervisory board has a positive impact on corporate irregularities.

H2b: The organizational size of the supervisory board has a negative impact on corporate irregularities.

Third, *structural characteristics* includes three components: Average age, the proportion of Communist Party of China (CPC) members, and the proportion of women, which comprehensively shows the external dominant state and characteristics of the supervisory board team. Among them, the average age is a more obvious feature, older age means it is easier to accumulate experience and social resources to some extent, but younger have more vigorous energy, enthusiasm and adventurous spirit^[38]. Women are more risk averse and place more value on reputation usually^[39–41], participation of CPC in corporate governance has also been shown to be beneficial to improve and improve corporate governance levels, and therefore, the proportion of women and CPC members should be positively correlated with supervisory performance^[42]. So hypothesize:

H3: The structural characteristics of the board of supervisors have a positive impact on supervisory performance and have an inhibitory effect on irregularities.

Fourth, *identity background* can include three factors: The average educational background^[43], the proportion of external supervisors^[44], and the proportion of members with a government or college background, which comprehensively reflects the team educational background and

professional identity characteristics. It is generally believed that identity background characteristics can enable supervisors to obtain more political status, regulatory experience, policy information^[45] and a broader perspective^[46], it also has an incentive effect to a certain extent, incentivize supervisors to perform their supervisory duties more proactively, thereby reducing the occurrence of irregularities^[44]. So hypothesize:

H4: The more obvious the identity and background characteristics of the board of supervisors, the more significant the negative impact on irregularities.

Fifth, the *company scale* in this paper mainly reflects the total amount of company assets. Generally speaking, large-scale companies have high corporate brand value, which the motivation is weak because violations will damage the image and value. Based on the theory of information transmission, it can be further explained that the size of the company can also reflect the economic strength of the company and the reasonableness and reliability of its daily business activities, then convey the quality of assets and accounting information to the market, thereby improving investors' judgment and confidence. Studies have shown that there is a negative correlation between company size, unfair related party transactions and information disclosure violations^[47, 48]. From a regulatory perspective at the same time, companies with larger assets bear less burden of fines and confiscations than companies with smaller assets, the reason might be that local governments, for the sake of regional economic development, take stimulating GDP growth as their main work goal, and tend to relax supervision on large enterprises and large projects^[49]. So hypothesize:

H5: Company scale is negatively correlated with irregularities.

2.2 Analysis of Other Factors Affecting Irregularities

With the rapid development of capital market and the continuous improvement of the corporate governance level, more and more attention and evaluation are given to violations or irregularities of Listed Companies not only from regulators, but also from all aspects of society. At present, existing studies have demonstrated that the complex external environment is also the irregular motivation and manifestation of violations, involved the economic environment^[50], policies and regimes^[51], department supervision^[52, 53], media supervision^[54], government intervention and behavior^[55, 56], industry investment confidence^[57], product market competition^[58], etc. Although the macro environment can usually be used as an intermediary effect to affect the internal governance and performance of enterprises, the current research still lacks data support and measurement indicators. Therefore, when this paper temporarily ignores external factors such as geography, policy and market competitiveness, it focuses on observing some more important factors related the corporate internal organizational structure and governance which closely necessary for supervisory board researching and could be mainly attributed to several aspects:

Assets-liability ratio. The factors and indicators that reflect the basic information of the company can convey the advantages and disadvantages of financial status and quality to the market. When the changes and measurement of assets and liabilities in daily business activities are more reasonable and reliable, market confidence can be enhanced, information transparency can be improved accordingly as well, thereby reducing the probability of violations. The higher the asset-liability ratio, the greater the financial pressure, and the higher the possibility of

illegal information being disclosed^[59].

Enterprise property rights. The property rights attribute reflects the nature of the enterprise and can be fundamentally divided into state-owned property rights and non-state-owned property rights in China. The difference of property rights affects the level of governance, which in turn affects irregularities. Gu and Liu^[9] pointed out that privately controlled companies have higher financing costs and usually pay more attention to short-term performance, in contrast, state-controlled listed companies have fewer violations.

Shareholding structure, shareholding concentration and institutional shareholding ratio. Chen, et al.^[12] found that the largest shareholder concentrating shareholding is conducive to restraining violations. The research conclusion of Shuai^[60] proves that the shareholding concentration of listed companies has a significant positive correlation with the operating performance. Yu and Liu^[61] also proved through research that the higher the shareholding ratio of the largest shareholder, the higher the institutional shareholding ratio, and the higher the shareholding concentration of listed companies, the lower the probability of information disclosure violations. With the increasing shareholding of institutional investors, it plays an important role in preventing and combating irregularities^[14], it also plays a positive role in the information disclosure of listed companies in particular^[62].

Director board structure and characteristics. Studies have shown that the larger the board of directors, the more likely to engage in financial fraud^[2]. Board meetings of companies occurred violation are more frequent^[63]. The higher the proportion of external independent directors, the less the irregularities, and the establishment of an audit committee can also significantly reduce the probability of violations^[64]. On the other hand, there are studies also believe that board characteristics such as the size of board, the proportion of independent directors, and the leadership structure cannot play a role in explaining and supervising the untrustworthy behavior, corporate scandals, and accounting fraud^[11, 65, 66].

External auditors. The audit function of an accounting firm is an important part of the external supervision, and it has the function of restraining and revealing the improper operation and illegal operation of the company. Many scholars choose to use the size of the accounting firm to indirectly confirm the audit quality^[4, 15, 16]. Zhou^[17] believed that larger accounting firms have a more obvious role in audit supervision, and play a significant role in reducing corporate violations.

To sum up, the mechanism analysis and research hypotheses about the influence of the heterogeneity of the supervisory board on irregularities follow three steps (see Figure 1): Research on the heterogeneity and the performance of the supervisory board, the effectiveness of the supervisory board and irregularities, and the research on irregularities.

3 Data Selection, Design and Analysis

3.1 Source of Sample Data

Considering that the attention of the regulatory authorities will increase the probability of violations being discovered and disclosed, this article intends to select some companies as samples that the regulatory authorities are more willing to strengthen supervision and invest more supervision resources. Samples including CSI 300 and ST companies, in order to highlight

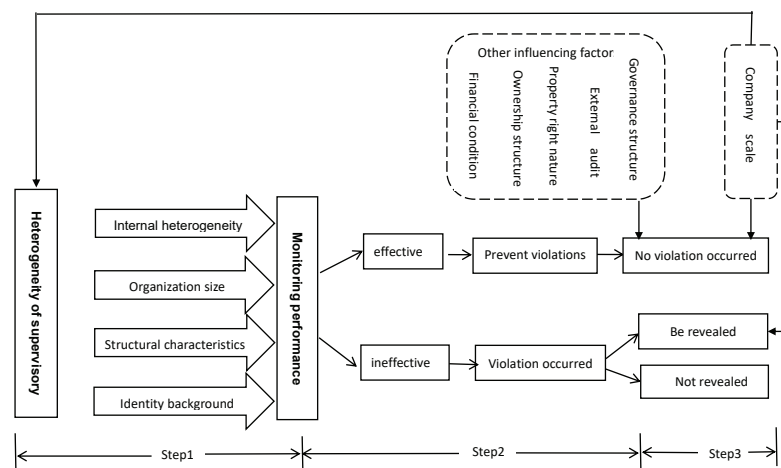


Figure 1 Analysis of the impact path of the heterogeneity of the supervisory board on irregularities

the differences in company scale, asset quality and internal governance structure, which facilitates the analysis and comparison of data results. The CSI 300 Index of listed companies reflects representative stocks with strong liquidity and large scale, covering about 60% of the market value of the Shanghai and Shenzhen markets, with good market representation and profitability. On the other hand, ST companies usually have abnormal financial or other conditions, and there are investment risks and even delisting risks. Therefore, this paper selects the latest supervisory committees of CSI 300 companies (300 companies) and ST companies (141 companies) as samples and units for calculation from 2015 to 2019, meanwhile, the violations are usually caused by long-term poor management, so this paper selects the time span that can cover the latest board of supervisors. Financial data, ownership structure data and board data are all from the WIND database, some individual data are obtained by manually viewing publicly announced information and manually calculating. Data processing was performed using Excel and Stata 16.0.

3.2 Variable Selection and Descriptive Statistics

3.2.1 Explained Variable

In this paper, the evaluation and calculation of irregularities are based on two indicators, ‘whether or not’ and ‘number of’. The definition methods and descriptive statistics are shown in Table 1 as follows:

Table 1 Measurement methods and descriptive statistics of irregularities

Irregularities and symbols	Definition and measurement method	Descriptive Stats (441 companies)			
		Min	Max	Avg	SD
whether or not (y)	Assigned to 1 when a irregularity occurred in 2015–2019, 0 otherwise.	0.0000	1.0000	0.4966	0.5006
number of (Y)	Sum of irregularities in 2015–2019.	0.0000	882.00	12.44	69.94

3.2.2 Explanatory Variables

This paper firstly selects 13 indicators representing the heterogeneity of supervisory boards as the basis for further inductive features and dimensionality reduction processing (see Table 2).

Table 2 Measurement methods and descriptive statistics of heterogeneity indicators of supervisory boards

Heterogeneity Indicators	Definition and measurement method	Descriptive Stats (441 companies)			
		Min	Max	Avg	SD
No. of people	Actual number of the most recent supervisory board.	3.0000	12.0000	4.0930	1.6957
Female ratio	Number of female supervisors / supervisory board members.	0.0000	1.0000	0.2839	0.2462
Turnover	Number of replacements during the most recent supervisory board.	0.0000	9.0000	1.5011	1.6612
Avg. age	Take logarithm (Total age of members as of the end of 2019 / Number of)	3.5165	4.1897	3.9186	0.1240
External supervisor	Number of external supervisors / Number of supervisors.	0.0000	1.0000	0.4139	0.2586
Govnt / Uni Experience	Number of supervisors with government (university) background / Number of supervisors.	0.0000	1.0000	0.1306	0.1941
Avg. Education	Consecutive coding of variables (1 for less than bachelor's degree, 2 for bachelor's degree, 3 for master's degree, 4 for doctorate), Sum of all coded values / Number of supervisors.	1.0000	4.0000	2.1879	0.6029
CPC member ratio	Number of CPC supervisors / Number of supervisors.	0.0000	1.0000	0.3408	0.3510
Age heterogeneity	Age of the latest supervisory board members as of the end of 2019 Standard deviation / Average.	0.0000	0.8992	0.1440	0.0906
Education heterogeneity	Heterogeneity coefficient using Herfindahl index.	0.0000	0.7500	0.4223	0.2041
Professional heterogeneity	Heterogeneity coefficient using Herfindahl index.	0.0000	0.8000	0.4391	0.2371
Remuneration heterogeneity	Take logarithm (the difference between the average value of the remuneration of the chairman and the remuneration of the employee supervisors during the supervisory board).	-2.3539	6.1602	3.0800	1.4041
Employment background	The variables are assigned categories (1 for executive background, 1 for government or university background, and 2 for both), and the Gini coefficient is used to calculate the degree of variation in employment background.	0.0000	0.8889	0.3696	0.2970

Then, according to the theoretical model, four potential characteristics of *Internal Heterogeneity*, *Organization Scale*, *Structural Characteristics* and *Identity Background* were constructed, and the 13 indicators were standardized and divided into four groups and assigned to each above potential characteristic. It was found that the KMO of each group of indicators was greater than 0.5 after principal component analysis by SPSS, $P = 0 < 0.05$, so that dimensionality reduction analysis can be performed, on this basis, the method of increasing the variance is used to perform spatial rotation, and the factor analysis method is used to extract 'factors' with more explanatory power to describe the above four implicit variables that hard be directly measured. It is believed that the individual heterogeneity within the supervisory board can not only directly affect the supervisory performance, but also interact to form potential characteristics that affect the supervisory performance.

The *Internal Heterogeneity* extracted by factor analysis includes five indicators: Age heterogeneity, Education heterogeneity, Professional heterogeneity, Remuneration heterogeneity and Employment background, all of which show the differences between individuals. These differences have positive or negative impact on the overall performance of the supervisory board. *Organization Size* includes not only the number of people in the static sense, but also the dynamic flow and turnover of people. *Structural Characteristics* includes factors such as Average age, Female ratio and CPC member ratio, and comprehensively shows the external dominant state and characteristics of the supervisory board. The *Identity Background* of supervisors selected the Average education, the proportion of External supervisors, and the proportion of members with a Government/College background, which comprehensively showed the team educational background and professional identity. To sum up, this paper finally examines the influence of four potential variables that cannot be directly measured. The indicators and descriptive statistics explained are shown in Table 3.

Table 3 Explanatory indicators and descriptive statistics of four potential characteristics

Potential characteristics and symbols	Included indicators of heterogeneity	KMO value	Descriptive Stats (441 companies)	
			Min	Max
<i>Internal heterogeneity</i> (N)	Age heterogeneity;	0.606	-2.7694	2.0769
	Education heterogeneity;			
	Professional heterogeneity;			
	Remuneration heterogeneity; Employment background.			
<i>Organization size</i> (Z)	Number of people;	0.500	-0.9401	3.7521
	Turnover.			
<i>Structural characteristics</i> (J)	Avg. age;	0.609	-2.9413	2.2438
	Female ratio;			
	CPC member ratio.			
<i>Identity background</i> (S)	Avg. Education;	0.595	-1.9797	2.8414
	External supervisor;			
	Govnt/Uni Experience.			

In addition, *Company Scale* as an important variable, has a certain relationship with the internal company governance structure and irregularities. Therefore, this paper considers the interaction between the company asset scale and each the characteristics of supervisory board, as well as the impact on the efficiency of irregularities. The definition and measurement method of company scale is: Logarithm of total assets (2015–2019 average). Through descriptive statistical analysis, it can be seen that among the 441 samples, the minimum value of the company scale is 17.8161, the maximum value is 30.8910, the mean value is 23.9623, and the standard deviation is 2.2657. Further comparison of the two types of data samples with extreme differences (CSI 300 and ST companies) shows a large difference in performance. The logarithm of the total assets of the CSI 300 companies has a maximum value of 30.89 and an average value of 25.00. The maximum value is 24.82 and the average value is 21.65 in ST companies. Comparing the statistical results of observation, it can be seen that the CSI 300 companies with larger assets generally perform better in operation management, profitability and market representation. At the same time, a total of 100 companies had irregularities during the inspection period in the CSI 300 companies, violation rate is about one third. Compared with 141 ST companies, 119 companies have violated regulations, accounting for 84.40%, which also shows that the occurrence of irregularities is closely related to the basic conditions such as company size, performance, and profitability.

3.2.3 Control Variables

This paper selects those factors mentioned above that have an impact on corporate internal organizational structure and governance as control variables. The data of control variables are mainly from the basic information and annual financial statements of listed companies. The definitions and descriptive statistics of control variables are shown in Table 4.

Table 4 needs to be explained: The ‘Institutional shareholding ratio’ referred to in this article include general legal persons, funds, securities companies, insurance companies, banks, and Mainland Stock Connect, etc. Regarding the definition of ‘External auditor’, the ‘Big Four’ accounting firms refer to Ernst & Young, KPMG, Deloitte, and PricewaterhouseCoopers, and the ‘Big Eight’ refer to Dahua, Daxin, Lixin, Ruihua, Tianjian, Tianji International., ShineWing and Grant Thornton. ‘Major shareholder is absolutely controlling’ refers to a company in which the largest shareholding ratio exceeds 20% of the second largest one in any year from 2015 to 2019.

3.3 Measurement Model Setting

This paper studies the relationship between the heterogeneity of the supervisory board and the irregularities of listed companies. Based on the ordinary OLS regression, the model can be set as:

$$Y = \alpha_0 + \alpha_1 J + \alpha_2 S + \alpha_3 Z + \alpha_4 N + \alpha_5 X + \alpha_6 XJ + \alpha_7 XS + \alpha_8 XZ + \alpha_9 XN + \alpha_{10} P + \varepsilon.$$

Among them, Y represents the number of irregularities of the enterprise, and the 4 potential factors extracted by factor analysis are used as explanatory variables (J representing *Structural*

Table 4 Definitions and descriptive statistics of control variable

Variable name	Definition and measurement method	Descriptive Stats (441 companies)			
		Min	Max	Avg	SD
Assets-liability ratio	Total liabilities / Total assets (average 2015–2019).	0.0712	6.6837	0.6217	0.4593
Property rights	State-owned enterprises are assigned a value of 1, otherwise 0.	0.0000	1.0000	0.3810	0.4862
External auditor	Assigned ‘International Big Four’ or ‘Domestic Top Ten’ accounting firm as 1, otherwise it is 0.	0.0000	1.0000	0.6259	0.4845
Director board size	Total number of board of directors in 2018.	5.0000	18.0000	9.3084	2.4007
Proportion of independent directors	Number of independent directors/Number of board of directors (2018).	0.2500	0.6667	0.3816	0.0598
Institutional shareholding ratio	Number of shares held by all institutions at the end of the year / Tradable share capital (2015–2019 average).	0.0062	98.2978	38.5203	31.7773
Ownership concentration	The sum of the squares of the shareholding ratio of the top three shareholders (2015–2019 average).	0.0033	0.7292	0.2659	0.1656
Major shareholder is absolutely controlling	The company whose shareholding ratio of the largest shareholder exceeds 20% of the shareholding ratio of the second largest shareholder is assigned a value of 1, otherwise it is 0.	0.0000	1.0000	0.4717	0.4998

characteristics, S representing *Identity background*, Z representing *Organization size*, N representing *Internal heterogeneity*). α_{1-4} represent the regression coefficients of each explanatory variable in turn. X represents the company scale (total assets), and XJ , XS , XZ , XN are the interaction items between the company scale and the four potential characteristics. α_{5-9} are the corresponding coefficients respectively. P stands for control variables, α_{10} is P 's regression coefficient. ε is the error term.

However, not all irregularities are the result of random selection, e.g., companies that have not been found or have not disclosed violations are assigned a value of 0, just like companies that have disclosed no violations. Therefore, only using disclosed violations to examine influencing factors will lead to sample selection bias. In order to solve this problem, this paper adopts the two-stage model method proposed by Heckman^[24], the first stage builds a Probit model, estimating the Inverse Mills Ratio (IMR) to predict the probability of a irregularities for each company; in the second stage, IMR is added as a control variable to the OLS model to correct the problem of sample selection bias.

$$y_i = \begin{cases} 1, & y_i^* > 0, \\ 0, & y_i^* \leq 0, \end{cases} \quad (1)$$

$$y_i^* = \beta_0 + \beta_1 X_i + \varepsilon_i. \quad (2)$$

Among them, the explained variable y_i of Equation (1) is a dummy variable, indicating whether the enterprise violates the rules, and its value depends on the latent variable y_i^* . y_i^* represents the possibility of irregularities, when taken > 0 , it means that a violation occurred and was discovered or disclosed, the dummy variable is 1 at this time; when taken ≤ 0 , it means that no violation occurred or was not discovered and disclosed, the dummy variable is 0. In Equation (2), X_i is the factor affecting irregularities of corporate i , β_0 is the constant term, β_1 is the coefficient of the explanatory variable, and ε_i is the random error term.

In the paper, ‘whether the enterprise has violated the rules’ is used as the explained variable y , the factors that affect irregularities are used as the explanatory variable X_i , then use the Probit model in the first stage of the Heckman two-stage model to analyze whether there are unobserved irregularities and correct possible sample selection biases. The benchmark model is jointly expressed by Equations (1) and (2) as:

$$y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 J + \beta_{10} S + \beta_{11} Z + \beta_{12} N + \varepsilon.$$

Among them, y is a dummy variable representing ‘whether or not irregularity’, β_0 is a constant term. X_{1-8} in turn represent the asset-liability ratio, property rights, external audit, director board size, proportion of independent directors, institutional shareholding ratio, ownership concentration, and absolute control by major shareholders, β_{1-8} correspond to the coefficients of each variable respectively. J , S , Z and N represent the potential characteristics of the board of supervisors respectively: *Structural Characteristics*, *Identity Background*, *Organizational Size*, and *Internal Heterogeneity*, β_{9-12} are the corresponding coefficients, respectively; ε is the error term.

Subsequently, the second-stage OLS irregularity influencing factor model is set as:

$$Y = \alpha_0 + \alpha_1 J + \alpha_2 S + \alpha_3 Z + \alpha_4 N + \alpha_5 X + \text{IMR} + \varepsilon.$$

Among them, Y represents the number of irregularities, and the 4 potential factors extracted by factor analysis are used as explanatory variables, α_{1-4} represent the regression coefficients of each explanatory variable in turn. X represents company scale (total assets), and α_5 is X ’s regression coefficient. IMR used as a correction parameter for the second stage operation, if the IMR is non-zero and statistically significantly different from zero, there is sample selection bias. α_0 is a constant term, ε is a random error term.

In addition, on the basis of the Heckman two-stage model, the influence and role of company scale on the characteristics of the supervisory board and irregularities can be further tested. The model can be expressed as:

$$Y = \alpha_0 + \alpha_1 J + \alpha_2 S + \alpha_3 Z + \alpha_4 N + \alpha_5 X + \alpha_6 XJ + \alpha_7 XS + \alpha_8 XZ + \alpha_9 XN + \alpha_{10} P + \text{IMR} + \varepsilon.$$

Among them, XJ , XS , XZ and XN still represent the interaction terms of the company scale and the 4 potential characteristics respectively, and P represents the control variables other than IMR.

4 Empirical Research Results and Analysis

4.1 Correlation Analysis

The Spearman Method was used to calculate the correlation coefficient of the main variables, and the correlation between the variables was preliminarily judged. The results (see the attached table) showed that the two variables that define ‘irregularity’, ‘whether or not’ and ‘the number’ were significantly positively correlated (the correlation coefficient is 0.928), the reason is that the ‘number of irregularity’ reflects the degree of violations, and it is a quantitative statistics based on ‘whether irregularity’. At the same time, through the correlation analysis, it can also be seen that irregularities are significantly positively related to the *Organization Size*; irregularities are significantly negatively related to the control variables company scale, property rights, institutional shareholding ratio, and the absolute control of major shareholders, on the contrary, it is significantly positively correlated with asset-liability ratio and ownership concentration. The absolute values of most correlation coefficients between the variables are less than 0.3, except the one between the institutional shareholding ratio and the company scale is $0.695 > 0.5$, indicating that there is no serious multicollinearity between the variables. Next step can incorporate these variables into the regression.

It should be noted that, as an important control variable, *Company Scale* is significantly negatively correlated with ‘whether or not’ and ‘the number of’ irregularities, indicating that company scale has a certain inhibitory effect on the occurrence of violations. On the other hand, *Company Scale* is significantly positively correlated with various characteristics of the board of supervisors, indicating that it affects the setting and governance level of the board of supervisors.

4.2 Analysis of Full Sample Regression Results

This article uses Stata 16.0 to run the calculation, and the regression results are listed in Table 5. Models (1) (2) and (3) are the results of ordinary OLS analysis. Models (1) and (2) detect the influence of each variable on the number of irregularities. Model (3) adds 8 control variables. Models (4) (5) (6) and (7) are the Heckman two-stage regression results. From the regression results, it can be seen that in the OLS regression without considering the sample selection bias, no matter whether the control variable is added or not, the coefficient, sign and significance of each variable are somewhat different from the results in (5) (6) and (7). In particular, the IMR in model (5) passed the significance test at the 5% level, and the IMR value in model (6) and (7) did not reach significance but was not zero, indicating that the original model had sample selection bias, so that the Heckman two-stage model is suitable for the analysis.

Table 5 Regression results of comprehensive analysis of the whole sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	OLS	OLS	OLS	Heck1	Heck2	Heck2	Heck2
Dependent variable	Number of violations	Number of violations	Number of violations	Whether or not	Number of violations	Number of violations	Number of violations
Independent variable							
Structural characteristics (J)	0.0022 (0.572)	-0.0242** (-2.465)	-0.0210** (-2.101)	-0.0192 (-0.248)	-0.0002 (-0.033)	-0.0445*** (-2.635)	-0.0394** (-2.363)
Identity	0.0137*** (3.309)	-0.0539*** (-5.443)	-0.0497*** (-4.866)	0.1975** (2.497)	0.0002 (0.030)	-0.0462*** (-2.988)	-0.0405** (-2.586)
Background (S)	0.0177*** (4.508)	-0.0448*** (-4.434)	-0.0403*** (-3.884)	0.1579** (1.976)	0.0087 (1.145)	-0.0411** (-2.575)	-0.0325** (-2.043)
Organizational Size (Z)	-0.0029 (-0.695)	-0.0115 (-1.120)	-0.0071 (-0.671)	0.0178 (0.215)	-0.0077 (-0.990)	-0.0154 (-0.938)	-0.0156 (-0.960)
Heterogeneity (N)							
Company scale (CS)		0.0792*** (3.584)	0.0897*** (2.980)		0.3097*** (6.928)	0.1384*** (2.872)	0.1414** (2.403)
CS*J		0.0466** (2.241)	0.0426** (2.001)			0.1048*** (2.628)	0.1006** (2.576)
CS*S		0.1271*** (6.332)	0.1207*** (5.849)			0.1100*** (3.074)	0.1085*** (3.089)
CS*Z		0.0890*** (5.030)	0.0828*** (4.580)			0.0841*** (2.897)	0.0812*** (2.862)
CS*N		0.0221 (1.013)	0.0149 (0.669)			0.0283 (0.726)	0.0357 (0.929)
Control variable							
IMR					-0.0367** (-2.073)	-0.0025 (-0.151)	0.0294 (0.512)
Assets-liability ratio			0.0303 (0.653)	5.8509*** (2.847)			0.0307 (0.412)
Property rights			-0.0150* (-1.933)	-0.3137* (-1.860)			-0.0121 (-0.777)
External auditor			-0.0024 (-0.369)	-0.0978 (-0.679)			-0.0044 (-0.363)
Director board			0.0027	0.5118			-0.0188

size			(0.117)	(1.069)			(−0.409)
Proportion of independent director			0.0108	0.3940			0.0634
			(0.453)	(0.754)			(1.277)
Institutional shareholding ratio			0.0105	−1.9362***			0.0147
			(0.746)	(−7.310)			(0.184)
Ownership concentration			0.0429***	0.6751*			0.1306***
			(2.677)	(1.895)			(3.796)
Major shareholder control absolutely			−0.0073	−0.2486			−0.0190
			(−1.029)	(−1.562)			(−1.263)
Constant	0.0141***	−0.0426***	−0.0617***	0.0530	−0.0856***	−0.0618***	−0.1412***
	(3.911)	(−4.043)	(−3.756)	(0.154)	(−4.402)	(−3.382)	(−2.772)
Observations	441	441	441	441	219	219	219
R-squared	0.096	0.393	0.410		0.314	0.470	0.530

Note: *t*-statistics in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4.3 Regression Test Results and Analysis

4.3.1 Ordinary OLS Regression

Model (1) shows that without considering the control variables, the characteristics of *Identity Background* and *Organization Size* have a significant positive impact on irregularities at the 1% level, it does not pass the hypothesis H4, but the H2a of the competing hypothesis was confirmed. The *Structural Characteristics* had a positive but insignificant effect, and the H3 was not passed. The *Internal Heterogeneity* had an insignificant negative effect, which verified the H1b of the competing hypothesis.

Model (2) adds the company scale and the variables generated by the interaction terms between company scale and various characteristics of the board of supervisors on the basis of (1), the null hypothesis H5 *Company Scale is negatively correlated with irregularities* does not hold. The company scale changes the direction of the influence of *Structural Characteristics*, *Identity Background* and *Organizational Size* on irregularities, supporting the null hypothesis H2b, H3 and H4, indicating that the company scale does have an important impact on the governance and performance of the supervisory board.

Model (3) added 8 control variables based on model (2), the result is that the effect of each variable did not change basically. Among the control variables, the property rights has a significant negative impact on irregularities at the 10% level, and the ownership concentration has a significant positive impact at the 1% level, indicating that state-owned enterprises have a certain inhibitory effect on the occurrence of irregularities. The top three shareholders within a company concentrating shareholding does not mean a reduction in the probability of irregularities.

4.3.2 Heckman Two-Stage Model Test Results

Models (4) and (5) are regression results using Heckman's two-step method. The company scale and the four potential characteristics of the board of supervisors are used as explanatory variables for regression, and it is found that IMR is significantly negatively correlated with the number of irregularities at the 5% confidence level, which verifies the hypothesis of sample selection bias in the original model. However, all the potential characteristics have no significant impact on irregularities at this time, the company scale and the number of irregularities are significantly positively correlated at the 1% level.

Model (6) substitutes the interaction terms between the company scale and the characteristics of the supervisory board into the second step for regression. The impact of IMR on the number of irregularities is negative, but not significant. *Structural Characteristics*, *Identity Background* and *Organizational Size* all have a significant negative impact on the number of irregularities, and the interaction terms between the three characteristics and company scale have a significant positive impact on the number of irregularities, indicating that *Company Scale* as a variable has a moderating effect, its existence directly verifies the significance of IMR, and indirectly affects the influence efficiency of the potential characteristics of the supervisory board. The influence sign of the interaction item is opposite to the influence sign of the characteristic item of the board of supervisors, indicating that the expansion of the company scale increases the negative correlation of the board of supervisors on the number of irregularities, it means that company scale enhances the exercise of the supervisory power and function of the supervisory board. In other words, larger companies have a higher level of management, their internal management and financial control mechanisms are more complete, which also affects the company's internal governance structure, including the organizational size and structure of the board of supervisors, which can directly hinder the occurrence of irregularities to a certain extent.

Model (7) is also based on model (5) with 8 control variables added. The result is that the effect of each variable does not change much, and the ownership concentration has a significant positive impact at the 1% level.

4.3.3 Analysis Results of the Main Characteristic Variables of the Board of Supervisors

Regardless of the ordinary OLS regression or the Heckman two-stage model test, after adding the interaction terms between the company scale and the characteristics of the supervisory board, the three potential characteristics of the *Structural Characteristics*, *Identity Background* and *Organizational Size* all have significant influence on irregularities, however, in the case of not adding interaction items, it does not show a negative effect, indicating that the expansion of the company scale has strengthened the supervisory board's inhibitory effect on irregularities. The impact of company scale and the interaction terms themselves on violations are positive and significant at the 5% or 1% level, except for the interaction term of company scale and *Internal Heterogeneity*, this explains that the company scale is significantly positively correlated with irregularities, and larger companies do not represent a reduction in violations, nor less

regulation. But the *Company Scale* plays a very important role in internal governance, and there is a mutual influence each other. For example, the supervisory board strives to perform its supervisory function efficiently, which can bring economic benefits to the company and its stakeholders, or it may positively affect the overall supervision efficiency of the company, and that might indirectly benefit the improvement of the company's asset quality and the expansion of the company's scale.

The *Internal Heterogeneity* of the board of supervisors includes factors in differences, such as age, education, major and salary background, those can directly show the level of vertical differences among members of the board of supervisors, the larger the value, the higher the degree of heterogeneity, and the easier it is to form a dominant ranking. There are also some individual characteristics that are not easy to measure, such as employment background factors, if we simply measure the proportion of people with executive, government or college backgrounds in the team, it is difficult to express the level of gaps in the background factors in the team, as well as the hierarchy or order caused by the gaps. Through model verification, the impact of *Internal Heterogeneity* on irregularities is not significant, even after the company scale and interaction terms are increased, there is still no more impact, indicating that the company scale factor has a weak and indirect impact on individual differences within the board of supervisors. To explain from a theoretical level, it may be that neither tournament theory nor social comparison theory can be fully applied to non-decision-making supervisory teams. The gap between internal personnel does not play a motivating role, on the contrary, it will lead to team disharmony and reduced work performance, it may also be that the composition of the board of supervisors is relatively simple and rigid, e.g. the chairman of the board of supervisors and employee supervisors are basically created or appointed by internal personnel, and are not easily affected by external factors such as company scale.

5 Robustness Test

Given that the above samples are based on company scale and comprehensive performance, assuming that companies with larger assets, higher quality, and better performance have stronger management capabilities and can restrain the occurrence of irregularities, on the contrary, ST companies with poor performance have more violations. In order to ensure the robustness of the research, this paper selects a new set of data samples for calculation. Hu, et al.^[67] pointed out in their research that rough classification of industries can distinguish factors that are difficult to control in the model, such as the degree of industry competition, technological opportunities, resource advantages, and demanding feature. According to the *Guidelines for Industry Classification of Listed Companies* (Revised in 2012), with operating income and other financial data as the main classification standards and basis, it is divided into 19 categories. Among them, 125 companies were included in the financial category, but the number of irregularities in the past five years accounted for 64.38% of the total number of irregularities. The manufacturing category includes the largest number of companies (2815), with the number of irregularities 1910 times. Followed by information category, there are currently 354 companies with 269 irregularities. It can be seen that the ratio of manufacturing category and information category is about 8:1 in the number of companies, and the ratio of

the number of irregularities is about 7:1.

Based on the industry distribution of the above companies and the overall irregularities within five years, the paper intends to select 400 companies as samples, of which it is expected to select about 350 manufacturing companies and about 50 information companies. After determining the number of industry samples, within the above manufacturing and information categories, randomly select companies with similar assets as samples¹, exclude companies already included in the scope of CSI 300 companies and ST companies², after that exclude companies with missing information, finally, 408 samples were selected (including 325 manufacturing enterprises and 83 information enterprises). Subsequently, the supervisory board information and basic operating data were collected one by one.

In the same way, the ordinary OLS regression and the Heckman two-stage model are tested according to the above methods in this article. The sample at this time no longer highlights the importance of the *company scale* factor, nor does it need to consider the influence of the interaction term between the company scale and the characteristics of the supervisory board. From the regression results in Table 6, it can be seen that the ordinary OLS regression did not test the significant influence of the potential characteristics of the supervisory board on irregularities. Using the Heckman two-step test, model (5) found that IMR was significantly negatively correlated with the number of violations at the 10% confidence level, validating the hypothesis that the model had sample selection bias, at this time, the *Structural characteristics* has a significant positive correlation with the number of irregularities at the 5% level, and the other three characteristics have no significant impact on irregularities. After adding more variables to models (6) and (7), almost all of them have no significant effect on the dependent variable.

Different from the original sample group, the sample selected for the robustness test is 408 companies with similar total assets. Under the premise of meeting industry restrictions, the gap in the asset scale is not highlighted, but the company scale factor still has a positive and significant impact on irregularities in Ordinary OLS regression results. The Heckman two-stage model is used to further test the influence of the interaction term between the company scale and the characteristics of the supervisory board, and it is found that the effect on the irregularities is not significant. After changing the sample group, the direction and extent of the influence of the characteristics of the board of supervisors on irregularities are different from the original conclusions, and the conclusions of this paper are not robust. It explains that the original theory hypothesis can be verified only if to be placed under the conditional background

¹The processing method of company scale is as follows: First, calculate 2815 manufacturing companies in the five years from 2015 to 2019, and take the average value of the total assets of each company, the maximum value is 691.579 billion yuan, the minimum value is 55 million yuan, and the average value is 7.617 billion yuan, therefore, the sample was selected from companies with assets between RMB 5 billion and RMB 10 billion (397 in total). For the 354 information companies, among the five-year averages of the total assets of each company, the maximum value is 582.167 billion yuan, the minimum value is 143 million yuan, and the average value is 5.082 billion yuan, the sample was selected from companies with assets ranging from RMB 2.5 billion to RMB 7.5 billion (101 in total).

²According to the above-mentioned processing method of company scale, excluding companies already included in CSI 300 companies and ST companies, there are 336 manufacturing companies and 84 information companies that meet the establishment conditions.

of the ‘scale of the company assets becomes an important factor’.

Table 6 Robustness test analysis results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable	OLS Number of violations	OLS Number of violations	OLS Number of violations	Heck1 Whether or not	Heck2 Number of violations	Heck2 Number of violations	Heck2 Number of violations
Independent variable							
Structural characteristics (J)	0.0067 (1.582)	−0.0156 (−1.476)	−0.0114 (−1.062)	−0.0424 (−0.592)	0.0168** (2.058)	−0.0312 (−1.279)	−0.0295 (−0.760)
Identity	0.0006 (0.130)	−0.0003 (−0.025)	−0.0012 (−0.110)	−0.0900 (−1.204)	0.0143 (1.393)	0.0295 (1.052)	−0.0077 (−0.090)
Background (S)	−0.0046 (−1.107)	0.0172 (1.405)	0.0168 (1.367)	−0.0044 (−0.066)	−0.0113 (−1.244)	0.0243 (0.986)	0.0190 (0.758)
Organizational Size (Z)	−0.0016 (−0.335)	0.0023 (0.214)	0.0042 (0.380)	0.0426 (0.570)	−0.0071 (−0.732)	−0.0096 (−0.390)	0.0051 (0.120)
Heterogeneity (N)		0.0566*** (3.172)	0.0539*** (2.889)	0.8849*** (2.978)		0.0655 (1.000)	0.3126 (0.469)
Company scale (CS)		0.0383** (2.100)	0.0312* (1.685)			0.0771** (2.009)	0.0530 (1.314)
CS*J		0.0013 (0.070)	0.0052 (0.274)			−0.0399 (−0.901)	−0.0169 (−0.331)
CS*S		−0.0399** (−2.047)	−0.0409** (−2.097)			−0.0626 (−1.625)	−0.0571 (−1.458)
CS*Z		−0.0073 (−0.389)	−0.0090 (−0.477)			0.0150 (0.375)	0.0102 (0.250)
CS*N							
Control variable							
IMR					−0.1053* (−1.862)	−0.0270 (−0.275)	0.4294 (0.366)
Assets-liability ratio			0.0348 (1.460)	−0.0362 (−0.096)			0.0752 (1.350)
Property rights			−0.0079 (−0.794)	−0.1513 (−0.963)			−0.0449 (−0.382)
External auditor			−0.0017 (−0.201)	−0.0175 (−0.127)			−0.0083 (−0.397)
Director board size			0.0206 (0.334)	0.0049 (0.005)			0.0077 (0.056)
Proportion of			0.0799	0.1824			0.2371

independent director			(1.173)	(0.169)			(1.182)
Institutional shareholding ratio			-0.0364*	-0.1334			-0.1236
Ownership concentration			(-1.803)	(-0.417)			(-1.164)
Major shareholder control absolutely			-0.0017	-0.9297			-0.1699
			(-0.042)	(-1.391)			(-0.228)
			0.0044	0.1683			0.0457
			(0.452)	(1.084)			(0.345)
Constant	0.0273***	-0.0026	-0.0487*	-0.4793	0.1501***	0.0470	-0.5601
	(6.777)	(-0.251)	(-1.671)	(-1.036)	(3.086)	(0.407)	(-0.429)
Observations	408	408	408	408	186	186	186
R-squared	0.008	0.047	0.070		0.047	0.082	0.128

Note: *t*-statistics in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

6 Conclusions and Recommendations

6.1 Research Conclusions

From the perspective of the heterogeneity theory, this paper analyzes and examines the influence of the internal heterogeneity factors and potential characteristics of the supervisory board on the corporate irregularities, and the influence and moderating effect of the *Company Scale* as an important variable both on the characteristics of the supervisory board and irregularities. The research results show that:

1) The three potential characteristics of the supervisory board, *Organizational Size*, *Identity Background* and *Structural Characteristics*, all play a significant inhibitory role on irregularities, while the *Internal heterogeneity* characteristic has no significant effect.

2) The *Company Scale* does have an important impact on corporate violations and the governance of the board of supervisors, especially in the sample group composed of CSI 300 and ST companies with extremely different asset quality and scale. Not only the expansion of the asset scale can enhance the negative correlation and degree of the supervisory board on the number of irregularities, but also the interaction terms with the characteristics of the supervisory board have a significant impact on the irregularities.

3) After selecting a sample group of a specific industry and similar asset size for testing, the conclusion is not robust, it shows that when the sample is limited to a certain interval according to the pre-set conditions, the heterogeneity of the supervisory board and other variables are often ineffective.

4) By using the Heckman two-step model, it is verified that IMR is significantly negatively correlated with the number of irregularities at the 5% confidence level, and then the problem of sample selection bias is corrected.

The theoretical contributions in brief of this paper are: Deepening the research on the heterogeneity factors and potential relationships of supervisory boards. Enriched the multifaceted research on the influence of the company asset scale. It is verified that there is a problem of sample selection bias while violation behavior is used as a surrogate variable of supervision performance.

6.2 Related Recommendations

Firstly, pay attention to the scientific and rational allocation of the team of the Supervisory Committee. Xiong, et al.^[68] pointed out that the primary problem with the current supervisory board system in China is that the society, the company and shareholders have low actual requirements for the work of the supervisory board, it only examines whether the board of supervisors has completed the supervision work, without considering the quality of the members of the board of supervisors. However, with the rapid development of the market economy and the gradual improvement of corporate governance, especially for companies with large assets and good operating conditions, the overall characteristics of the board of supervisors have a very significant positive effect on monitoring performance, while the heterogeneity of board members is the determinant of team governance performance. Therefore, pay attention to the micro-composition of the internal governance structure, fully consider factors such as the frequency of personnel replacement, the ratio of men and women, average educational background, and the proportion of external supervisors, and adjust and appropriately optimize the overall characteristics of the supervisory board through internal incentive control and coordination, which can strengthen the level of corporate governance, improve the long-term business performance, and reduce the occurrence of irregularities.

Secondly, objectively analyze the role of ‘information and decision-making theory’ on non-decision-making teams, and appropriately weaken individual differences within the board of supervisors. Information decision theory^[32] believes that decision-making is based on information, so individual differences in teams should be paid more attention, the heterogeneity is special conducive to obtaining different information, and individuals can also play complementary advantages and share resources in teams. However, the main responsibility of the supervisory board is to supervise, it often does not have the expertise in business decision-making, moreover, the board of supervisors abides by the ‘collective decision-making’ mechanism and needs to form a unified conclusion on opinions, so that excessive individual differences may lead to team instability, communication barriers and even conflict. The empirical analysis of this paper finds that the longitudinal differences of members in age, major, education, salary, occupational background and other factors have a very limited impact on supervisory performance, which shows that the application of information and decision-making theory in the governance of supervisory board has its limitations.

Finally, comprehensively consider the interaction between factors such as company asset scale and the performance of the supervisory board. The company scale is significantly positively correlated with irregularities, which may confirm the value judgment of ‘building a big tree and attracting wind’. When the company scale is used as a moderating variable, it will affect the supervisory performance, with the expansion of the asset size, the inhibitory effect of the supervisory board on irregularities can be enhanced. Therefore, when a company develops rapidly, its total assets grow, and its debt ratio rises, it will also face an increase in the risk of violations and an increase in external supervision, at this time it is possible to appropriately increase the size of the board, increase the number of external supervisors, pay more attention to factors such as the average age, average education, and the proportion of party members, comprehensively improve the stability, independence and professional ability of the supervisory

board, thereby strengthening the internal supervision of enterprises, reducing the chance of a breach. When the enterprise is in the initial stage or the lower asset level, the balance between business performance and internal supervision can be considered more, and the internal management of the supervisory board can be strengthened, e.g. ensure that the basic legal constraints can be realized, such as senior management personnel cannot concurrently serve as supervisors, the economic interests of supervisors should not be related to the financial status, employee supervisors are given full understanding of production and operation activities, so as to avoid excessive internal consumption affecting the company development and business operation.

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Attached table: Spearman correlation analysis of main variables

	Whether or not	Number of	Company scale	Assets-liability ratio	Property rights	External auditor	Director board size	Proportion of independent director	Institutional shareholding ratio	Ownership concentration	Major shareholder control absolutely	Structural characteristics	Identity background	Organizational size	Internal heterogeneity
Whether or not	1														
Number of	.928**	1													
Company scale	-.270**	-.208**	1												
Assets-liability ratio	.271**	.353**	.315**	1											
Property rights	-.172**	-.226**	.337**	.068	1										
External auditor	-.094*	-.072	.316**	.088	.163**	1									
Director board size	-.023	.028	.432**	.226**	.216**	.159**	1								
Proportion of independent director	-.046	-.036	.098*	-.053	.017	.008	-.425**	1							
Institutional shareholding ratio	-.462**	-.444**	.695**	-.111*	.360**	.238**	.251**	.171**	1						
Ownership concentration	.168**	.157**	-.318**	.021	.084	-.078	-.226**	.007	-.220**	1					
Major shareholder control absolutely	-.157**	-.217**	.065	-.089	.269**	.083	-.068	.045	.190**	.406**	1				
Structural characteristics	-.072	-.032	.366**	.144**	.423**	.137**	.307**	-.025	.287**	.023	.088	1			
Identity background	.027	0.041	.400**	.228**	.363**	.127**	.292**	.038	.276**	-.100*	.052	.294**	1		
Organizational size	.107*	.163**	.298**	.261**	.272**	.113*	.372**	-.053	.124**	-.068	-.032	.192**	.253**	1	
Internal heterogeneity	-.086	-.082	.443**	.121*	.345**	.148**	.307**	.021	.374**	-.164**	.053	.243**	.449**	.348**	1

Note: ** means significant correlation at 0.01 level, * means significant correlation at 0.05 level.