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Governance Structure and Substantive Innovation in Southern China's Manufacturing Enterprises: An Empirical Investigation

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Abstract

From the perspective of manufacturing enterprises' sustainable development, this study investigates the relationship between corporate governance structure and substantive innovation behavior. By combining theoretical research and empirical research methods, the research selected data information from manufacturing enterprises in southern China from 2016 to 2020 to conduct regression analysis to investigate the impact of key factors in the internal governance structure of manufacturing enterprises on their substantive innovation behavior. The results show that in the development of manufacturing enterprises, substantive innovation behaviors such as product innovation and service innovation are influenced by the equity structure, board structure, and management structure of the enterprise. The concentration of equity structure and innovation behavior exhibit an inverted U-shaped relationship. The larger the board size, the worse the innovation behavior, huge stakeholders and excessive distribution of interests will lead to shareholders' concession logic, thus restricting the sustainable development of enterprises.

Keywords

Sustainable Development, Manufacturing Enterprises, Governance Structure, Innovative Behavior, Regression Analysis

1. Introduction

As an important pillar of China's industry and economy, the manufacturing industry has become a complex and diverse system covering a wide range of fields. According to the 2023 China Undergraduate Employment Report (Employment

blue-book, 2023) released by Mycos, a Chinese higher education management data company, the employment rate of manufacturing undergraduate graduates has reached 22.2% in 2022. Over the past decade, the number of employees in China's listed manufacturing companies has increased from 8.91 million to 15.67 million, reflecting that the overall size and attractiveness of the manufacturing sector is still a significant proportion. At the same time, despite the impact of global economic fluctuations, development investment is still considerable from the perspective of China's manufacturing industry, which usually has a relatively high investment intensity (Geng et al., 2022). According to statistics, shown in **Figure 1**, published by Textor (2023), China's R&D investment in the manufacturing sector has exceeded 184 billion yuan (about 25 billion US dollars). According to the data released by the 2023 CCID Forum (SaiDiZhiKu, 2024) hosted by the China Electronics Information Industry Development Research Institute (CCID), the manufacturing innovation index (referring to innovation resources, output, synergy and environment) shows a steady growth trend, of which the index in 2020 has more than doubled compared with 2012 as shown in **Figure 2**, and the growth rate has also increased significantly compared with the era dominated by traditional manufacturing ten years ago.

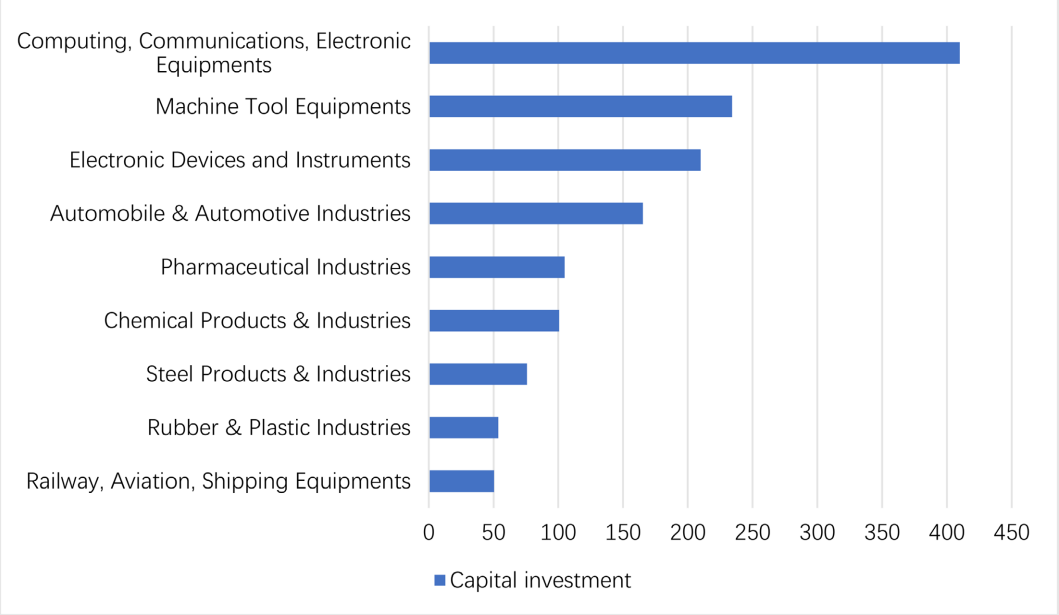

Figure 1. Distribution of Major R&D Funds Invested in Manufacturing Industry in China source.

However, due to the fact that the manufacturing industry involves multiple fields and a wide range of distribution areas, as well as the huge differences in the size of companies and the quality of operations, this has led to uneven development in various areas of the manufacturing industry. Problems such as outdated management systems, lack of breakthrough capabilities and value creation (Jalilian & Mirghafoori, 2020), and large scale but weak actual capabilities can hinder the development of the industry. This has also led to the polarization

of China's manufacturing industry after experiencing the rapid development of the world factory stage. On the one hand, the high-tech industry has made significant progress through continuous R&D investment and substantial innovation.

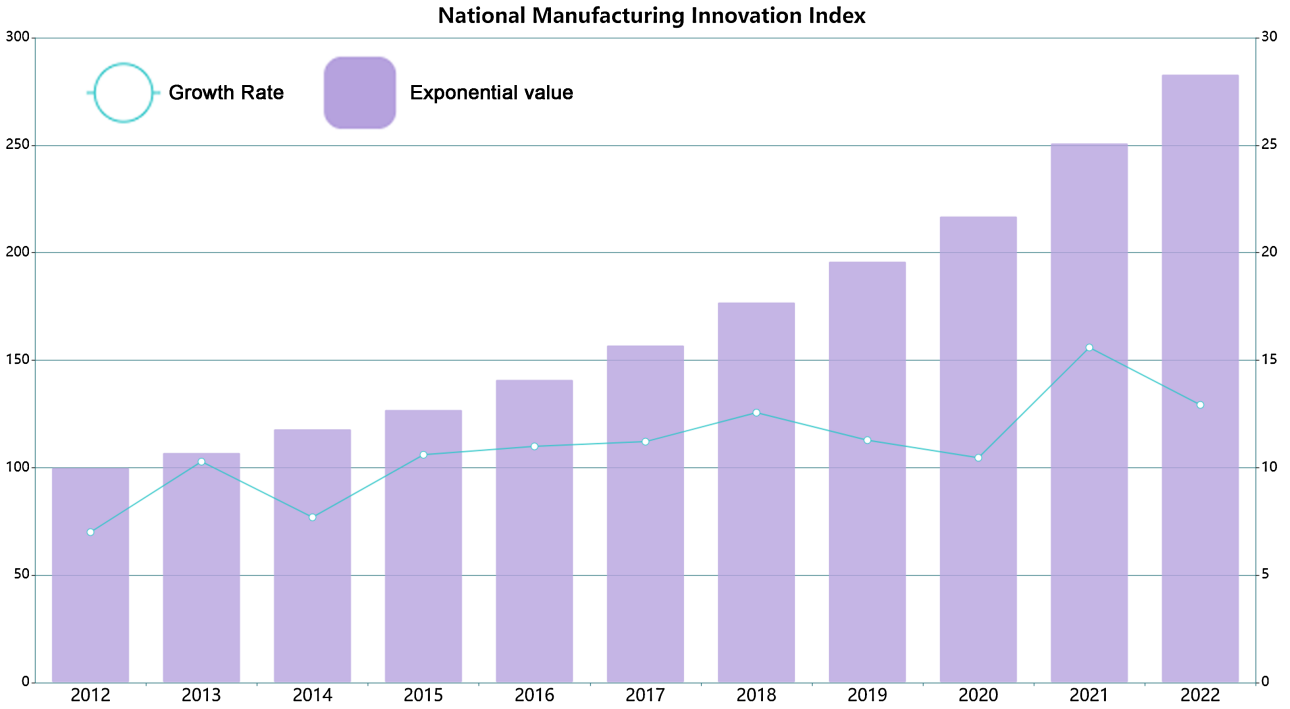

Figure 2. National manufacturing innovation index.

On the other hand, the traditional manufacturing industry in South China, for example, is facing bankruptcy due to rising labor costs, intensified external competition, and insufficient innovation capabilities. According to the statistics of the National Enterprise Bankruptcy Information Disclosure Platform of the Supreme People's Court of China, the number of enterprise bankruptcies has increased geometrically in recent years (see **Figure 3**), and various industries are facing severe challenges. According to the definition of bankruptcy, economic activity goes bankrupt when the efficiency of investment is lower than that is common for similar investments, suggesting that while many well-known firms in China's industrial sector are experiencing rapid growth, others are facing multiple challenges such as institutional reform, product innovation, and strategic transformation. These factors undoubtedly pose a huge obstacle to corporate decision-making and the determination of sustainable development pathways. As a result, in recent years, China's manufacturing industry has shown a significant trend of high investment ratio, while the growth rate and bankruptcy rate have also increased simultaneously. Therefore, this study aims to explore the relationship between corporate governance structure and substantive innovation in this context, and to analyze the factors influencing the sustainable development of the industry.

2. Purposes and Implications of Study

With the continuous improvement of China's innovative industrial environment, institutional environment and policy environment, the crux of the low level of substantive innovation of Chinese enterprises mainly exists within the enterprises, such as the modern enterprise system has not yet been fully established, the corporate governance structure is not sound, the state-owned shares are dominant, and the internal control is serious, which directly affects the development of enterprise technological innovation. Based on the specific national conditions, this paper puts forward countermeasures to solve the problems of corporate governance and substantive innovation of Chinese enterprises, so as to change the current situation of insufficient substantive innovation of Chinese enterprises, so the research results of this paper can provide realistic guidance for the optimization of corporate governance structure and substantive innovation decision-making of more companies. In order to deeply analyze the intrinsic relationship between corporate governance structure and substantive innovation elements, this study aims to comprehensively expand on the basis of existing theories. Specifically, this paper not only systematically divides the key elements of corporate governance and substantive innovation, but also discusses in detail the role path of each element of corporate governance on substantive innovation elements, and then constructs a comprehensive impact model. Previous studies have tended to focus on a specific aspect of corporate governance structure, such as the impact of equity incentives or board structure on substantive corporate innovation, or to explore the overall relationship between the two in general through regression analysis. However, these research pathways are insufficient in revealing the underlying mechanism of the impact of corporate governance structure on substantive innovation. This paper aims to fill this theoretical gap, and through a detailed analytical framework, it deeply explores the essential relationship between

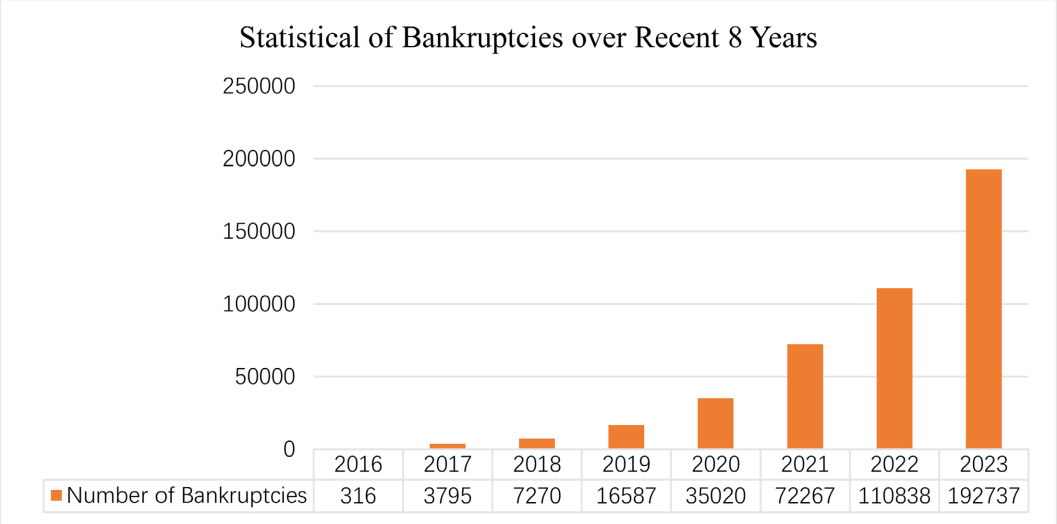

Figure 3. Statistics on the number of corporate bankruptcies.

corporate governance structure and substantive innovation, so as to enrich and expand the theoretical boundaries and connotations of corporate governance and substantive innovation. In the current critical period of China's economic transformation, optimizing the corporate governance structure and enhancing the substantive innovation ability of enterprises have become the two core challenges faced by enterprises. From a new perspective of corporate governance, this study aims to identify and strengthen the key factors that drive substantive innovation of enterprises, which has far-reaching practical value for improving business performance and building the core competitiveness of enterprises. In the face of the urgent needs of the knowledge-based economy, Chinese enterprises urgently need to find a feasible way to promote substantive innovation by optimizing their corporate governance structure. This study not only responds to this practical demand, but also provides an important reference and enlightenment for the practical application of corporate governance and substantive innovation theory, and further promotes the improvement and development of related theories at the practical level.

3. Literature Review

Corporate governance and technological innovation, as core elements of business operations, are attracting widespread attention from academia due to their close connection. Current research mostly focuses on corporate governance structures, particularly equity structures, board of directors and supervisory board compositions, as well as how managerial decision-making capabilities impact technological innovation activities.

3.1. Equity Structure and Corporate Technological Innovation

Equity structure encompasses both equity concentration and ownership attributes, and academia primarily explores the relationship between equity structure and technological innovation from these two aspects.

1) Equity Concentration

Regarding the relationship between equity concentration and technological innovation, academia holds diverse opinions. Mainstream research tends to believe that higher equity concentration positively promotes technological innovation investment, as major shareholders are more inclined to drive long-term value growth through technological innovation (Hill & Snell, 1988). Bushey (1998) also point out that moderate equity concentration contributes to increased financial support for technological innovation. However, another viewpoint is that there may be a "U-shaped" relationship between equity concentration and technological innovation investment, where both excessively high and low concentrations are detrimental to innovation, and moderate concentration is crucial. This view underscores the importance of the monitoring effect of major shareholders and takeover market efficiency in balancing managerial behavior and reducing agency costs (Shleifer & Vishny, 1986; Peggy & O'Neill Hugh, 2003).

2) Ownership Attributes

The attribute of ownership, i.e., the identity characteristics of controlling shareholders, also profoundly influences corporate technological innovation strategies. Most studies indicate that privately controlled enterprises are more proactive in technological innovation compared to state-controlled ones. This is primarily attributed to the potential ambiguity of ownership and insufficient investment in technological innovation under state control (Becker-Blease, 2011). In China's unique institutional context, the prevalence of "dominant shareholding" in state-owned enterprises (SOEs) leads to severe insider control issues and a lack of sufficient incentives to promote technological innovation (Minetti et al., 2015; Zahra et al., 2000). Therefore, optimizing ownership structures and strengthening ownership incentives are seen as key avenues to enhance SOEs' technological innovation capabilities.

3) Empirical Research Support

A series of empirical studies further corroborate the above viewpoints. For instance, Asensio-López et al., (2019) found through WLS analysis that the innovation investment of state-controlled companies is significantly lower than that of privately controlled companies. Kitschelt (1991) research indicates that while SOEs can more easily access government resource support, their performance in technological innovation remains less agile and efficient than that of private enterprises. These studies not only reveal differences in corporate technological innovation behaviors under different ownership structures but also provide empirical evidence for optimizing corporate governance structures and promoting technological innovation.

3.2. Board of Directors Structure and Substantive Innovation of the Enterprise

The composition and operating mechanism of the board of directors, as the core body of the company's decision-making and supervision, play a decisive role in the implementation of substantive innovation strategies. To explore which board structure is most conducive to substantive innovation, we can analyze in depth from three dimensions: board size, board composition and leadership setup.

1) Size of the Board of Directors.

Board size, referring to the number of board members, is a crucial factor influencing the efficiency and effectiveness of technological innovation decisions. On the one hand, a larger board size can bring together a more diverse range of professional insights and management experience, providing a wealth of perspectives and challenging opinions for technological innovation strategies, thereby reducing decision-making uncertainty. However, on the other hand, an expanded size also comes with increased communication costs and the phenomenon of "free-riding," which may weaken decision-making efficiency. Therefore, balancing size and efficiency becomes essential. Jensen (1993) pointed out that when the number of board members exceeds a certain threshold, efficiency significantly declines,

making the board susceptible to managerial manipulation. Gonzales-Bustos & Hernández-Lara (2016) emphasized the communication efficiency advantages of smaller boards but acknowledged their potential knowledge limitations. Heubeck & Meckl (2024) and Feller et al., (2009) further supported an inverted U-shaped relationship between board size and corporate innovation, suggesting an optimal moderate size.

2) Board structure

The structure of the board of directors involves the classification of directors and the establishment of special committees. Depending on whether they are employees of the company, directors can be divided into internal directors and outside directors, with independent directors being particularly important because their independence and objectivity help to supervise managers and protect the interests of shareholders. However, a higher percentage of independent directors is not always better. With the increase in the number of independent directors, the knowledge and ability level of the board of directors can be significantly improved in the initial stage, but then the decision-making efficiency may be reduced due to overlapping knowledge and rising coordination costs. Filatotchev et al., (2020) noted that the proportion of independent directors was not significantly correlated with performance indicators, reflecting the influence of industry and firm-specific characteristics. Munari & Sobrero (2003) proposed that the number of external directors should be flexibly adjusted based on the specific circumstances of the enterprise to achieve optimal innovation decision-making outcomes.

In addition, various special committees under the Board of Directors, such as the Nomination Committee and the Strategy Committee, help to improve the professionalism and efficiency of decision-making, reduce the phenomenon of "free riding", and provide strong support for high-risk, high-investment substantive innovation projects.

3) The status of the chairman and the general manager

The degree of separation between the chairman and the general manager not only reflects the independence of the board of directors, but also affects the decision-making freedom of the management. In China, although it was common to hold two positions, this trend has gradually weakened in listed companies. There are differing views on the pros and cons of combining the two positions. Proponents believe that in a rapidly changing market environment, the integration of the two roles can respond more quickly to market changes, unify strategic direction, strengthen control, and improve innovation performance. Research by Clifton et al., (2010), Heidenreich & Koschatzky (2011), and Carmella supports this view, finding a positive correlation between duality and innovation performance. However, the trade-offs must be carefully weighed based on the actual situation of the enterprise to ensure that the governance structure can flexibly respond to the market while effectively supervising and controlling (Cannella & Lubatkin, 1998).

3.3. Executive Incentives and Substantive Innovation of Enterprises

Enterprise innovation decision-making is a comprehensive behavior in which entrepreneurs set goals, design and select activity plans for the innovation process, and then organize and implement them, aiming to maximize the benefits of substantive innovation of enterprises. In this process, the role of top management, as the core of corporate governance and the core driver of substantive innovation activities, is crucial (Tierney et al., 1999). They not only need to possess a strong desire for innovation, excellent innovation capabilities, and necessary decision-making power to ensure the scientific nature of decisions and the effective implementation of technological innovation; their management styles and leadership behaviors also profoundly influence the cultural tone of the enterprise, stimulate employees' innovative consciousness, and promote the actual occurrence of innovative behaviors.

Specifically, transformational leadership behavior is one of the traits that top managers should exhibit. By cultivating employees' sense of responsibility and trust, as well as shaping a positive and innovative culture, they lay a solid foundation for the long-term development of the enterprise (Lacetera, 2001). Frischer's (1993) research further emphasizes the importance of innovative leaders in decentralizing power and fostering an innovative atmosphere within the enterprise, which can stimulate the innovative potential of technical personnel. Additionally, the positive expectations of managers have also been proven to have a significant positive incentive effect on the innovative behaviors of technical personnel (Scott & Bruce, 1994).

3.4. The Impact of Other Factors on the Substantive Innovation of Enterprises

1) The double-edged sword effect of the control market

In mature capital markets, the control market is seen as an effective tool to improve the efficiency of companies, and has a profound impact on the choice of internal control and innovation strategies. In countries such as the United States and the United Kingdom, this mechanism is particularly significant, forcing managers to focus on long-term value creation and enhance the motivation for innovation through the takeover pressure of survival of the fittest. However, this mechanism can also have negative consequences. However, this mechanism can also bring negative consequences. Koschatzky & Kroll (2007) pointed out that the threat of takeover may lead managers to cut technological innovation investments to avoid short-term performance declines, as high investments and risks in technological innovation are often accompanied by unstable short-term financial performance.

2) The Alignment of Governance Models and Innovation Paths

Corporate governance models, as comprehensive frameworks for addressing corporate governance issues, exhibit diversity due to differences in economic, social, legal, and other environments across countries. The external governance model,

exemplified by the Anglo-American model, emphasizes market supervision and incentives, tending towards disruptive innovation. In contrast, the internal governance model, such as the Japanese model, values internal governance structures and long-term growth, making it more suitable for incremental innovation. Each governance model has its applicable scenarios, with the key lying in its alignment with specific corporate contexts and innovation needs. Research on high-tech enterprises has shown that external financing advantages may promote technological innovation in certain contexts (Yoshikawa et al., 2007).

3) Controversy Over the Role of Institutional Investors

Since the 1990s, institutional investors have gradually become an important force in the capital market, with an investment preference for companies with long-term growth potential. Institutional investors not only focus on a company's current performance but also prioritize its future prospects, thus having an incentive to participate in corporate governance and promote innovation. However, there is controversy surrounding the impact of institutional investors on enterprise technological innovation. On the one hand, as long-term investors, institutional investors may promote innovation by influencing corporate governance (Jensen, 1988). On the other hand, if perceived as short-sighted, they may inhibit investment in innovation (Arnold et al., 2003). This divergence may stem from differences in research samples, the evolving role of institutional investors, and market environments. Currently, systematic research on the relationship between institutional investors and technological innovation remains insufficient, leading to inconsistent conclusions.

3.5. Research Review

As the two core issues of enterprise development, the relationship between substantive innovation and corporate governance has always been a hot topic in academic research. The existing research not only provides rich theoretical support for enterprises to explore the path of substantive innovation and improve their innovation ability, but also reveals the diversity of influencing factors of substantive innovation, including internal and external aspects. At present, the research focuses on external factors, and explores the impact of macro variables such as national policies and industry characteristics on substantive innovation through quantitative analysis. These studies examine the role of national culture, economic openness, foreign investment, R&D manpower, and patent protection in promoting substantive innovation from the perspective of macro environment. At the same time, the relationship between tax policy, market size, industrial demand and substantive innovation is also discussed from the industry level.

However, in the research on the impact of various dimensions of corporate governance mechanism on substantive innovation, the conclusions are divided. This may be related to the limitation of the research perspective, that is, it focuses on the micro level of enterprises and ignores the interweaving of macro factors. In

fact, national policy orientation, industrial environment characteristics, and regional economic differences all have a profound impact on the substantive innovation of enterprises. In addition, the possible interactions, synergies or countervailing effects between different dimensions of corporate governance mechanisms also increase the complexity of the research results and reduce the accuracy of the single-dimensional analysis.

In view of this, this study adopts a combination of theoretical analysis and empirical verification, focusing on the specific field of manufacturing in South China, and deeply analyzes the key components of corporate governance (such as ownership structure, board allocation, and senior management team) on the key impact of corporate substantive innovation. This move not only aims to fill the existing theoretical gaps, improve the theoretical framework of governance structure and substantive innovation, but also provide targeted and operational strategic suggestions for the innovation practice of manufacturing enterprises, so as to help them achieve innovation-driven sustainable development.

4. Materials and Methodology

4.1. Research Hypotheses

4.1.1. Ownership Structure and Enterprise Innovation

As the fundamental institutional arrangement of an enterprise, ownership structure has a significant impact on the enterprise's innovation behavior and performance. On one hand, the existence of information asymmetry and transaction costs makes a dispersed ownership structure more prone to opportunism and moral hazard, leading to a lack of motivation for innovation among management. Especially when there are multiple major shareholders, excessive supervision can inhibit enterprise innovation. On the other hand, a concentrated ownership structure can reduce agency costs, enhance the ability to supervise management, and theoretically promote innovation. Lee and O'Neill (2003) analyzed the relationship between ownership concentration and R&D investment using data from enterprises in different industries in the United States and Japan. The results showed a significant positive correlation between ownership concentration and R&D investment in American enterprises, while the relationship was not significant in the sample of Japanese enterprises. Hosono et al. (2004) found a positive correlation between ownership concentration and R&D capability in large Japanese manufacturing enterprises, with higher ownership concentration leading to more prominent innovation performance. Sivak et al., (2011) studied enterprises in 19 developing countries and found that under imperfect investor protection mechanisms, high ownership concentration increases the intensity of enterprises' R&D investment. However, a concentrated structure can lead to tunneling behavior by major shareholders, resulting in more severe double agency problems, and ultimately reducing the enterprise's innovation efficiency. Due to differences in market environment and systems, the empirical data of Minetti et al., (2012) showed an inverted U-shaped relationship between ownership concentration and

enterprise technological innovation. While excessively concentrated ownership can reduce agency costs and improve innovation efficiency, it also increases the risks faced by shareholders, making them more likely to reject investment in innovation projects. Therefore, compared to excessively dispersed or overly concentrated ownership structures, a moderate level of ownership concentration is more conducive to technological innovation, especially in state-owned enterprises. As for whether ownership balance, as a constraint mechanism, can effectively alleviate agency conflicts among major shareholders and reduce the infringement of minority shareholders' interests, there is currently no consistent conclusion. From a control perspective, when there are controversies among major shareholders over innovation decisions or projects, ownership balance will inevitably hinder the implementation of enterprise innovation strategies to some extent, with its "supervision effect" outweighing the "alliance effect," thus being detrimental to enterprise innovation. Based on this, the following hypotheses are proposed:

H1: There exists a notable inverted U-shaped correlation between ownership concentration and substantive innovation behavior among manufacturing enterprises in southern China.

H2: Excessive expansion of the board of directors will have a negative impact on the substantive innovation behavior of enterprises.

4.1.2. Board Composition and Enterprise Innovation

As an important part of board composition, although the actual role of independent directors has been far from public expectations, theoretically, they should shoulder the dual responsibilities of supervising management behavior and providing professional guidance to reduce decision-making risks. Kuhlmann (2001) pointed out that especially in an uncertain environment, introducing independent directors closely related to the external business environment is more conducive to enterprises discovering new investment opportunities. The analysis of manufacturing data by Jia et al. (2019) showed that independent directors, due to their lack of direct interest relationships with the company, can effectively reduce decision-making errors caused by internal control and enhance the enterprise's technological innovation capability. It can be seen that if independent directors can truly "maintain the overall interests of the company" and "express independent opinions on major matters of listed companies," they can promote enterprise innovation. Regarding the impact of executive shareholding scale on enterprise technological innovation, when the scale of executive shareholding expands and the number of executives increases, the complexity of enterprise decision-making can easily lead to "free-rider" behavior. A small-scale board of directors, on the other hand, can respond quickly and efficiently to uncertainty, thereby promoting enterprise technological innovation. Unless the proportion of directors with professional technical and knowledge backgrounds is relatively high, the expansion of executive shareholding will only reduce innovation efficiency. In summary, the following hypotheses are proposed:

H3: An increase in the proportion of independent directors in manufacturing enterprises in southern China may promote substantive innovation behavior.

H4: An increase in the proportion of executive shareholding can significantly promote substantive innovation behavior, but this promotion may weaken or reverse after the proportion of executive shareholding reaches a certain level.

4.1.3. Management Incentives and Enterprise Innovation

An appropriate incentive mechanism is one of the important factors influencing enterprises' R&D activities. Therefore, how to stimulate the motivation for innovation through effective incentives is the core content of enterprise innovation. Cerna (2014) believes that in China's management compensation incentive system, equity incentives, annual salaries, and perks are three important components. Due to the intensification of anti-corruption efforts, which has reduced the level of perks for senior executives, this paper only considers the impact of equity incentives and annual salaries on enterprise innovation. Meijer (2015) believes that the long-term nature and benefit sharing of equity incentives can align the interest goals of management and shareholders. Hirshleifer et al. (2012) point out that since managerial incentives have a significant impact on enterprise innovation, companies will encourage investment in higher-risk projects and promote technological innovation by implementing equity incentives for management. From this perspective, equity incentives have a positive effect on the innovation efficiency of enterprises. Generally, the higher the annual salary of the management, the more willing they are to maximize the shareholder value of the enterprise. However, due to the cyclical and fixed nature of executive annual salaries, which conflicts with the long cycle, high risk, high investment, and uncertain returns of innovation activities, Balkin et al. (2000) found that the short-term compensation of CEOs is beneficial to enterprise innovation after analyzing the relationship between CEO compensation and innovation behavior in high-tech enterprises. The structure of the board of directors also directly affects the rights and interests and working methods of stakeholders. Among them, middle and senior managers have a significant impact on the future development of the company, and the industry environment will affect the strategic decisions of managers in innovation strategies. The impact of management practices on enterprise innovation is reflected in two aspects. First, the compensation structure of senior managers has a significant positive impact on enterprise innovation, showing a clear positive correlation. Specifically, when managers receive generous treatment, their management behaviors and attitudes are often more proactive, thereby creating an environment conducive to enhancing the innovation capability of the enterprise. Secondly, the shareholding ratio of senior managers also plays a key role. Some researchers argue that increasing the shareholding ratio of senior managers can effectively promote the implementation of enterprise innovation activities. Since managers may possess internal information about the company's future prospects, they have the motivation to adjust their investment portfolios based on their future performance predictions. On the contrary, other researchers warn

that an excessively high shareholding ratio of senior executives may have a negative impact on enterprise innovation activities, as it may lead to increased control by the management over the company, thereby triggering power struggles in the process of pursuing personal interests with shareholders. Therefore, there is also an inverted U-shaped relationship between the shareholding ratio of senior executives and enterprise innovation capability. Based on this, the following hypothesis is proposed in this paper:

H5: The compensation structure of managers plays an intermediary role under the influence of governance structure and shows an inverted U-shaped relationship with the substantive innovation behavior of enterprises.

4.2. Research Design

4.2.1. Sample Selection

For supplementing the related research and filling the vacancy with data and investigate in the enterprises' sustainability and innovation field, after completing the relevant research, this paper selects the data information of manufacturing enterprises in designated region of China, classifies and organizes them according to relevant standards, delve to explore the relationship within the goal of sustainable development between the governance structure of manufacturing enterprises and substantive innovation behavior through empirical research.

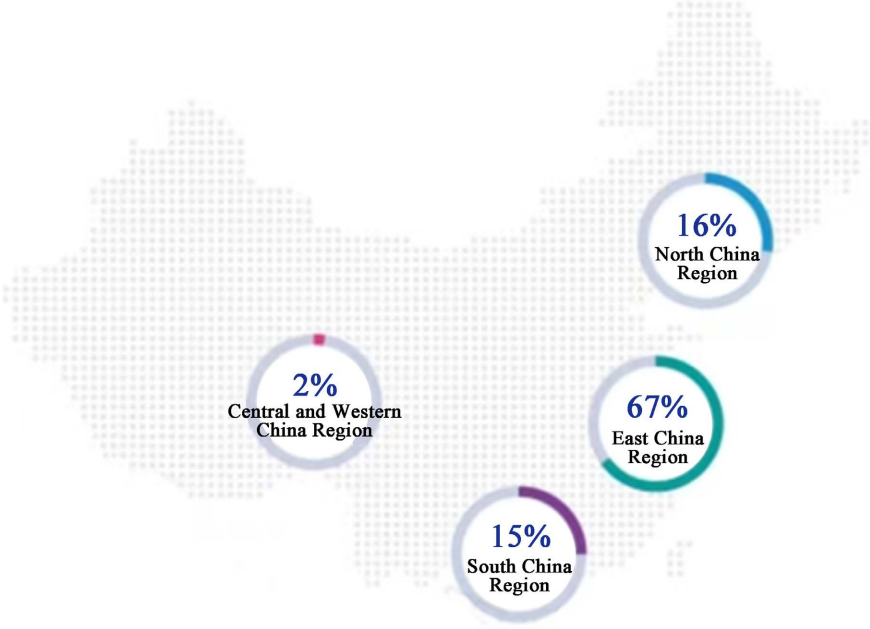

Figure 4. Distribution of manufacturing industry in China.

From the perspective of China, the distribution of the manufacturing industry is quite extensive, primarily concentrated in North China, East China, South China, as well as the Central and Western regions and mainly located in the Southeastern area of the country shown in Figure 4. This article selects and organizes data information pertaining to manufacturing enterprises in South China, spanning from 2016 to

2020. The data have selected from China National Bureau of Statistics; China National Intellectual Property Administration Repository; China Stock Market & Accounting Research Database and Wind database, thus underwent a comprehensive cleaning and screening process, involving the removal of enterprises for which data could not be obtained, elimination of samples with incomplete data, meanwhile inquire and correct of any identified errors or inconsistencies. The final sample size obtains comprised 235 companies and a total of 9400 pieces of data. Encompassing industries include processing manufacturing, high-tech manufacturing, spare parts manufacturing, physical therapy equipment and pharmaceuticals, etc.

4.2.2. Variable Definition

Recognizing that innovation ought to emphasize the output effect, this paper adopts the ratio of the company's annual research and development expenditure to its operating income as a metric for assessing substantive innovation within the enterprise. To elucidate the explanatory variables, we consider ownership concentration (Gaur et al., 2015), board size (Ganguli & Guha, 2021), executive shareholding ratio (Jentsch, 2019), independent director ratio (Shahrier et al., 2020), and equity balance degree (Ma & Gao, 2021). Meanwhile, enterprise size, employee labor productivity, profitability, and asset-liability ratio are taken as control variables in the analysis (Li et al., 2023) details shown in **Table 1**.

Table 1. Definition and explanation of variables.

Variable Type	Variable	Definition
Explained variable	Substantive innovation of enterprises	The company's annual research and development accounts for the proportion of operating income
Explanatory variable	Ownership concentration (OC)	The sum of squares of the shareholding ratios of the top five major shareholders
	Board size (BS)	Number of directors/total number of directors
	Senior management shareholding ratio (ES)	Proportion of shares held by senior management in the company
	Proportion of independent directors (IDR)	Number of Independent Directors/All Directors
	Equity balance degree (HS)	Sum of the shareholding ratios of the second to fifth largest
Control variable	Scale of enterprise (Size)	Natural logarithm of total assets
	Employee labor productivity (BP)	Product quantity/production time
	Profitability (ROA)	Net profit/average total assets
	Asset-liability ratio (LEV)	Total liabilities/total assets

5. Results

5.1. Descriptive Statistics

To gain insights into the fundamental characteristics of the data, detect outliers, and analyze variable discrepancies, drawing inspiration from the research conducted by Wang et al. (2023), the present study commenced with the application of descriptive statistical analysis, the descriptive statistics for the variables of interest are presented in Table 2. It is evident that the mean R&D investment as a proportion of operating income for the enterprises is relatively low, while the disparity between the maximum and minimum values is substantial. This suggests significant heterogeneity in R&D investment levels across different enterprises.

Table 2. Descriptive statistics of the variables.

	N	Mean value	max value	minimal value	Standard deviation	P25	P50	P75
II	1235	0.0529	0.582	0.00577	0.0428	0.031	0.043	0.063
Effective N	1235							

Subsequently, the descriptive statistics for the explanatory variables are detailed in Table 3. The data reveal a pronounced divergence between the maximum and minimum values of equity concentration within the sample, with some enterprises exhibiting a dominant single shareholding. This disparity may be attributed to the conflicting interests between major and minority shareholders. Regarding board composition, the mean number of directors is 2.108, a figure that aligns with conventional standards, while the average number of independent directors is 37.915, suggesting a board structure that is relatively balanced and well-considered. In terms of incentive mechanisms, the average equity holding ratio for senior executives stands at 9.501, with a minimum of 0 and a maximum of 67.96. This indicates that the overall equity participation of enterprise management in the sample is rather modest, and some companies have yet to implement an equity incentive

Table 3. Explain descriptive statistics of variables.

	N	Mean value	Max value	Minimal value	Standard deviation	P25	P50	P75
OC	1235	0.0529	0.582	0.000577	0.0428	0.055	0.09	0.159
BS	1235	2.108	0.521	0.0138	0.0869	1.946	2.197	2.197
IDR	1235	37.915	57.14	33.33	5.803	33.33	36.36	42.86
ES	1235	9.501	67.96	0	14.04	0.012	0.902	17.185
HS	1235	0.784	2.962	0.0421	0.591	0.309	0.655	1.114
Effective N	1235							

system. The average equity balance is 0.784, with a minimum value as low as 0.0421. Collectively, this indicates a general weakness in the equity balance among the sample enterprises, reflecting an irrational ownership structure within the manufacturing sector. This situation points to a prevalent phenomenon where large shareholders exert control over high-end manufacturing industries.

Finally, the control variables, whose descriptive statistics are shown in Table 4. The enterprise scale variable is expressed by the natural logarithm of its total assets, and the sample data is relatively stable, and there is no abnormal value; the maximum and minimum labor productivity of employees are 16.39 and 11.72 respectively, with an average of 13.78; the average debt capacity is 0.407, indicating that most enterprises still have debts. The maximum value of profitability is only about 0.237, and the minimum value is -0.332, indicating that the profitability of enterprises is not very large, and even some enterprises have negative values.

Table 4. Descriptive statistics for the control variables.

	N	Mean Value	Max Value	Minimum Value	Standard deviation	P25	P50	P75
SIZE	1235	22.54	26.40	20.01	1.039	21.888	22.478	23.073
BP	1235	13.78	16.39	11.72	0.605	13.381	13.726	14.133
ROA	1235	0.407	0.85	0.056	0.166	0.282	0.413	0.535
LEA	1235	0.0418	0.237	-0.332	0.0611	0.015	0.039	0.071
Effective N	1235							

5.2. Correlation Analysis

Correlation analysis serves as a valuable tool for comprehending the strength and direction of relationships among variables, an analysis of the inter-variable correlations yields several pivotal insights, details see Table 5. Building upon the research findings on employee productivity by Murphy and Sun (2023), we embarked on the following investigative study: initially, the correlation coefficient for ownership concentration is 0.059, signifying a noteworthy positive association. However, it is posited that an extreme concentration of ownership could inversely affect innovation, suggesting that excessive equity concentration may exert adverse effects on substantive corporate innovation. Secondly, the board size's correlation coefficient is 0.318, indicating that an enlargement of the board may have repercussions on corporate innovation. The correlation coefficient for the proportion of independent directors is 0.112, reflecting a significant positive relationship, which implies that a greater proportion of independent directors correlates with enhanced corporate innovation capabilities. Lastly, the compensation and stock ownership ratio of senior executives are positively correlated with the innovation capabilities of manufacturing enterprises. This suggests that augmenting the compensation and stock ownership ratio of top executives could

bolster the innovation capabilities of manufacturing firms. Moreover, the equity balance degree shows a positive correlation with corporate innovation investment, indicating that an elevated equity balance degree is accompanied by increased corporate innovation vigor. The correlation coefficient for firm size and corporate innovation is −0.050. While larger firm size is initially associated with greater innovation investment, a certain magnitude of firm size may later influence innovation, indicating that manufacturing enterprises have been attentive to innovation from inception, with appropriate scale expansion potentially providing a robust support for innovation. The correlation coefficient between labor productivity and corporate innovation is 0.252. An intensification of a company's innovation efforts is likely to be met with a corresponding increase in labor productivity, thus sustaining the company's innovative progression. The debt capacity's correlation coefficient with corporate innovation is 0.126. Profitability and corporate innovation are positively correlated, with a coefficient of 0.075. An increase in a company's profitability is likely to be mirrored by an increase in its innovation efforts, thereby enhancing its competitive edge and capacity to secure greater revenue.

In addition, the multicollinearity test was carried out for each variable. The results are shown in Table 6, and the average value is in the interval of (1,10), indicating that there is no multicollinearity in the variables.

Table 5. Correlation analysis.

	II	OC	BS	IDR	ES	HS	SIZE	BP	ROA	LEA
II	1									
OC	0.059**	1								
BS	0.318***	0.081***	1							
IDR	0.112***	0.140***	0.135***	1						
ES	0.102***	−0.00100	0.516***	0.082***	1					
HS	0.0160	0.455***	0.100***	0.137***	−0.0370	1				
SIZE	−0.050*	0.126***	0.234***	0.153***	0.0450	0.080***	1			
BP	0.252***	0.108***	0.00300	0.112***	0.069**	−0.0310	0.355***	1		
ROA	0.126***	−0.0150	0.072**	0.107***	0.0100	0.059**	0.362***	0.362***	1	
LEA	0.075***	0.110***	0.104***	−0.00500	−0.0150	−0.0370	0.149***	0.142***	0.314***	1

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. (*means significant at 10%, **means significant at 5%, ***means significant at 1%.)

Table 6. Multiple collinearity test of variables.

Variable	VIF
OC	1.330
BS	1.570
IDR	1.080
ES	1.440

Continued

HS	1.310
SIZE	1.500
BP	1.210
ROA	1420
LEA	1.260

5.3. Regression Analysis

1) First of all, it is necessary to verify whether there is an inverted U-shaped relationship between Ownership Concentration and enterprise Innovation Investment, this can be achieved by including the square term of equity concentration in the regression model, inspired by the insightful analysis of OC and its impact on firm performance conducted by Gaur et al. (2015), we have designed the subsequent model:

$$II_{it} = \beta_0 + \beta_1 OC_{it} + \beta_2 OC_{it}^2 + \sum_{k=1}^{K} \gamma_k X_{kit} + \epsilon_{it}$$

Table 7. Regression analysis of ownership concentration, OC and enterprise innovation investment.

	II
OC	0.0270**
	(1.62)
OC^2	−0.0230*
	(−1.33)
$\gamma_k X_{kit}$	−0.0186***
	(−5.58)
_cons	0.218***
	(7.10)
N	1235
R^2	0.028
adj. R^2	0.025

t statistics in parentheses, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. (*means significant at 10%, ** means significant at 5%, *** means significant at 1%.)

According to the results shown in Table 7, the coefficient for OC is significantly positive, suggesting that at the initial stage, an increase in ownership concentration is associated with an increase in corporate innovation investment. This finding supports the perspective that ownership concentration exerts a positive influence on innovation investment. Conversely, the coefficient for the squared term of OC^2 is significantly negative, indicating that beyond a certain threshold, an

increase in ownership concentration is correlated with a reduction in corporate innovation investment. This observation aligns with the latter segment of the "inverted U-shaped" hypothesis.

In the context of an imperfect investor protection mechanism, a highly concentrated shareholding structure exhibits a tendency to intensify a company's R&D investment. However, such a concentrated structure can also cause major shareholders to use control rights to conduct behaviors that may harm the interests of enterprises or small and medium shareholders, exacerbating the issue of dual agency, leading to conflicts of interest and moral hazard among agents of different levels or types, and ultimately diminishing the company's innovation efficiency. Due to variations in market environments and institutional frameworks, the relationship between shareholding concentration and corporate technological innovation manifests an inverted "U" shape. Moderately concentrated shareholding has the potential to reduce agency costs and enhance innovation efficiency, whereas excessive concentration exposes shareholders to heightened risks, rendering them more prone to rejecting investments in innovative projects. Consequently, when juxtaposed against overly dispersed or overly concentrated shareholding structures, a moderately concentrated one proves more conducive to fostering corporate technological innovation, which aligns with the assertions of Hypothesis 1.

2) Li et al. (2023) conduct the research of board size as a determinant of R&D investment utilizes regression analysis, referring to its research methods and model design, in order to verify the influence of Board Size, on enterprise innovation investment, the following model can be established:

$$II_{it} = \alpha_0 + \alpha_1 BS_{it} + \sum_{k=1}^{K} \delta_k X_{kit} + \eta_{it}$$

Table 8. Regression analysis of Board size and BS on enterprise innovation investment.

	II
BS	−0.0594***
	(−10.97)
$\delta_k X_{kit}$	−0.0122***
	(−3.79)
_cons	0.290***
	(9.76)
N	1235
R^2	0.112
adj. R^2	0.110

t statistics in parentheses. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

From the regression results obtained in **Table 8**, we can see that the coefficient

of BS is significantly negative (−0.0594, t value is −10.97), which indicates that there is a negative correlation between the increase of board size and II of enterprises. Specifically, with the excessive expansion of the board of directors, the innovation investment of enterprises is decreasing. The scale of the board of directors exerts a significant and intricate influence on the innovation investment of enterprises. As the board expands and the number of members increases, the complexity and diversity of enterprise decision-making escalate, which can easily precipitate the emergence of "hitch-hiking" behavior, which denotes speculation aimed at maximizing personal interests through the efforts of others, while being unwilling to bear the corresponding costs. In such scenarios, some directors may opt not to actively engage in the decision-making process, instead relying on the efforts and judgments of their peers, ultimately diminishing the overall motivation and efficiency of innovation. Conversely, a small-scale board of directors, characterized by a reduced number of members, exhibits a heightened capacity to respond to uncertainty swiftly and efficiently. This enhanced flexibility enables small-scale boards to make decisions more rapidly when confronted with market shifts and technological innovations, thereby seizing opportunities and fostering technological innovation within enterprises. Except when directors with professional skills and knowledge backgrounds constitute a substantial proportion, the expansion of the board of directors generally serves to decrease the efficiency of innovation. These findings corroborate Hypothesis 2 of this study.

3) To analyze the impact of independent director ratio on enterprise innovation investment, referencing Jentsch (2019), who applies a regression model to examine the role of independent directors in enhancing firm innovation, we can set the following method:

$$II_{it} = \lambda_0 + \lambda_1 IDR_{it} + \sum_{k=1}^{K} \theta_k X_{kit} + \mu_{it}$$

Table 9. Regression analysis of the proportion of independent directors and IDR on enterprise innovation investment.

	II
IDR	0.000823***
	(3.98)
	−0.0193***
	(−5.87)
_cons	0.199***
	(6.47)
N	1235
R^2	0.037
adj. R^2	0.036

t statistics in parentheses. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

As can be seen from Table 9, the coefficient of IDR is 0.000823, and the t value is 3.98, which reaches the level of statistical significance. This shows that there is a significant positive correlation between the increase of the proportion of independent directors and the innovation investment of enterprises. In other words, with the increase of the proportion of independent directors, the innovation investment of enterprises also increases. Due to the unique position of independent director, independent directors do not hold shares in the company and are not involved in its daily operations and management, thus rendering them devoid of any direct interest relationship with the company, thus could assume critical functions in areas where insiders have potential conflicts of interest. This independence enables them to maintain objectivity and neutrality in the decision-making process. Such independence serves to mitigate the issue of insider control, preventing short-sighted decisions that may be motivated by personal interests, and subsequently reducing the risk of decision-making errors. Furthermore, the professional background and extensive experience of independent directors often bring fresh perspectives and innovative ideas to the enterprise, positively influencing the enhancement of its technological innovation capabilities. Therefore, if independent directors adhere to their responsibilities, genuinely uphold the overall interests of the company, and express independent and professional opinions on major issues pertaining to listed companies, it can significantly promote innovation and foster the development of enterprises. Thus, assumption 3 is regarded as valid.

4) Building upon the method and regression analysis performed by Shahrier et al. (2020) in their exploration of how diverse levels of executive shareholding exert varying influences on innovation investment, the following model can be established:

$$II_{it} = \phi_0 + \phi_1 ES_{it} + \phi_2 ES_{it}^2 + \sum_{k=1}^{K} \xi_k X_{kit} + \nu_{it}$$

From the results in Table 10, the ES coefficient is significantly positive and the ES coefficient is significantly negative. As can be seen from the table, the ES coefficient is 0.00121, and the t value is 5.25, which reaches the level of statistical significance. This shows that in the initial stage, there is a significant positive correlation between the increase of the shareholding ratio of executives and the innovation investment of enterprises. However, the coefficient of ES is −0.0000232, and the t value is −4.43, which also reaches the level of statistical significance, indicating that with the further increase of the shareholding ratio of executives, its role in promoting innovation investment begins to weaken and may be reversed. When executives hold a substantial proportion of company shares, their personal interests become more closely aligned with the long-term interests of the company. This alignment acts as an effective incentive mechanism, prompting executives to prioritize the long-term development and competitiveness of the enterprise. By reducing short-term behavior, this alignment encourages executives to invest in long-term value-creating activities. However, as the shareholding

proportion of executives increases significantly, factors such as concerns for personal wealth security and stability may incur distraction, leading to reluctance to bear the potential losses associated with innovative investments which present lower levels of performance for firms with very large management holdings. To maintain stock prices and short-term performance, executives may sometimes have to sacrifice long-term innovative investments in order to meet market expectations. Concurrently, they must address a broader range of corporate governance and shareholder relationship issues. These intertwined factors ultimately contribute to the phenomenon where "too much of a good thing can indeed be bad." And consistent with hypothesis 4.

Table 10. Regression analysis of executive shareholding and ES on enterprise innovation investment.

	II
ES	0.00121***
	(5.25)
ES2	−0.0000232***
	(−4.43)
	−0.0168***
	(−5.01)
_cons	0.202***
	(6.53)
N	1223
R^2	0.050
adj. R^2	0.048

t statistics in parentheses. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

5) To examine whether the impact of the compensation ratio of managerial personnel on corporate substantive innovation behavior is mediated, drawing inspiration from the methodologies employed by Ganguli & Guha (2021) as well as Xu & Bai (2019) in their respective examinations of corporate performance, board governance and composition, with innovation capability and corporate expansion, the article constructs an analytical model that incorporates mediation effects, in this model, consideration is given to the independent variables (ownership concentration OC, board size BS, proportion of independent directors IDR, and executive shareholding ratio ES), the intermediary variable (compensation ratio of CS), and the dependent variable (corporate substantive innovation behavior II).

$$CS_{it} = \tau_0 + \tau_1 OC_{it} + \tau_2 BS_{it} + \tau_3 IDR_{it} + \tau_4 ES_{it} + \tau_5 HS_{it} + \tau_6 SIZE_{it} + \tau_7 BP_{it} + \tau_8 ROA_{it} + \tau_9 LEA_{it} + \sigma_{it}$$

Subsequently, Following the approach adopted by Wang and Cheng (2023) in their investigation into the impact of executive shareholding on corporate innovation across various industries, the analysis examines the joint impact of the independent variables and the intermediary variable on corporate substantive innovation behavior, which is achieved by including both the independent variables and the intermediary variable in a single model.

$$II_{it} = \pi_0 + \pi_1 OC_{it} + \pi_2 BS_{it} + \pi_3 IDR_{it} + \pi_4 ES_{it} + \pi_5 HS_{it} + \pi_6 SIZE_{it} + \pi_7 BP_{it} + \pi_8 ROA_{it} + \pi_9 LEA_{it} + \eta_{it}$$

Initially, the research examines the influence of independent variables on the mediating variable as shown in **Table 11**, OC significantly affects the CS of senior executives, with a regression coefficient of −0.636 and a t-value of −2.89. This suggests that an increase in ownership concentration may be associated with a decrease in the managerial compensation ratio. Additionally, BS has a significant positive impact on CS, with a coefficient of 0.334 and a t-value of 3.50, indicating that an expansion in the size of the board of directors is typically linked to an increase in the managerial compensation ratio. ES also significantly influences CS, with a coefficient of 0.00622 and a t-value of 1.82, implying that an increase in the executives' shareholding ratio is generally accompanied by an increase in their compensation ratio. Subsequently, when the mediating variable CS and the independent variables are concurrently included in the model, the mediating effect of CS on the II is observed: the coefficient for CS is 0.0140, with a t-value of 7.56. This significant result indicates that an increase in the compensation ratio of managers is likely to enhance the substantive innovation behavior of enterprises. By comparing the regression results, we can find that the influence of some independent variables on II has changed after adding the intermediary variable CS. After adding CS, the influence of OC on innovation behavior has changed from 0.0358 to 0.0446, and the significance level has changed from * to **, indicating that the salary structure of managers has played a partial intermediary role between ownership concentration and innovation behavior. Similarly, the influence of BS and ES on innovation behavior has also changed after joining CS, which further supports the existence of mediation. To sum up, we can draw a conclusion that the salary structure of managers plays an intermediary role in the influence of management structure on the substantive innovation behavior of enterprises, and presents a logical inverted U-shaped relationship with management structure and substantive innovation behavior of enterprises. The compensation structure for managers comprises the remuneration schemes devised by enterprises for the management level, encompassing various forms such as base salary, bonuses, allowances, equity incentives etc. This compensation structure not only acknowledges the past performance of managers but also serves as a vital instrument to stimulate their future work enthusiasm and innovative behavior. Within the context of an enterprise, the governance structure determines the design principles, levels, and formats of the compensation

Table 11. Regression analysis of independent variables and intermediary variables on the substantial innovation behavior of enterprises.

	II	CS	II
M			0.0140***
			(7.56)
OC	0.0358*	−0.636**	0.0446**
	(2.47)	(−2.89)	(3.14)
BS	−0.0775***	0.334***	−0.0821***
	(−12.34)	(3.50)	(−13.32)
IDR	0.000162*	0.00135	0.000143
	(2.02)	(1.11)	(1.83)
ES	−0.000680**	0.00622	−0.000767***
	(−3.03)	(1.82)	(−3.49)
HS	0.00420*	0.0212	0.00390
	(2.00)	(0.67)	(1.90)
SIZE	0.00758***	0.400***	0.00199
	(5.89)	(20.47)	(1.36)
BP	−0.0192***	−0.0362	−0.0187***
	(−9.64)	(−1.19)	(−9.59)
ROA	−0.0310***	−0.381**	−0.0257***
	(−4.00)	(−3.24)	(−3.38)
LEV	−0.0449*	1.004***	−0.0589**
	(−2.25)	(3.32)	(−3.01)
_cons	0.342***	6.273***	0.254***
	(9.77)	(11.80)	
N	1235	1235	1235
R^2	0.212	0.356	0.247
adj. R^2	0.206	0.351	0.241

structure. Subsequently, by influencing the behavioral decisions of managers, the compensation structure can indirectly exert an impact on the enterprise's innovation activities. When the compensation level is moderate under healthy governance principles, an increase in it can significantly elevate managers' enthusiasm and motivation for innovation, thereby empowering the management to explore and implement innovative projects with greater vigor. However, when the compensation level becomes excessively high, a series of adverse effects may emerge, including internal sentiments of unfairness and conflicts, short-term and overly conservative measures adopted by managers to safeguard their

interests, and ultimately, imbalances in distribution may exert a detrimental impact on the long-term development of the enterprise. So, it conforms to hypothesis 5.

To thoroughly examine the impact of multiple variables on enterprise innovation, minimize the interference of potential confounding factors, and uncover the intricate relationships among these influences, this study employs a comprehensive model for analysis. The findings are presented in Table 12.

$$II_{it} = \alpha_0 + \alpha_1 OC_{it} + \alpha_2 BS_{it} + \alpha_3 IDR_{it} + \alpha_4 ES_{it} + \alpha_5 HS_{it} + \alpha_6 SIZE_{it} + \alpha_7 BP_{it} + \alpha_8 ROA_{it} + \alpha_9 LEA_{it} + \eta_{it}$$

*The coefficient of ownership concentration is 2.47 at the 10% level, indicating a significant positive correlation between ownership concentration and the

Table 12. The effect of multivariable effect on enterprise innovation.

	II
OC	0.0358*
	(2.47)
BS	−0.0775***
	(−12.34)
IDR	0.000162*
	(2.02)
ES	−0.000680**
	(−3.03)
HS	0.00420*
	(2.00)
SIZE	0.00758***
	(5.89)
BP	−0.0192***
	(−9.64)
ROA	−0.0310***
	(−4.00)
LEV	−0.0449*
	(−2.25)
_cons	0.342***
	(9.77)
N	1235
R^2	0.212
adj. R^2	0.206

t statistics in parentheses. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

substantive innovation performance of manufacturing enterprises. This corroborates that in their operational development, enterprises can provide solid support for the implementation of innovation activities and facilitate new innovation initiatives by maintaining a certain level of ownership concentration. However, if ownership concentration is excessively high, the burden it brings should still be considered.

*In the structure of the board of directors, the coefficient of board size is −12.34 at the 1% level, showing a significant negative correlation between board size and enterprise innovation. This suggests that a smaller board size is more conducive to enterprises making correct innovation decisions.

*The correlation coefficient of the proportion of independent directors is 2.02 at the 10% level, indicating a significant positive correlation between independent directors and innovation activities in manufacturing enterprises, which significantly influences enterprise innovation. This indicates that in the current development environment, the independent director system implemented by most enterprises has effectively played its expected role and influences enterprise innovation decisions.

*The coefficient of management shareholding ratio is −3.03 at the 1% level, indicating that when the proportion of management shareholding is not high, implementing equity incentive mechanisms can effectively promote the smooth unfolding of enterprise innovation activities.

*The coefficient of ownership balance is 2 at the 10% level, also indicating a positive correlation between ownership balance and substantive innovation behavior. When ownership balance increases, it can provide good support for innovation behavior. In determining and adjusting governance structures, optimizing the ownership structure and appropriate ownership concentration can stimulate innovation.

5.4. Robustness Test

To ensure the objectivity and accuracy of the research results, a robustness test was conducted by reducing the sample size. In practice, owing to the epidemic events in 2020, the samples from that year were excluded, and only those from 2016 to 2019 were studied. The test results shown in Table 13 indicate that, except for a few variables, there has been a certain degree of change in the level of significance. However, this has not altered the positive and negative aspects of enterprise innovation, and other results have remained largely unchanged. This suggests that the research results possess good objectivity and the model is robust.

Table 13. Results of the robustness test.

	II
OC	0.0464**
	(2.86)

Continued

BS	−0.0845***
	(−12.43)
IDR	0.000173*
	(1.97)
ES	−0.000783**
	(−3.10)
HS	0.00424
	(1.80)
SIZE	0.00776***
	(5.32)
BP	−0.0200***
	(−8.80)
ROA	−0.0314***
	(−3.64)
LEV	−0.0515*
	(−2.21)
_cons	0.364***
	(9.26)
N	978
R^2	0.248
adj. R^2	0.241

t statistics in parentheses. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

6. Discussion

Based on the regression analysis presented in this paper, we can identify some of the potential reasons for the poor performance of manufacturing companies and suggest improvements to the lack of sustainability in their management and innovation practices. In the conclusion section, hypotheses 1 to 5 were validated and supported. The study confirms that there is an inverted U-shaped relationship between ownership concentration and substantive innovation behavior. Corporate governance structures, including ownership concentration, board composition, and management hierarchies, are key determinants of manufacturing companies' substantive innovation behavior and long-term sustainability. From the perspective of ownership structure, manufacturing companies should strive to establish a reasonable concentration and balance mechanism of ownership to avoid the dominance of a single shareholder, as this can help enhance the company's ability to innovate. When considering the structure of the

board of directors, expanding the size of the board of directors can effectively enhance the innovation ability of manufacturing enterprises. However, it is important to note that an oversized board may adversely affect the implementation of substantial innovation activities within a manufacturing company, as divergent perspectives in large boards may hinder the development and implementation of innovation policies. Specifically, the impact of board size on innovation behavior involves the following nuances:

1) Decision-making: Complex decision-making processes, high delegated costs, and low efficiency will hinder developers' flexibility and responsiveness in innovation.

2) Divergent opinions: When the board is made up of members with different backgrounds and interests, differences of opinion may arise, which can lead to conflicting views, difficulty reaching consensus, and employing non-traditional strategies.

3) Dilution of accountability: In large boards, individual board members may feel less accountable, which can lead them to neglect the most innovative projects.

4) Complex resource allocation: The complexity of resource deployment, especially for innovation projects, sometimes leads to a reduction in resource allocation, which hinders innovation.

With regard to the proportion of independent directors, an analysis of the industries in which the sample companies operate shows that the lack of independent directors in key industries may hinder the implementation of innovative activities in manufacturing companies. This observation can be attributed to the fact that companies are at different stages of development, and when products need to be updated, independent directors play a vital role in providing valuable reference for corporate decision-making. Therefore, it is necessary to improve the corporate governance structure, further strengthen the board of directors' system, give full play to the advisory and part-time functions of directors, streamline the size of the board of directors, and establish a fast and efficient decision-making system.

From a management perspective, it is worth noting that the excessive increase in executive compensation has not significantly affected the ability of companies to innovate. However, Tylecote & Conesa (1999) argue that increasing executive ownership can indeed promote the implementation of firm innovation activities. Innovation and efficiency are increased as major shareholders have an incentive to control the company's operations and safeguard its long-term interests, but it is critical to keep the shareholding within a certain range. Goyer (2001) argues that too high executive ownership may have a negative impact on corporate innovation. Based on the empirical analysis of the impact of corporate governance structure on technological innovation behavior, the following aspects can be improved to improve the corporate governance structure of manufacturing enterprises in South China and promote their technological innovation performance:

6.1. Optimize the Shareholding Structure to Promote Technological Innovation

In order to ensure the effective operation of the corporate governance structure, it is important to establish a reasonable shareholding structure. Previous studies, such as those by Deschamps & Nelson (2014), have revealed the differential effects of U.S. and Japanese shareholding structures on firm technological innovation: the U.S.'s fragmented shareholding structure leads to weak internal oversight, while Japan's concentrated ownership makes firms too conservative and affects their competitive vitality. In view of this, the empirical analysis of this paper points out that the shareholding structure of Chinese enterprises should avoid excessive diversification to ensure that there are a sufficient number of active large shareholders to support technological innovation, and at the same time, prevent excessive concentration of state-owned shares, so as to avoid the "administrative" tendency to weaken the profit motive.

Therefore, for Chinese listed companies, the ideal shareholding structure should increase the proportion of institutional shareholdings, and form a diversified structure dominated by institutional shareholdings, with state, institutional and individual shares checking and balancing each other. Reducing the proportion of state shares as the largest shareholder and flexibly adjusting the shareholding strategy according to the characteristics of the industry can achieve the strategic optimization of state-owned assets. This structure not only provides a solid foundation for effective checks and balances between the general meeting of shareholders, the board of directors and management, but also promotes the embodiment of the corporate nature of corporate governance. At the same time, weakening the monopoly position of state-owned shares reduces administrative intervention, encourages the cultivation of entrepreneurial spirit, and promotes the market-oriented selection of professional management talents, thereby stimulating the vitality of technological innovation of enterprises.

6.2. Strengthen the Incentives and Constraints of Managers and Stimulate the Impetus for Technological Innovation

1) Building a Healthy Securities Market Environment

A fair and transparent securities market environment is an indispensable condition for the effective implementation of equity incentives. Lopes & Farias (2022) point out that the core of equity incentives is to realize excess profits through market advantages, reflecting the "capital value" of managers. Fernandes & Solimun (2017) highlights the importance of the pricing mechanism of the securities market in assessing the performance of managers. Sullivan (2011) further argues that if the stock price does not reflect the firm's future earnings potential, managers will lack positive incentives and negative constraints. At present, China's securities market is still immature, and there are problems such as information asymmetry and frequent violations of laws and regulations. Bobillo et al., (2018) suggest strengthening market regulation, reducing market manipulation, and making

stock prices more accurately reflect corporate value, thereby motivating managers to focus on technological innovation.

2) Improve the legal framework to support equity incentives

Although China has issued a number of documents related to employee stock ownership, there are still insufficient national and systematic legal norms, especially in the specific aspects of the implementation of stock options, such as issuance, reservation, repurchase, additional issuance, circulation, transfer, etc., there are still legal and institutional obstacles. Therefore, there is an urgent need to improve relevant laws and regulations, formulate national rules and regulations for equity incentives of listed companies, and consider incorporating them into the legal system to provide stable institutional guarantees. This will vigorously promote the implementation of the equity incentive system of enterprises, so as to actively promote the technological innovation of enterprises.

6.3. Optimize the Structure and Functions of the Board of Directors, and Accelerate the Scientific Process of Technological Innovation Decision-Making

In view of the current situation and challenges faced by the board of directors in China, combined with the international advanced governance principles and the trend of board reform, this paper proposes the following strategies to improve the efficiency of technological innovation decision-making.

1) Deepen the responsibilities of the board of directors and strengthen the dual functions of decision-making and supervision

Scherer & Voegtlin (2020) pointed out that the board of directors, as the core of corporate governance, has both decision-making and oversight responsibilities. However, in the past, the supervision function was often overlooked and its key role in strategic decision-making was neglected. To this end, the leading role of the board of directors in the formulation and evaluation of technological innovation strategies should be clarified and strengthened, and the company's development direction should be closely aligned with the technological innovation strategy, so as to continuously promote the company's innovation and development (Tylecote & Ramirez, 2006).

2) Reasonably set the size and composition of the board of directors to promote the balance of interests and efficient decision-making

According to the characteristics of the company and the requirements of the industry, it is very important to scientifically plan the size and membership structure of the board of directors. Although China's Company Law stipulates that the number of board members is between 5 and 19, the specific size needs to be flexibly adjusted according to the actual situation of the company. Considering the inverted U-shaped relationship between board size and technological innovation performance, the ideal board composition should be broadly representative of a wide range of stakeholders while ensuring efficient execution of technological innovation decisions (Salike et al., 2022). In addition, employee representatives

should be included in the board of directors to enrich the knowledge base of technological innovation decision-making and improve the scientific nature of decision-making (Zhang et al., 2019). At the same time, in order to enhance the independence of the board of directors, outside directors should be appropriately recruited to ensure that they have independent judgment, decision-making expertise, and dedication, so as to effectively supervise and promote the scientific nature of technological innovation decision-making (Priporas et al., 2020).

3) Establish a Technological Innovation Committee with clear responsibilities to improve decision-making efficiency

In order to further enhance the professionalism and execution of technological innovation decision-making, the board of directors should set up a special technological innovation committee. The committee will be responsible for proposing technological innovation projects, conducting risk assessment, monitoring and follow-up management to ensure the effective implementation of technological innovation strategies. By clarifying the responsibilities of the committee and implementing them to individuals, the efficiency and accountability of technological innovation decisions can be significantly improved, so as to continuously improve the company's technological innovation capabilities.

6.4. Build a Collaborative Governance System with Multiple Stakeholders to Stimulate the Innovation Potential of Stakeholders

The concept of collaborative governance advocates that key stakeholders such as creditors, suppliers, customers, and employees are included in the corporate governance structure, giving them a voice in the company's decision-making and operations, and jointly driving the company's growth. Morisson & Doussineau, (2019) pointed out that this model establishes a more efficient incentive and supervision mechanism by integrating the power of stakeholders, and promotes scientific and rational decision-making within the company. The Organisation for Economic Co-operation and Development's (OECD) Principles of Corporate Governance also emphasize the importance of stakeholders by emphasizing that the competitiveness and success of a business stems from the synergistic contribution of various resources.

In China, the practical path to promoting collaborative governance mechanisms can focus on the following aspects:

First, deepen the Employee Stock Ownership Plan (ESOP) to truly inspire employees to feel a sense of belonging. Employee stock ownership plans should not only stop at the fundraising level, but should become a bridge connecting the interests of employees and the company, and stimulate employees' enthusiasm to participate in governance. By improving laws and regulations, establishing the legal status of employee stock ownership plans, designing a reasonable shareholding structure, protecting the rights of employee stockholders, and realizing the deep integration of labor and capital, an effective incentive and restraint mechanism

can be constructed.

Second, implement the employee director system to ensure that the voice of employees is reflected in decision-making. As contributors to human capital, the wisdom and experience of employees are essential to technological innovation. The implementation of the employee director system should follow the principles of universality and equality, expand its scope of application, ensure the equal participation of human capital and non-human capital owners in the corporate power structure, and jointly shape a new paradigm of corporate governance.

In addition, the role of banks in corporate governance should be strengthened and financing channels should be broadened. In view of the unique position of banks as the main creditors of enterprises, new types of bank-enterprise relationships, such as bank shareholding and the establishment of bank director systems, should be explored to provide stable financial support and supervision for technological innovation projects. Through innovative mechanisms such as debt-to-equity swaps and voting rights trusts, banks and enterprises can bind their interests, jointly respond to innovation risks, and seize market opportunities.

Finally, promote cross-shareholding between upstream and downstream enterprises in the supply chain to form a close enterprise group. This cooperation model helps to reduce administrative intervention and enhance the support and promotion of technological innovation by suppliers, customers and other stakeholders. Through resource sharing, collaborative innovation, and joint efforts, the competitiveness and market adaptability of enterprises can be enhanced.

6.5. Trends of Governance Structure and the Potential Impact of Innovation Policy from a Macro Perspective

According to the official report of China's State Taxation Administration (2024), the government intends to enhance tax incentive policies to support technological innovation, aiming to reduce the tax burden on enterprises and bolster their innovation drive. Meanwhile, China Economic Net (2024) also points out that the government is supporting the development of "specialized, refined, specialized, and novel" small and medium-sized enterprises (SMEs) through central financial assistance, providing a certain proportion of post-subsidy for actual investments made by national-level "specialized, refined, specialized, and novel" enterprises within their valid period. Furthermore, the government is guiding and encouraging financial institutions to increase financial support for these SMEs by adopting an "equity participation plus direct investment" approach to support strategic emerging industries and future industries. The importance of optimizing the innovation ecosystem and strengthening the role of innovators as the mainstay is also emphasized. However, to align with the implementation of these policies, adjustments and innovations at the corporate management level are still required.

Li (2024) mentioned that rigid management systems and outdated frameworks within enterprises have already led to production cuts and losses for a significant number of companies. Consequently, in pursuit of sustainable corporate development, the refinement and optimization of corporate governance structures have become a pivotal trend. As businesses confront an ever-evolving and intricate market landscape, the implementation of flattening reforms stands as a strategic imperative (Sorenson, 2022). These reforms entail the reduction of management hierarchies, the expansion of managerial span, and the transition from traditional pyramidal organizational structures to more dynamic, network-centric models. By doing so, they not only centralize decision-making authorities but also expedite information flow, enabling enterprises to adapt swiftly to market fluctuations. Furthermore, the resultant decrease in management tiers and personnel contributes to a reduction in management costs, thereby enhancing overall organizational efficiency.

Additionally, networking entails the utilization of cutting-edge information technology by enterprises to construct agile and efficient organizational networks, thereby facilitating the optimal allocation and effective utilization of resources. This approach dismantles departmental silos, promotes the seamless sharing of real-time information, and optimizes resource distribution (Todeva, 2016), enterprises can more readily forge collaborative partnerships with other companies or institutions to collectively tackle market challenges. Leveraging networked information platforms, businesses can gather and analyze extensive data and intelligence, furnishing robust support for informed decision-making. Thereby, Abatecola et al. (2016) emphasize that upgrading and adjusting management structures is necessary to respond to rapid changes in the economic environment and intense market competition. While government support policies for enterprises are continuously being optimized, most companies still need to optimize their internal structures to mitigate the ongoing impact of outdated concepts on management.

7. Conclusion

Based on the panel data of listed manufacturing companies in South China from 2016 to 2020, this paper empirically analyzes the relationship between governance structure and substantive innovation behavior in South China's manufacturing industry. The results indicate that: 1) There is a significant inverted U-shaped relationship between ownership concentration and corporate substantive innovation behavior. Excessive expansion of the board of directors will have a negative impact on corporate substantive innovation behavior. 2) An increase in the proportion of independent directors in South China's manufacturing enterprises may promote their substantive innovation behavior. An increase in the shareholding ratio of executives can significantly facilitate corporate substantive innovation behavior, but this promotion effect may weaken or reverse after the executive shareholding ratio reaches a certain level. 3) The compensation structure of managers plays an intermediary role under the influence of the governance structure and

exhibits an inverted U-shaped relationship with corporate substantive innovation behavior.

The following insights can be drawn from the above research findings: 1) The mixed-ownership reform of manufacturing enterprises in South China should not merely aim at "mixing" for the sake of reform but should focus on substantive content; 2) Improve corporate governance structures, further strengthen the independent director system, and genuinely leverage the consulting and supervisory functions of independent directors, streamline the board of directors to form a rapid and efficient decision-making system; 3) Strengthen equity incentives for executives in state-owned enterprises, especially technical executives, and expand the scope of equity incentives; establish a reasonable executive compensation system that balances annual salaries and equity compensation, while minimizing the amount and proportion of annual salaries in the compensation package, adhering to the dominance of equity incentives.

In light of the global economic downturn in recent years, this study aims to explore sustainable development models for the manufacturing industry through constructive thinking. By integrating theoretical and empirical research, we delve into the influence mechanisms of factors such as corporate ownership structure, resource allocation, and innovation incentives, yielding multiple research outcomes. These results can provide insights into the study of corporate governance models in the new era. However, upon deeper analysis, it becomes evident that the impact of manufacturing enterprises' governance structures on substantive innovation behavior varies across different sectors. This primarily stems from the diverse developmental stages of enterprises, yet this is a preliminary conclusion based solely on the sample and has yet to be empirically verified. Therefore, further research should involve more in-depth analyses and data collection.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

Abatecola, G., Belussi, F., Breslin, D., & Filatotchev, I. (2016). Darwinism, Organizational Evolution and Survival: Key Challenges for Future Research. *Journal of Management & Governance, 20,* 1-17. https://doi.org/10.1007/s10997-015-9310-8

Arnold, E., Boekholt, P., Deiaco, E., Mckibbin, S., De la Mothe, J., Simmonds, P., Zaman, R. et al. (2003). *Research and Innovation Governance in Eight Countries: A Meta-Analysis of Work Funded by EZ (Netherlands) and RCN (Norway).* Technopolis.

Asensio-López, D., Cabeza-García, L., & González-Álvarez, N. (2019). Corporate Governance and Innovation: A Theoretical Review. *European Journal of Management and Business Economics, 28,* 266-284. https://doi.org/10.1108/ejmbe-05-2018-0056

Balkin, D. B., Markman, G. D., & Gomez-Mejia, L. R. (2000). Is CEO Pay in High-Technology Firms Related to Innovation? *Academy of Management Journal, 43,* 1118-1129. https://doi.org/10.5465/1556340

Becker-Blease, J. R. (2011). Governance and Innovation. *Journal of Corporate Finance, 17,* 947-958. https://doi.org/10.1016/j.jcorpfin.2011.04.003

Bobillo, A. M., Rodríguez-Sanz, J. A., & Tejerina-Gaite, F. (2018). Corporate Governance Drivers of Firm Innovation Capacity. *Review of International Economics, 26,* 721-741. https://doi.org/10.1111/roie.12321

Bushey, B. (1998). The Influence of Institutional Investors on Myopic R&D Investment Behavior. *Accounting Review, 73,* 305-353.

Cerna, L. (2014). The Governance of Innovation in Education: The Governance of Innovation in Education. *Neveléstudomány: Oktatás-Kutatás-Innováció, 2,* 5-21.

Clifton, N., Keast, R., Pickernell, D., & Senior, M. (2010). Network Structure, Knowledge Governance, and Firm Performance: Evidence from Innovation Networks and SMEs in the UK. *Growth and Change, 41,* 337-373. https://doi.org/10.1111/j.1468-2257.2010.00529.x

Deschamps, J. P., & Nelson, B. (2014). *Innovation Governance: How Top Management Organizes and Mobilizes for Innovation.* John Wiley & Sons.

Feller, J., Finnegan, P., Hayes, J., & O'Reilly, P. (2009). Institutionalising Information Asymmetry: Governance Structures for Open Innovation. *Information Technology & People, 22,* 297-316. https://doi.org/10.1108/09593840911002423

Fernandes, A. A. R., & Solimun, (2017). Moderating Effects Orientation and Innovation Strategy on the Effect of Uncertainty on the Performance of Business Environment. *International Journal of Law and Management, 59,* 1211-1219. https://doi.org/10.1108/ijlma-10-2016-0088

Filatotchev, I., Aguilera, R. V., & Wright, M. (2020). From Governance of Innovation to Innovations in Governance. *Academy of Management Perspectives, 34,* 173-181. https://doi.org/10.5465/amp.2017.0011

Frischer, J. (1993). Empowering Management in New Product Development Units. *Journal of Product Innovation Management, 10,* 393-401. https://doi.org/10.1016/0737-6782(93)90097-a

Ganguli, S. K., & Guha Deb, S. (2021). Board Composition, Ownership Structure and Firm Performance: New Indian Evidence. *International Journal of Disclosure and Governance, 18,* 256-268. https://doi.org/10.1057/s41310-021-00113-5

Gaur, S. S., Bathula, H., & Singh, D. (2015). Ownership Concentration, Board Characteristics and Firm Performance: A Contingency Framework. *Management Decision, 53,* 911-931. https://doi.org/10.1108/md-08-2014-0519

Geng, H., Huang, Y., Lin, C., & Liu, S. (2022). Minimum Wage and Corporate Investment: Evidence from Manufacturing Firms in China. *Journal of Financial and Quantitative Analysis, 57,* 94-126. https://doi.org/10.1017/s0022109021000053

Gonzales-Bustos, J. P., & Hernández-Lara, A. B. (2016). Corporate Governance and Innovation: A Systematic Literature Review. *Corporate Ownership and Control, 13,* 33-45. https://doi.org/10.22495/cocv13i3p3

Goyer, M. (2001). Corporate Governance and the Innovation System in France 1985-2000. *Industry and Innovation, 8,* 135-158. https://doi.org/10.1080/13662710125208

He, X. (2024). *Gather Global Wisdom and Talk about the Future of Science—Written before the 2024 World Forum on Science, Technology and Development.* China Economic Net. http://intl.ce.cn/qqss/202410/21/t20241021_39175800.shtml

Heidenreich, M., & Koschatzky, K. (2011). Regional Innovation Governance. In P. Cooke,

B. Asheim, R. Boschma, R. Martin, D. Schwartz, & F. Tödtling (Eds.), *Handbook of Regional Innovation and Growth* (p. 648). Edward Elgar Publishing. https://doi.org/10.4337/9780857931504.00061

Heubeck, T., & Meckl, R. (2024). Does Board Composition Matter for Innovation? A Longitudinal Study of the Organizational Slack–innovation Relationship in Nasdaq-100 Companies. *Journal of Management and Governance, 28,* 597-624. https://doi.org/10.1007/s10997-023-09687-4

Hill, C. W. L., & Snell, S. A. (1988). External Control, Corporate Strategy, and Firm Performance in Research - intensive Industries. *Strategic Management Journal, 9,* 577-590. https://doi.org/10.1002/smj.4250090605

Hirshleifer, D., Low, A., & Teoh, S. H. (2012). Are Overconfident CEOs Better Innovators? *The Journal of Finance, 67,* 1457-1498. https://doi.org/10.1111/j.1540-6261.2012.01753.x

Hosono, K., Tomiyama, M., & Miyagawa, T. (2004). Corporate Governance and Research and Development: Evidence from Japan. *Economics of Innovation and New Technology, 13,* 141-164. https://doi.org/10.1080/10438590410001628125

Jalilian, N., & Mirghafoori, S. H. (2020). Presenting Sustainable Supply Chain Fuzzy Rotation Matrix Framework to Manage Business Challenges in the Context of Sustainable Supply Chain Management. *Journal of Modelling in Management, 15,* 35-49. https://doi.org/10.1108/jm2-05-2018-0065

Jensen, M. C. (1988). Takeovers: Their Causes and Consequences. *Journal of Economic Perspectives, 2,* 21-48. https://doi.org/10.1257/jep.2.1.21

Jensen, M. C. (1993). The Modern Industrial Revolution, Exit, and the Failure of Internal Control Systems. *The Journal of Finance, 48,* 831-880. https://doi.org/10.1111/j.1540-6261.1993.tb04022.x

Jentsch, V. (2019). Board Composition, Ownership Structure and Firm Value: Empirical Evidence from Switzerland. *European Business Organization Law Review, 20,* 203-254. https://doi.org/10.1007/s40804-018-00128-6

Jia, N., Huang, K. G., & Man Zhang, C. (2019). Public Governance, Corporate Governance, and Firm Innovation: An Examination of State-Owned Enterprises. *Academy of Management Journal, 62,* 220-247. https://doi.org/10.5465/amj.2016.0543

Kitschelt, H. (1991). Industrial Governance Structures, Innovation Strategies, and the Case of Japan: Sectoral or Cross-National Comparative Analysis? *International Organization, 45,* 453-493. https://doi.org/10.1017/s002081830003318x

Koschatzky, K., & Kroll, H. (2007). Which Side of the Coin? The Regional Governance of Science and Innovation. *Regional Studies, 41,* 1115-1127. https://doi.org/10.1080/00343400701530857

Kuhlmann, S. (2001). Future Governance of Innovation Policy in Europe—Three Scenarios. *Research Policy, 30,* 953-976. https://doi.org/10.1016/s0048-7333(00)00167-0

Lacetera, N. (2001). Corporate Governance and the Governance of Innovation: The Case of Pharmaceutical Industry. *Journal of Management and Governance, 5,* 29-59. https://doi.org/10.1023/a:1017907119114

Lane, P. J., Cannella, A. A., & Lubatkin, M. H. (1998). Agency Problems as Antecedents to Unrelated Mergers and Diversification: Amihud and Lev Reconsidered. *Strategic Management Journal, 19,* 555-578. https://doi.org/10.1002/(sici)1097-0266(199806)19:6<555::aid-smj955>3.0.co;2-y

Lee, P. M., & O'Neill, H. M. (2003). Ownership Structures and R&D Investments of U.S. and Japanese Firms: Agency and Stewardship Perspectives. *Academy of Management*

Journal, 46, 212-225. https://doi.org/10.2307/30040615

Li, S., Liu, Y., & Xu, Y. (2023). Does ESG Performance Improve the Quantity and Quality of Innovation? The Mediating Role of Internal Control Effectiveness and Analyst Coverage. *Sustainability, 15,* Article 104. https://doi.org/10.3390/su15010104

Li, T. T. (2024). Probe into the Path of Financial Digitalization Construction of State-Owned Enterprises. *Chinese Agricultural Accounting, 34,* 6-8.

Lopes, A. V., & Farias, J. S. (2022). How Can Governance Support Collaborative Innovation in the Public Sector? A Systematic Review of the Literature. *International Review of Administrative Sciences, 88,* 114-130. https://doi.org/10.1177/0020852319893444

Ma, J. W. and Gao, Y. Q. (2021). Shareholding Structure, Board Governance, and Corporate Performance. *International Journal of Frontiers in Sociology, 3,* 18-29.

Meijer, A. (2015). E-Governance Innovation: Barriers and Strategies. *Government Information Quarterly, 32,* 198-206. https://doi.org/10.1016/j.giq.2015.01.001

Minetti, R., Murro, P., & Paiella, M. (2012). *Ownership Structure, Governance, and Innovation: Evidence from Italy.* Government of the Italian Republic (Italy), Ministry of Economy and Finance, Department of the Treasury Working Paper.

Minetti, R., Murro, P., & Paiella, M. (2015). Ownership Structure, Governance, and Innovation. *European Economic Review, 80,* 165-193. https://doi.org/10.1016/j.euroecorev.2015.09.007

Morisson, A., & Doussineau, M. (2019). Regional Innovation Governance and Place-Based Policies: Design, Implementation and Implications. *Regional Studies, Regional Science, 6,* 101-116. https://doi.org/10.1080/21681376.2019.1578257

Munari, F., & Sobrero, M. (2003). Corporate Governance and Innovation. In M. Calderini, P. Garrone, & M. Sobrero (Eds.), *Corporate Governance, Market Structure and Innovation* (p. 304). Edward Elgar Publishing. https://doi.org/10.4337/9781843765363.00010

Murphy, B., & Sun, L. (2023). Asset Redeployability and Employee Performance. *International Journal of Disclosure and Governance, 20,* 185-199. https://doi.org/10.1057/s41310-022-00158-0

Mycos News (2023). *Blue Book of Employment in 2023 Was Officially Released.* http://www.mycos.com.cn/index.php/Index/news_info/nav/3/id/2023714.html

Peggy, M., & O'Neill Hugh, M. (2003). Ownership Structures and R&D Investments of U.S. and Japanese Firms: Agency and Stewardship Perspectives. *Academy of Management Journal, 46,* 212-225. https://doi.org/10.5465/30040615

Priporas, C., Kamenidou, I., Nguyen, N., & Shams, R. (2020). The Impact of the Macro-Environment on Consumer Scepticism Towards Cause-Related Marketing: Insights from an Economic Crisis Setting. *International Marketing Review, 37,* 841-861. https://doi.org/10.1108/imr-04-2019-0124

SaiDiZhiKu (2024). *2024 CCID Forum: CCID Released Manufacturing Innovation Index Report 2023.* https://ccidgroup.com/info/1155/39599.htm

Salike, N., Huang, Y., Yin, Z., & Zeng, D. Z. (2022). Making of an Innovative Economy: A Study of Diversity of Chinese Enterprise Innovation. *China Finance Review International, 12,* 496-518. https://doi.org/10.1108/cfri-10-2020-0135

Scherer, A. G., & Voegtlin, C. (2020). Corporate Governance for Responsible Innovation: Approaches to Corporate Governance and Their Implications for Sustainable Development. *Academy of Management Perspectives, 34,* 182-208. https://doi.org/10.5465/amp.2017.0175

Scott, S. G., & Bruce, R. A. (1994). Determinants of Innovative Behavior: A Path Model of

Individual Innovation in the Workplace. *Academy of Management Journal, 37,* 580-607. https://doi.org/10.2307/256701

Shahrier, N. A., Ho, J. S. Y., & Gaur, S. S. (2020). Ownership Concentration, Board Characteristics and Firm Performance among Shariah-Compliant Companies. *Journal of Management and Governance, 24,* 365-388. https://doi.org/10.1007/s10997-018-9436-6

Shleifer, A., & Vishny, R. W. (1986). Greenmail, White Knights, and Shareholders' Interest. *The Rand Journal of Economics, 17,* 293-309. https://doi.org/10.2307/2555712

Singh, D. A., & Gaur, A. S. (2013). Governance Structure, Innovation and Internationalization: Evidence from India. *Journal of International Management, 19,* 300-309. https://doi.org/10.1016/j.intman.2013.03.006

Sivak, R., Caplanova, A., & Hudson, J. (2011). The Impact of Governance and Infrastructure on Innovation. *Post-Communist Economies, 23,* 203-217. https://doi.org/10.1080/14631377.2011.570050

Sorenson, O. (2022). Flat Firms, Complementary Choices, Employee Effort, and the Pyramid Principle. *Journal of Organization Design, 11,* 11-14. https://doi.org/10.1007/s41469-022-00115-9

Sullivan, R. S. (2011). Business Schools and the Innovation Conundrum. *Journal of Management Development, 30,* 492-498. https://doi.org/10.1108/02621711111133000

Textor, C. (2023) *Internal Research and Development (R&D) Spending of Industrial Enterprises in China in 2022, by Industry.* https://www.statista.com/statistics/234726/research-and-development-spending-in-china-by-industry/

Tierney, P., Farmer, S. M., & Graen, G. B. (1999). An Examination of Leadership and Employee Creativity: The Relevance of Traits and Relationships. *Personnel Psychology, 52,* 591-620. https://doi.org/10.1111/j.1744-6570.1999.tb00173.x

Todeva, E. (2016). Network Management and Governance. In R. Alhajj, & J. Rokne (Eds.), *Encyclopedia of Social Network Analysis and Mining* (pp. 1-10). Springer. https://doi.org/10.1007/978-1-4614-7163-9_70-1

Tylecote, A., & Conesa, E. (1999). Corporate Governance, Innovation Systems and Industrial Performance. *Industry and Innovation, 6,* 25-50. https://doi.org/10.1080/13662719900000003

Tylecote, A., & Ramirez, P. (2006). Corporate Governance and Innovation: The UK Compared with the US and 'Insider' Economies. *Research Policy, 35,* 160-180. https://doi.org/10.1016/j.respol.2005.09.004

Wang, N., Cui, D., & Jin, C. (2023). The Value of Internal Control during a Crisis: Evidence from Enterprise Resilience. *Sustainability, 15,* Article 513. https://doi.org/10.3390/su15010513

Wang, T., & Cheng, D. (2023). Executive Shareholding, Institutional Investor Shareholding and Enterprise Innovation. *European Journal of Innovation Management, 26,* 1744-1762. https://doi.org/10.1108/ejim-11-2021-0553

Xu, P., & Bai, G. (2019). Board Governance, Sustainable Innovation Capability and Corporate Expansion: Empirical Data from Private Listed Companies in China. *Sustainability, 11,* Article 3529. https://doi.org/10.3390/su11133529

Yoshikawa, T., Tsui-Auch, L. S., & McGuire, J. (2007). Corporate Governance Reform as Institutional Innovation: The Case of Japan. *Organization Science, 18,* 973-988. https://doi.org/10.1287/orsc.1070.0290

Zahra, S. A., Neubaum, D. O., & Huse, M. (2000). Entrepreneurship in Medium-Size

Companies: Exploring the Effects of Ownership and Governance Systems. *Journal of Management, 26,* 947-976. https://doi.org/10.1177/014920630002600509

Zhang, W., Li, J., & Mai, Y. (2019). The Effect of Industry Association on Firm Innovation in Chinese Private Ventures. *Management Decision, 57,* 2414-2435. https://doi.org/10.1108/md-05-2018-0538

List of Abbreviations

OC	Ownership Concentration
BS	Board Size
ES	Senior Management Shareholding Ratio
IDR	Proportion of Independent Directors
HS	Equity Balance Degree
II	Substantive Innovation of Enterprises
CS	Compensation Structure of Managers
R&D	Research and Development
SOE	State-owned Enterprise
ROA	Return on Assets
LEV	Asset-liability Ratio
VIF	Variance Inflation Factor
CCID	China Institute of Electronic Information Industry Development
SOEs	State-owned Enterprises
R&D	Research and Development
ESOP	Employee Stock Ownership Plan
OECD	Organisation for Economic Co-operation and Development
BP	Employee labor productivity
CEO	Chief Executive Officer