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Article

Optimization of corporate governance structures in ESG Practice: Corporate social responsibility synergies with the environment

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Abstract: Introduction: The growing global focus on Environmental, Social, and Governance (ESG) standards necessitates that companies optimize their corporate governance to balance economic, social, and ecological responsibilities. This study examines how the synergistic effects of Corporate Social Responsibility (CSR) and Environmental Responsibility (ER) can promote sustainable corporate development. **Objective:** The objective of this study is to analyze the critical elements of corporate governance structure optimization and to explore how companies can enhance their governance to achieve sustainable development through strengthened social and environmental management practices. **Methods:** The study uses case analysis and literature review to assess high-performing enterprises in CSR and ER integration, examining their governance, policy, and environmental strategies to uncover the factors behind their success in economic, social, and environmental spheres. **Results:** The research shows that optimizing governance structures markedly improves operational effectiveness. Companies need to create strong internal controls for equitable and transparent decisions, embedding CSR and ER into their strategies. CSR fulfillment builds public trust and environmental support, whereas ER improves brand reputation and competitiveness, driving sustainable and mutually advantageous development. **Conclusion:** The key to sustainable development in ESG practice lies in optimizing corporate governance and strengthening the synergy between social and environmental responsibilities. It is imperative for companies to build a governance structure that complies with ESG standards and to incorporate social and environmental considerations into their corporate strategies to effectively manage the triple bottom line of economic, social, and environmental performance.

Keywords: corporate governance; structural optimization; social responsibility; synergies

1. Introduction

In a time when corporate behavior profoundly affects global sustainability, an impressive 88% of S&P 500 firms disclose their CSR efforts, signaling a major shift. However, incorporating CSR and ER into governance is still a key issue. The Global Reporting Initiative finds that just 25% of companies have fully merged ESG into strategic planning. This paper explores the convergence of corporate governance and sustainability, assessing how firms can refine their structures to address urgent demands and spur innovation for enduring success. In line with the OECD's classification, our study acknowledges innovation in its dual forms: product innovation, which pertains to new or significantly improved products, and business process innovation, referring to the implementation of new or significantly improved processes within the firm. At the 19th CPC National Congress, the blueprint of the national development strategy places innovation at the center, and technological innovation is established as the fundamental driving force for sustained national

development. In our academic research, the author profoundly recognizes innovation's central role in national development, which drives economic growth and is the key to leading future changes and shaping international competitive advantages (Qi et al., 2024). Therefore, the author aims to build a modernized development system oriented toward market demand, deeply integrating industrial R&D and business practices and taking technological innovation as the core competitiveness. The core competitiveness of enterprises is significant in the pursuit of the overall improvement of the country's comprehensive strength. The sound development of enterprises is related to their prosperity and essential support for national economic stability and social progress (Bhandari et al., 2022).

Especially in the current critical period of economic transformation, innovation has become necessary for enterprises to maintain competitiveness in the global market and pursue high-quality products and sustainable growth. However, the process of innovation is full of challenges. It requires enterprises to face high uncertainty and invest many resources. Therefore, companies urgently need support from multiple stakeholders, including the environment, government, consumers, investors, and creditors. Such support is crucial for firms to address innovation risks and access high-quality resources to accelerate innovation. At the same time, high economic growth rates have created a series of social challenges (Maali et al., 2021).

In pursuing short-term economic benefits, some enterprises have neglected environmental protection, consumer rights and interests protection, and the rational use of social resources, leading to environmental degradation, damage to consumer rights and interests, and waste of social resources. These problems have attracted widespread attention in the academic community and have become essential factors constraining the sustainable development of enterprises. In order to meet these challenges, the State has put forward ambitious strategies such as a "dual carbon target," "carbon peak," and "carbon neutral," aiming to guide enterprises in undertaking environmental responsibility and actively promoting green development. At the same time, the State has also formulated and implemented a series of environmental policies to encourage enterprises to increase their environmental investment, raise their environmental protection awareness, and strengthen their environmental management (Liu et al., 2024). These policies will encourage enterprises to take environmental responsibility and accelerate the building of China's ecological civilization. In this process, enterprises play an essential role. They have not only assumed social responsibilities such as CO_2 emission reduction but also played a crucial role in fulfilling national innovation commitments and building innovation centers. Through technological innovation, product innovation, management innovation, and other means, enterprises enhance their competitiveness and contribute to the country's innovation development. At the same time, enterprises actively participate in international cooperation and exchanges, promote the optimal allocation and sharing of global innovation resources and contribute to developing the global innovation ecosystem. Encouraging enterprises to fulfill their environmental, social, and governance systems responsibilities and stimulating innovation vitality has become one of China's key development goals. This requires policy guidance, strong government support, and broad participation and joint efforts from all sectors of society. Only through the concerted efforts of the whole society can the author realize

sustainable economic, social, and environmental development and leave a better future for future generations.

Reform and enterprise are new growth opportunities. Pursuing the unknown means looking to the future. Increased investment in technological innovation can significantly enhance China's overall strength and core competitive advantages. Enterprises play a pivotal role in the innovation mechanism of society as a whole, not only as an essential pillar of the market but also as the core force of the social innovation system. Continuous enterprise innovation brings considerable profits for enterprises and is the solid foundation for their long-term development. In academic research, the correlation between the innovation potential of enterprises and national competitiveness has been widely explored. It is considered to have a far-reaching impact on economic growth, social progress, and the enhancement of the country's overall strength. This coupling relationship is particularly significant at the frontier of science and technology development, and therefore, stimulating the innovation vitality of science and technology enterprises has become an indispensable core element in enhancing national innovation capability (Neves et al., 2023). As a high-risk, high-investment process with uncertain results, technological innovation requires enterprises to achieve technological breakthroughs and make great efforts in innovation culture, mechanism, and resource optimization. However, due to various challenges in the innovation process, many enterprises feel they need more motivation on the innovation road (Aldowaish et al., 2024). To address this challenge, the government, enterprises, and all sectors of society should focus on promoting business innovation (Coelho et al., 2023). The government needs to formulate preferential policies, provide financial support, and create an innovative environment; enterprises should enhance their innovation capabilities, introduce and train talents, deepen cooperation between industry, academia, and research institutes, and promote the transformation of technological achievements (Yang et al., 2024).

Meanwhile, with the intensification of global environmental problems and the implementation of the Paris Agreement, enterprises should not only pursue economic benefits but also assume social responsibility, especially in the field of innovation (Niu and Wang, 2024). Through technological innovation, they develop environmentally friendly and efficient products and services to contribute to the sustainable development of society. The innovation potential of enterprises is closely related to national competitiveness and is a critical factor in promoting national development. In the face of the challenges in the innovation process, it is necessary for the government, enterprises, and all sectors of society to work together to create a favorable innovation environment, promote the integration of technological innovation and sustainable development, and realize the harmonious coexistence of enterprises and society. The structure of this paper is meticulously crafted to first set the stage with an introduction to the critical importance of ESG integration in corporate governance, followed by a literature review that establishes the conceptual framework, a methodology section detailing our approach to data collection and analysis, a results chapter presenting our findings, and concluding with a discussion that synthesizes the implications of our research and suggests directions for future inquiry.

2. Background of the study

Having established the urgency for corporate governance to incorporate CSR and ER, we examine the challenges and opportunities of today's business strategies. ESG integration is essential for sustainable growth, evolving from an option to a governance mainstay. This study's background highlights the shift in recognizing business practices' impact on the environment and society, signaling a need to reassess standard governance approaches. Into the 1920s, China set out the strategic goal of achieving peak CO_2 emissions and carbon neutrality, which meant that companies needed to take responsibility for innovation while pursuing technological innovation.2022, the government's Financial Control and Management Board established the Office of Science, Technology, and Innovation and the Office of Social Responsibility, which signaled the need for companies to not only promote technological innovation but also to fulfill their social responsibilities actively (Ma et al., 2023). The company will also need to fulfill its social responsibilities actively. To achieve the dual-carbon goal, the author must guide and strengthen technological innovation and effectively promote high-quality development in critical areas such as environmental protection and low-carbon emission reduction.

The investment strategy has significantly contributed to business innovation and is now widely recognized. To promote corporate environmental responsibility and improve social performance and corporate governance, it is recommended that companies focus more on the non-economic aspects of the message, especially throughout the development process, and set clear guidelines and structures for corporate innovation (Radu and Smaili, 2021). Promoting and deepening the implementation of corporate strategies has gradually become a key means for companies to realize economic transformation and move towards sustainable development, as well as an essential force for driving corporate innovation (Alkaraan et al., 2022). Compared to developed countries' environmental, social, and governance (ESG) concepts, China's conceptualization of ESG is still in its infancy. However, thanks to the strong drive towards dual carbon targets, Chinese ESG concepts have rapidly emerged and dominated the market. To drive robust and rapid progress and to make entrepreneurship and innovation competitive on a lasting basis, not only are leading forces within companies needed, but external forces also need to play a vital role (Huang et al., 2024). The academic field is divided on the impact of research outcomes on business innovation. Some scholars firmly believe that results can help business innovation, while others are concerned that these results may be a stumbling block to business innovation (Sancha et al., 2023). In addition, past research has focused on the single dimensions of the environment, society, or corporate governance. It has yet to address the combined impact of all three on business innovation.

In delving into the multidimensional impact of corporate governance on business innovation, this paper not only deepens the research on the economic effects of corporate governance but also complements the pool of elements that influence the dynamics of business innovation (Csedő et al., 2022). Current academic research provides a rich platform for scrutinizing business innovation, particularly the economic effects and indicators of corporate governance systems, from multiple perspectives, including environmental, social, and managerial (Hu et al., 2023).

Although researchers are divided on the correlation between performance and business innovation, and existing studies have been repeatedly questioned, this reinforces the need to explore the complex relationship between them further. Based on the current context of innovative development strategies and the concept of "dual-carbon sustainability," this paper provides a detailed analysis of digital change and institutional investor engagement in corporate governance effectiveness and business innovation processes to enhance corporate governance performance and the related assessment metrics steadily.

With the widespread acceptance of environmental, social, and governance concepts, this paper provides an in-depth discussion of the impact of strategic corporate governance on the innovation activities of Chinese listed companies from a realistic perspective (Kenneth et al., 2024). These findings are significant in promoting the cognition, popularization, and practice of sustainable development approaches, vital to enhancing innovation capabilities and strengthening the country's overall competitiveness (Ruan and Liu, 2021). In particular, the author emphasizes the need for companies to understand and integrate the concept of sustainable development better. In pursuing high-quality development, especially in fierce competition for technological innovation, corporate development strategies must fully consider their social responsibilities to achieve a harmonious symbiosis among enterprises, the environment, and society. To illustrate the practical implications of our research, we examine the case of Tesla, a frontrunner in the electric vehicle (EV) industry, which embodies the dual-carbon goals of reducing emissions and achieving carbon neutrality. Tesla's strategic integration of sustainable practices and innovation in its governance has not only distinguished it within the automotive sector but also accelerated the broader industry's shift towards sustainable transportation. This case exemplifies how companies can leverage ESG criteria to drive economic growth while addressing environmental and social responsibilities, underscoring the significance of our study in the current business climate.

E creates an environment based on the national environmental regulatory strategy, with particular emphasis on the central role of enterprises in environmental protection (Zeng et al., 2023). It calls on companies to focus on ecological protection in the development process, learn and adopt environmentally friendly production and operation modes, strive to minimize or avoid pollution, and avoid sacrificing the environment for the sake of short-term benefits (Zaporowska and Szczepański, 2024).***S*** is committed to coordinating and balancing the relationship between the company and its stakeholders, including employees, customers, products, supply chain, community and welfare at all levels (Budsaratragoon and Jitmaneeroj, 2021). The company not only pursues economic benefits but also actively fulfills its social responsibilities, focuses on the community's interests, and is committed to promoting the company's long-term and stable development. ***G*** stands for Corporate Governance, which focuses on the corporate governance structure, transparency, management compensation, executive independence, business ethics standards such as anti-corruption, the reporting system, and the management of negative information. This article conducts environmental correction analysis through time series simulation, and the combination of E, S, and G forms the foundation of enterprise structure optimization. The enterprise structure optimization model is shown in **Figure 1**.

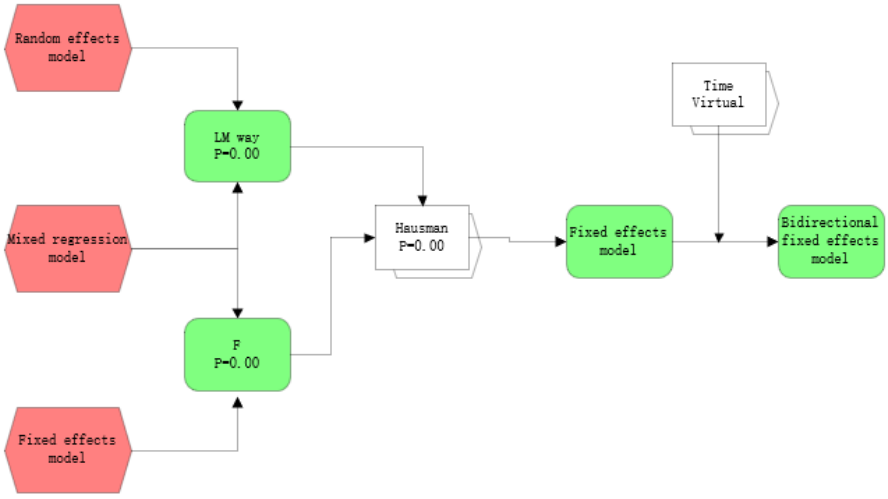

Figure 1. Enterprise structure optimization model.

3. Research methods

3.1. Synergistic effects of digital transformation on ESG and the environment

The ascendancy of corporate social responsibility (CSR) correlates with China's economic evolution from prioritizing growth velocity to valuing quality and sustainability. In this transformative phase, the advent of avant-garde technologies, including big data and cloud computing, has propelled the societal transition into a digital economy milieu. These technologies, instrumental in augmenting corporate productivity and innovation, also engender a more holistic and balanced performance trajectory as enterprises undergo digital transformation. This evolution is conducive to nurturing a business ecosystem imbued with corporate responsibility. Within this context, the present study meticulously examines the regulatory impact of emergent digital technologies on corporate ESG performance and the management of innovation. Additionally, the study delineates the rationale for the exclusion of specific sectors—namely finance and real estate—from the purview of analysis. The unique regulatory landscapes and market particularities of these sectors could potentially introduce extraneous variables, thereby risking the general applicability of our ESG and corporate governance insights. This exclusion is methodologically prudent to ensure the clarity and precision of our research findings.

Enterprise digital transformation means companies use digital technologies to completely revolutionize their operations, management, research and development, and manufacturing processes. By integrating and applying various modern technologies (e.g., information technology, communications technology), companies can profoundly change the character of their organizations, reshaping their structures, behaviors, and operating systems. The key to effective business management is to strengthen and innovate the supply chain and all aspects of the business. At the core of the digital transformation strategy is the ability to adapt to changes in the environment to improve operational efficiency. This transformation helps organizations achieve accurate and efficient extensive data management, strengthen their IT position, optimize the management of R&D processes, and ultimately achieve

cost savings and increased economic value. Digital technology's value lies in optimizing traditional factors of production through technological innovation and valuable data capabilities. Highly digitized companies can take this opportunity to adopt new thinking, implement innovative actions, and innovate with limited resources, thus optimizing productivity, accelerating innovation, and increasing the value of their business. These positive signals attract the attention of external investors and provide solid resources for long-term stable development.

The proposal of the dual carbon target encourages the capital market to make environmental sustainability its core investment criterion. The digital transformation has greatly promoted the flow and exchange of information, while also promoting the effective utilization of resources by various innovative participants. By adjusting production structure, optimizing process flow, and adapting innovative design to resource utilization, the knowledge base of technological innovation has been expanded, thereby improving the efficiency of enterprise production management and promoting efficient, low-carbon, and circular technological innovation. This not only achieves high-level development goals guided by environment and sustainable development, but also plays a key role in supporting data-driven and improving efficiency in business innovation processes.ESG needs to consider environmental, social, and governance efficiency, as well as cost factors, as shown in **Figure 2**.

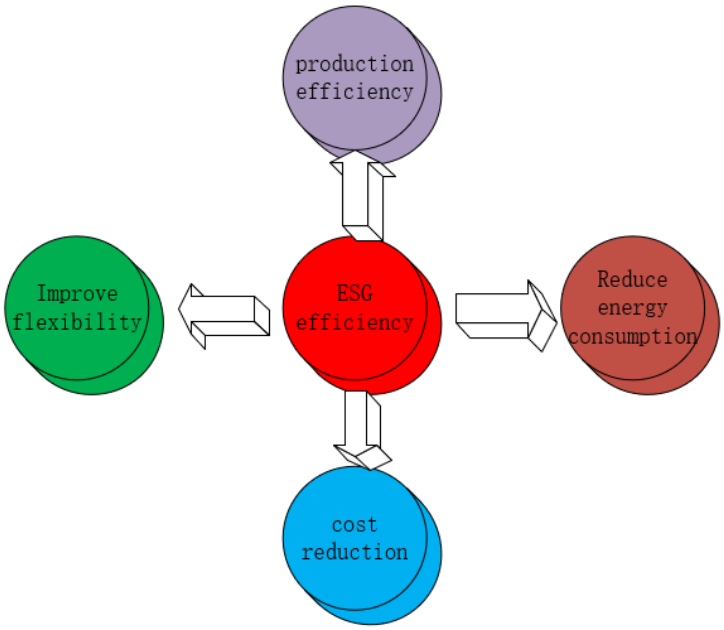

Figure 2. Environmental, social and governance efficiency.

3.2. Research design

Under the profound influence of digitalization, the relationship management of companies towards their employees, society, and multiple stakeholders has received increasing attention from academics, covering a wide range of dimensions such as employment security, respect for human rights, optimization of supply chain management, and safeguarding of customers' rights and interests. Against this backdrop, "intelligent decision-making" has become the signature decision-making mode in the digital and intelligent era, which can accurately insight and satisfy

consumers' urgent needs for personalized functions, products, or services, and thus occupy an advantageous position in the fierce competition in the market. The wide application of digital technology not only drives companies to focus more on critical economic and social values in traditional CSR, such as environmental protection and labor rights but also gives new connotations to CSR, especially emerging topics such as data management and algorithm regulation. By enhancing the application of data encryption and privacy protection technologies, companies can better protect consumers' personal information and rights, thereby winning their trust and loyalty. Digital transformation aims to enhance the transparency of non-financial information and demonstrate a company's unique value and style.

In our research, ESG performance is evaluated across environmental, social, and governance dimensions. Environmental metrics include carbon emissions and resource efficiency, while social metrics focus on employee welfare and community involvement. Governance is assessed by board diversity and transparency. We analyze the governance structure's impact on financial performance using ROA, ROE, and EVA, aiming to understand the link between governance and sustainable development synergies.

Digital innovation has greatly improved the efficiency of information exchange between enterprises and the outside world, breaking the boundaries of traditional organizational structures and building a networked business ecosystem. This ecosystem promotes the formation of new types of cooperative relationships, strengthens trust bonds among stakeholders, and provides a broader platform for collaboration between enterprises. More importantly, digital technology transforms the originally linear innovation chain into a complex and multi-directional interactive network in an open environment, making multilateral interactions between companies and their partners the core driving force for innovation, further driving business expansion and market expansion. Currently, business innovation is in a new era centered on innovation, collaboration, sharing, and mutual benefit. This era not only requires enterprises to have sharp market insights and excellent technological capabilities, but also requires them to establish deep trust relationships with various stakeholders, jointly explore the possibility of innovation, and achieve sustainable business development. This article delves into ESG registration and application solutions, discussing the service collaboration process of ESG from both public and private domains, as shown in **Figure 3**.

As shown in **Figure 3**, in the modern corporate governance framework, various subjective challenges often surface between companies and shareholders and within management, with opportunism and moral hazard being particularly prominent. Sometimes, companies utilize opportunistic strategies to pursue virtual corporate responsibility, by which they win the approval and support of stakeholders (e.g., revenue managers). However, with the onset of the digital revolution, the high availability and wide dissemination of digital technologies have effectively brought companies and stakeholders closer together while also revolutionizing corporate disclosures. Today, information asymmetry between stakeholders and companies is gradually decreasing, and companies' opportunistic tendencies are thus curbed, creating a more transparent environment for both parties to build deep and mutually beneficial relationships. This shift highlights the positive role of digitization in

reducing risk. When a company's decision-making system is based on digital transformation, managers can manage it more effectively, reducing decision-making errors and operational risks and resulting in the benefits of "accurate and efficient" business decisions. At the same time, digital transformation not only improves the efficiency and sensitivity of all aspects of internal control through the provision of advanced internal control management tools but also significantly improves the level of internal control by shifting from passive to active identification of internal control risks. This positive impact will continue to be optimized and strengthened by deepening digital transformation and creating an innovative environment.

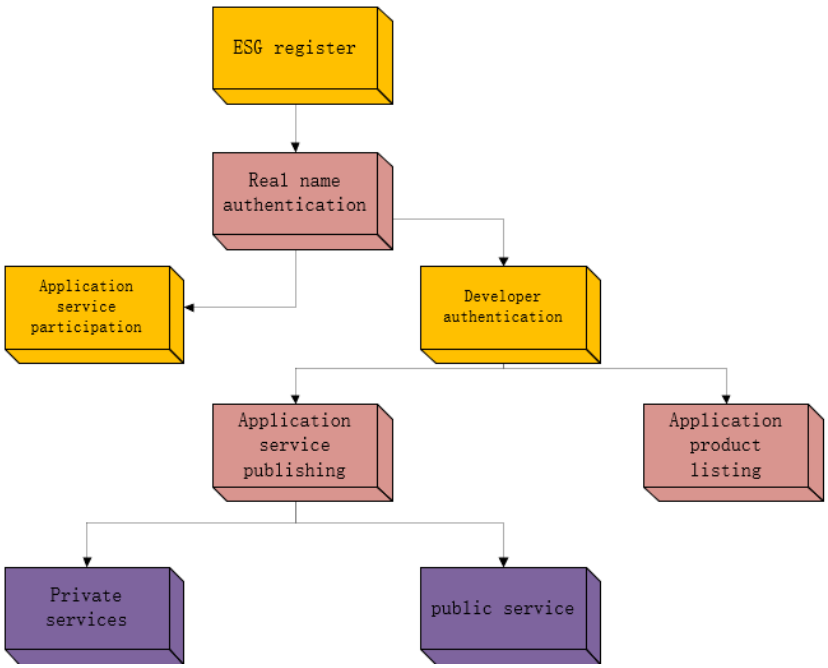

Figure 3. Synergy program service process.

In this paper, the research subjects are selected to be Chinese companies listed on the Shanghai and Shenzhen stock exchanges, whose investment data are mainly derived from WIND. In contrast, the patent data are taken from iFind and other relevant data provided by WIND and CSMAR. The author determined the sample period as 2009 to 2021 based on when the WIND CSM ESG ratings were released. It should be clear that the information covered in this paper: i) does not include samples from the financial and real estate sectors; ii) does not include samples labeled ST or ST*; and iii) has excluded data containing missing variables. To ensure the regression results' accuracy and minimize the effect of bias, the author has used 1% continuous cross-sectional data for the treatment. The specific vector explanation is shown in **Table 1**.

As a critical driver of R&D innovation, patents can effectively reflect a company's effective use of investment and further enhance its technological innovation capabilities. They are regarded as an essential measure of business innovation. Therefore, this paper chooses to use the number of patent applications as the basis of the study rather than the concept of innovation alone. Given the limited number of patent applications per year and uneven distribution of many companies,

the author has transformed the number of patent applications into a natural logarithm to reflect their actual impact better.

Table 1. Basic description of variables.

Variable type	Variable Name	Variable symbols	Variable measurement
Dependent variable	Enterprise Innovation	Patent	Add 1 to the total number of patent applications and take the natural logarithm
Explanatory variables	ESG	HZ_ESG	According to the ESG rating of Huazheng, assign a value of 1-9 from low to high
Adjusting variables	DIG index	DCGI	According to the sub indicators of big data technology, cloud computing technology, blockchain technology, artificial intelligence technology, and digital technology applications in the year The logarithm of the total number of occurrences in financial reports
	Institutional investor shareholding	Investor	Total shareholding ratio of various institutional investors
control variable	Enterprise scale	LEV	Total liabilities/total assets
	Profit level	Size	The logarithm of total assets
	Year	ROA	Net profit/total assets

Concerning the existing literature, other factors need to be considered, including, but not limited to, the firm's debt ratio (LEV), firm size, investment performance index (EPI), return on assets (ROA), fixed asset ratio (TANG), industry index (INDEX), cash flow ratio, capital intensity (FHELD), capital expenditure ratio (CAPEX), and revenue Growth rate (usually not expressed as "age," but may be misspelled or replaced by other suitable indicators). The synergies between environmental and structural optimization are modeled as follows:

$$Patent_{i,t} = \alpha_0 + \alpha_1 HZ\_ESG_{i,t} + \sum controls_{i,t} \quad (1)$$

In Equation (1), HZ is the environmental, social, and performance performance assigned with a score from 1 to 9. It $\sum controls_{i,t}$ is the sum of control variables.

$$ln\ D\ ig = \beta_0 + \beta_1 HZ\_ESG + \beta_2 DCG1 + \sum ind \quad (2)$$

In Equation (2), Dig is the index of digital finance's impact on ESG, and it is the impact of industry variables.

$$Patent = \gamma_0 + \gamma_1 HZ\_ESG_{i,t} + \gamma_2 Investor + \sum year \quad (3)$$

Equation (3) $Investor$ is the share of large investors, and year is the number of years of patents.

Performance is further modeled as follows:

$$ROA_{i,t} = \alpha_i + \beta_1 ESG_{i,t-1} + \sum_{i=2}^{n} \beta_i Control + \varepsilon \quad (4)$$

$$ROA = \alpha_1 LEV_{i,t-1} + \beta_3 ESG_{i,t-1} \times LEV_{i,\ t-1} + \delta_{i,\ t} \quad (5)$$

LEV is the leverage ratio, $\delta_{i,\ t}$ the least squares residual term ε is the performance residual term, and ROA is the debt-to-asset ratio.

In the model, based on environmental structure optimization and patent technology expansion (Equation (1)), further analysis was conducted on the impact of financial leverage ratio and DIG technology on data assets, in addition to environmental and social factors, as shown in **Figure 4**.

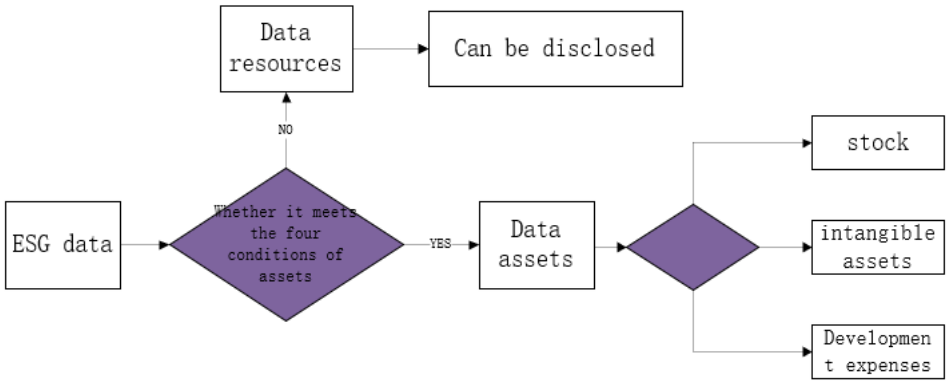

Figure 4. Data asset processing flow.

4. Results and discussion

4.1. The moderating role of investment

Based on the principle of organizational compliance, there is an implicit social contract between the company and its stakeholders, whereby the company is sanctioned by its stakeholders if it fails to achieve the desired development. To cut unnecessary costs, the company has adapted by implementing strategic strategies. Thus, external pressures can somewhat alleviate the pressure to perform and stimulate business innovation. The growing prosperity of the market economy has led to the rapid rise of institutional investors. The China Securities Regulatory Commission (CSRC) vigorously put forward an extraordinary strategy to develop institutional investors in 2000 to activate the capital market and optimize the investor structure. As a result, institutional investors have high expectations for the long-term sound development of their portfolio companies.

First, institutional investors have significant advantages in data collection, resource analysis, and development compared to individual investors. Not only can they provide more authoritative interpretations, but they can also accurately distinguish between a company's financial information and other relevant information and reveal the actual actions of investors and their effectiveness through diversified communication channels. To a certain extent, they support and monitor the activities of companies committed to sustainable development. Second, institutional investors have more significant influence over companies and are actively involved in decision-making processes closely related to their business. Their rational investment philosophy partially offsets irrational investment behavior, leading to better management decisions than ordinary investors. Institutional investors are more likely to choose long-term holdings over other shareholder choices, as traditional progressive voting tends to result in higher transaction costs. In previous studies, researchers conducted a dynamic examination of corporate responsibility and environmental efficiency for a year, where the time series was stationary ($P < 0.05$) and the fluctuations were within a reasonable range ($8000 < N < 11500$), as shown in **Figure 5**.

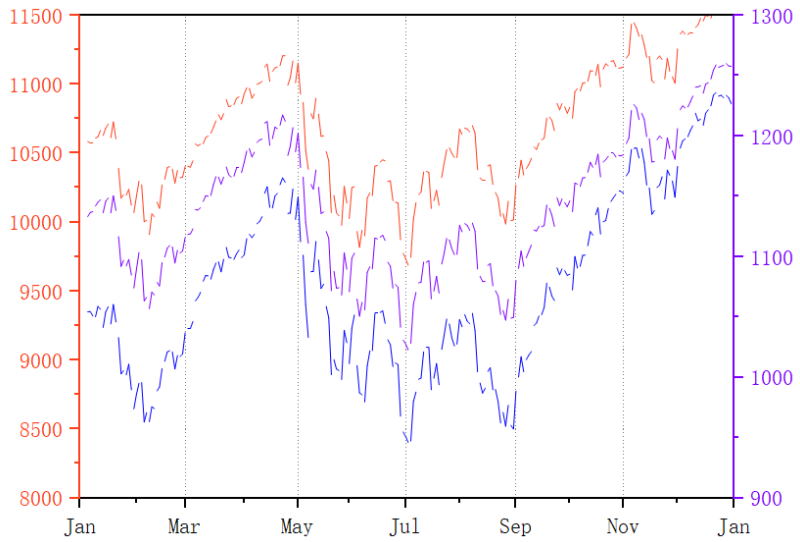

Figure 5. Liability and environmental efficiency based on time series.

In a typical business environment, institutional investors tend to collaborate rather than act in isolation, motivating them to actively engage in all aspects of corporate governance to drive and enhance corporate performance. In-depth analysis from the academic performance management perspective reveals that institutional investors have significantly contributed to the efficient, scientific, and professionalization of the corporate decision-making process by incrementally increasing their capital investment. In doing so, boards of directors fully recognize the value of institutional investors' professional guidance as a core component of the corporate governance structure and encourage management to fully incorporate institutional investors' long-term strategic vision in making critical decisions. Further, institutional investors are committed to capital investment and actively explore strategic paths that align with corporate development. By analyzing industry trends, corporate resources, and market opportunities, they aim to create sustainable value-added and drive innovation. As the proportion of institutional investors in the company's shareholding structure continues to increase, they have demonstrated a more vital willingness to participate and excellent governance capabilities, participating in corporate governance in a more in-depth and comprehensive manner, thus optimizing the governance structure of listed companies and significantly enhancing the overall effectiveness of governance.

From the perspective of investment institution behavior and shareholder expectations, DIG's corporate performance is better in terms of clustering effect, as shown in **Figure 6**; ESG performance has gradually shown a trend of synergistic effects, as shown in **Figure 7**. Further comparative analysis was conducted in section 4.2 of this article, and it was found that the synergistic effects showed a high level; When the financial risk of the enterprise is reduced ($P < 0.01$, N = 422), the synergy between the environment and society has increased, reflected in the increased coupling degree, as shown in **Figure 8**.

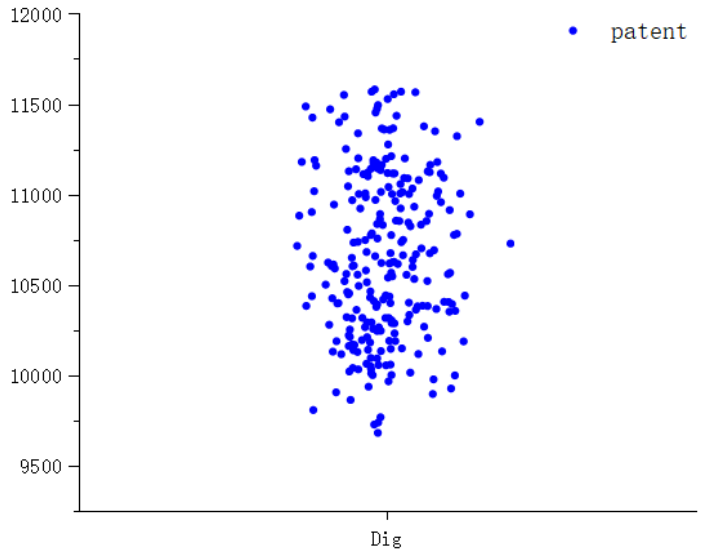

Figure 6. Dig's corporate performance.

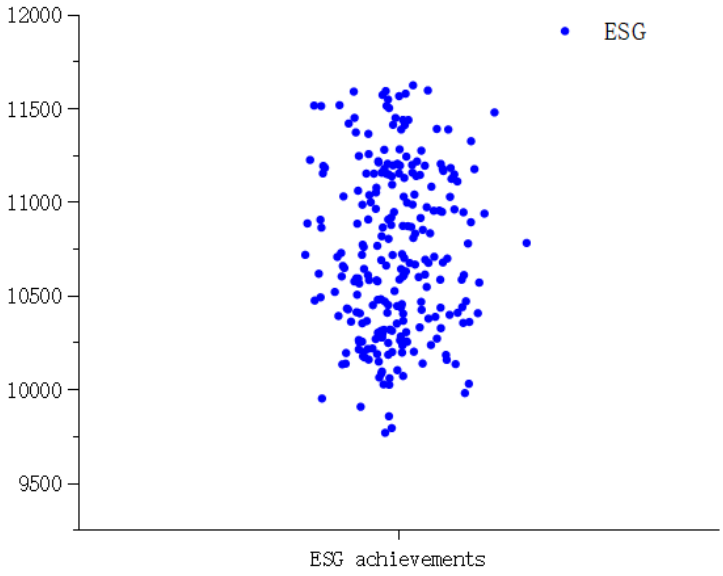

Figure 7. Synergies in performance assessment.

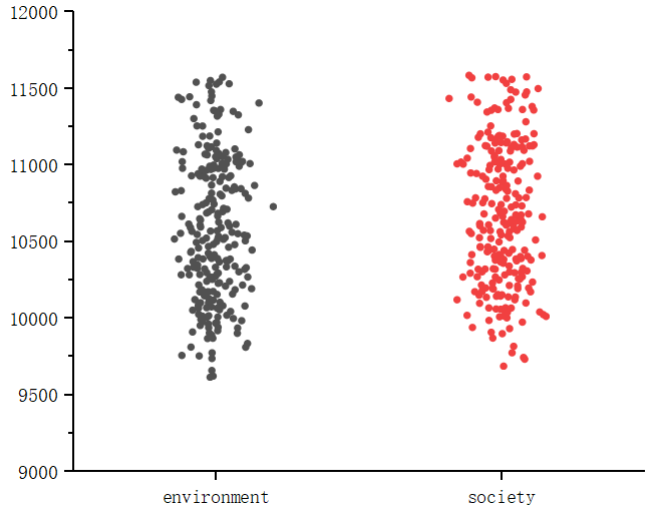

Figure 8. Comparison of environmental and social efficiency.

It has shown a significant positive impact on the dissolution of complex challenges in the management field, the reduction of information asymmetry, the curbing of potentially self-serving behavior by management, the reconciliation of conflicting interests among significant shareholders, and the deepening of the understanding of long-term corporate strategic planning. This not only helps to optimize the firm's internal management but also enhances the firm's ability to adapt to the external environment. Further, the board of directors, as the core stakeholder of the company, demonstrated a high sense of responsibility and professionalism in dealing with institutional investors with significant influence. They have developed strategies and solutions for institutional investors' long-term interests. They are conducive to the company's development through an in-depth understanding of the topics of concern to institutional investors. This positive interaction and cooperation enhances the trust relationship between the company and institutional investors and lays a solid foundation for the company's long-term development. The investment philosophy of promoting the overall interests demonstrated by institutional investors has received widespread attention. As the market places increasing emphasis on value creation and value-address, and as social responsibility becomes a focus of public attention, institutional investors have begun to devote more resources and energy to enhancing a company's core competitiveness and sustainable development potential. This shift not only reflects institutional investors' active commitment to social responsibility but also highlights their strong belief in the long-term value of companies. Therefore, altruistic investment motives have become one of the core driving forces for institutional investors to participate in corporate governance. Institutional investors realize the harmonious unity of their interests and social responsibilities by actively fulfilling their social responsibilities and promoting the healthy development of enterprises. This change in investment philosophy not only brings new development opportunities for institutional investors but also positively contributes to the sustainable development of society. Provide relevant descriptions of variables, as shown in **Table 2**.

Table 2. Descriptive statistics.

variable	sample size	mean value	standard deviation	minimum value	P50	Maximum value
Patent	422	4.025	2.032	0.000	6.324	8.624
HZ_ESG	422	3.987	2.614	1.305	3.914	8
DCGI	422	0.985	3.362	0	0.987	6.36
Investor	422	26.362%	26.314%	0.003%	36.151%	91.36%
LEV	422	4.012	0.321	0.063	0.141	0.635
Size	422	0.025	4.285	4.311	0.362	1.365
ROA	422	0.084	0.024	0.362	2.036	2.365

Institutional investors are not only able to monitor corporate social responsibility performance but also actively pursue altruistic investment objectives. At the same time, institutional investors can influence corporate social responsibility preferences by reducing or selling shares, which provides positive incentives for companies to fulfill their social responsibilities. In addition, institutional investors use the potential threat

of exit to force management to take on the dual mission of protecting shareholders' interests and fulfilling social responsibility. Institutional investors play a pivotal role in the market due to their deep insight. They maintain market order through regulation and promote innovation by providing information to technology-leading countries, effectively minimizing the risk of innovation failure, and providing the necessary support for target companies' R&D activities. Adhering to the principle of responsible investment, institutional investors stick to their investment philosophy. As a result, institutional investors holding stocks in diversified portfolios have a deeper understanding of low-carbon companies. Against the backdrop of improved social and natural environments, fiscal support has a significant positive impact on ESG ($\beta > 0$, indicating a positive fiscal correlation coefficient). Through the analysis of the synergy between environment and finance, it was found that the improvement in fiscal conditions has a significant driving effect ($P > 0.01$, ST = 0.423***), as shown in **Figure 9**.

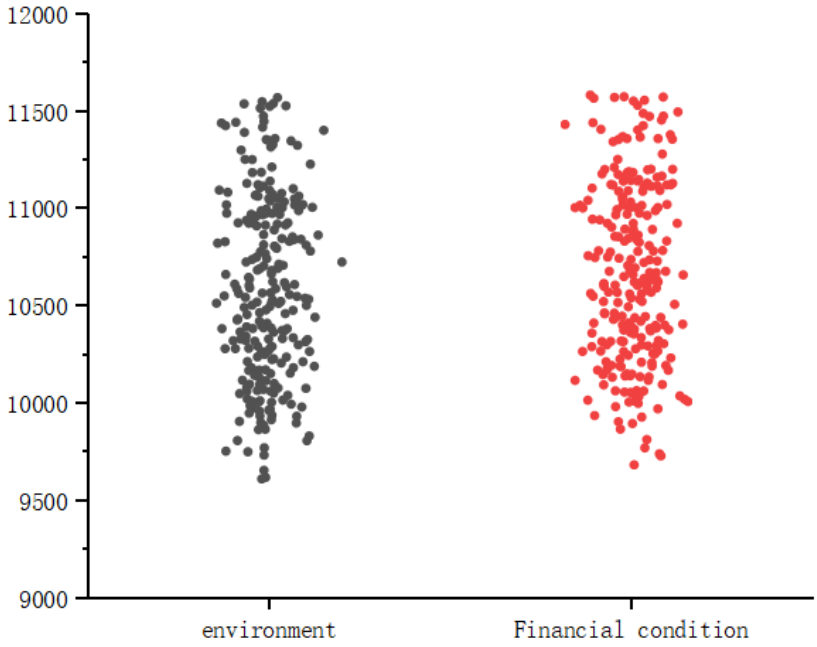

Figure 9. Environmental and financial conditions.

4.2. Relevant statistical results

The data shows that in terms of the number of patent applications, the maximum value is as high as 7892, while the minimum is zero, with a standard deviation of 1631, highlighting the significant disparity in innovation capabilities among enterprises. The level of digital transformation also varies significantly among enterprises, with the highest value reaching 5063 and a standard deviation of 1334, showing an uneven distribution of listed companies in digital transformation.

Based on the descriptive statistics analysis, different companies show significant variability in the gearing ratio (VAT), with the highest value reaching 0.865 while the lowest value is only 0.049, highlighting the considerable variations in the companies' debt levels in the sample. It is further observed that the mean value is 0.396 and the median value is 0.386, both below the critical value of 0.5, indicating that the debt level of the sampled firms is within a reasonable range. The average equity index (EPI)

value is 0.213. This data pattern suggests that the sample firms exhibit significant differences in their investment ratios due to the low percentage of fixed assets in total assets and the operational solid capacity of most firms. For the size of the sampled firms, the average size reaches 22,063 firms with a standard deviation of 1238, while the smallest size is 19.96 and the largest is as high as 26,026. These figures reveal the sample firms' relatively large size and significant differences between the sizes.

Further analysis reveals that the selected companies also show significant profitability differences, mainly reflected in the large gap between the highest and lowest values of ROA (Return on Assets). This pattern of data is a strong indication that the sampled companies are generally financially strong. The average percentage of ownership of independent directors is 37.484%. This high percentage shows the importance of independent directors in the company, and the possible reason behind this is the involvement of more than one-third of the independent directors. On the other hand, the mean stock concentration (FHELD) shows 33.959% with a median of 31.86%, which indicates that more than half of the companies in the sample data have a stock concentration of more than 30%, which further highlights the greater influence of significant shareholders with a standard deviation of 14.51 in the decision making of the company. It is worth noting that the stock concentration of firms within the sample shows significant differences. In terms of tax rate, the lowest tax rate is only 0.139%, which implies that some companies may face operational challenges. The cost of capital index (CAPEX) has a minimum value of 0001 and a maximum value as high as 0227, a significant difference that reveals the diversity of the sample firms in terms of investment in long-term assets and future earnings expectations. Observing the growth rate of net operating sales, its maximum and minimum values are 1.44, but it is noteworthy that the minimum value is harmful, reflecting the great diversity in growth potential of the sampled firms, especially those that show negative growth and low growth potential. Moreover, the standardized age difference of the firm is as high as 18.97 years, which reflects the significant period difference in the year of incorporation of the different firms. As for the rate of consolidation of the two businesses, it reveals the company's consideration of whether the two businesses are operated independently or not, as well as whether the CEO position is concurrent or not, indicating that more and more companies are focusing on the independence of the two operations and the arrangement of the CEO's position. The test for multicollinearity of variables is shown in **Table 3**.

Table 3. Multicollinearity test.

variable	VIF	1/VIF
Age	2.61	0.624
ROA	2.01	0.841
LEV	2.21	0.114
Size	3.63	0.002
DCGI	4.63	0.002
Growth	4.66	0.142
Mean	1.645	

According to descriptive statistical analysis, different companies show significant differences in their asset liability ratio (VAT), with the highest value reaching 0.865 and the lowest value only being 0.049, highlighting the significant differences in the debt levels of the companies in the sample. However, the effect of optimizing structural selection is not ideal, and the overall level is relatively low, as shown in **Figure 10**.

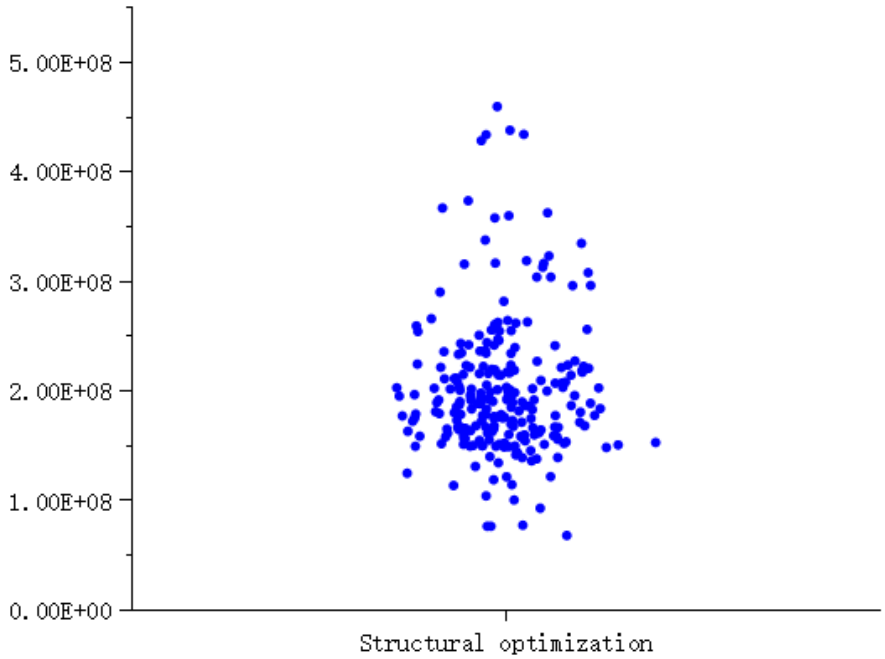

Figure 10. Efficiency values for structural optimization.

In exploring this paper, Pearson and Spearman executed a correlation test to provide insight into the multiple circularity properties of the variables. Observations show that none of the absolute correlation coefficients of these variables exceeded 0.8, which indicates the absence of a highly linear relationship between them. However, it is worth noting that although correlation analysis can reveal the association between the variables, it is difficult to gain insights into their internal interactions, which weakens its persuasive power to some extent. In addition, this study also focuses on the impact of digital change and institutional investor participation on firm performance and innovation activities, thus providing a more in-depth analysis of the resulting feedback. The author delves into the potential link between performance and firm innovation through a combined regression analysis (OLS) of 26,449 observations. The results show that the ratio between productivity (Hz) and business innovation (patents) is 0.182 and that this ratio exhibits a significant positive relationship (1%) considering sectoral, yearly, and regional variables, which indicates that financial constraints have a positive effect on driving business innovation. Well-performing firms show significant advantages in driving innovation. The concept of environmental, social, and corporate governance, defined as "sustainability," encompasses not only corporate social responsibility but also seeks long-term development companies long-term development in a broader social and environmental dimension. The basic regression results are shown in **Table 4**.

Table 4. Basic regression results.

Variable	(1) test	(2) test	(3) test
Patent	0.251***(19.351)	0.214***(18.67)	0.324***(30.325)
HZ_ESG		0.325***(0.032)	
DCGI		0.036***(3.62)	
Investor			0.002***(2.631)
LEV			0.635***(6.35)
Size	0.624***(28.614)	0.361***(6.354)	–0.847***(−3.625)
ROA	−0.947***(−5.64)	−0.514***(−3.48)	–0.957***(−5.62)

In **Table 4**, the *** symbol indicates statistical significance at the 1% level, denoting a robust and reliable result in our analysis.

The concept of environment, society, and corporate governance is defined as "sustainability", which not only encompasses a company's social responsibility, but also seeks long-term development at a broader social and environmental level. In the OLS analysis of enterprise environment, performance, and society, this article found that although performance has significant advantages compared to the other two items (N = 223, $P < 0.05$), the clustering effect of environment and society is significant, as shown in **Figure 11**.

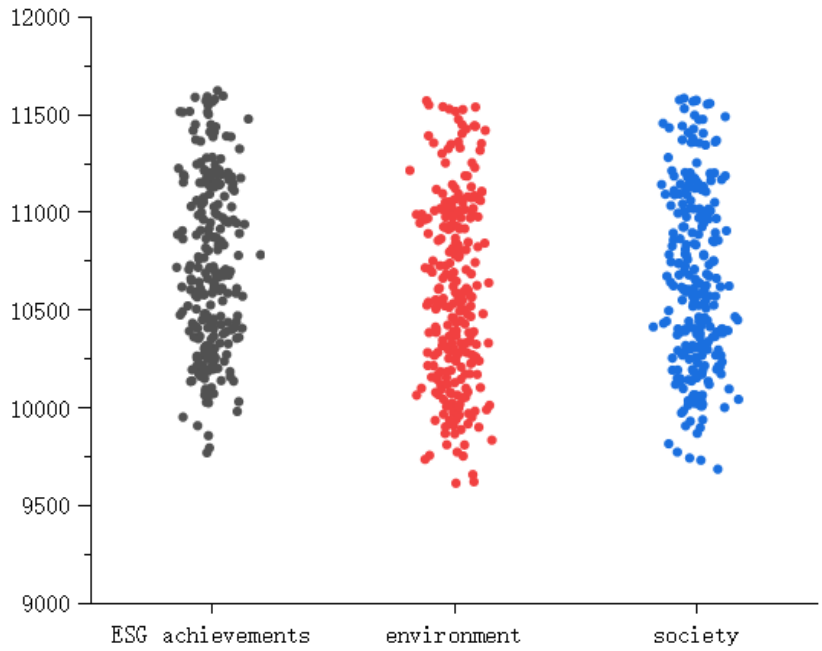

Figure 11. Overall efficiency vs. environment and society.

The positive value of conversion rate (DCG1), as a suitable average measure of digital conversion rate, significantly reveals a positive correlation interaction effect between performance (Hz) and the degree of digital transformation (DCG1), reaching a significant level of −1%. This suggests that more profound digital transformation reinforces the positive effect of performance on firm innovation and drives firm innovation regulation. As firms' digital transformation deepens, productivity gains

further broaden opportunities for technological innovation and become a critical factor in regulating the impact of productivity on corporate innovation. A company's innovation ability is closely linked to its keen insights into the latest market needs. Digital technology helps organizations to accurately capture user data, reveal dynamic changes in market demand by analyzing massive amounts of data, provide more accurate and comprehensive data support, and identify market players through data optimization. Digital change is susceptible to future technology trends, enabling organizations to quickly grasp innovation trends based on performance, improve the accuracy of technology innovation projects, and drive business innovation. This change not only reduces the cost of acquiring information but also reduces the cost of adapting and developing the innovation process, shortens the technological innovation cycle, accelerates the transformation of innovation results, and effectively reduces the risk of innovation.

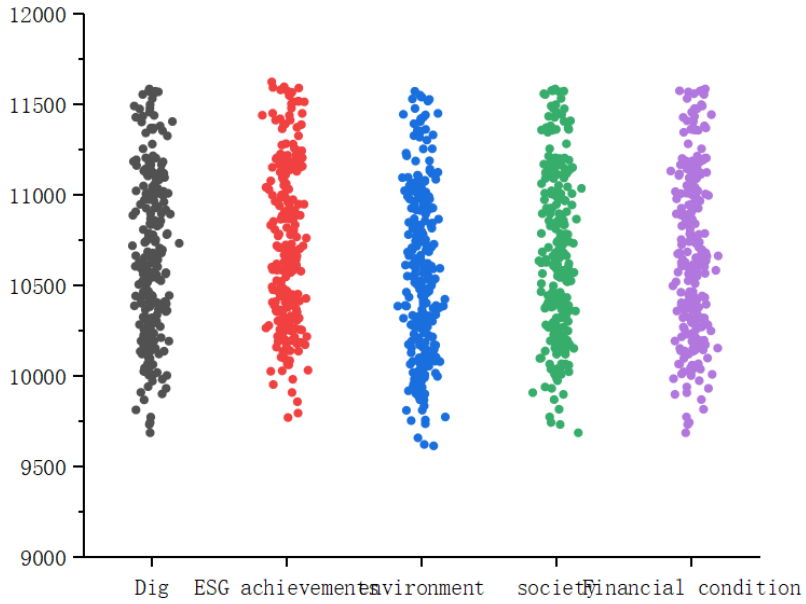

Figure 12. DIG and integrated efficiency evaluation.

As institutional investors' shareholdings in target companies continue to climb, their importance to the company is becoming more pronounced. They are increasingly focused on participating in corporate governance and are committed to improving the company's core competencies to achieve long-term profit goals. Due to high production costs and the difficulty of achieving significant results in the short term, management often needs to pay more attention to developing performance management systems based on opportunistic principles. In contrast, rule-following institutional investors are more inclined to actively monitor the company's development dynamics, focus on corporate governance, and pursue stable returns. They bring core expertise to professional investment and management research to create a pro-growth environment that allows companies to focus on innovation, enhancing and maintaining their sustainable competitive advantage. In addition, institutional investors are gradually expanding their capital commitments, forcing management to adopt more appropriate decision-making strategies to reduce short-

sightedness in R&D and innovation. Based on the research on the synergy between corporate responsibility and the environment, this article incorporates digital and financial conditions to conduct a joint synergy and coupling analysis. The results show that there is a high degree of synergy between DIG, FC, and ESG, and the coupling is also well achieved ($0.78 < E < 0.97$), as shown in **Figure 12**.

5. Conclusion

The optimization of corporate governance structures is essential in the context of environmental, social, and governance practices. This study delves into optimizing corporate governance structure in practice and pays special attention to the synergistic effects of CSR and environmental responsibility. First, the author recognizes that optimizing corporate governance structure is not only a need for the internal management of enterprises but also an inevitable requirement to respond to external standards and meet the expectations of investors and stakeholders. By optimizing the governance structure, enterprises can establish a more transparent, fair, and effective decision-making mechanism to consider social and environmental factors while pursuing economic benefits fully. Secondly, the synergy between CSR and environmental responsibility is critical in optimizing the corporate governance structure. By fulfilling their social responsibilities, enterprises can win public trust and support and create a favorable social environment for environmental protection. At the same time, the practice of environmental protection can, in turn, enhance the enterprise's brand image and market competitiveness, realizing a win-win situation for both the economy and the environment. This synergistic effect enables enterprises to balance better the interests of the economy, society, and environment and realize sustainable development. Finally, optimizing the corporate governance structure requires the leadership and decision-making wisdom of the enterprise's top management. They should deeply understand ESG concepts and integrate them into the company's strategic planning and daily operations. At the same time, enterprises must establish corresponding systems and mechanisms to ensure effective implementation and continuous improvement of practices. Our research adds theoretical depth by showing how aligning ESG practices with corporate governance is crucial for ethical standards and boosts organizational strength and innovation. It highlights that embedding ESG in governance can transform companies, broadening their sustainability goals. The study provides evidence that strong governance is key to maximizing ESG benefits, offering insights into how corporate duties align with economic success. By strengthening the synergy between CSR and ESG, companies can establish a more complete, efficient, and sustainable governance structure, laying a solid foundation for long-term development. Our research highlights how strong corporate governance, integrated with ESG values, drives sustainable growth. It shows that companies with effective governance and CSR/ER strategies perform better, with higher ROA and ROE. The study confirms the mutual benefits of good governance and sustainable practices, urging companies to make ESG a strategic priority. This work provides valuable guidance for implementing ESG in business strategies and policy. This study, though insightful, has limitations. It concentrates on top ESG performers, potentially restricting the applicability of results to firms with varying

ESG maturity. Future work should include a broader company spectrum and longitudinal analyses to track governance changes with evolving ESG demands. Investigating cultural and regional influences on ESG and governance could further enrich the field, aiding a holistic view of how ESG integrates with corporate strategies for sustainable progress. This study offers both theoretical and practical significance by advancing the discourse on ESG integration within corporate governance and providing actionable insights for organizations aiming to enhance their sustainability performance and long-term viability.

Conflict of interest: The author declares no conflict of interest.

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