

Research on the Impact of ESG Rating on Innovation in Chinese Enterprises

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Abstract. How to give full play to the innovative role of enterprises, implement the new development concept and achieve sustainable development of enterprises and society is an important issue of concern to all sectors of society in recent years. ESG is a new sustainable development concept about pursuing synergistic development of environmental, social and economic benefits, which provides a comprehensive framework for enterprises and investors to integrate environmental, social and corporate governance. Improving ESG performance helps a company win the recognition and support of its stakeholders, but it also means a reallocation of the company's limited resources. Therefore, what is the impact of practicing ESG concept on the development of corporate innovation? Does it cause crowding out of innovation activities, or can it promote technological innovation by enhancing ESG performance? This question needs to be studied in depth. This paper analyzes the impact of ESG performance on technological innovation by combining domestic and international literature on ESG and corporate technological innovation with relevant basic theories, and explores the specific paths of action, then introduces situational moderating variables from inside and outside the firm respectively to construct a mechanism model of corporate ESG performance affecting technological innovation. In the empirical research part, this paper selects A-share listed companies from 2011-2020 as the research sample, constructs a multiple linear regression model to verify the research hypotheses, and explores the differences in the impact of ESG performance on corporate technological innovation based on innovation heterogeneity and property rights heterogeneity. The results of the study show that : improving ESG performance of firms can significantly promote technological innovation of firms and works through the path of suppressing agency costs, reducing operational risks, alleviating financing constraints, and bringing human capital. Introducing internal and external contextual factors, we find that the higher the quality of internal control and the higher the degree of marketization in the region, the stronger the positive effect of ESG performance on the level of technological innovation. Compared to exploitative technological innovation, the promotion of exploratory technological innovation is more pronounced when firms improve their ESG performance, and the promotion of corporate technological innovation is greater for ESG performance in non-state-owned firms compared to state-owned firms. The findings of the study help to stimulate the intrinsic motivation of enterprises to implement ESG concepts and guide their technological innovation management practices.

Keywords: ESG rating; Enterprise innovation; agency costs; Soft constraints.

1. Introduction

1.1. Research background

ESG (Environmental, Social and Governance) is an abbreviation for environmental, social, and corporate governance. It is a new integrated concept that emerged in the pursuit of coordinated development of environmental, social, and economic benefits. It provides a comprehensive framework for enterprises and investors to integrate environmental, social, and corporate governance. For investors, ESG is an extension of modern social responsibility investment. When investors make investment decisions in the capital market, ESG differs from traditional corporate evaluation standards. ESG emphasizes the performance of corporate targets in terms of environment, society, and responsibility, rather than just focusing on corporate financial performance. For enterprises, guided by the ESG concept, their daily business management no longer only focuses on pursuing

financial returns as the goal, but also shoulders environmental and social responsibilities and values corporate governance, in order to achieve the unity of economic value and social value.

The research on the individual dimensions of ESG, namely environment, social responsibility, and corporate governance, can be traced back to 1978, but the discussion of ESG as a whole concept has only begun in recent years. As ESG concepts gradually penetrate into the development strategies and management processes of companies, ESG has also received increasing attention from scholars. The practice of ESG concepts in developed country capital markets has initially formed systematic research, and foreign scholars have conducted extensive discussions on ESG's impact on corporate performance, capital costs, stock market performance, corporate risk, and corporate value. However, due to the relatively short time that the ESG concept has entered the Chinese market, domestic scholars have relatively weak research on ESG, and most of it is theoretical research in the field of sound ESG systems. At the same time, there is also a small amount of empirical research on the impact of ESG on business operations. But with the continuous improvement of the domestic ESG system construction, its research value will also continue to enhance.

As a major strategic action of enterprises, it is generally believed that improving ESG scores can bring greater economic benefits to the enterprise. Will it provide assistance to technological innovation activities that are also part of the enterprise strategy? Many studies have confirmed that one aspect of environment, social responsibility, and corporate governance can have a positive or negative impact on corporate technological innovation, but there is very little research on the relationship between the overall dimensions of ESG and innovation. Improving ESG ratings for enterprises can help establish a good social reputation and gain support from internal and external stakeholders, but it also means reallocating limited resources for the enterprise. Therefore, what is the impact of implementing ESG concepts on the innovation and development of enterprises? Is it causing a crowding out of innovation activities, or can it promote technological innovation by improving ESG scores? There is currently no consensus in the academic community on the above issues, and there is a lack of in-depth exploration of the specific impact mechanisms in this process. Meanwhile, enterprise technological innovation is a complex activity with long-term and multi-party participation, which is inevitably influenced by the internal and external environment of the company. According to the theory of new institutional economics, the institutional environment not only directly affects the formulation of corporate management decisions, but also indirectly affects the implementation effect of corporate management policies by influencing the operation of internal governance mechanisms. Therefore, the degree of marketization, as a representative indicator of the external institutional environment of a company, may affect the ESG score of the enterprise, thereby affecting its technological innovation. Internal control, as a system arrangement that supplements the incompleteness of internal contracts, can guide and constrain various production and business activities of the enterprise, as well as affect the achievement of strategic goals, including the implementation of ESG strategies and technological innovation.

Therefore, this article takes A-share listed companies in China as the research object, focusing on the impact of ESG scores on corporate technological innovation, and deeply explores and clarifies the role path of ESG scores on corporate technological innovation; And based on the heterogeneity of enterprise property rights attributes and technological innovation types, the impact of ESG scores on technological innovation is refined.

1.2. Research ideas and content

This article is generally divided into six chapters, and the specific content is as follows:

Chapter 1 Introduction: Firstly, by analyzing the importance and development trends of ESG concepts, as well as the lag of empirical research compared to capital market practice, this chapter introduces the research background of this article, and summarizes the research significance of this article from both theoretical and practical aspects. Secondly, the literature on ESG and enterprise technological innovation was reviewed and summarized, exploring the areas for improvement in existing research and determining the research direction of this article. Finally, introduce the research

content and chapter arrangement of this article, and build the overall framework of the entire text; Elaborate on the research methods and technical roadmap used in this article, and explain the innovative aspects of this study.

Chapter 2 Conceptual Definition and Theoretical Basis, combined with relevant literature, defines the concepts of ESG and technological innovation in this article by introducing the proposal, development, and representative viewpoints of ESG scoring and technological innovation. Then, a systematic review was conducted on eight main theories related to this study, including stakeholder theory, principal-agent theory, information asymmetry theory, Schumpeter's innovation theory, Porter's hypothesis and signal transmission theory, corporate reputation theory, and resource dependence theory, laying the foundation for the hypothesis proposal in the next chapter of this article.

Chapter 3: Theoretical Analysis and Hypothesis Proposition. By analyzing relevant theories and referring to some viewpoints in existing literature, the mediating path of ESG score affecting technological innovation is inferred, and the research hypothesis of this article is proposed.

Chapter 4 Research Design mainly includes an explanation of the sample selection range and data sources, defining the important variables used in this article, explaining their calculation methods, and then designing an empirical model based on the research questions in this article.

Chapter 5 Empirical Analysis: Based on the collection and organization of data related to this study, descriptive statistics and correlation tests were conducted on the sample data. Multiple regression analysis and heterogeneity analysis were conducted according to the model. Then, the previous hypotheses were validated through the analysis of empirical regression results. Finally, robustness tests were conducted using the method of replacing core variables to ensure the reliability of the research conclusions.

Chapter 6 Research Conclusion and Outlook, based on the assumptions and empirical results in the previous section, summarizes and summarizes the research conclusions obtained in this article. Then, based on the research findings, corresponding suggestions are proposed to the management work of enterprises and governments respectively.

1.3. Research Methods and Innovations

1.3.1. Research methods

(1) Literature analysis method

Starting from the practical needs of high-quality economic development and innovation driven development in our country, this paper uses Chinese and English literature databases such as CNKI and WOS to sort out and analyze the latest research achievements and trends in the field of ESG and enterprise technology innovation, summarizes the current research status, and explores potential research space in the future. Based on this, the research questions and ideas of this article are clarified. Secondly, based on the current views of scholars summarized, this study combines stakeholder theory, principal-agent theory, information asymmetry theory, Schumpeter's innovation theory, Porter's hypothesis and signal transmission theory, corporate reputation theory, and resource dependence theory to analyze the specific impact mechanism of ESGp score on corporate technological innovation, and proposes hypotheses.

(2) Comparative analysis method

By comparing different studies on ESG, we can further deepen our understanding of the overall ESG; Propose a feasible and effective regression model by comparing financial data from different ESG companies with the regression data required for existing model assumptions.

(3) Empirical research method

Based on the research questions in this article, determine the scope of the research sample, and combine relevant authoritative literature to clarify the main indicators and measurement methods in this study. After collecting and organizing relevant data, based on the research model constructed in this article, use Stata15.0 data processing software to statistically analyze the sample data and verify the research hypothesis of this article. Firstly, conduct descriptive statistics and correlation analysis to understand the characteristics of the sample data, and preliminarily determine the correlation

between ESG scores, mediating variables, and various control variables with technological innovation. Secondly, multiple regression analysis was conducted to verify the main effect of ESG scores on technological innovation, as well as the mediating role of variables such as agency costs and financing constraints. Furthermore, heterogeneity analysis was conducted on different enterprise properties and innovation types, and corresponding conclusions were drawn. Finally, in the robustness testing section, the method of replacing core variables is used to verify the robustness of the conclusions in this paper.

1.3.2. Innovations

Compared with previous studies, the innovation of this article mainly lies in: firstly, based on the quasi natural experiment brought by the 2019 Huazheng Database's release of enterprise ESG scores, it enriches the relevant research on the influencing factors of enterprise innovation. Innovation is the core driving force for enterprise growth in the new era. Existing research has explored the influencing factors of innovation from multiple dimensions such as internal conditions and external environment of enterprises. However, as an important indicator for measuring the sustainable development ability of enterprises, ESG is rarely associated with enterprise innovation. This article finds that the publication of ESG scores can effectively improve the innovation level of enterprises and help enrich research in the field of enterprise innovation. Secondly, this article uses the number of patents cited by a company within one to three years to measure its innovation quality. Previous studies have mostly measured a company's innovation capability based on the number of patent applications or R&D investment. However, unlike these two indicators that can be observed in the current period, innovation quality is difficult to evaluate in a short period of time. This is because due to time constraints, third-party rating agencies can only observe the number and type of green patents applied by enterprises in the current year, and cannot determine the long-term quality of the cumulative citations of green patents applied by enterprises in the next few years. Therefore, it is difficult to include the quality of enterprise green patent citations in the rating assessment. Therefore, the market cannot determine the future citation quality of the patent, which may lead managers to adopt opportunistic behavior of increasing the number of explicit innovations but reducing the quality of implicit innovations in order to meet the current ESG rating pressure. In fact, compared to the current observable number of green patent applications, the future citation quality of enterprise green patents can better reflect the sustainable development goals of ESG, because patent citation can bring "win-win" benefits to enterprises and society. In addition, unlike existing literature that generally uses patent types to judge patent quality, even invention patents still have uneven quality. Measuring quality through market evaluated patent citations is more in line with the requirements of the 19th National Congress on "building a market-oriented green technology innovation system.". Thirdly, this article clarifies the impact mechanism of ESG rating disclosure on corporate innovation. Some existing studies have explored the transmission pathways of ESG's three sub dimensions on corporate innovation, but few have summarized the mechanism by which ESG ratings directly affect corporate innovation, and tested it through empirical evidence from a large sample. This article is based on empirical research and tests the two mechanisms by which ESG rating disclosure reduces agency costs and alleviates financing constraints on corporate innovation, providing a reasonable explanation for the relationship between ESG rating and innovation.

2. Literature Review

2.1. Research on ESG Scoring

ESG rating is a system that comprehensively evaluates enterprises from three dimensions: environment, social responsibility, and corporate governance. Its core focus is not on financial indicators, but on conveying to stakeholders issues such as corporate value orientation that traditional financial indicators cannot reflect, which is an important standard for measuring the green and

sustainable development of enterprises. Below, we will provide a specific discussion on the basic concepts, development history, quantitative research, and economic impact of ESG rating.

2.1.1. Basic concepts of ESG scoring

The ESG rating mainly discloses information on the environmental, social responsibility, and corporate governance dimensions of listed companies, and comprehensively evaluates the specific performance of enterprises in these aspects. For enterprises, a good ESG score represents market recognition of their investment and performance in environmental protection, social responsibility, and corporate governance. Among them, environmental indicators mainly focus on the environmental awareness and investment of enterprises in their production and operation, including strengthening and training of environmental awareness in daily operations, or corresponding measures taken in production. Specific indicators can include: the amount of waste emissions reduced in production, whether the enterprise uses renewable resources, the efficiency of energy use by the enterprise, whether the enterprise provides environmental protection related training to employees, and so on. Corporate social responsibility was first proposed by Thompson and Sheldon (1923), who believed that companies need to consider the needs of various groups of people both inside and outside the industry in their operations, and that ethical factors are also an important part of corporate social responsibility. Bowen (1953) formally defined the concept of corporate social responsibility, stating that businesses operate according to social goals and values, and make corresponding decisions based on government policies in order to achieve long-term development. Carroll (1979) further defined corporate social responsibility as four dimensions of economic, legal, moral, and social expectations, which have been widely accepted worldwide. From the perspective of indicators, factors such as gender composition, employee health and safety, product quality, public welfare and charity that will affect other types of people and even social development should be included. The indicator of corporate governance is defined by Shleifer and Vishny (1997) as a means for investors to ensure returns, and includes shareholders, creditors, and management in a unified framework, forming rights and obligations under legal constraints. Wu Jinglian (1994) [5] believes that corporate governance is an organizational structure that checks and balances each other, and its structure may include shareholders, management, etc. Therefore, corporate governance is not a rigid concept, and its connotation is constantly enriching. At present, the principal-agent problems that corporate governance attempts to solve can be roughly divided into the first type of principal-agent problems between company owners and managers, the second type of principal-agent problems between controlling shareholders and small and medium-sized shareholders, and the dual principal-agent problems that include both. In terms of indicator dimensions, it can include board independence and diversity, risk management, corruption and bribery management, executive compensation, and so on.

2.1.2. The Development History of ESG Scoring

The ESG related industry is developing rapidly, with over 600 rating agencies worldwide. China's ESG industry started relatively late, with only about 20 local rating agencies. The characteristics of Huazheng ESG rating include: 1. comprehensiveness: Huazheng ESG rating comprehensively considers multiple factors such as environmental, social, and governance, in order to comprehensively evaluate the sustainable development performance of enterprises. 2. Data driven: The rating process relies on a large amount of data and information, and is evaluated based on objective data by analyzing a company's financial statements, environmental data, social responsibility practices, and governance structure. 3. Standardization: Huazheng ESG rating refers to internationally recognized ESG standards and guidelines, making the rating results internationally comparable and helping investors make better cross-border investment decisions. 4. Transparency: The rating process has high transparency, and the rating standards and methods are open and transparent, which can enable investors to understand the basis of the rating and carefully analyze and apply the rating results. 5. Sustainability: Rating is not a one-time activity, but a continuous monitoring and evaluation process that can reflect changes and improvements in ESG by the enterprise. Since 2009, Huazheng ESG has continuously increased the coverage of rating reports, and the number of participating companies has

maintained a trend of increasing year by year. Currently, it has completed full coverage of listed companies.

2.2. Research on Enterprise Innovation

Innovation to a certain extent determines a company's operational ability, comparative advantage, market value, and investment return, and is an important manifestation of measuring whether a company has long-term competitiveness (Porter, 1992). Schumpeter (1934) pointed out that innovation should not be limited to the surface of products, but should include multiple dimensions such as adopting new equipment, opening up new markets, and changing the way funds are managed. Subsequently, domestic and foreign scholars have conducted extensive research on corporate innovation. As for the influencing factors of enterprise innovation, it is influenced by both its internal conditions and external environment (Feng Genfu and Wen Jun, 2008; Hsu et al., 2014). For the internal conditions of enterprises, existing research suggests that organizational structure (Zhong Yunjia et al., 2016; Cai Weixing et al., 2019), executive traits (Lin et al., 2011; Shen Yu et al., 2017; Yu Yihua et al., 2018), and financial characteristics (Pu Wenyan and Zhang Honghui, 2016; Zhang Xuan et al., 2017) all affect the innovation level of enterprises. In terms of organizational structure, Zhong Yunjia et al. (2016) examined the innovation efficiency of private enterprises before and after privatization based on China's mixed ownership reform, and found that the innovation efficiency of private enterprises in China is significantly lower than that of state-owned enterprises. Starting from the unique organizational structure of enterprise groups, Cai Weixing et al. (2019) found that enterprise groups can significantly promote innovation output, and this impact is more significant on the invention patents of enterprises. In terms of executive traits, Lin et al. (2011), based on data from private enterprises in some cities in China, believe that the education level and professional background of CEOs are positively correlated with the innovation performance of enterprises. Shen Yu et al. (2017) found a positive correlation between executive alumni networks and corporate innovation performance. Executive alumni networks can alleviate financing constraints and promote corporate innovation through information sharing mechanisms.

2.3. The Impact of ESG Scores on Enterprise Innovation

We believe that ESG rating strengthens external market supervision of enterprises by publicly disclosing information on environmental, social responsibility, and corporate governance. It may change the internal governance and financing environment of enterprises, thereby affecting their innovation level. Therefore, this article intends to explore the impact of ESG rating disclosure on corporate innovation from the perspective of ESG. Although there are currently few empirical studies on the relationship between ESG ratings and corporate innovation, ESG ratings mainly disclose information about the environment, social responsibility, and corporate governance of enterprises. Therefore, we mainly explore their impact on corporate innovation based on these three aspects of information. There are three hypotheses regarding the impact of corporate environmental investment on corporate innovation: the Porter hypothesis that supports its positive impact, the traditional hypothesis that supports its inhibitory effect, and the uncertain hypothesis that the effect is not clear. Scholars who support the Porter hypothesis believe that environmental investment by enterprises will promote innovation. They believe that the costs of environmental governance or compliance with rules will force enterprises to engage in green innovation, and the compensation effect of innovation can completely offset the costs.

2.4. Literature Review

The literature on ESG ratings and corporate innovation has laid a solid theoretical foundation for this study, but there are also some shortcomings:

Firstly, ESG rating and innovation are important metrics for sustainable development concepts, but there is little research linking the two. For enterprise ESG rating, existing research mainly focuses on ESG rating or its impact on enterprise economic performance and behavior. The former includes

multiple aspects such as business performance, financial performance, and financial institution performance, while the latter includes financing costs, corporate investment, and financial violations. For enterprise innovation, existing research generally believes that innovation is not only influenced by internal conditions, but also constrained by external environments. The former mainly includes multiple aspects such as organizational structure, executive characteristics, financial characteristics, etc., while the latter involves market environment, policy environment, financial environment, etc. Currently, there are few empirical studies linking ESG with innovation, so the correlation between the two needs further exploration.

Secondly, previous literature has found that when facing external market pressure, managers may develop a short-sighted mentality, sacrificing some long-term more valuable investment projects to maintain short-term stock prices to meet short-term market demand. Liu et al. (2021) found that managers tend to opportunistically emit higher intensity sulfur dioxide when facing profit pressures in the capital market, especially in areas with weaker enforcement. Tong et al. (2014) and Li Wenjing et al. (2016) found that corporate innovation is not about enhancing competitiveness, but rather about adapting to government policies and regulatory requirements through quantity and speed of innovation. Garvey et al. (2016) argue that ESG ratings only symbolically encourage companies to comply with external requirements for personal gain, and may not necessarily truly improve their sustainable development behavior.

Thirdly, the transmission mechanism of corporate ESG ratings on corporate innovation still needs to be clarified and tested. Existing research focuses more on the three ESG sub dimensions of environment, social responsibility, and corporate governance, exploring their impact on innovation. The theories involved include Porter's hypothesis, stakeholder theory, and agency theory. But in recent years, there has been a wave of development in the ESG industry. How ESG as a whole concept affects enterprise innovation, and the mechanisms involved will undoubtedly have a significant impact on the formulation of industry development strategies. Therefore, we need to clarify the transmission mechanism of corporate ESG scores on corporate innovation based on existing theories and literature, and further conduct empirical tests.

Fourthly, the transmission mechanism of the impact of corporate ESG ratings on corporate economic performance needs further exploration. Innovation is the core driving force for enterprise growth in the new era. Although existing research has focused on the impact of ESG ratings on enterprise value, it has not delved into the role of innovation in the relationship between the two. Therefore, it is necessary for us to further examine the mediating mechanism of innovation between the two. In response to the above shortcomings, this article explores the impact of enterprise ESG rating disclosure on enterprise innovation and the transmission mechanism between the two, and tests the economic consequences of enterprise ESG rating disclosure, in order to provide feasible suggestions for China's innovation driven sustainable development strategy in the new era.

3. Conceptual definition, theoretical basis, and research hypotheses

3.1. Conceptual Definition

3.1.1. Concept of ESG

The environmental, social, and governance dimensions in ESG encompass the three core dimensions of whether sustainable development of enterprises can be achieved. The ESG indicator focuses on non-financial information beyond obtainable information, which reflects the sustainable development social values that enterprises adhere to. ESG information can convey the corporate value orientation that traditional financial information is difficult to convey to stakeholders, avoiding investors from avoiding high-risk or "black swan" risk companies, and allowing stakeholders to receive high returns. To implement the ESG concept, enterprise managers prevent climate risks, policy risks, and ethical risks by improving capital operation efficiency, sustainable management, and

other direct or indirect impacts. They adjust and optimize the transformation methods of enterprises, which will efficiently promote the high-quality development of the industry.

3.1.2. Concept of ESG Information Disclosure

ESG information disclosure usually refers to the integration of current ESG information into social responsibility reports or sustainable development reports, and the dissemination of the company's efforts in sustainable development to various stakeholders or individuals. However, for a long time, although various stakeholders have been increasingly concerned about the non-financial performance of enterprises in environmental protection and social responsibility, there is no clear carrier to integrate ESG information. It was not until 2006 that Goldman Sachs officially released an ESG research report in accordance with the United Nations Principles of Responsible Investment (UN PRI), integrating ESG information together. Subsequently, domestic and foreign investment institutions have continuously deepened their ESG indicator system, evolving more comprehensive and systematic information disclosure standards for the three dimensions of ESG.

3.1.3. Measurement of ESG Information Disclosure

For a long time, although companies that disclose ESG information have been favored by investors, and domestic and foreign government organizations advocate for companies to disclose ESG information, most countries, including China, have not mandatory requirements for companies to fulfill their responsibilities related to ESG activities, let alone mandatory disclosure of ESG information. Most companies showcase their efforts in sustainable development activities and disclose ESG information annually in their social responsibility or sustainable development reports. However, due to the lack of regulatory and inspection requirements, the disclosed information may be biased. Therefore, many international professional institutions have developed ESG evaluation methods. Foreign companies such as Bloomberg and Thomson Reuters, as well as China's Huazheng ESG rating and Shangdao Ronglv.

Drawing on previous research, the ESG information disclosure scores of Huazheng and Shangdao Ronglv were used as the measurement indicators for information disclosure in this study. The ESG score of Huazheng Development is a mechanism to publicly indicate the level of corporate social responsibility information disclosure to market investors, and this indicator can transmit a certain degree of risk signal to many investors. Firstly, the ESG information data provided by Huazheng is obtained from the company's social responsibility report or sustainable development report, as well as other public media resources, making ESG ratings more in line with the standards for measuring corporate social responsibility activities.

3.1.4. Economic consequences of ESG information disclosure

ESG has only gradually entered China's field of vision in recent years, and few experts and scholars have conducted research on the possible economic consequences of ESG information disclosure. Therefore, when summarizing the relevant research results in this article, most of them are foreign experts and scholars, providing a reference basis for this article. How ESG information disclosure affects the financial performance and ultimate corporate value of micro enterprises has always been a hot topic of academic debate.

More recent research findings suggest that ESG information disclosure can bring positive economic returns to businesses. Non-financial information can be used to predict a company's expected future finances. A survey by Merrill Lynch Bank found that companies engaged in more ESG investments can avoid about 90% of bankruptcies when their operations are poor. Yu et al. (2018) also found through their study of the relationship between ESG transparency and corporate value in 49 countries that for most listed companies, the benefits of ESG information disclosure outweigh the costs. Other researchers have reached similar conclusions that companies with more transparent ESG information disclosure, due to their higher operational reputation than other companies, reduce reputation risk and are more able to obtain investments at lower costs. Cheng et al. (2014) also pointed out that companies with higher actual ESG scores can indeed benefit from lower capital constraints.

3.1.5. Innovation performance

Similar to concepts such as organizational performance and financial performance, it is an evaluation of the efficiency and effectiveness of enterprise business activities. Innovation performance generally refers to the evaluation of the efficiency and effectiveness of enterprise technological innovation activities. In foreign literature, two terms are commonly used to describe the technological innovation results of enterprises, one is "Innovative performance"; the other is "Innovation success". Domestic literature often uses "innovation performance" as a term to evaluate the technological innovation activities of enterprises.

HAGEDoor and Cloudt (2003) et al., based on a comprehensive study of some scholars on measuring innovation performance, used four indicators: R&D investment, number of patents applied, number of cited patents, and number of new product developments, and measured the innovation performance of approximately 1200 sample enterprises in four high-tech industries in the United States.

Similarly, some domestic scholars have measured innovation performance from two aspects: innovation benefits and innovation efficiency, with indicators generally including ① the number of new products; ② The number of patents applied for; ③ The proportion of new product output value to total sales; ④ The development speed of new products; ⑤ The success rate of innovative products. In addition, Gemunden et al. used the term "innovation success" instead of "innovation performance" to describe the results of innovation. This does not include specific indicators such as R&D investment and patent applications, but expands the scope of innovation and covers concepts such as innovation efficiency. The content includes two aspects: product innovation success and process innovation success.

3.2. Theoretical Basis

3.2.1. Stakeholder theory

Since 1984, stakeholder theory has been around for almost 40 years, and it was first proposed by Freeman. Unlike traditional enterprises that pursue the maximization of enterprise value or shareholder equity, stakeholder theory focuses on the numerous interest groups of the enterprise and strives to achieve optimal returns for each interest group. The successful development of an enterprise cannot be separated from the support of various groups of people. Stakeholders must think about the survival and development of the enterprise from a human perspective, and in order to prolong the development life cycle of the enterprise as much as possible, they must start thinking about how to meet the interests of stakeholders and achieve maximum returns. In the development process of stakeholder theory, only the driving force of practice and the problems exposed in the process can drive its development and test its accuracy. At the beginning of the discussion on stakeholder theory, Freeman used it to explain why companies should engage in social responsibility.

3.2.2. Principal Agent Theory

The principal-agent theory is a fundamental theory of modern corporate governance, which can be traced back to a passage proposed by Adam Smith in his book "The Wealth of Nations". He believed that for joint-stock companies, because owners only have residual distribution rights and do not have actual management rights, operators are not completely loyal to owners and there is always waste in handling company affairs. The separation of ownership and management rights of enterprises has brought about the problem of agency. The assumption of "economic man" is a prerequisite for this theory. The principal-agent theory suggests that under the framework of modern corporate governance, both the principal and agent of a company pursue the maximization of their own benefits, but their utility functions are different. As the principal, the owner of the enterprise pursues the maximization of their own wealth, which requires the premise of realizing the value appreciation of the company, while as the agent, the manager pursues personal benefits such as salary and benefits, personal reputation, and social status maximization. At the same time, as managers, managers can directly participate in the daily business decision-making process of the enterprise and have a better

understanding of the enterprise. However, owners of the enterprise generally rarely participate in the actual business management process of the company, and they have less information than managers. There is a certain information asymmetry between the two. In this situation, managers may sacrifice shareholder rights to achieve their own interests, resulting in "moral risks" and other issues in the principal-agent relationship. Therefore, for the principal, i.e. the owner, of the company, a series of effective measures should be formulated to effectively restrain the agent, i.e. the company manager, from engaging in behaviors that harm the company's benefits and alleviate the principal-agent problem between the two parties.

3.2.3. Theory of Information Asymmetry

The theory of information asymmetry refers to the situation where two or more groups, due to the different positions of the subject and object, hold different levels of information depending on their location. In most cases, the amount of information they hold determines who holds the initiative in economic activities. Based on this, two types of problems have emerged: moral hazard and adverse selection. In practical problems, the first type of problem often leads to the use of one's position for personal gain. A common case is when fund managers use free riding to engage in "rat trading" activities, which not only touches the moral bottom line but is also legally prohibited. The occurrence of the second type of problem is usually more disrespectful. One party, due to their own possession of more information, engages in behavior that harms others and benefits themselves in the face of interests. If a certain product is profitable and there are a large number of counterfeit and inferior products in the market, price distortion and uneven quality will occur, and good products will eventually be squeezed and taken off the shelves.

3.2.4. Schumpeter's Innovation Theory

When Schumpeter proposed the traditional innovation theory, it scientifically unraveled the mystery of how enterprises can have a more competitive advantage and achieve value appreciation. In the mid to late 19th century, which was an era of war and chaos, economic development was sluggish, and crises occurred frequently. Scholars of various schools used Schumpeter's innovative theory to dig deeper into the development path of economic recovery. It has been proven that Schumpeter's innovation theory provides an effective theoretical basis for economic development and achieving economic recovery. This theory believes that technological progress and reform of production management methods can both promote innovation, which provides an explanation for the connotation of economic development. Innovation is the driving force, and economic development originates from innovation. Nowadays, social progress and economic development are no longer suitable for the original predatory development mode. Domestic and foreign societies have been actively seeking economic models that can achieve sustainable green development. At this time, enterprise innovation has become a key to opening the door to economic realization. But now there is a doubt about what kind of innovation innovation is, whether traditional innovation theories can be applied to the background of ESG, and whether innovation can still play a positive role in economic development for enterprises while balancing ESG. In order to encourage enterprises to innovate, the role of government environmental regulation has gradually emerged, and the Porter hypothesis has emerged.

3.2.5. Porter hypothesis

The Porter hypothesis suggests that the intensity of environmental regulations has a significant impact on the innovation activities of enterprises. Timely environmental regulations not only do not have crowding out and restraining effects on enterprises, but can also offset the pollution costs generated by previous "dirty" technologies, achieve positive growth in net income, and achieve a win-win situation between environmental and economic benefits. Research has shown that green products can reach customers who are more sensitive to environmental issues, enabling them to accept the premium of green products and achieve a differentiated business model, thereby gaining profits from the premium. This is also in line with the explanation of traditional innovation theory. Nowadays,

theoretical research on innovation can be continued from traditional Schumpeter's innovation theory and developed from Porter's hypothesis. In recent years, China has been striving to achieve high-quality development and maintain the harmonious development of ecological civilization, which is in line with the current development goals. In order to achieve this goal, the country vigorously promotes various environmental protection regulations to promote the green transformation and upgrading of enterprises. This article is based on this and examines whether ESG has achieved micro incentives and improved the innovation ability of enterprises under the call of the country.

3.3. Research hypotheses

3.3.1. The Impact of ESG Scores on Enterprise Innovation

Based on stakeholder theory and resource dependence theory, when a company invests a certain amount of resources in implementing ESG strategies, it helps to maintain relationships with stakeholders, establish a wider and closer network of cooperative relationships, and obtain the necessary financial, knowledge, information, and other resource support for various aspects of technological innovation from the network, promoting the smooth progress of innovation in various environments. For example, in the investment process of technological innovation, enterprises can obtain financial support from creditors and knowledge and technical support from upstream suppliers by establishing and maintaining relationships with stakeholders such as suppliers and creditors.

Enterprises with good ESG scores also pay more attention to improving supervision mechanisms and improving supervision efficiency. Major shareholders can effectively constrain and supervise the behavior of executives through their own power, suppress their opportunistic behavior, promote executives to actively carry out innovation activities based on the long-term development of the enterprise, and thus promote enterprise innovation. Based on the above analysis, this article proposes hypothesis 1.

H1: A good ESG score helps promote innovation in enterprises.

3.3.2. ESG ratings and technological innovation: mediating effects

(1) Suppressing agency costs

Due to the uncertainty and long-term nature of the returns from technological innovation activities, it is difficult for management to receive immediate personal reputation improvement and work performance rewards. Therefore, there is often a lack of motivation when conducting research and development innovation. According to the principal-agent theory, managers may be motivated by self-interest and invest more energy in investment projects that can bring them more personal benefits and faster returns, rather than innovative activities, leading to the problem of technological innovation shortsightedness. This article believes that implementing the ESG concept in enterprises can reduce the agency costs between owners, shareholders, and managers, thereby promoting enterprise innovation.

In summary, this article proposes hypothesis H2: A good ESG score promotes technological innovation in enterprises by reducing agency costs.

(2) Reduce operational risks

According to reputation theory and stakeholder theory, actively assuming ESG responsibilities can establish a positive public image, form moral and reputation capital, enhance social trust, and ultimately influence the behavior of stakeholders towards the enterprise. For example, when a company faces problems such as supply chain disruptions, customer churn, and financing difficulties caused by the deterioration of the external business environment, a good ESG score helps the company maintain a good cooperative relationship with supply chain partners and reduce production and operational risks caused by supply chain changes; Beneficial for enterprises to enhance customer loyalty and reduce the risk of fluctuations in operating income; Beneficial for enterprises to gain the trust and support of investors and creditors, enabling them to better cope with financial deterioration when facing operational difficulties. Thus, when the external business environment of the enterprise deteriorates, it can play a certain "insurance" effect, maintain the stability of the enterprise's business

situation, improve its risk resistance, and focus on dealing with technical problems when facing uncertain external environmental impacts, promoting technological innovation of the enterprise.

In summary, this article proposes hypothesis H3: A good ESG score promotes technological innovation in enterprises by reducing operational risk.

(3) Relieve financing constraints

Based on signal transmission theory and stakeholder theory, a good ESG score conveys positive information about the enterprise, which is beneficial for establishing a good image and gaining support from stakeholders. On the one hand, the better the ESG score of a company, the more committed it is to environmental protection and actively assuming social responsibility. In recent years, the government has incorporated environmental protection and corporate social responsibility into the performance evaluation system. The behavior of enterprises to improve their ESG scores meets the expectations of stakeholders such as the government and regulators, which helps them obtain external financial support such as government subsidies. On the other hand, the better the ESG score of a company, the better its operating conditions and sustainable development capabilities. Only companies with better operating conditions are more willing to take on environmental and social responsibilities, continuously improve their corporate governance level, and companies in crisis may be unable to do so even if they have the intention. Therefore, investors choosing these companies as investment targets will have a greater probability of obtaining expected returns. At the same time, a higher ESG rating level indicates that corporate governance mechanisms are sound, and investor interests can be better protected. These positive signals can enhance investor confidence in the company, making it easier for the company to gain favor from external investors and obtain more funds from them. Therefore, a good ESG score can help reduce the cost of capital for enterprises, provide financial support for enterprises, expand the sources of funding for technological innovation activities, and enhance their innovation capabilities.

In summary, this article proposes hypothesis H4: A good ESG score enhances corporate innovation by alleviating financing constraints.

(4) Enhancing human capital

Managers and personnel engaged in research and development activities in enterprises can acquire information and knowledge from the collaborative network through learning and communication, effectively enhancing the knowledge stock of internal personnel, and thus triggering the innovation potential of the enterprise. In addition, enterprises that actively practice the ESG concept focus on employee training and improving the work environment, which can cultivate more knowledge and skilled talents for the enterprise, enhance employee sense of belonging, stimulate employee creativity, and promote the continuous development of innovative activities.

In summary, this article proposes hypothesis H5: A good ESG score promotes technological innovation in enterprises by enhancing human capital.

(5) Increase media attention

Media attention has a significant impact on a company's environmental, social, and governance (ESG) performance. On the one hand, active media attention can help companies establish a good ESG image, enhance their social reputation and brand value. Positive media coverage can enhance public awareness of corporate environmental protection, social responsibility, and good governance, and enhance the image and reputation of enterprises in ESG. This helps to attract support from investors, consumers, and employees, providing more resources and opportunities for sustainable development of the enterprise. Secondly, media coverage can also help companies obtain more market feedback and user demand information, thereby guiding them to better carry out product research and innovation. In addition, media promotion and reporting can motivate employees within the company, enhance team cohesion and innovation motivation, and drive continuous technological and business innovation in the enterprise.

In summary, this article proposes the hypothesis H6a: a good ESG rating promotes the number of innovations in enterprises by increasing their media attention.

On the other hand, too much media attention can have soft constraints on the quality of innovation for enterprises, leading them to innovate in both quantity and speed to meet the demands of market media and government. The use of higher quality green patents in research and development not only fails to further enhance ESG ratings to obtain excess returns, but also increases additional costs for enterprises, resulting in a lack of effective incentives to enhance substantive innovation and leading to formalistic behavior in enterprise innovation. Due to the fact that financial analysts and media can only provide corresponding support based on the ESG rating signals of enterprises, and cannot identify the quality of short-term patents of enterprises, when the improvement of patent quality cannot obtain more compensation from the market, this phenomenon of meeting soft regulatory standards will become more common. Market media attention to soft regulatory shocks will distort micro enterprise innovation behavior.

In summary, this article proposes the hypothesis H6b: a higher ESG score reduces the quality of innovation for enterprises by increasing their media attention.

4. Chapter 4 Research Design

4.1. Research Samples and Data Sources

ESG started relatively late in China and is a relatively new field. The statistical start year for ESG rating data in the Wind Huazheng ESG database is 2009. This article will collect innovation data from companies listed on A-shares from 2009 to 2021, excluding the financial industry. This article uses Stata15 to perform a series of processing on the sample: (1) excluding financial and ST companies; (2) the financial data used in the study mainly came from CSMAR and RESSET databases. For some missing values, this study tried to find and fill them in through various methods such as enterprise annual reports and Wind databases; (3) Perform Winsor truncation on all continuous variables at the 1% level to reduce the potential impact of extreme data values on regression results. Among them, ESG scores are from the Wind database, relevant innovation indicators are from the State Intellectual Property Administration, and other variable data mainly come from the CSMAR database.

4.2. Variable Definition

4.2.1. Explained variables - quantity and quality of enterprise innovation

Referring to previous practices, measure the number of enterprise innovations (INNOV-PAT) based on the number of patent applications filed by enterprises. Specifically, the number of invention patent applications, utility model applications, and design applications are added together, and the total number of patent applications is added by 1 to take the natural logarithm to eliminate the problem of right skewed distribution of patent data. Due to the lag of innovation, investment in innovation may not produce patent results in the current year, but in one or two years. Therefore, the number of patents applied by enterprises one to three years later is taken, Take the logarithmic $\ln(1 + \text{number of patents})$. Due to the fact that the number of green patent citations in the database for the current year includes citations from past green patent applications, it is not targeted; However, without time constraints on the number of patent citations applied for that year, it will lead to a lack of comparability between company patent citation data, as the later the patent application year, the fewer citations during the sample period. Therefore, drawing inspiration from Lahiri's method, based on the green patent citation data from the CNRDS database, manually organize and match the sum of the green patent citations applied by the enterprise in the next two years, and then add 1 to take the natural logarithm to measure the innovation quality of the enterprise (INNOV-CITE).

4.2.2. Explanatory variable - ESG score of the enterprise

The core explanatory variable of this article is enterprise ESG performance (ESG), which refers to the degree to which enterprises participate in ESG concepts. There are two main methods in existing literature to measure the ESG performance of enterprises: one is to construct indicators independently, but this method may have strong subjectivity and insufficient information coverage;

the second is the ESG rating of mature independent third-party institutions. Taking into account the comprehensiveness, accuracy, and applicability of various evaluation methods, this article refers to the approach of GAO Jieying Et Al. (2019) and constructs the core explanatory variable ESG score based on the Huazheng ESG evaluation system.

4.2.3. Mediating variables

(1) Financing Constraints (KZ)

The most commonly used metrics for measuring financing constraints in current research include the KZ index, WW index, and SA index. The WW indicator requires a large time span and a large number of companies, while the SA indicator is established using two external variables: company age and asset size. However, the choice of variables is limited and the representativeness is insufficient.

Referring to the methods of domestic scholars, the KZ index is constructed by selecting five financial indicators, including operating cash flow and Tobin's Q value, which represent the characteristics related to financing constraints, such as the company's financial status, debt paying ability, and investment opportunities. Then, a comprehensive indicator is calculated by grouping and orderly Logit regression to measure financing constraints. The larger the KZ index, the more severe the financing constraints.

(2) Agency cost (AC)

Previous studies have mainly focused on two types of agency costs. The first type is operating expense ratio, management expense ratio, and asset turnover ratio, while the second type is occupied by major shareholders. Because agency conflicts between management and major shareholders can lead to self-interest or abuse of power by managers, thereby increasing the company's agency costs. Therefore, this article chooses the occupation of major shareholders as the agency cost of the company. The calculation formula is "other receivables/total assets", and the higher the value, the more severe the second type of agency conflict.

(3) Operating Risk (RK)

John et al. (2008) and ACharya et al. (2011) both believe that the higher the operational risk of a company, the higher its profit volatility. This article also uses the volatility of corporate profits to measure the magnitude of operational risk. The calculation formula for operational risk (degree of profit volatility) is:

$$\delta_{i,t} = \sqrt{\frac{1}{T-1} \sum_{t=1}^T (E_{i,t} - \frac{1}{T} \sum_{t=1}^T E_{i,t})^2}, T=4, \quad (1)$$

$$E_{i,t} = \frac{EBIT_{i,t}}{A_{i,t-1}} \quad (2)$$

Among them, $\delta_{i,t}$ - The operational risk of the i-th company in the t-th year (degree of profit volatility); $EBIT_{i,t}$ - The profit before interest, tax, depreciation, and amortization of the i-th company in the t-th year; $A_{i,t-1}$ - The total assets of the i-th company in the t-1st year. As shown in the formula, this article calculates operational risk using the standard deviation of the rolling values of the EBITDA profit margin from year t-4 to year t-1 (four years). In addition, since the operating risk calculated using this method does not follow a normal distribution, this article calculates the cumulative distribution probability of the standard deviation of the interest, tax, depreciation, and amortization profit margin representing operating risk, and uses it to measure operating risk (RK).

(4) Human Capital (HC)

Enterprise human capital itself is difficult to directly measure, and proxy variables are generally used for measurement. Common indicators used include employee education level (level/years), executive technical background, and so on. The main force for enterprises to carry out technological innovation activities is innovative employees with good humanistic qualities and high research and development capabilities. Compared to undergraduate students, high-level talents with a graduate degree or above will have more professional knowledge and innovation advantages in this area.

Therefore, this article selects the proportion of employees with graduate degrees or above to the total number of employees in the company as an indicator to measure human capital.

(5) Media attention

External media attention can leverage its information disclosure and supervision mechanisms, positive reporting can have an impact on corporate innovation, and the nature of media coverage can also have an impact on corporate performance. This article refers to the research of Xuan Tian [62] and selects the number of analysts as the media attention of the enterprise. The specific calculation formula is the natural logarithm of the number of analysts tracked plus 1. Within a year, how many analysts (teams) have conducted tracking analysis on the company, and the number of members in each team is 1. The calculation number of its members is not separately listed.

4.2.4. Control variables

Referring to the analysis of the influencing factors of technological innovation in the previous text, and combined with the research question in this article, this article introduces the following control variables from four aspects: enterprise characteristics, operating conditions, governance situation, and external industry environment:

(1) Profit situation (ROA). Profitability reflects the basic financial condition of a company, and this article uses the ratio of total profit to total assets to measure it. Companies with good profitability will have more funds for technological innovation activities, which will affect the quantity and quality of innovative research and development patents.

(2) Size of the enterprise. The scale of an enterprise represents its comprehensive strength and can affect its technological innovation. It is generally believed that compared to small-scale enterprises, large enterprises have stronger financial strength and risk resistance, better management level, and can fully utilize their scale advantages to share R&D investment, possessing stronger innovation motivation and ability. On the other hand, large-scale enterprises do not have the flexibility advantage in innovation compared to small enterprises. This article measures this indicator using the natural logarithm of the annual total assets of the enterprise.

(3) Debt leverage (LEV). Debt leverage reflects a company's ability to utilize debt financing to achieve its own production and operation. Generally speaking, a higher debt to asset ratio means a higher financial risk for the enterprise. The enterprise will reduce high-risk investments to cope with future debt pressure, while technological innovation has high risks, long duration, and unclear effects. Therefore, using enterprises will reduce innovation investment. This article uses asset liability ratio as a measure.

(4) Cash Holding Level (CASHFLOW). The higher the cash holding level of a company, the more funds it can use for innovation investment, which is beneficial for the company to carry out innovation activities. This article draws on the research of Liu Ligang and Sun Ya, and uses the net cash flow generated from operating activities divided by total assets to measure the level of cash holdings.

(5) Fixed asset ratio (FIXED). On the one hand, fixed assets include specialized equipment, factories, production lines, etc. used for innovation in the enterprise. The proportion of fixed assets can to some extent reflect the resource investment of "material" in the process of technological innovation. On the other hand, the higher the proportion of fixed assets, the less popular assets the enterprise has, the poorer its operating ability, and under the condition that other variables remain unchanged, the enterprise has higher operating leverage and higher operating risks, This will affect the willingness of enterprises to innovate in technology. This indicator is measured by the proportion of fixed assets to total assets.

(6) GROWTH. The growth of an enterprise reflects its operational status and development potential. Enterprises with high growth usually have good development prospects, and the stronger the motivation for innovation, the more it can promote innovation. This article draws on the research of Yu Yihua et al. and uses the ratio of current year's revenue to previous year's revenue -1 to measure the growth of enterprises

(7) Board size. The larger the board of directors, the greater the constraints on the management, which may have an impact on the innovation decisions of executives. This article draws on the

research of Chen Kejing et al. and uses the natural logarithm of the number of board members as a measure.

(8) Equity concentration (TOP1). The concentration and dispersion of equity structure will directly affect the decision-making and effectiveness of technological innovation. On the one hand, when the equity structure is concentrated, it is easier for shareholders to reach consensus on resolutions and actions, and it can better constrain and supervise the management, thereby promoting the company's technological innovation. On the other hand, in cases where the equity structure is too concentrated, major shareholders may engage in behaviors that harm the interests of minority shareholders due to self-interest motives, such as improper decision-making, abuse of resources, and illegal occupation of funds, which will be detrimental to corporate technological innovation. This article uses the shareholding ratio of the largest shareholder to measure the concentration of equity in a company.

(9) Investment Value (TOBINQ). Enterprises with high investment value are more likely to be favored by external investors, investing in them and providing financial support for innovation. This article draws on the research of GU Qun Et Al. and uses Tobin's Q value to measure investment value.

(10) Age of Business (AGE). At different stages of development, the strategic decision-making and innovation characteristics of enterprises will vary. On the one hand, the older a company is, the richer its knowledge and research and development experience it accumulates, which is more conducive to innovation output. On the other hand, new startups may actively engage in technological innovation activities for their long-term development, while those established for a long time may develop a certain degree of inertia. This article uses the natural logarithm of the establishment time of a company to represent its age.

(11) DUAL. When the chairman and CEO are held by the same person, executives have greater power, which can effectively regulate the decision-making behavior of the team and enhance the ability of the executive team to make innovative decisions. This article draws on the research of Ling Hongcheng and Sun Yilong. If the chairman and CEO are held by the same person, take 1; otherwise, take 0.

In addition, to control for differences in innovation requirements based on the development characteristics of different industries, as well as over time in different years

This article also controls for fixed effects on industries and years due to factors such as macroeconomic fluctuations caused by the passage of time. The definitions and measures of all the variables mentioned above are explained in Table 1.

Table 1. Definition of Main Variables.

Variable Type	Representation Symbol	Name	Description
Dependent Variable	INNOV-PAT	Patent Applications	Number of patents applied by the company one to three years later, logarithm of $\ln(1+\text{number of patents})$
	INNOV-CITE	Patent Citations	Number of times the company's patents are cited within the next two years, logarithm of $\ln(1+\text{number of patent citations})$
Independent Variable	ESG	ESG Composite Score	HuaZheng Database
Mediating Variable	KZ	Financing Constraints	KZ Index
	AC	Agency Costs	Other receivables/Total assets
	RK	Operating Risk	The volatility of corporate profits
	HC	Human Capital	The proportion of employees with postgraduate and above education to total employees
	ANAATTENTION	Media Attention	Natural logarithm of analyst coverage plus 1
Control Variables	ROA	Profitability Net	profit/average total assets
	SIZE	Company Size	Natural logarithm of annual total assets
	LEV	Debt-to-Equity Ratio	Total liabilities at the end of the year divided by total assets at the end of the year

	CASHFLOW	Cash Flow Ratio	Net cash flow from operating activities divided by total assets
	FIXED	Fixed Asset Ratio	Net fixed assets divided by total assets
	GROWTH	Revenue Growth Rate	Current year's operating income/last year's operating income-1
	BOARD	Board Size	Natural logarithm of the number of board members
	TOP1	Top Shareholder Ownership Ratio	Number of shares held by the largest shareholder/total number of shares
	BM	Book-to-Market Ratio	Book value/total market value
	TOBINQ	Tobin's Q	(Market value of circulating shares + number of non-circulating shares × net asset value per share + liability book value)/total assets
	AGE	Company Age	ln(current year - year of establishment + 1)
	DTURN	Average Monthly Excess Turnover Rate	Monthly average turnover rate of stocks for the current year - monthly average turnover rate of stocks for the previous year
	DUAL	Dual Role 1	if the chairman and CEO are the same person, 0 otherwise
	SOE	Ownership Nature	Dummy variable, 1 for state-owned enterprises, 0 for non-state-owned enterprises

4.3. Model design

This article aims to test research hypotheses and underlying influencing mechanisms. Referring to previous research, core dependent variables and explanatory variables will be introduced, and a fixed time effect model will be adopted to conduct regression analysis on the collected data. Firstly, this article takes the number of patent applications (INNOV-PAT) of enterprises as the dependent variable and the ESG score of enterprises as the explanatory variable, and establishes the following model:

$$\text{INNOV} - \text{PAT}_{i,t} = \alpha_0 + \alpha_1 \text{ESG}_{i,t} + \alpha_2 \text{ROA}_{i,t} + \alpha_3 \text{TBQ}_{i,t} + \alpha_4 \ln \text{SIZE}_{i,t} + \alpha_5 \text{top1}_{i,t} + \alpha_6 \text{AGE}_{i,t} + \alpha_7 \text{growth}_{i,t} + \alpha_8 \text{Lev}_{i,t} + \alpha_9 \text{Cashflow}_{i,t} + \alpha_{10} \text{bm}_{i,t} + \alpha_{11} \text{dturn}_{i,t} + \alpha_{12} \text{dual}_{i,t} + \alpha_{13} \text{fixed}_{i,t} + \varepsilon_{i,t}$$

Secondly, in order to further investigate the impact of a company's ESG score on its innovation level, the company's patent citation count (INNOV CITE) is used as an explanatory variable to measure the innovation quality of the company. This article proposes the following model:

$$\text{INNOV} - \text{CITE}_{i,t} = \beta_0 + \beta_1 \text{ESG}_{i,t} + \beta_2 \text{ROA}_{i,t} + \beta_3 \text{TBQ}_{i,t} + \beta_4 \ln \text{SIZE}_{i,t} + \beta_5 \text{top1}_{i,t} + \beta_6 \text{AGE}_{i,t} + \beta_7 \text{growth}_{i,t} + \beta_8 \text{Lev}_{i,t} + \beta_9 \text{Cashflow}_{i,t} + \beta_{10} \text{bm}_{i,t} + \beta_{11} \text{dturn}_{i,t} + \beta_{12} \text{dual}_{i,t} + \beta_{13} \text{fixed}_{i,t} + \varepsilon_{i,t}$$

5. Chapter 5 Empirical Testing and Analysis

This chapter uses the variables defined in Chapter 4 and the constructed model to test the research hypothesis proposed in this paper, and provides a basis for the policy recommendations in Chapter 6. Firstly, conduct descriptive statistics on the selected data variables and determine the basic characteristics of the data used in this article based on the results; Secondly, perform variance inflation factor calculation and correlation analysis on the variables to verify that there is no serious multicollinearity problem between the variables; Again, conduct empirical analysis based on the research model and conduct robustness tests; Then, examine the channel analysis between ESG scores and corporate innovation; Finally, further analyze the impact of property rights and innovation on the relationship between ESG scores and corporate innovation.

5.1. Descriptive statistics

Table 2 presents the descriptive statistical results of the main selected variables. From Table 2, we can see that from 2006 to 2021, the mean innovation quantity (INNOV-PAT) of the sample enterprises was 1.853, the median was 1.609, and the standard deviation was 1.891. The mean patent

citation quantity (INNOV-CITE) of the enterprises was 3.357, the median was 3.258, and the standard deviation was 1.594. This indicates that there are significant differences in the quantity and quality of innovation among different enterprises, and studying the factors affecting enterprise innovation has great practical significance. The minimum ESG score (ESG) is 36.62, the maximum value is 92.93, and the median is 73.38, indicating that the overall ESG score of enterprises needs to be improved. The ESG scores of sample enterprises vary greatly, with some enterprises having poor ESG scores.

Table 2. Descriptive Statistical Results.

variable	N	mean	p50	sd	min	max
INNOV-PAT	43683	1.853	1.609	1.891	0	10.39
INNOV-CITE	28034	3.357	3.258	1.594	0.693	10.80
ESG	35005	72.98	73.38	5.554	36.62	92.93
SIZE	39873	22.06	21.87	1.292	19.40	26.43
LEV	39873	0.426	0.420	0.207	0.027	0.937
ROA	39872	0.043	0.041	0.067	-0.398	0.254
CASHFLOW	39873	0.047	0.046	0.071	-0.224	0.283
FIXED	39873	0.217	0.183	0.164	0.002	0.806
GROWTH	39853	0.184	0.119	0.428	-0.676	4.330
BOARD	39830	2.135	2.197	0.201	1.609	2.708
indep	39830	0.374	0.333	0.0530	0.250	0.600
DUAL	39873	0.272	0	0.445	0	1
TOP1	39833	0.347	0.326	0.149	0.0810	0.758
BM	39286	1.011	0.647	1.155	0.0510	10.14
TOBINQ	39234	2.036	1.606	1.385	0.802	17.73
SOE	39873	0.369	0	0.482	0	1
AGE	39873	2.819	2.890	0.381	0.693	3.611
DTURN	36471	-0.109	-0.0330	0.514	-2.757	1.585

5.2. Correlation analysis

Table 3 lists the Pearson correlation coefficients of the main variables selected in this article. From Table 3, we can see that the absolute correlation coefficients between the dependent variable and the explanatory variable are both less than 0.6, indicating that there is no serious multicollinearity problem between the variables. The correlation coefficients between ESG score and INNOV-PAT and INNOV-CITE are 0.167 and 0.123, both significant at the 1% level and showing a significant positive correlation, which is consistent with the hypothesis.

Table 3. Correlation Analysis of Main Variables.

	INNOV-PAT	INNOV-CITE	ESG	SIZE	LEV	ROA	CASHFLOW
INNOV-PAT	1						
INNOV-CITE	0.440***	1					
ESG	0.167***	0.123***	1				
SIZE	0.025***	0.346***	0.192***	1			
LEV	-0.099***	0.141***	-0.074***	0.470***	1		
ROA	0.148***	0.036***	0.234***	-0.020***	-0.388***	1	
CASHFLOW	0.051***	0.00900	0.079***	0.063***	-0.148***	0.365***	1
FIXED	-0.011**	0.012*	-0.057***	0.087***	0.110***	-0.092***	0.242***
GROWTH	0.00600	0.00300	0.00200	0.047***	0.028***	0.239***	0.026***
BOARD	0.019***	0.129***	0.031***	0.234***	0.161***	0.00700	0.047***
indep	0	0.013**	0.075***	0.020***	-0.022***	-0.021***	-0.020***
DUAL	0.057***	-0.058***	-0.010*	-0.156***	-0.160***	0.059***	-0.020***
TOP1	0.025***	0.063***	0.102***	0.186***	0.046***	0.140***	0.090***
BM	-0.101***	0.106***	0.091***	0.620***	0.534***	-0.222***	-0.080***
TOBINQ	-0.014***	-0.079***	-0.116***	-0.339***	-0.228***	0.131***	0.089***
AGE	-0.161***	-0.116***	-0.040***	0.215***	0.139***	-0.129***	0.00300

DTURN	-0.065***	0.057***	-0.050***	0.108***	0.145***	-0.115***	0.030***
	FIXED	GROWTH	BOARD	indep	DUAL	TOP1	BM
FIXED	1						
GROWTH	-0.061***	1					
BOARD	0.165***	-0.00400	1				
indep	-0.064***	0	-0.515***	1			
DUAL	-0.118***	0.019***	-0.183***	0.112***	1		
TOP1	0.088***	0.020***	0.025***	0.032***	-0.055***	1	
BM	0.079***	-0.042***	0.145***	0.00800	-0.135***	0.096***	1
TOBINQ	-0.095***	0.035***	-0.129***	0.051***	0.065***	-0.128***	-0.404***
AGE	-0.046***	-0.059***	-0.038***	0.030***	-0.050***	-0.140***	0.181***
DTURN	0.078***	-0.043***	0.050***	-0.017***	-0.096***	-0.046***	0.066***
	TOBINQ	AGE	DTURN				
TOBINQ	1						
AGE	0.033***	1					
DTURN	0.045***	0.084***	1				

In addition, in order to test whether there are serious multicollinearity issues among the selected variables, this paper conducted a variance inflation factor test between variables, and the results are shown in Table 4. From the test results in the table, it can be seen that the variance inflation factor (VIF) values between each variable are all below 3, far below the critical value of 10, indicating that there is no serious multicollinearity problem between the variables.

Table 4. Results of variance inflation factor test.

Variable	VIF	1/VIF
SIZE	2.620	0.382
BM	2.140	0.468
LEV	1.790	0.557
ROA	1.630	0.614
BOARD	1.590	0.628
indep	1.460	0.686
TOBINQ	1.340	0.748
CASHFLOW	1.340	0.749
INNOV-CITE	1.240	0.807
AGE	1.150	0.868
ESG	1.150	0.871
FIXED	1.140	0.877
TOP1	1.110	0.898
GROWTH	1.110	0.904
DTURN	1.070	0.936
DUAL	1.060	0.940
Mean	VIF	1.430

5.3. Regression Results and Analysis

5.3.1. ESG Scoring and Corporate Innovation

Based on regression model (1), this article will use OLS estimation method to examine the impact of ESG score on the number of enterprise patent applications and the number of patent citations. All model estimates control for fixed effects of year and individual enterprise. Table 5 lists the corresponding regression results. Columns (1) - (2) report the impact of ESG rating disclosure on the number of enterprise patent applications. In column (1) of Table 5, only industry dummy variables and annual dummy variables were controlled for, and the results showed a regression coefficient of 0.015 for ESG score (ESG), which is positively significant at the 1% level. On the basis of column (1), column (2) added a series of control variables, and the results showed that the regression coefficient of ESG score (ESG) was 0.006, still significantly positive at the 1% level. Columns (3) -

(4) report the impact of ESG scores on the number of citations of corporate patents. The third column shows that in the absence of other control variables, the estimated coefficient of ESG is 0.035, which is positively significant at the 1% level. After adding control variables, the estimated coefficient of ESG in the fourth column is 0.009, which is significant at the 1% level, indicating a positive correlation between a company's ESG score and the number of patents cited. Hypothesis 1 is validated, indicating that a good ESG score helps promote innovation in the company.

Table 5. Main Regression Results.

	(1)	(2)	(3)	(4)
	INNOV-PAT	INNOV-PAT	INNOV-CITE	INNOV-CITE
ESG	0.015*** (0.001)	0.006*** (0.001)	0.035*** (0.002)	0.009*** (0.002)
SIZE		-0.042*** (0.014)		0.599*** (0.011)
LEV		-0.424*** (0.057)		0.260*** (0.065)
ROA		0.711*** (0.117)		0.174 (0.189)
CASHFLOW		-0.553*** (0.093)		-0.976*** (0.169)
FIXED		0.281*** (0.073)		-0.282*** (0.068)
GROWTH		-0.024* (0.013)		-0.149*** (0.026)
BOARD		-0.042 (0.051)		0.351*** (0.052)
TOP1		0.447*** (0.088)		-0.389*** (0.069)
BM		-0.003 (0.008)		-0.241*** (0.011)
TOBINQ		-0.022*** (0.005)		0.023*** (0.008)
AGE		-0.992*** (0.038)		-1.063*** (0.031)
DTURN		-0.140*** (0.011)		0.157*** (0.022)
DUAL		0.008 (0.018)		-0.077*** (0.023)
_cons	0.869*** (0.096)	5.438*** (0.287)	0.834*** (0.134)	-7.887*** (0.267)
N	35004.000	30848.000	24164.000	22619.000
r2	0.004	0.102	0.015	0.192
r2_a	-0.133	-0.027	0.015	0.192

5.4. Robustness testing

5.4.1. Selecting Subsamples

Due to the more outstanding performance of high-tech enterprises in the field of technological innovation, this article selects 8 industries (electronics, computer, communication, national defense and military industry, media non-ferrous metals, pharmaceutical and biotechnology, and some companies related to technology in power equipment) from Shen Wan's 31 industry classifications of A-shares to form a new sample, and conducts main effect regression on the samples again. As shown in Tables 6, the regression coefficients between ESG score and the number and quality of enterprise innovation are 0.042 and 0.010, respectively, which are still significantly positive at the 1% level, indicating that the previous empirical results in this article are robust.

Table 6. Selecting sub samples of high-tech enterprises.

	(1) INNOV-PAT	(2) INNOV-CITE
ESG	0.042*** (0.002)	0.010*** (0.002)
SIZE	0.159*** (0.012)	0.599*** (0.011)
LEV	-0.133** (0.068)	0.260*** (0.065)
ROA	2.184*** (0.206)	0.174 (0.189)
CASHFLOW	0.103 (0.173)	-0.976*** (0.169)
FIXED	0.200*** (0.069)	-0.282*** (0.068)
GROWTH	-0.150*** (0.026)	-0.149*** (0.026)
BOARD	0.200*** (0.056)	0.351*** (0.052)
TOP1	-0.535*** (0.074)	-0.389*** (0.069)
BM	-0.219*** (0.012)	-0.241*** (0.011)
TOBINQ	-0.049*** (0.008)	0.023*** (0.008)
AGE	-0.978*** (0.032)	-1.063*** (0.031)
DTURN	-0.052** (0.021)	0.157*** (0.022)
DUAL	0.168*** (0.024)	-0.077*** (0.023)
_cons	-1.763*** (0.290)	-7.887*** (0.267)
N	8605.000	6058.000
r2	0.082	0.192
r2_a	0.082	0.192

5.4.2. Replacing variables

(1) Replacing independent variables

Although Huazheng ESG rating data has the advantages of wide coverage and high data availability, the fairness of an institution's evaluation results may be controversial due to the different selection of indicators, weight design, and calculation methods in different rating systems. Therefore, this article uses Bloomberg ESG score as a substitute variable for corporate ESG score for variable substitution, further testing the impact of corporate ESG score on corporate innovation. The results are shown in Table 7. The ESG score (ESG) has coefficients of 0.013 and 0.012 for the quantity and quality of innovation in enterprises, which are significantly positive at the 1% level. This indicates that after using ESG scores from other institutions to exclude potential unfairness in using single institution rating data, the main research conclusion of this article is still valid.

Table 7. Replacement variables for ESG ratings of enterprises.

	(1) INNOV-PAT	(2) INNOV-CITE
ESG1	0.013*** (0.003)	0.012*** (0.002)
SIZE	0.166*** (0.025)	0.614*** (0.022)
LEV	0.463*** (0.143)	0.744*** (0.130)
ROA	3.944*** (0.429)	0.766** (0.387)
CASHFLOW	0.479 (0.355)	-0.457 (0.327)
FIXED	0.329*** (0.125)	-0.491*** (0.115)
GROWTH	-0.237*** (0.051)	-0.201*** (0.047)
BOARD	0.471*** (0.105)	0.327*** (0.093)
TOP1	-0.748*** (0.133)	-0.874*** (0.119)
BM	-0.221*** (0.018)	-0.253*** (0.016)
TOBINQ	-0.015 (0.017)	-0.044*** (0.015)
AGE	-1.154*** (0.065)	-1.264*** (0.058)
DTURN	0.011 (0.058)	0.252*** (0.055)
DUAL	0.162*** (0.051)	0.064 (0.045)
_cons	0.401 (0.571)	-6.403*** (0.509)
N	10991.000	9012.000
r2	0.070	0.159
r2_a	0.069	0.158

5.4.3. Endogeneity Discussion

(1) Consider the issue of missing variables

To avoid the omission of some unobservable company characteristic factors that affect enterprise technological innovation, this article further controls for individual fixed effects at the company level, that is, uses a bidirectional fixed effects model to re test, and the results are shown in Table 8. Although the significance level of ESG regression coefficient has decreased, it is still significantly positive at the 5% level. After considering the issue of omitted variables, the results are still robust and do not change the main conclusion of this article.

Table 8. Bidirectional Fixed Effects Model.

	(1) INNOV-PAT	(2) INNOV-CITE
ESG	0.010** (0.001)	0.001** (0.001)
SIZE	-0.079*** (0.012)	0.332*** (0.009)
LEV	-0.198*** (0.051)	0.088** (0.037)
ROA	0.850*** (0.104)	-0.313*** (0.071)
CASHFLOW	-0.206** (0.086)	0.074 (0.063)
FIXED	0.157** (0.063)	0.141*** (0.048)
BOARD	0.035 (0.045)	-0.027 (0.032)
DUAL	-0.004 (0.016)	-0.011 (0.011)
TOP1	0.088 (0.075)	-0.445*** (0.055)
BM	0.050*** (0.008)	-0.007 (0.006)
TOBINQ	-0.029*** (0.005)	0.026*** (0.004)
AGE	-0.673*** (0.055)	0.323*** (0.044)
DTURN	-0.040*** (0.011)	0.061*** (0.008)
_cons	4.596*** (0.291)	-5.668*** (0.218)
N	30852.000	22621.000
r2	0.0659	0.3609

6. Chapter 6 Research Conclusion and Suggestions

6.1. Research Conclusion

Third party rating agencies are an important part of the ESG industry chain, and they disclose their corporate ESG ratings to the public by publishing their ratings. The announcement of corporate ESG ratings, as an exogenous shock, more efficiently conveys information to stakeholders, helping participating companies gain more attention and supervision. This kind of attention and supervision is particularly important for enterprises deeply trapped in internal governance and financing constraints, which in turn has a profound impact on enterprise innovation and its economic consequences. Therefore, this article focuses on examining the impact of corporate ESG rating disclosure on corporate innovation and its influencing channels. This article is based on a sample of Chinese listed companies in Shanghai and Shenzhen from 2006 to 2021, and tests the impact and mechanism of the quasi natural experiment of ESG score disclosure on corporate innovation. It analyzes the heterogeneity of the effect of ESG scores on corporate innovation under different property rights and industry properties. The main research findings indicate that:

(1) ESG ratings have a promoting effect on corporate innovation. Firstly, a good ESG score can meet the needs of all stakeholders, strengthen the connection between the enterprise and all stakeholders, gain the trust and support of all stakeholders, obtain diversified resources such as funds,

manpower, and knowledge from all stakeholders, and promote enterprise innovation; Secondly, a good ESG score can convey a signal to the capital market that a company has a higher level of sustainable development, establish a responsible positive image and good social reputation, enhance the confidence of external investors, attract external investment, and provide financial support for innovation; Finally, companies with high ESG scores focus on improving corporate governance, establishing sound incentive and supervision mechanisms, effectively reducing agency costs, curbing opportunistic behavior among executives, increasing their risk tolerance, and motivating executives to carry out innovative activities to achieve sustainable and healthy development of the enterprise.

(2) The release of ESG ratings for enterprises promotes innovation by suppressing agency costs, reducing operational risks, alleviating financing constraints, enhancing human capital, and increasing media attention. With the inclusion of enterprises in ESG rating reports, agency costs, operational risks, and financing constraints have significantly decreased, while human capital and media attention have significantly increased. These five changes in turn have a significant promoting effect on the number of patent applications and citations in enterprises. This conclusion supports our hypothesis.

(3) The effect of ESG rating on corporate innovation varies significantly among different property rights and industry properties. On the one hand, state-owned enterprises and non-state-owned enterprises have different management systems, connections with the government, and functions they undertake, and ESG scores also have different promoting effects on enterprise innovation. Compared to state-owned enterprises, non-state-owned enterprises must maintain their market competitive advantage through innovation in order to survive in the fierce product market competition. Therefore, they are more inclined to use resources to carry out innovation activities. At the same time, non-state-owned enterprises do not have resource advantages and face serious resource constraints. They rely more on improving ESG scores to establish good relationships with various stakeholders, enrich their financial, human, and knowledge resources, and promote enterprise innovation. Therefore, compared to state-owned enterprises, ESG scores have a more significant promoting effect on corporate innovation in non-state-owned enterprises. On the other hand, high-tech enterprises and non-high-tech enterprises have different promoting effects on innovation in ESG. High tech enterprises usually have innovation oriented and technology driven characteristics, and they face rapidly changing and fiercely competitive market environments, requiring continuous technological innovation and product research and development to maintain competitive advantages. Therefore, in the process of improving ESG ratings, high-tech enterprises are more likely to integrate innovation into environmental, social, and governance practices, and solve ESG related challenges through innovation; High tech enterprises have significant influence and demonstration effects in many industries, and their ESG behavior and performance have a demonstrative and leading role in the entire industry chain. They can influence suppliers, partners, and competitors, driving the entire industry towards higher ESG standards. By increasing ESG ratings, high-tech enterprises can exert greater influence in the industry, prompting other enterprises to strengthen innovation and improvement to meet the increasing market demand for ESG. At the same time, high-tech enterprises often face higher expectations and pressure from investors and stakeholders, demanding outstanding performance in ESG. These stakeholders may include investors, consumers, employees, government agencies, etc. Improving ESG ratings has become a necessary strategy for high-tech enterprises to meet the expectations of these stakeholders. To meet these pressures, high-tech enterprises need to constantly innovate to improve their ESG scores and achieve sustainable development goals. In summary, high-tech enterprises, due to their innovation orientation, technological solutions, industrial influence, and pressure from investors and stakeholders, improving ESG scores can better promote corporate innovation. These factors give high-tech enterprises more motivation and resources to drive innovation to meet the growing ESG standards and market demand.

6.2. Policy recommendations

6.2.1. Suggestions for enterprises

(1) Actively implement ESG concepts and improve ESG ratings. With the popularization and deepening of the concept of sustainable development, in recent years, the attention of various entities such as academia, government, investors, and enterprises in the market to ESG has gradually increased. However, currently, some listed companies in China still have certain doubts about the significance of ESG practice, and the internal motivation to improve ESG ratings is insufficient. The research conclusion of this article indicates that a good ESG score for a company can effectively suppress agency costs, reduce operational risks, alleviate financing constraints, bring in human capital, increase media attention, and promote corporate innovation. Enterprises should realize that at present, the investment made by enterprises in improving environmental performance, fulfilling social responsibilities, and improving corporate governance may not bring direct and immediate economic benefits to the enterprise like production and operation activities, but it does not increase the additional cost burden on the company. On the contrary, it can bring benefits to the company in many other aspects. Enterprises should abandon the "burden theory" view that improving ESG ratings is a simple cost investment. They should realize that investing in ESG can bring broad and far-reaching benefits to companies in alleviating principal-agent conflicts, forming a good reputation, attracting high-level talents, and promoting technological innovation. It is an important measure related to the long-term sustainable development of enterprises. Therefore, enterprises should not view the expenditure of improving ESG ratings as a simple resource consumption behavior, but as an investment similar to call options, strengthen positive understanding of ESG concepts, actively improve ESG ratings, especially non-state-owned enterprises, and actively participate in ESG practices within the enterprise. Regarding the specific practices for enterprises to implement ESG concepts, this article suggests that firstly, enterprises can incorporate the requirements and goals of ESG concepts into their business philosophy and articles of association, forming a corporate culture and overall atmosphere that values ESG construction within the company, and promoting the attention and participation of employees at all levels of the company in ESG concepts. Secondly, enterprises should strengthen the disclosure of ESG information, timely and proactively disclose high-quality ESG reports in accordance with policy requirements, and fully communicate their positive attitude and good performance in implementing ESG concepts to the outside world.

(2) Proactively disclosing ESG reports

At present, China has not yet popularized the obligation to disclose ESG. The ESG rating information of enterprises mainly comes from third-party evaluation agencies, and the number of enterprises that independently publish ESG reports is relatively small. Regular and proactive disclosure of ESG reports can facilitate stakeholders to understand the true situation of enterprises, and improve the understanding, recognition, and support of external stakeholders towards enterprises. Therefore, enterprises should establish a comprehensive and standardized ESG information disclosure system, actively disclose ESG reports to the outside world, strictly abide by the information disclosure system, improve the quality of information disclosure, accept external supervision, convey positive signals of good ESG scores and strong sustainable development capabilities to the outside world, enhance the confidence of external stakeholders in the enterprise, and help the enterprise strive for more resources needed for innovation, Provide guarantees for enterprise innovation.

6.2.2. Suggestions to the government

(1) Improve the ESG information disclosure system for enterprises and establish an ESG evaluation system. In the process of reviewing and organizing ESG related literature both domestically and internationally, the author found that several mainstream ESG evaluation systems have been formed internationally, such as Tom Reuters and Ming Sheng, which are also the most commonly used in foreign research on ESG. However, in domestic research on ESG, scholars have adopted various rating methods, such as constructing their own indicators and using different third-party agencies for rating, including Huazheng, Shangdao Ronglv, CNDRS, Bloomberg, and Hexun,

which will lack comparability in various measurement methods. The reason is that the introduction of ESG concepts in China was relatively late, and a unified ESG evaluation system suitable for Chinese enterprises has not yet been formed. Some companies are rated, while others are not. There is also a lack of mandatory laws and regulations requiring companies to disclose ESG information. In order to standardize and improve China's ESG related systems to promote better development in the ESG field, this article proposes the following policy recommendations to the Chinese government: firstly, the government or relevant departments should take the lead in establishing an authoritative ESG evaluation system that is suitable for China's national conditions, clarify the ESG evaluation standards for Chinese enterprises, select the most suitable indicators for China's national conditions, and objectively and fairly evaluate the ESG scores of Chinese enterprises. Secondly, incorporate the content formulation and disclosure requirements of enterprise ESG information into legal provisions, take mandatory measures to supervise the disclosure behavior of enterprises, and introduce systematic disclosure norms and frameworks to guide enterprises to improve the quality of ESG information disclosure. Thirdly, encourage the development and compilation of ESG investment tools in China's capital market, such as ESG related indices, fully leverage market mechanisms, that is, enterprises with good ESG scores can receive positive market feedback, guide enterprises to actively participate in ESG practices, and consciously disclose ESG related financial and non-financial information.

(2) Establish supporting incentive and supervision mechanisms. Firstly, the government should improve its legal system and strengthen the legislative work related to enterprise ESG rating and intellectual property protection. For example, in terms of enterprise ESG rating, detailed rules for ESG content can be clearly defined, and reward and punishment measures can be formulated based on ESG rating to guide enterprises to make correct ESG decisions, increase the cost of ESG poor performance and punishment for false performance, so as to encourage enterprises to truly take responsibility for environmental protection Social responsibility and strengthening corporate governance. In terms of knowledge protection, the government should establish a sound system for patent protection, management, and transfer, promote the revision and implementation of laws and regulations such as the Patent Law and Anti-Monopoly Law, protect the innovative achievements and benefits obtained by enterprises, provide legal basis for enterprise innovation, and stimulate the enthusiasm of enterprises to carry out research and development activities. Secondly, the government should regulate and improve the factor market, comply with the latest policy guidelines of the comprehensive reform of factor marketization allocation released by the country, such as improving the multi-level capital market system, relaxing household registration policies, activating property rights incentives, etc., so that funds, talents, technology, etc. in the market can flow smoothly and orderly, so as to better leverage the positive effect of ESG ratings and promote technological innovation in enterprises.

6.3. Shortcomings and Prospects

(1) This article only considers A-share listed companies in Shanghai and Shenzhen, and does not select non listed companies as research samples. Therefore, the conclusions may differ among non-listed companies. In future research, the scope of the research sample can be further expanded to conduct in-depth research on the relationship between ESG performance and corporate innovation in non-listed companies.

(2) This article uses the Huazheng ESG rating system data to measure corporate ESG ratings, which largely depends on the quality of company information disclosure and the ability of third-party organizations to collect information. As ESG disclosure in Chinese enterprises mainly relies on self-awareness, third-party ESG ratings may have certain shortcomings in accurately reflecting the true ESG ratings of enterprises. However, the use of ESG ratings from other institutions still has the aforementioned issues. The use of self-constructed indicator methods is subjective, lacks information coverage, and is difficult to calculate and implement. Each method has some shortcomings to some extent. Therefore, it is hoped that future research can explore an accurate method for measuring corporate ESG ratings, making the research more rigorous.

(3) The impact of ESG ratings on corporate behavior is profound, and the micro activities of enterprises are not limited to technological innovation behavior. Future related research can also be expanded from new perspectives such as M&A activities and employee performance.

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