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Can Green Innovation Affect ESG Ratings and Financial Performance? Evidence from Chinese GEM Listed Companies

Jianzhuang Zheng [1], Muhammad Usman Khurram [1,2] and Lifeng Chen [1,3,*]

[1] School of Business, Zhejiang University City College, Hangzhou 310015, China; zhengjz@zucc.edu.cn (J.Z.); usmankhurram@zju.edu.cn (M.U.K.)
[2] School of Economics, Zhejiang University, Hangzhou 310058, China
[3] School of Public Affairs, Zhejiang University, Hangzhou 310058, China
* Correspondence: chenlifeng@zucc.edu.cn

Abstract: Socially and environmentally responsible investing is becoming the benchmark in financial markets. Promoting emerging industries' environmental performance, social responsibility, and corporate governance (ESG) ratings are increasingly becoming the consensus of multinational green financial institutions, investors, and governments. This study employs 3100 panel data from 2014 to 2019 to conduct empirical research on green innovation, ESG indicators, and the financial performance of China's Growth Enterprise Market (GEM) listed companies. Based on the "causal steps approach", we adopt the Sobel–goodman and Bootstrap test to explore the partial mediation effect of ESG indicators. Moreover, when testing the interactive effect of endogeneity, instrumental variables combined with two-stage least squares (2SLS) and a general method of moments (GMM) system are applied in the dynamic panel for robustness. Combing with the approach of ESG factors-integrated and ESG factors-embedded regression models, we find that: (1) Green innovation can significantly improve the ESG scores of GEM listed companies. (2) Both green innovation and ESG performance can improve the financial performances of GEM listed companies, and ESG performance plays an indirect mediating role in the promotion of green innovation on financial performance. (3) Both political connection strength and regional innovation capabilities can negatively moderate the promotion of green innovation on financial performance, and moderating the effect of corporate political connections is more significant than the regional innovation. This study expands the research on the effectiveness of ESG indices and green innovation from the view of micro-GEM companies, providing policy enlightenment for the sustainable development of emerging industries. Our findings provide noteworthy implications for regulators, academicians and practitioners interested in exploring green innovation, ESG rating and financial performance. In addition, providing regulators and the board of directors with insights into the company's and country's future growth prospects.

Keywords: green innovation; ESG indicators; financial performance; GEM listed companies

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1. Introduction

1.1. Research Significance

Global climate change has become a major challenge since the potential overall risk it brings is unprecedented. Therefore, sustainability has evolved into a core social factor affecting the competitiveness of enterprises and organizations. Investment in sustainable development and social responsibility has attracted attention worldwide since environmental, social, and governance (ESG) could measure the three most important factors of sustainability and ethical impact on business investment [1]. Recently, investors' demand for ESG-related information disclosure significantly increased, as the focus of investors in the past decade has gradually shifted to analyzing the impact of climate and other ESG risks on investment decisions. As a result of the new challenges emerging from social and ethical issues, companies now face more pressure externally since the information disclosed

on sustainable performance in ESG aspects can directly affect the financing and corporate value of the companies. Therefore, the Sustainable Development Performance Goals issued by the United Nations in 2015 have become a critical part of the 2030 Agenda, aiming to achieve a better and more sustainable future. Related agencies, including the United Nations-supported Principles for Responsible Investment (UNPRI) and Climate-Related Financial Information Disclosure Working Group (TCFD), are committed to improving information disclosures of ESG indexes that can positively impact sustainable development. Meanwhile, within the Sustainable Accounting Standards Board (SASB) framework, specific industrial guidance for incorporating financial factors into ESG reports has been proposed i.e., the world's largest asset management company, BlackRock, has expressed its support for reporting financial performance based on SASB's standards and the TCFD's climate framework, especially for those firms who have been included in this project. These firms should ensure their financial reports align with such standards [2]. As companies pay more attention to the development of databases and indicators, ESG plays a key role in understanding the financial risks associated with sustainable development. From the perspective of compliance trends, with the increasing maturity of ESG-related investment concepts, many countries require institutional investors to disclose their ESG investment strategies (For example, in Sweden, institutional investors need to disclose their ESG investment status; in France, in addition to disclosing ESG investment strategies, they also have to disclose their contribution to climate goals). From the investors' perspective, ESG evaluation has become a benchmark to prevent social risks and help investors avoid exterior losses caused by investment strategies (i.e., in recent years, various catastrophic events, such as wildfires in Australia and locust plagues in East Africa, occurred frequently. So, the professional investors have begun to be wary of the "green swan" event from the global climate change, and they tend to take the ESG factors of enterprises into their investment strategies).

Previous studies analyzing CSR and corporate governance in the past few decades have presented mixed and uncertain results, and further integration of environmental indicators makes the ESG scoring system more complicated (for instance, in a digital economy, human and social interactions have undergone a disruptive change [3], and ESG issues would create a worse social image of shareholders, affecting the market value and long-term interest of listed companies): based on the Stakeholder Theory, the development of an enterprise is inseparable from the participation and investment of all stakeholders, including the company's shareholders, external creditors, employees and customers [4]. According to the Resource Dependency Theory, influential stakeholders are those who have the ownership or conformity of important resources [5]. Enterprise is more likely to "comply and implement" if those influential stakeholders pay enough attention to ESG ratings i.e., the banks and investors have important resources of corporate. From the perspective of Risk Management Theory, banks are more inclined to control and reduce the decision-making risk of information asymmetry through mandatory information disclosure [6]. In addition investors' willingness to provide capital would also be higher while the degree of information asymmetry decreases [7]. According to the Signaling Theory, this kind of practice is a positive signal from the company, meaning companies are willing to take altruistic activities into the social environment to provide implicit service to all stakeholders [8]. This social trust can improve the innovation performance of enterprises, and the promoting effect is more significant when the corporate governance mechanism is absent [9]. In this regard, the environmental and social information disclosure would give impetus to financial institutions (i.e., banks) when providing loans/credit under certain conditions. However, there is a negative or irrelevant relationship between ESG scores and financial performance, probably because expenditure on external factors such as environment and social responsibility cannot bring any monetary benefits to the firms [10]. A higher environmental and social investment will inevitably lead to more financial expenditure, ultimately increasing costs but reducing financial performance. Under this

circumstance, financial institutions (i.e., banks) would prefer short-term loans/credits to control the dynamic operation of the enterprise.

As ESG performance continues to affect investment strategies, investors and consumers will pay enough attention to these ESG systems, just like the increasing demand for ESG strategies has explained this trend in the market. Therefore, investors and enterprises are trying to predict the future development direction from the dimensions of environment, society, and governance (e.g., professional investment institutions will take ESG rating as a guarantee to reduce their investment risks. The expectation from investors and banks on the "stakeholder values" of listed companies has brought new challenges to companies and financial markets and has even passively integrated ESG factors into their financial decision-making process). Recently, the emergence of numerous Sustainability Rating Agencies (SRAs) implies that the scoring system of ESG rating has increasingly become the focus of financial institutions, investors, and governments worldwide, as more and more companies have accepted the ESG assessment [11] (i.e., ESG scores can accurately reflect a company's ESG performance, investors can incorporate these scores into the business analysis as an evaluation tool, and companies can also implement ESG factors into operational processes and investment strategies [12]. The evaluation methodologies and algorithms of different SRAs are also alternatives, resulting in more ESG scores and ratings participating into the financial risk management process when cooperating with investment institutions [13–15], as well as providing an important reference in the non-financial risk controlling process [16]. However, the ESG scoring system also measures the contributions and effectiveness of related indicators from the company's annual report to assess the company's enthusiasm for ESG activities [17] (i.e., the ESG score is also closely related to the quality and efficiency of employees, i.e., those companies with high ESG rating are more likely to attract high-quality employees, effectively promoting labor productivity [10], reducing the energy and resource consumption, to improve their operational efficiency [18]. Since the MSCI Index began to conduct ESG ratings on China's A-shares market in recent years, China's listed companies have improved their understanding of ESG performance, and the level of ESG information disclosure also continues to increase. At present, the regulatory authorities have incorporated ESG requirements into the entire process of bank credit granting, establishing the mandatory environmental information disclosure requirements for all listed companies to strengthen ESG information disclosure while communicating with stakeholders. With ESG-based growth strategies, many listed companies even utilize core resources to improve ESG competitiveness and related performance, contributing to their sustainable growth.

To sum up, the ESG score is a key indicator of sustainability that could influence investment decisions. ESG indicators can help investors to analyze the standard data to make cross-company comparisons during the decision-making process; while from the company perspective, ESG ratings provide a valuable, standardized, quantitative benchmark that can more intuitively highlight its overall green performance and corporate social value. Further, previous literature has paid too much attention to traditional financial and accounting indicators rather than environmental and social influences. Moreover, the financial report combined with ESG indices could potentially explain the innovation–financial performance relationship controversy. In practice, the ESG index can be a bridge between corporate innovations and financial statements, especially for green innovations.

1.2. Green Innovation of GEM Listed Companies

The uniqueness of GEM (The Growth Enterprise Market (GEM) was established as the second board of the Chinese stock market in 2009 with the goal of providing a platform for smaller companies with growth potential that cannot meet the full listing requirements of the Chinese stock market's Main board to obtain financing through public offerings (i.e., NASDAQ and HKGEM in US and Hong Kong, respectively)) listed companies exists in the high growth driven by technology innovation. Technology innovation can significantly affect the financing efficiency of GEM listed companies, which is an important output and

an assessment indicator of the R & D department in listed companies. In the quantitative research field, technology innovation could be measured from the dimension of quantity and quality, respectively. Several previous studies adopted different types of patents to calculate the quantity of patents, while current research on the patent focuses more on the impact of standardized statistical indicators involved in patent applications and authorization documents, such as [19–22]. Different countries and regions have different patent laws, in the case of the patent starting time, some count from the date of application, while some count from the date of authorization. The period of patent maintenance in China counts from the date of patent application [23]. However, many patents do not represent a high level of innovation quality (i.e., Mansfield [24] indicates that about 60% of patents in the United States were terminated within 4 years after being granted, and the maintenance period of most patents was much shorter than the statutory protection period of 17 years stipulated at that time. The research of Lanjouw & Putnam [25] implies that less than 50% of patents from various technical fields have been maintained for more than 10 years). Schankerman & Packes [26] built a patent maintenance period-based model for the quantitative evaluation of patent values and distributions in developed countries, which should be recognized as a precedent for quantitative research on the quality of innovation. Within the background of rapid economic development, the motivation of innovations and R & D activities of Chinese listed companies is constantly being stimulated, prominently manifested by the quickly growing patent grant in recent years. Feng [27] suggested the maintenance period of the patent is an effective indicator to reflect the quality of the innovation. Furthermore, Hikerova et al. [28] also deemed that the forward citations of patents are obviously related to the patent lifespan or maintenance period. Innovation measurement is one of the limitations often mentioned in previous quantitative research. Dang & Motohashi [29] and Zhang & Xu [30] recommend forward citations of patents as the quantitative indicator to measure the quality of innovation in future research. In this case, we manually obtain information on patent forward citations from China Intellectual Property (CIP) database, using a more precise measurement methodology to evaluate the impact of technological innovation.

Green innovation has brought to reckoning several government sectors; especially in recent years, green innovation and sustainable development have received extensive attention from the international community (i.e., China (The Chinese economy is shifting toward innovation to assure long-term development and sustainability. China is currently the world's second biggest economy, with more than $300 billion invested in research and development and 361,000 patents issued in 2019. As a result, the Chinese government continues to make every effort to implement regulations that encourage innovation. In 2014, China suggested a massive entrepreneurship and innovation plan that closely connected entrepreneurship and innovation. The Science and Technology Innovation Board, which is supported by a registered system, was formally founded in 2019, reflecting the Chinese government's willingness to use the financial market to encourage entrepreneurship and drive innovation)). In response to global climate change, the World Intellectual Property Organization (WIPO) launched a "Green Database" project in 2013, seeking to share environmentally-friendly technologies among different groups worldwide. Generally speaking, green innovation can benefit both environmental and technological progress [31], carrying out innovative activities in terms of environmental management, green product designing, energy-saving, waste recycling, etc. [32]. Literature can reflect the basic characteristics of green innovation, for previous research on the determining factors of green innovation concentrated on the external environment, such as the impact of macro policies and external stakeholders [33] and the type of corporate finance management has also affected the speed and direction of innovation activities [34]. Therefore, green innovation is under the dual effect of environmental regulation and green finance [35]. As for China, both environmental regulation and financial development have significantly improved the green technological progress of Chinese firms [36]. Moreover, the tolerance for innovation failure will have an important impact on the probability of innovation success and will also affect

the level of innovation results [37]. Innovation is the soul of most of GEMs' development, but the possible failure of R & D activities may seriously influence the financial performance of these Small and Medium-sized Enterprises (SMEs). Compared with other patents, green technology requires more investment while not being profitable in the short term [1]. Green innovation is a long-term activity with more emphasis on environmentally-friendly products and services. As a result, the actual profit cycle should be longer than other R & D activities, affecting financial institutions' enthusiasm to invest in green innovation. Especially after 2014, the quantitative indicators of the Green Credit Guidelines began to affect corporate interests. Thus, the new green loan structure will definitely influence the enthusiasm of China's listed companies for green innovation. Based on the analysis above, our empirical research on green innovation and financial performance will use the data after 2014 to evaluate the efficiency of GCG policy.

1.3. Main Contribution

The main findings of this paper can be summarized as follows: First, by using the data of China's GEM listed firms from 2014 to 2019, we find that green innovation can significantly improve the ESG scores of GEM listed companies in China. Secondly, both green innovation and ESG performance can improve the financial performances of GEMs, and ESG performance indirectly mediates the promotion of green innovation on financial performance. Lastly, the political connection strength and regional innovation capabilities can negatively moderate the promotion of green innovation on financial performance, and moderating the effect of corporate political connections is more significant than the regional innovation.

As for the contribution of this paper, we demonstrate an empirical study on GEM-listed companies after the implementation of green credit policies, providing policy enlightenment for the sustainable development of emerging industries by evaluating the mechanism of macro indicators involving factors of green innovation; ESG indicators, financial performance, corporate political connections, and regional innovation capabilities. Several theoretical studies have found that high-growth entrepreneurial enterprises originate from the resources they own or the unique innovation capabilities they could acquire [38]. So, we first focus on the green innovation capabilities because innovation measurement is one of the limitations often mentioned quantitatively in previous studies. Dang & Motohashi [29] and Zhang & Xu [30] suggest that the earlier citation of patents should be adopted to measure the quality of green innovation in future research. Since the quantity of GEM-listed companies is much smaller than that of the Main Board, we manually obtained earlier citations and patents classified from the Chinese Intellectual Property (CIP) database, thus evaluating the impact of green innovation more accurately. Secondly, Jiang et al. [39] found that enterprises' green activities can improve their environmental and financial performances. In this case, sustainable development performance can be roughly decomposed into financial performance, environmental indicators and social responsibility [40,41]. Therefore, both ESG indices and the financial performances of this study belong to the category of sustainable development indicators. According to the Sustainable Development Theory, the financing cost depends on the company's long-term operating performance, and the financing cost is also closely related to the ESG indicators [42]. While companies' investment in ESG performance may incur a certain financial expenditure in the short term, but this ESG behavior could improve their long-term operating efficiency [43]. Starting from the company's ESG scoring system, we sort out its path to influence the company's financial performance. Based on that, this paper also fully analyzes the mechanisms between ESG score, financing performance and green innovation, enriching and expanding the Sustainable Development Theory. This approach provides empirical evidence for the prediction of basic theories in related research fields and offers theoretical support for the green financial system in supporting the promotion of green technologies as well. Given the limited availability of high-quality ESG indices from GEM-listed companies in China, we combine the approach of factor-integrated and factor-embedded ESG based on Thomson

Reuters' ESG weighting system to verify the significance of the ESG scoring system in statistical regression analysis. Ultimately, in the late-coming scenario, the heterogeneity of these entrepreneurial companies is not being ignored; this paper combines the regression methodology of the general method of moments (GMM) two-step system and instrumental variables to reduce the endogeneity of fixed effects (FE) model. Based on the "causal steps" approach, we further apply Sobel–goodman and Bootstrap test to explore the indirect mediation effect of ESG indices.

In general, the main contributions of this paper can be summarized as follows: (1) In terms of research methodology, we manually acquire the information about patents, the forward citation of patents being adopted in measuring the quality of green innovation, and the quantity of green innovation being evaluated by the quantity of green patents, which is also employed in the robustness test. This approach could expand the current quantitative measurement methodology of innovational research. Moreover, our ESG algorithm reflects the same features and significance as the sub-indicators in each regression model. Therefore, the stability and reliability of the ESG scoring system have been verified in Chinese GEM listed companies, providing substantial ground for the following research in the future. (2) From the perspective of theoretical thinking, through empirical research on ESG scores, financing performance, and other sustainable indicators of emerging industries, we enrich the Sustainable Development Theory proposed at the end of the last century, providing a more practical reference for future research in related field. (3) From the aspect of policy practice, the research conclusions of this paper objectively reflect the internal mechanism between sustainable indicators and financial performance of GEM listed companies after China launched the "Green Credit Guidelines" (GCG) policy. The results show that green innovation can significantly improve ESG scores of GEM's listed companies, both green innovation and ESG performance can improve the financial performance of GEM listed companies, and ESG performance plays a partial intermediary role within the promotion of green innovation on financial performance. Moreover, both the political connection strength and regional innovation capabilities can negatively moderate the relationship between green innovation and financial performance. We also provide policy enlightenment and decision support for the relevant regulatory departments in the conclusion part.

The rest of this paper is organized as follows: Section 2 describes the hypothesis and research design. Section 3 presents the methodology, including data collection and models' construction. Section 4 demonstrates the empirical results with hypothesis testing. Section 5 explains the robustness test. Finally, Section 6 concludes the paper with a summary of our findings, policy implications and limitations of the study.

2. Hypothesis Development and Research Design

2.1. Mediation Effect of ESG Performance

Although the type of corporate finance could affect the speed and direction of innovation activities [34], few studies extended to green innovation mechanisms. Traditional economic literature often suggested that green innovation needed more additional costs from daily business operations [44], meaning high investments in green innovation would increase the financial burden on enterprises as well as reduce their profits [37]. Generally speaking, green technology may require more investments compared with other patents and may not be profitable in the short term [1]. As mentioned earlier in the literature, green innovation is a long-term activity, with more emphasis on environmental-friendly indicators. Caracuel & Mandojana [45] compared the innovative behavior of listed companies, pointing out that the green innovative behavior did not improve financial performance. Doran & Ryan [46] took a sample of 2181 companies that invested in 9 types of green innovations, discovering that up to 77.8% of green innovations in these companies have seriously hindered their financial performances. Especially for specific industries, the green innovations of Spanish manufacturing companies significantly inhibited their corporate performances [47], with less than 20% of resource companies (REs) having the highest energy consumption that can get a profitable return on green-related investment [48]. The

investment risk of green innovation is much higher than the output income of green innovation, making companies compromise, contrary to the original intention of green activities. Thus, green innovation may have no significant effect or even negatively hinder financial performance [48]. And the financial development had a nonlinear, double-threshold impact on green factor productivity which would diminish the marginal efficiency [49].

On the other hand, some scholars are still convinced that green innovation could differentiate products and services to improve the company's reputation, and these benefits can offset the cost of implementing these green innovation activities [50]. Therefore, while considering external factors such as corporate value and social image, green innovation can improve financial performance under certain ideal conditions [51]. Based on Innovation Theory and Sustainable Development Theory, Fan & Wang [52] conducted an empirical analysis of 19 coal companies, whose results implied that green innovation could effectively integrate the core resources, thereby transforming them into a competitive advantage to promote the financial performance of these Environmental Enterprises (EEs). In addition, both green product innovation and process innovation can forecast corporate performance, and there is a positive impact between green process innovation and corporate performance, but not product innovation if considering managerial factors [53]. From the global perspective, the proposal from the United Nations 2030 Sustainable Development Goals of the '2 °C temperature rise' target in the Paris Agreement has addressed climate change as a global consensus. Based on the Paris Agreement, Verdolini et al. [54] recommend green innovation as an opportunity to prevent financial risk for those Small and Medium-sized Enterprises (SMEs) in G20 countries. Miroshnychenko et al. [55] also suggested that green practices including green supply chain and pollution protection could promote financial performance, while other external green practices such as green product development would have a secondary impact on corporate performance. More recently, Marín-Vinuesa et al. [56] demonstrated the investment of resources could improve the financial performance of eco-innovative companies. According to the analysis above, the relationship between corporate financial performance and green innovation is still unclear.

Nevertheless, GEM-listed companies have many natural advantages in solving such problems in response to problems such as economic barriers and lack of expertise in green innovation [37]. As for those GEMs, the research of Xue and Li [57] implied the R & D input of China's GEMs could promote corporate financial performance with a two-period lag. However, Liu and Zhang [58] also conducted an empirical analysis based on the relevant data from 2012 to 2014, illustrating R & D input of GEM-listed companies has significantly hindered financial performance, but R & D investment has a positive correlation with the market value of these companies. The research from Li and Zhang [59] indicated that the R & D personnel investment of GEMs was not significantly positively correlated to the overall performance of Chinese GEM manufacturing enterprises, but the R & D capital investment could negatively affect the financial performance. An inverted U-shape exists between green factor productivity and financial development in developing countries [60]. Especially after launching the Green Credit Guidelines in 2014, the mechanism and effectiveness of eco-innovation on corporate financial performance has become a hot topic in academia, but there still exist large holes in related research. Based on the above analysis, this study proposes some competitive assumptions as follows:

Hypothesis 1a (H1a). *Green innovation has improved the financial performance of Chinese GEM listed companies.*

Hypothesis 1b (H1b). *Green innovation has hindered the financial performance of Chinese GEM listed companies.*

Compared with green innovation, the ESG comprehensive rating or scoring includes more social and environmental information related to climate change, working environment, and board of directors. Among the previous theoretical studies on the relationship

between social responsibility and technological innovation, the Agency Theory indicated that the overemphasis on social responsibility is an abuse of power [61]. Creditors would feel that managers invest too much in their corporate social responsibility (CSR) performance and personal reputation, while these CSR activities may occupy the resources that originally planned for product innovation and upgrade [62]. However, Peng & Isa [63] recently stated that ESG is not associated with these agency problems. Therefore, decision-makers of enterprises and institutions need to make a wiser decision to balance social responsibility activities and corporate governance performance to realize the transformation from social welfare to corporate strategic interests. Furthermore, the relationship between green innovation and ESG performance is becoming clearer while embedding environmental influence. Huang et al. [32] proposed that applying forward-looking green innovation and diversified business strategies could reduce the environmental protection burden on relevant stakeholders, improve social awareness, increase the market share of green products, and ultimately create a valuable sustained competitive advantage for these firms. Generally speaking, green innovation is mostly related to technological progress and environmental indicators [31], where a higher value of regulations and policy sustainability will increase the investments in green innovation [64]. The purpose of green innovation is to be eco-friendly, positively affecting the environmental dimension of ESG indicators. Furthermore, green innovation can also promote the firms' sustainability, such as environmental, social responsibility, and financial indicators [41], improving the level of corporate governance. And the enthusiasm for corporate governance positively moderates the relationship between environmental protection enthusiasm and corporate innovation [65]. The results above demonstrated that green innovation could positively affect the ESG indicators from the comprehensive factors of environment, society, and governance. Thus, hypothesis 2 is also proposed from a positive perspective on their relationship:

Hypothesis 2 (H2). *Green innovation has improved the ESG scores of Chinese GEM listed companies.*

Environmental, social, and governance (ESG) investment is a fast revolution from financial institutions. This study also explores the interconnection between ESG scores and financial performances. Based on the Signal Theory, CSR could help improve the reputation of firms and increase their market value [66]. However, earlier researcher such as Boyle et al. [10] has predicted a negative or irrelevant relationship between ESG score and financial performance, probably because the expenditure on external factors such as environmental and social responsibilities cannot bring any monetary benefits to the company. Actually, research by Zhao et al. [67] and Ahmad et al. [68] suggested that ESG indices could promote the financial performance of firms. De Lucia et al. [69] combined the inferential model and Machine Learning (ML) approach to discover that the improvement of ESG practices on financial performance appears more noticeable when companies invest in green innovation; they verified ROA as a perfectly predicting indicator in evaluating financial performance. The results of García [12] also demonstrated that the financial performance of ROA is useful in the prediction of ESG ranking when firms are clustered in three or four equally balanced groups. Among the various dimensions of ESG, social factors have the greatest influence on credit ratings, while unexpectedly, environmental ratings have negative effects on them [70]. And Peng & Isa [63] also found that total ESG scores and their individual dimensions are positively related to financial performance, supporting the views of Stakeholder Theory. A better ESG performance could be reflected in the stock market through financial performance, and the popularization of ESG investment standards would make professional, institutional investors more inclined to socially responsible investment [71] and tend to have obvious ESG related investment preferences [72]. Hence a better ESG performance can attain more financial support from the stock market. This study investigates the financial performance and ESG performance based on our objective, employing ROA in the main model to measure the financial performance of GEMs.

To summarize, we make the following experimental design to discuss whether the ESG performance is favorable for the financial performance of GEMs. This approach could also further explore the mediating role of ESG indicators, i.e., Whether green innovation could achieve the goal of improving financial performance by promoting ESG performance. Therefore, we propose Hypothesis 3, and Hypotheses 1–3 have constituted the mediation model of this research.

Hypothesis 3 (H3). *ESG performance has improved the financial performance of Chinese GEM listed companies.*

2.2. Moderating Effect of Political Connection and Regional Innovation

Concerning the innovation-driven GEMs, whether the improvement of financial performance and sustainable development stems from their green innovation abilities or is more influenced by external environmental factors, current studies and relevant theories have not yet cleared that yet. The influence of system design at China's national level can also be reflected in the Mixed Ownership Reforming (MOR) since the beginning of the 1990s, leading to the emergence of many entrepreneurs with certain political backgrounds. With the further development of Reform and Opening (RO) in recent years, the political connection of GEM listed companies has aroused large-scope concerns within Chinese society. Li and Xiao [73] pointed out that the political connection of GEM private enterprises weakened the motivation of foreign investments under institutional constraints and restrained the innovation abilities of these emerging economies. Based on some empirical research on GEMs in China, Huang and He [74] also found that the political association weakened the investment in innovation, which may reduce the effect of green innovation on ESG performance. However, Chen et al. [75] proposed that the influence of entrepreneurs' political affiliation on R & D investment is not linear but presented as a U-shaped relationship, showing both the economic statuses of entrepreneurs and the size of enterprises can significantly affect this U-shaped relationship. Since these start-ups rely more on embedding external networks to seek partners to integrate external resources [76], interacting with the external environment, and integrating various internal and external resources to carry out innovative activities [77], the political connection of GEMs may promote the green innovation on ESG performance. Recently, at the 19th National Congress of the Communist Party of China (NCCPC), the reform of Mixed Ownership Reforming (MOR) is required to improve, and the internal mechanism of political affiliation will further affect the future development of China's GEMs. Under the great wave of MOR, executive equity incentives will inevitably be mentioned in related policies and research. Based on the external environment of the determinants of green innovation, this paper fully investigates the moderating effect of the political connection on the relationship between green innovation and financial performance, seeking to expand the current Sustainable Development Theory as well as the research field of the external environment of green innovation, to provide the policy suggestions and decision supports further.

On the other hand, environmental regulations in China have recently driven the upgrading of regional industrial structures, leading to a rapid increase in corporate credit demands [78]. The mechanism of green credit policies on credit structure and cost constraints is more likely to improve the regional industrial structure upgrading. In a macro view, China's regional green innovation capabilities are generally unbalanced; that is to say, the green innovations of 30 provinces have a positive spatial spillover effect in geographic space [79]. Due to the differences in economic development and industrial structure among various provinces of China, GCG policy had an unbalanced mechanism for green innovation. It might have a greater impact on the interaction of sustainable development indicators and financial performance. Furthermore, the decisive factor in developing the regional economy is transforming from traditional advantages of resources to the regional innovation ability [80]. In addition, according to the Industrial Cluster Theory, giving full play to the advantages of regional resources integration can improve the

regional innovation capability, as well as promote the efficiency of technological innovation in regional economic development [81]. Regional innovation capability is showing its important value in China's economic development. However, there is an inverted U-shaped relationship between Intellectual Capital (IC) on financial performance but no impact on green innovation [82]. Therefore, the differences in regional innovation capabilities caused by the imbalance of resource distribution, industrial structure, and economic development among different provinces in China may also have a regulating impact on the improvement of green innovation on financial performance. In general, the regional innovation capability of the eastern and central areas in China has appeared to be upward, with a downward trend in the western and northeastern regions [83]. There is a mutual causality connection between regional innovation ability and regional economic development, i.e., interacting with each other in an inter-causal relationship. Thus, this unbalanced trend will further affect the future development of China's regional economy. Combined with the above spatial differences and temporal trends, we will further explore the non-equilibrium mechanism of GEM-listed companies' green innovation at the macro level through the regional innovation ability index. After summarizing the above research intentions, this paper carries out the experimental design as shown in Figure 1 and proposes the following competing hypotheses for the moderating models:

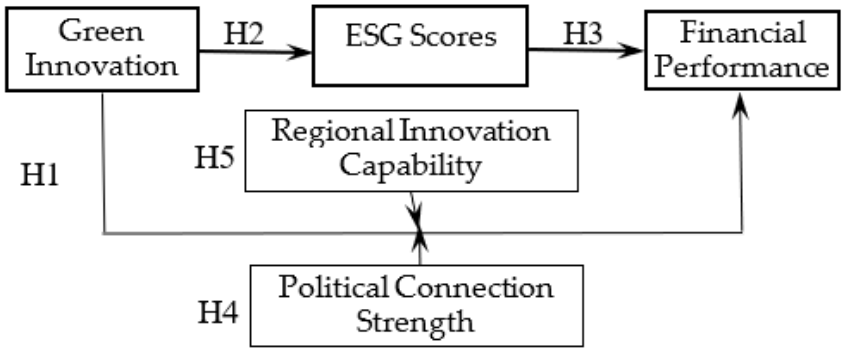

Figure 1. Research Design Concept.

Hypothesis 4a (H4a). *The political connection of GEM listed companies positively moderates the promotion of green innovation on financial performance.*

Hypothesis 4b (H4b). *The political connection of GEM listed companies negatively moderates the promotion of green innovation on financial performance.*

Hypothesis 5a (H5a). *The regional innovation capability of listed GEM companies positively regulates the relationship between green innovation and financial performance.*

Hypothesis 5b (H5b). *The regional innovation capability of listed GEM companies negatively regulates the relationship between green innovation and financial performance.*

3. Methodology

3.1. Sample and Data Acquisition

This research employs China's GEM-listed firms from 2014 to 2019 as research objects, extracting all financial data from the China Stock Market & Accounting Research (CSMAR) database. Samples are selected from 2014 because the quantitative indicators of GCG policy proposed in 2014 would have a greater influence on green innovation and ESG scores. Samples whose financial state was in PT and ST, samples of financial companies, and samples with data missing are excluded during our data collection.

In terms of environmental protection, various countries have stipulated relevant legislations in the production and consumption of pollutants since the last century. The

Sustainable Development Theory was proposed in the report of "Ground breaking Agenda 21", an international environmental conference attended by 172 heads of state held in June 1992. And this concept was first introduced to China in the report "China's Sustainable Development Strategy" in 1999 by the Chinese Academy of Sciences (CAS). The Sustainable Development Theory is committed to attaining more long-term sustainable economic growth, except the corporation-level, standardized, homogeneous, and publicly available scores and ratings. Extensive public records demonstrate that investors desire the average Standard Energy Consumption (SEC) to ensure a better disclosure of environmental information [84]. The indicator of SEC is also one of the determining factors within the investment decision process, providing more necessities while shareholders' proposals may be excluded from voting [85]. Therefore, one reliable route that should be considered is the evolution from a specific standard setter of ESG scoring system under SEC data to derive an ESG algorithm framework. Due to the lack of high-quality company-level environmental indicators, referred to Li et al. [84], we employ the average Standard Energy Consumption (SEC) by using the ratio of the total industrial standard energy consumption to the total industrial output value. These values of SEC can be used as quantitative indicators to assess the industry's environmental performance. Based on the industry classification of the China Statistics Bureau, 22 sub-categories of industries were screened due to the available relevant data, and each category was assigned a unique two-digit code for our empirical research. These data could be acquired from the National Bureau of Statistics (NBS) database. The calculation formula of SEC is as follows:

$$SEC_{\mathrm{i}} = \frac{Total\ Stanard\ Energy\ Consumption\ of\ Industry_{\mathrm{i}}}{GDP\ of\ Industry_{\mathrm{i}}}, \quad (1)$$

With the increasing disclosure of corporate social and sustainable development reports, the recent two years epidemic situation has triggered a new round of discussions on social order and social justice. For this reason, companies face stricter scrutiny of their sustainability practices, and this development trend in social supervision seems to accelerate. Given the Stakeholder Theory, Freeman et al. [86] proposed that Corporate Social Responsibility (CSR) was an important or most critical factor in the social system. The specific manifestation of CSR is that the company "goes beyond" the scope required by the law to do more social activities that could promote public welfare. So, CSR performance can be defined as a voluntary behavior of the company [87]. Considering the financial value of CSR scores, related business research has also become the focus of academic circles because enterprises with high CSR levels usually can attract more consumers, thus achieving the investors' expectations of financial performance and meeting the requirements of internal staff management. This paper uses CSR scores to measure the ESG scoring system's social factors; these data are collected and sorted manually from the Social Responsibility Reports of listed companies disclosed by the Hexun database.

Drawing on the methods of Gu & Zhou [88], we construct the comprehensive indicators of Corporate Governance (CG) from the dimensions of supervision, incentive, and decision. This paper selects the executive compensation and shareholding to assess the incentive mechanism of corporate governance, with the independent director proportion and scale to represent the supervision role of the board of directors and equity balance (sum of 2nd to 5th biggest shareholder's shares/controlling shareholder's shares) to represent the supervision of equity structure. The decision-making power is represented as the combination of the chairman and general manager. Based on the above seven dimensions, we use the methodology of Principal Component Analysis (PCA) to construct the corporate governance indicator. The above financial data can be acquired from the CSMAR database. In order to measure corporate ESG performance as a whole, we standardize the above three scores of Standard Energy Consumption (SEC), Corporate Governance (CG), and Corporate Social Responsibility (CSR).

Dang & Motohashi [29] and Zhang & Xu [30] suggested that the forward citation of patents should be adopted to measure the quality of green innovation in future research.

Thus, this paper aims to investigate the impact of different innovation metrics on sustainable development, seeking to expand the current contribution to the quantitative research of the green economy. We evaluate the green innovation capability from quality and quantity dimensions, respectively (see in robustness test of replacing variables). According to the research methodologies of Qi et al. [89] and Cao et al. [1], we apply the green patent classification defined by the World Intellectual Property Organization (WIPO) for the data cleaning and screening manually obtain patent categories and forward citations based on the code and year of firms, employ the number of forward citations as the proxy variable to measure patent quality in the main test. These annual forward citations of patents and the type of patents can be obtained from the China Intellectual Property (CIP) database.

The moderating variables are political connection strength and regional innovation index. According to the measurement methods of Zhu et al. [90] and Chen et al. [75], this research adopts the highest political level of the entrepreneur as the explanatory variable of political connection. The strength of the political correlation is divided into central, provincial, municipal, district, township, and none, represented individually from 5 to 0. Those with multiple political connections in the same enterprise are selected for the highest level as the representative; we manually sort out the regional innovation ability from each province's annual innovation ability ranking disclosed in China's Regional Innovation Ability Evaluation (CRIAE) report. A higher ranking with a smaller value indicates that the regional innovation ability of certain years is stronger in this area.

This study draws on related scholars' research to employ Return on Assets (ROA) as the explanatory variable of financial performance. Referring to previous research, we select the control variables as follows: (1) Variables that can reflect the characteristics of the board entailing the proportion of independent directors and the size of the board. (2) The characteristic variables of equity concentration. (3) Other firms' characteristics involving corporation characteristics, firm size, and fixed investment and asset-liability. Appendix A shows the specific variable name, meaning, and calculation methodology of each variable, including Board Size (BS), Independence Board (IB), Ownership Concentration (OC), Corporation Characteristics (CC), Firm Size (FS), Fixed Investment Growth Rate (FIGR), Asset Liability Ratio (ALR), and all control variable data are from CSMAR database.

3.2. Research Model

The Fixed Effect (FE) model was performed on benchmark regressions. The model of green innovation, ESG scores, and financial performance is based on the hypothesis. Model (1–3) is to explore the mediation effect of ESG performance, and Model (4–5) is to verify the moderating effect of political connection and regional innovation capability.

Model (1):

$$Financial\ performance_{it} = \beta_0 + \beta_1 Green\ Innovation_{it} + \gamma Control + \delta_i + \lambda_t + \varepsilon_{it}, \quad (2)$$

Model (2):

$$ESG\ scores_{it} = \beta_0 + \beta_2 Green\ Innovation_{it} + \gamma Control + \delta_i + \lambda_t + \varepsilon_{it}, \quad (3)$$

Model (3a):

$$Financial\ performance_{it} = \beta_0 + \beta_4 Green\ Innovation_{it} + \beta_5 ESG\ scores_{it} + \gamma Control + \delta_i + \lambda_t + \varepsilon_{it}, \quad (4)$$

Model (3b):

$$Financial\ performance_{it} = \beta_0 + \beta_4 Green\ Innovation_{it} + \beta_5 ESG\ scores_{it} + \gamma Control + \delta_i + \lambda_t + \varepsilon_{it}, \quad (5)$$

Model (3a) is used to examine Hypothesis 3, and the discrepancy between Model (3a) and Model (3b) is how to control the influence of green innovation in the model. In addition, according to Wen & Ye [91], we apply Model (3b) as the mediation equation to test the mechanism effectiveness of ESG scores. Among these models, coefficient β_1 of Model (1) is

the total effect of green innovation on financial performances; coefficient β_2 of Model (2) is the total effect of green innovation on ESG indicators; coefficient β_3 of Model (3a) is the total effect of ESG indicators on financial performances; coefficient β_4 of Model (3b) represents the direct effect of the mediating variable on the dependent variable after controlling the influence of the independent variable, and the coefficient β_5 of Model (3b) represents the direct effect of green innovation on financial performances after controlling the influence of ESG scores. The most common methodology in the mediating model is to test the regression coefficient step by step, which is generally called the "causal step approach" in previous literatures [92–94], or "joint significance test" [95]. Each step of this process is to test the coefficient β_1, β_2 and β_5 in Model (1–3) sequentially. The mediation effect of ESG performance could be established while all of the coefficient β_1, β_2 and β_5 are significant. In addition, the additional requirement for direct mediation is that coefficient β_4 is not significant within this process. As for such a simple mediating model, the mediation effect is equal to the indirect effect of $\beta_2 \times \beta_5$ [91], and this mediation effect has the following relationship with the total effect β_1 and the direct effect $\beta_1 = \beta_4 + \beta_2 \times \beta_5$ [96]. Based on the "causal step approach", this study will also discuss this indirect effect of $\beta_2 \times \beta_5$ in robust test to confirm the indirect mediation effect of ESG scores. In particular, this study distinguishes the sequential test of partial mediation from the "causal step approach" (H0: the coefficient of $\beta_2 \times \beta_5$ equal to 0), and we will discuss this hypothesis later in the Sobel and Bootstrap test. According to the "causal step approach" of Baron and Kenny [92], the first step should be testing the total effect of green innovation on financial parameters; the second step is to examine the indirect effect of $\beta_2 \times \beta_5$ by the sequentially testing coefficient β_2 and β_5; the third step is to distinguish the complete and partial mediation. These three steps can be carried out separately in the actual operation, and further identifying each step's purpose is very important in understanding and discussing this "causal step approach" [91].

We employ the number of forward citations of green patents as the quantitative indicator to evaluate the green innovation, using Return on Assets (ROA) to assess the financial performance. The ESG scores in this study will verify the reliability from dimensions of factors integrated and embedded. The approach of factors embedded includes aspects of Standard Energy Consumption (SEC), Corporate Social Responsibility (CSR), and Corporate Governance (CG). Based on these three parameters, the total score of ESG is calculated according to Equation (2). In addition, FCGP is the forward citation of green innovation of GEM listed company i at time t, ROA represents the financial performance of firm i at time t, and $Control_{it}$ includes seven factors of control variables. δ_i is the individual fixed effect, λ_t is the time fixed effect, and ε_{it} is the residual. All those parameter settings are consistent with the moderating effect Model (4) and (5), as shown below.

Model (4):

$$Financial\ performance_{it} = \beta_0 + \beta_6 Green\ Innovation_{it} + \beta_7 Political\ Connection_{it} + \beta_8\ (Green\ Innovation \times Political\ Connection)_{it} + \gamma Control + \delta_i + \lambda_t + \varepsilon_{it}, \quad (6)$$

Model (5):

$$Financial\ performance_{it} = \beta_0 + \beta_9 Green\ Innovation_{it} + \beta_{10} Regional\ Innovation_{it} + \beta_{11}\ (Green\ Innovation \times Regional\ Innovation)_{it} + \gamma Control + \delta_i + \lambda_t + \varepsilon_{it}, \quad (7)$$

4. Empirical Results

4.1. Descriptive Statistics

We selected China's GEMs from 2014 to 2019 as the research objectives and winsorized at 1% of each tail on the continuous variables to avoid outliers' influence. Based on the descriptive statistics shown in Table 1, the mean value of CC is 0.771, indicating that nearly 80% of GEMs in this study are private enterprises. In addition, the standard deviations of SEC, CSR, CG, PCS, and RII show enough variation, which can help identify the interesting

relationship. Such as, the average value of RII is 5.885, and its standard deviation is 6.033, representing the substantial variation of regional innovation capability among these GEM firms. Further, the maximum and the minimum number of forward citations of green patents (FCGP) are 150.0 and 0.00, and the average value is 2.528, indicating a large variation in green innovation of the sample companies while most companies have poor green innovation capabilities.

Table 1. Descriptive statistics.

Variable	Obs.	Mean	Std.	Min.	Max.
ROA	3100	0.034	0.092	−0.549	0.205
FCGP	3100	2.528	8.382	0.000	150.000
SEC	3100	0.464	0.546	0.080	2.187
CSR	3100	20.497	10.317	−19.750	83.960
CG	3100	0.790	0.895	−1.985	3.402
PCS	3100	3.083	7.743	0.000	5.000
RII	3100	5.885	6.033	1.000	31.000
BS	3100	7.907	1.438	4.000	13.000
OC	3100	29.552	12.155	3.003	81.104
ID	3100	0.384	0.056	0.000	0.750
CC	3100	0.771	0.420	0.000	1.000
SIZE	3100	21.453	0.814	19.555	25.342
ALR	3100	21.453	0.814	19.555	25.342
FIGR	3100	0.497	2.758	−0.986	1.687

4.2. Correlation Analysis of Variables

We apply the variance inflation factor (VIF) test to find that there is no multicollinearity between variables (all results of VIF are less than 0.7). Table 2 presents the correlation analysis for all variables in the main test. As indicated, the correlation coefficients of all these variables are less than 0.6, suggesting that each variable can be clearly distinguished. In addition, most correlation coefficient in Table 2 is less than 0.5, presenting no serious multicollinearity between these variables. Both correlation coefficients of SEC and CSR are negatively correlated with the Corporate Governance (CG) at 1% significance level (r = 0.04, $p < 0.01$; and 0.03, $p < 0.01$), but positive with other independent and dependent variables. Furthermore, the moderator of Political Connection Strength (PCS) is negatively correlated with Regional Innovation Index (RII), while PCS has a positive relationship with all financial data except Board Size (BS) and Asset Liability Ratio (ALR), but RII has a negative relationship with all financial data except BS and ALR. It should be noticed that the Regional Innovation Index (RII) is an inverse indicator, meaning the lower the value is, the higher ranking of the innovation ability will be. All these results reflect the basic situation of GEM Chinese listed companies in the past 6 years, wherein green innovation, both indicators of CSR and SEC, are directly proportional to the Return on Assets (ROA), but Corporate Governance (CG) presents an inverse relationship with the financial performance.

Table 2. Correlation analysis of variables.

Variable	ROA	FCGP	SEC	CSR	CG	PCS	RII	BS	OC	ID	SIZE	ALR	FIGR
ROA	1.00												
FCGP	0.01 ***	1.00											
SEC	0.05 ***	0.02 **	1.00										
CSR	0.48 ***	0.05 ***	0.04 ***	1.00									
CG	−0.01 ***	0.02 **	−0.03 ***	−0.04 ***	1.00								
PCS	0.06 ***	0.69 ***	−0.02 ***	0.06 ***	0.02 ***	1.00							
RII	−0.01 ***	0.04 ***	0.03 **	−0.02 ***	−0.09 ***	−0.07 ***	1.00						
BS	0.04 ***	−0.06 ***	0.06 ***	0.06	−0.59 ***	−0.03	0.09 ***	1.00					
OC	0.16 ***	0.01 ***	0.02 ***	0.08 **	−0.06 **	0.01 **	−0.01 ***	−0.11 ***	1.00				

Table 2. *Cont.*

Variable	ROA	FCGP	SEC	CSR	CG	PCS	RII	BS	OC	ID	SIZE	ALR	FIGR
ID	−0.03 ***	0.08 ***	−0.07	−0.05 ***	0.54 ***	0.04 ***	−0.06 ***	−0.66	0.08 ***	1.00			
SIZE	−0.07 ***	0.16 ***	−0.04	0.05 ***	−0.30 ***	0.09 ***	−0.04 ***	0.13 ***	−0.14 ***	0.04 ***	1.00		
ALR	−0.36 ***	0.12 ***	−0.01 ***	−0.11 ***	0.03 ***	−0.03 ***	0.04 ***	−0.04 ***	−0.01 **	−0.11 ***	0.42 ***	1.00	
FIGR	0.02 ***	0.01 ***	−0.02 ***	0.04 ***	0.04 ***	0.02 ***	−0.01 ***	−0.02 ***	−0.02 ***	−0.01 ***	−0.01 ***	0.01 *	1.00

Annotates: ***, ** and * represent significance at the 1%, 5% and 10% levels, respectively.

4.3. Mediation Effect of ESG Performance

Firstly, we investigate Forward Citations of Green Paten (FCGP) of GEM listed companies on all dependent variables using the Hausman test before the regression analysis, and the results show that the *p*-value is 0.000, where the random effect model with a null hypothesis is rejected. Thus, the fixed effect (FE) model is chosen as the benchmark test with our equations. The FE regression results of ESG scores and financial performance on green innovation (controlling individual fixed effects and time fixed effects) are shown in Table 3.

Table 3. FE regression report of Models (1) and (2).

KERRYPNX	M 1		M 2		
Var.	**ROA**	**SEC**	**CSR**	**CG**	**ESG**
FCGP	0.001 ***	0.001 **	0.123 ***	0.003 **	0.002 ***
	(2.59)	(2.53)	(4.35)	(2.52)	(14.77)
BS	0.009 ***	0.003	0.827 ***	−0.221 ***	−0.010 ***
	(3.78)	(0.67)	(2.99)	(−21.94)	(−6.11)
OC	0.004 ***	−0.001	0.198 ***	0.003	0.001 ***
	(9.80)	(-0.07)	(4.59)	(1.93)	(3.25)
ID	0.061	−0.051	−5.108	3.949 ***	0.169 ***
	(1.09)	(−0.60)	(−0.82)	(17.38)	(4.77)
CC	0.027 ***	−0.002	1.318 **	0.091 ***	0.008 ***
	(5.65)	(−0.23)	(2.47)	(4.69)	(2.68)
SIZE	0.045 ***	−0.025 ***	2.487 ***	−0.185 ***	0.001
	(10.48)	(−3.83)	(5.24)	(−10.71)	(0.38)
ALR	−0.339 ***	−0.022	−17.265 ***	−0.108	−0.041 ***
	(−20.53)	(−0.88)	(−9.38)	(−1.61)	(−3.91)
FIGR	0.001 *	0.001	0.207 ***	0.009 ***	0.001 ***
	(1.78)	(1.00)	(3.54)	(4.41)	(2.76)
Con.	−1.043 ***	0.997 ***	−39.011 ***	4.848 ***	0.550 ***
Obs.	3100	3100	3100	3100	3100
Adj. R^2	0.23	0.01	0.08	0.48	0.16
F	86.76	4.26	24.21	274.38	56.39

Annotates: ***, ** and * represent significance at 1%, 5%, and 10% levels, respectively. The T value in parentheses.

All R-square values of the above models are maintained within a reliable range, meaning Models (1) and (2) have passed the statistical test with economic significance. However, the regression coefficients in these two models are relatively small, indicating that although the impact of green innovation on ESG scores is significant in statistical analysis, ESG performance is less affected by green innovation in the real context. According to the mediating definition from Baron and Kenny (1986), the mediation effect is based on the significance of the coefficient β_1 in Model (1), representing the independent variable can significantly affect the dependent variable. In this case, all coefficients of green innovation on the dependent variable in Models (1) and (2) are positively significant at a 5% level, showing that Hypothesis 1(a) and Hypothesis 2 are valid and green innovation can significantly promote the financial performance and ESG indicators. Comparing the results in columns (2–5), our ESG algorithm is highly reliable in empirical regression analysis, both

the significance and direction being consistent with each other during this stage. In the next step, we will discuss the stability and mechanism of ESG indicators based on Model (3a) and (3b).

The significance of all control variables is consistent with expectations except for Independence Board (ID), while all R-squares in columns (1–3) of Table 4 are more than 0.23, indicating that these models match to a large extent. All coefficients of the dependent variable on Return on Assets (ROA) in Model (3a) are significant and positive, meaning Hypothesis 3 is also valid in FE regression. And the regression coefficient of Model (3a) is larger than that of Models (1) and (2), suggesting that financial performance is more affected by ESG than green innovation. Since the Models (1)–(3) are significant, that is to say, H1 (a), H2, and H3 are valid, independent variables can directly and significantly affect the dependent variables and also indirectly affect the dependent variables through intermediate variables of ESG indicators. Therefore, the partial mediation effect of ESG's significant impact in promoting green innovation on financial performance could be established. Generally speaking, small sample size is easier to get the result of a complete mediation effect [97] due to our panel data's relatively larger sample size. The mediating effect of ESG indicators obtained in the main test should be further verified in the robustness test by replacing variables and other methodologies. Actually, there are very few cases of the complete mediation effect [98]. The direct mediator would rule out the possibility of exploring other intermediaries in the multiple regression analysis [99]. For this reason, Preacher and Hayes [97] appealed to abandon the concept of complete mediation, treating all intermediaries as a partial mediating variable. Moreover, the regression results of the integrated ESG score are quite consistent with the regression results of three embedded factors in Columns (2–4). Combined with the analysis from Models (1)–(3) in the main test, concluding that our ESG scoring system is highly reliable and stable in empirical regression analysis. Plus, ESG ratings play an indirectly mediating role in promoting eco-innovation on financial performance.

Table 4. FE regression report of Model (3a).

Var.	**ROA**			
SEC	0.038 ***			
	(2.80)			
CSR		0.003 ***		
		(15.02)		
CG			0.011 **	
			(2.13)	
ESG				0.259 ***
				(8.44)
BS	0.009 ***	0.007 ***	0.012 ***	0.012 ***
	(3.69)	(3.00)	(4.27)	(4.80)
OC	0.004 ***	0.003 ***	0.004 ***	0.004 ***
	(9.77)	(8.77)	(9.66)	(9.37)
ID	0.069	0.078	0.024	0.018
	(1.23)	(1.45)	(0.41)	(0.32)
CC	0.027 ***	0.023 ***	0.026 ***	0.025 ***
	(5.67)	(5.14)	(5.43)	(5.28)
SIZE	0.045 ***	0.037 ***	0.046 ***	0.044 ***
	(10.54)	(9.23)	(10.55)	(10.57)
ALR	−0.338 ***	−0.293 ***	−0.338 ***	−0.328 ***
	(−20.51)	(−18.25)	(−20.47)	(−20.10)
FIGR	0.001 *	0.001	0.001	0.001
	(1.76)	(0.79)	(1.62)	(1.35)
Con.	−1.066 ***	−0.932 ***	−1.080 ***	−1.185 ***
Obs.	3100	3100	3100	3100
Adj. R^2	0.23	0.29	0.23	0.16
F	86.94	122.03	86.40	56.39

Annotates: ***, ** and * represent significance at 1%, 5%, and 10% levels, respectively. The T value in parentheses.

Every coefficient of ESG indicators in Table 5 is significant, which shows similar trends just like the regression results in Table 4, so Hypothesis 3 is validated by the mediation effect of ESG indicators. According to step 2 of the 5-Stepped Mediation Test Method (MTM) from Wen & Ye [91], both coefficients of β_2 in Model (2) and the coefficient β_5 in Model (3b) are significant, indicating the indirect effect is significant, then we could skip step 3 and go directly to step 4, which is to examine the coefficient β_4 in Model (3b): The insignificance of β_4 implies the failure of any direct impacts, which indicates only a mediating effect; if this coefficient is significant, so is the direct effect [91]. In addition, the last step in the "causal steps approach" is also to distinguish between complete mediation and partial mediation by examining the coefficient β_4 in Model (3b). If the coefficient β_4 is not significant, it should be a complete intermediary model [100], and the premise of the direct mediation process is that the coefficient of green innovation in Model (3b) is insignificant [91]. Although the coefficient of FCGP on ROA is not significant in Columns (2) and (4), the coefficients of SEC and CG on ROA are significant in Columns (1) and (3) in Table 5; therefore, the complete mediation effect is not valid from the result analysis of Model (3b). Compare the results from Tables 4 and 5, all regression coefficients of the mediating variable are still positively significant at the 1% level except the Corporate Governance (CG), which is at the 5% level. While after the introduction of green innovation into Model (3a), the adjusted R^2 increased from 0.16 to 0.23, which could reflect a better model fitting of Model (3b) in comparison with Model (3a), and that also can be further interpreted as an indirect mediating effect of ESG performance. Based on these steps of the mediation test, we have completed four steps of the main test to get the results of the significantly indirect mediation effect of ESG scores. In conclusion, the above results have demonstrated that ESG indicators play a partial intermediary role within the promotion of green innovation on the corporate financial performance of Chinese GEMs.

Table 5. FE regression report of Model (3b).

Var.	**ROA**			
SEC	0.036 *** (2.67)			
CSR		0.003 *** (14.84)		
CG			0.010 ** (2.59)	
ESG				0.258 *** (8.02)
FCGP	0.001 *** (2.45)	0.001 (1.38)	0.001 ** (2.49)	0.001 (0.18)
BS	0.009 *** (3.71)	0.007 *** (3.02)	0.012 *** (4.47)	0.012 *** (4.81)
OC	0.004 *** (9.83)	0.003 *** (8.82)	0.004 *** (9.68)	0.004 *** (9.41)
ID	0.070 (1.25)	0.079 (1.47)	0.021 (0.35)	0.019 (0.35)
CC	0.027 *** (5.59)	0.023 *** (5.08)	0.026 *** (5.37)	0.025 *** (5.23)
SIZE	0.045 *** (10.66)	0.038 *** (9.32)	0.046 *** (10.75)	0.045 *** (10.64)
ALR	−0.338 *** (−20.52)	−0.293 *** (−18.26)	−0.337 *** (−20.41)	−0.328 *** (−20.11)
FIGR	0.001 * (1.68)	0.001 (0.78)	0.001 (1.54)	0.001 (1.34)
Con.	−1.079 ***	−0.941 ***	−1.092 ***	−1.185 ***
Obs.	3100	3100	3100	3100
Adj. R^2	0.23	0.29	0.23	0.25
F	78.11	108.72	77.66	86.34

Annotates: ***, ** and * represent significance at 1%, 5%, and 10% levels, respectively. The T value in parentheses.

4.4. Moderating Effect of Political Connection and Regional Innovation

The moderating model is another important methodology in social science to investigate the relationship between multiple variables. Suppose the regression slope of interaction between the independent variable X and the dependent variable Y changes when a third variable, Z, changes. In that case, Z should be regarded as a regulating variable within this function [101]. In this paper, we will identify the moderating effect of political connection strength and regional innovation capabilities by the regression coefficients of intersection variables, combining the instrumental variables to test the endogenous and stability of these results.

Table 6 illustrates Models (4) and (5) regression results. Similar to the results of Model (3b), the significance of those control variables is almost consistent with expectations except for the Independence Board (ID), and both values of the R-squares in Models (4) and (5) are greater than 0.23. The coefficients of FCGP × PCS and FCGP × RII are the main focus of this research, where both intersections of FCGP × PCS and FCGP × RII in columns (1–2) are significant and negative, which indicate the corporate political connection and regional innovation capability of GEMs could negatively moderate the promotion of green innovation on financial performance, so it is assumed that the H4 (b) and H5 (b) are valid. These results also reveal that green innovation and sustainable development of China's emerging industries are restricted by the interaction of regional differences and political connections to a certain extent. To summarize the fixed effects (FE) regression results above: the green innovation (number of forward citations of green patents) and financial performance (return on assets) of China's GEMs have a significant positive relationship, that is, the quality of corporate green innovation can improve their financial performance. The corporate political connection and regional innovation ability have a significant moderating effect on the promotion of green innovation on financial performance, while ESG performance has a partial positive mediation impact within the relationship between these two.

Table 6. FE regression report of Models (4) and (5).

Var.	M 4	M 5
FCGP	−0.001 (−0.11)	0.001 *** (3.36)
PCS	0.003 *** (6.62)	
FCGP × PCS	−0.001 *** (−3.08)	
RII		−0.001 (−0.80)
FCG × PRII		−0.001 ** (−2.45)
BS	0.009 *** (3.70)	0.009 *** (3.75)
OC	0.004 *** (9.47)	0.004 *** (9.78)
ID	0.064 (1.15)	0.065 (1.16)
CC	0.023 *** (4.89)	0.027 *** (5.58)
SIZE	0.049 *** (11.52)	0.044 *** (10.46)
ALR	−0.329 *** (−20.07)	−0.340 *** (−20.60)
FIGR	0.001 (1.60)	0.001 * (1.79)

Table 6. *Cont.*

Var.	M 4	M 5
Con.	−1.141 ***	−1.036 ***
Obs.	3100	3100
Adj. R^2	0.24	0.23
F	75.27	70.38

Annotates: ***, ** and * represent significance at 1%, 5%, and 10% levels, respectively. The T value in parentheses.

5. Robustness Test

5.1. Replacing Variables

In the case of new products and technologies, the authorized patent quantity is the most widely adopted and accepted innovative indicator [20,21], whose robustness and reliability have been acknowledged in empirical studies on eco-innovation [22]. According to Qi et al. [89], the number of granted green patents is employed as a substitute variable for green patents to carry out the robustness test in this study. Since appearance patents can't be attributed to green patents, the sum of eco-patents is obtained by adding the authorized green invention patents and utility patents. Same as the main test, column (1) reports the regression results of green innovation on financial performance, and columns (2)–(5) reports the results of green innovation on ESG indicators. After replacing the Forward Citations of Green Patent (FCGP) with the Green Patents Quantity (GPQ), the regression results of Model (1) and Model (2) are nearly consistent with the magnitude and trend in the main test. However, the reliability of the ESG composite value is better than SEC on GPQ in Table 7, where the regression coefficient of SEC is negative but not significant. It may be because the environmental indicator of SEC is an industry-level indicator, and it is not significant as other company-level indicators in statistical regression analysis. Although the environmental indicator is the core component of ESG scoring system, the current insufficiency of company-level and homogenized quantitative indicators is also one of the biggest obstacles to these environments related quantitative research.

Table 7. FE regression report of green patents quantity.

Var.	M 1	M 2			
	ROA	SEC	CSR	CG	ESG
GPQ	0.002 ***	−0.001	0.168 ***	0.015 ***	0.001 ***
	(3.54)	(−0.12)	(3.12)	(7.14)	(3.15)
BS	0.009 ***	0.003	0.806 ***	−0.221 ***	−0.010 ***
	(3.74)	(0.76)	(2.90)	(−20.87)	(−6.14)
OC	0.004 ***	−0.001	0.197 ***	0.004 **	0.001 ***
	(9.80)	(−0.10)	(4.54)	(2.42)	(2.91)
ID	0.070	−0.024	−3.651	3.877 ***	0.193 ***
	(1.25)	(−0.28)	(−0.58)	(16.23)	(5.24)
CC	0.028 ***	−0.002	1.382 ***	0.081 ***	0.009 ***
	(5.78)	(−0.29)	(2.58)	(3.96)	(2.71)
SIZE	0.043 ***	−0.026 ***	2.267 ***	−0.174 ***	−0.002
	(10.13)	(−3.94)	(4.77)	(−9.57)	(−0.73)
ALR	−0.341 ***	−0.021	−17.559 ***	−0.195 ***	−0.043 ***
	(−20.70)	(−0.83)	(−9.51)	(−2.76)	(−4.00)
FIGR	0.001 *	0.002 **	0.211 ***	0.011 ***	0.001 ***
	(1.81)	(2.06)	(3.59)	(4.76)	(2.86)
Con.	−1.012 ***	1.011 ***	−34.537 ***	4.633 ***	0.550 ***
Obs.	3100	3100	3100	3100	3100
Adj. R^2	0.23	0.01	0.07	0.45	0.09
F	87.69	3.69	22.99	244.69	27.99

Annotates: ***, ** and * represent significance at 1%, 5%, and 10% levels, respectively. The T value in parentheses.

TobinQ is one of the most commonly adopted indicators to reflect firm value in terms of innovation output and ESG. Qiu et al. [102] certified a positive and significant effect of social and environmental disclosure indices on market value; Deng & Cheng [103] also indicated that an enterprise's ESG scores could boost stock market performance and the effectiveness of ESG indicators is more significant on non-state-owned enterprises. In addition to these existing relationships between market value and ESG ratings, eco-innovation would particularly strengthen the corporate performance of those firm values at medium and high-level, while the interactive impact of social disclosure and green innovation would gradually weaken this promotion in terms of firm value [65]. However, the internal mechanism of market value for those small and medium-sized enterprises and private enterprises in the Growth Enterprise Market remains unclear. Investors in the Korean stock market do not view corporate social responsibility activity as a tool to support their long-term sustainability; instead, they judge from the firm value for a long period after their rating [104]. Therefore, we employed market value (TobinQ) to replace the dependent variable of Return on Assets (ROA) in the Hausman test to evaluate the financial performance from the perspective of firm value. In addition, the rest parameter settings for the robust test are the same as those in Models (2) and (3). The results in columns (1–5) of Table 8 demonstrate the significant effects of eco-innovation and ESG scores on financial performance, which are stable in multiple regression by replacing variables. However, the coefficients of SEC and CG to TobinQ are in the opposite direction of the regression by ROA, where the role of environmental indicators remains unstable in the regression results of TobinQ, and the coefficient of Corporate Governance (CG) presented an opposite impact when compared with the regression result in the main test. Nevertheless, the positive role of ESG overall rating in promoting firm value is significant and stable in column (5), with the coefficient value increasing while the significance level decreases. In general, the FE regression results of replacing variables in Model (1–3) are mostly consistent with the significance of the main test. Therefore, the partial mediation effect of ESG performance and the credibility of our ESG values has been reconfirmed in regression analysis of replacing variables.

Table 8. FE regression report of TobinQ.

	M 2		**M 3**		
Var.			**TobinQ**		
FCGP	0.053 ***				
	(12.29)				
SEC		−0.473 **			
		(−1.97)			
CSR			0.020 ***		
			(6.13)		
CG				−0.666 ***	
				(−7.54)	
ESG					0.918 *
					(1.67)
BS	−0.043	−0.053	−0.070	−0.202 ***	−0.045
	(−1.02)	(−1.21)	(−1.61)	(−4.25)	(−1.02)
OC	0.006	0.004	0.001	0.006	0.004
	(0.83)	(0.61)	(0.05)	(0.91)	(0.52)
ID	−0.740	−0.244	−0.148	2.421 **	−0.401
	(−0.77)	(−0.25)	(−0.15)	(2.33)	(−0.40)
CC	0.035	0.037	0.011	0.098	0.030
	(0.42)	(0.43)	(0.13)	(1.17)	(0.35)
SIZE	−1.085 ***	−1.154 ***	−1.189 ***	−1.267 ***	−1.141 ***
	(−14.88)	(−15.35)	(−15.89)	(−16.68)	(−15.22)
ALR	−0.690 **	−0.736 **	−0.383	−0.798 ***	−0.686 **
	(−2.44)	(−2.53)	(−1.30)	(−2.77)	(−2.35)

Table 8. *Cont.*

	M 2		M 3		
Var.			**TobinQ**		
FIGR	0.007	0.009	0.004	0.015	0.008
	(0.75)	(0.96)	(0.47)	(1.61)	(0.82)
Con.	26.369 ***	28.161 ***	28.387 ***	30.948 ***	27.120 ***
Obs.	3100	3100	3100	3100	3100
Adj. R^2	0.19	0.14	0.29	0.23	0.14
F	70.23	48.83	122.03	86.40	48.67

Annotates: ***, ** and * represent significance at 1%, 5%, and 10% levels, respectively. The T value in parentheses.

5.2. Endogeneity Analysis

Traditional econometric methodologies like Fixed Effects (FE), Ordinary Least Squares (OLS), and Generalized Least Squares (GLS) cannot effectively distinguish the harassment of endogeneity and exogeneity within the empirical practice. And in multiple regression-based moderation analyses, centralization does not influence the results of the moderating effect test [101], so we are inclined to explore the endogenous issues in our moderating models for the robustness test. According to the descriptive statistical analysis in Table 1, most of the GEM-listed companies in China are private enterprises. According to the Environmental Nesting Theory, the political associations of entrepreneurs in private enterprise will be nested into the complex external environment across various regions and industries, thus affecting the business operations of enterprises [75]. Furthermore, once these listed enterprises engage in innovation activities, they may seek official protection from the government to protect their interests and rights of technological innovation. These senior executives in GEMs tend to establish political connections to obtain superior resources and alleviate internal resource constraints [74]. That would inspire more companies' enthusiasm to bond political power, and those extra activities could also be affected by innovation capabilities and financial indicators. Meanwhile, enterprises in low regional innovation index areas are more likely to improve their R & D activities and sustainable development capability through off-site recruitment and cross-regional cooperation. Therefore, there may be seriously endogenous issues among the enterprises' political connection, regional innovation index, eco-innovation, and financial performance. Finally, due to the inertia and dynamic mechanism, ignoring the lag of financial data may also result in model deviation, ultimately affecting the coefficient valuation, while the unobservable heterogeneity among GEM listed companies could also impact their financial indicators leading to more endogenous problems. Although the externality of instrumental variables can only be confirmed by economic theory and background [105], instrumental variables can still be used to effectively solve the endogeneity of missing variables, measurement errors, and mutual causations. In order to solve the above endogenous problems, this paper employed the methodology of instrumental variables to conduct a robust analysis for moderators. It is necessary to outcrop a variable unrelated to the random disturbance but highly correlated with the explanatory variable, which is an instrumental variable used in regression analysis. Referring to Huang & He [74] and Chen et al. [75], we calculate the average number of political connections and regional innovation capabilities in the industry and region where the corporate headquarters location is the instrumental variable; thus, the instrumental values of IV_PCS, IV_RII, and the corresponding cross-variable are obtained, the intersection of the quantile was expressed as IV-PCS × FCGP and IV-RII × FCGP, respectively. The specific formula is as follows:

$$\mathrm{IV\_PCS}_{r,i} = (\sum_{1}^{n} \mathrm{PCS}_{r,i})/\mathrm{n} \tag{8}$$

$$\mathrm{IV\_RII}_{r,i} = (\sum_{1}^{n} \mathrm{RII}_{r,i})/\mathrm{n} \tag{9}$$

where r and i represent regions and industries, respectively. Two-stage least squares method (2SLS) is the most commonly adopted method in instrumental variable regression, but the 2SLS test would not be efficient enough when the random disturbance term has heteroscedasticity or autocorrelation in models. The general method of moments (GMM) has the advantage of generating instrumental variables from explanatory variables [106]; compared with other traditional instrumental variable methods such as 2SLS and 3SLS, etc., GMM is more applicable for the panel data [107]. Referring to the research methodology of Roodman [106] and Nesrine & Khemais [107], we adopted the two-step dynamic panel data evaluation, which would contain difference-GMM (DGMM) and system-GMM (SGMM) in its design architecture, using orthogonal deviation to reduce the risk of data loss. The grammar of the general method of moments (GMM) two-step system is more flexible and compound, thus more suitable for the panel data of listed companies in this study. The regression results of 2SLS and GMM method are shown in Table 9.

Table 9. Endogeneity test results of Models (4) and (5).

KERRYPNX	**2SLS Test Results**		**GMM Test Results**	
Var.	**M 4**	**M 5**	**M 4**	**M 5**
FCGP	0.001 (1.64)	0.002 ** (2.51))	−0.003 ** (−2.38)	0.001 (1.01)
PCS	0.001 (1.51)		0.006 *** (4.51)	
FCGP × PCS	−0.001 * (−1.79)		−0.001 (−1.21)	
IV-PCS			−0.008 *** (−3.51)	
IV-PCS × FCGP			−0.001 * (1.66)	
RII		0.001 (0.76)		−0.001 (1.05)
FCGP × RII		−0.001 * (−1.82)		−0.001 (−1.08)
IV-RII				−0.002 * (−1.78)
IV-RII × FCGP				−0.001 (0.16)
BS	0.004 *** (2.85)	0.004 ** (2.42)	−0.005 (−0.95)	−0.001 *** (−0.21)
OC	0.001 *** (9.70)	0.001 *** (9.43)	0.002 *** (2.75)	0.001 * (1.84)
ID	0.001 (0.02)	0.003 (0.09)	−0.123 (−0.95)	−0.076 (−0.51)
CC	0.020 *** (4.72)	0.019 *** (4.15)	−0.006 (−0.59)	0.008 (0.93)
SIZE	0.013 *** (5.44)	0.013 *** (5.38)	0.038 (1.14)	0.003 (0.66)
ALR	−0.201 *** (−12.61)	−0.200 *** (−12.44)	−0.034 (−0.86)	−0.114 ***
FIGR	−0.001 * (1.83)	0.001 * (1.79)	−0.002 (−0.66)	0.001 (0.30)
Obs.	3100	3100	2311	2311
AR (1)			0.000	0.000
AR (2)			0.112	0.053
Hansen Test			0.086	0.033

Annotates: ***, ** and * represent significance at 1%, 5%, and 10% levels, respectively. The T value in parentheses.

The direction and significance of the moderating effect in the regression results of 2SLS have mostly adhered to that of the main model. From the GMM regression results of instrumental variables, the significance and direction of the coefficient of IV-PCS×FCGP in

column (1) are consistent with the main test results, which strongly supports the research Hypothesis (4b). In addition, the coefficient of FCGP × PCS is not statistically significant, but the trend is identical with the FE regression. These results indicate that after controlling the endogeneity, corporate political connections can still negatively regulate the positive effects of eco-innovation on financial performance. However, the moderating effect of RII in column (2) is insignificant, but the direction is negative. Although the negatively regulating effect of regional innovation capability is consistent with the main test, the coefficient is insignificant in comparison with another moderator under a more rigorous situation. These endogenous analysis results also revealed that the moderating role of corporate political connections within the relationship between green innovation and financial performance is more stable than regional innovation capabilities. Therefore, the conclusion of this paper will take political association as the starting point to make further policy suggestions and enlightenment.

5.3. Sobel-Goodman and Bootstrap Test

With the introduction of emerging statistical methods, the "causal steps approach" has to withstand more doubts from the academic world. Zhao et al. [108] and Edwards & Lambert [109] suggested that the sequential test of this "causal steps approach" will have a significant mediating effect, but this methodology cannot fully verify the partial or complete effects. Therefore, this paper adopted Sobel and Bootstrap test to analyze in-depth and determine the directly or indirectly mediating effect of ESG ratings. Based on the mediation test process of Wen & Ye [91], the result of step 4 in our main test is that the significance of β_4 is not enough, especially for the coefficient of ESG total score is not significant in Table 5, that could account for the direct mediating effect is not significant. The last step is to test the zero hypothesis, which is $\beta_2 \times \beta_5 = 0$. The significance of this coefficient is not only against the zero hypothesis, but also to another critical means of testing the indirect mediation effect [91], and one of the most famous methods is the Sobel test [110]. The significance of the p-value in the Sobel test could imply the invalidation of the zero hypothesis, that is, $\beta_2 \times \beta_5$ is not equal to 0 in this case. Moreover, it is necessary to compare the directions of β_4 and $\beta_2 \times \beta_5$, the same orientation indicates that the indirect mediating effect could be established, while the different orientations suggest that this mediating effect would have a "masking effect".

Table 10 shows the total effect of green innovation on ESG performance is the combination of the direct effect of 0.016 and indirect effect of 0.00056, adding them up to get the total effect of 0.001656; the Z value of the Sobel test of the mediation effect is 2.368, which is exceed the critical value of 0.97, and the p-value of 0.018 is less than 0.05 (significant at the 5% level), that means the positive mediation effect of ESG rating should be validated. Both directions of the coefficient 'a' and 'b' are consistent with each other, indicating that the indirect mediating effect is more than the direct effect of ESG indicators. We should report the ratio of intermediary effect to total effect as the coefficient of Sobel inspection. The mediation effect accounted for 3.40% of the total effect calculated by the Sobel test.

Table 10. Sobel-goodman results.

Variable	Obs.	Coef.	Std. Err.	Z Score	P > Z
Soble	3100	0.000056	0.000024	2.368	0.018
Goodman-1	3100	0.000056	0.000024	2.339	0.019
Goodman-2	3100	0.000056	0.000024	2.399	0.016
a coefficient	3100	0.000476	0.000183	2.602	0.009
b coefficient	3100	0.118743	0.020767	5.718	0.001
Indirect effect	3100	0.000056	0.000024	2.368	0.018
Direct effect	3100	0.001603	0.000211	7.586	0.001
Total effect	3100	0.001659	0.000212	7.822	0.001
Proportion of total effect that is mediated			3.40%		

Also, if all coefficients are significant, the "causal steps approach" result is more reliable than the results of the Sobel test [94]. For testing the mediation effect of H 0: ab = 0, the Bootstrap test is more convincing than the Sobel examination [111], and the confidence interval calculation of the coefficient of $\beta_2 \times \beta_5$ can also be replaced by the Bootstrap approach. The bootstrap test employed the deviation-corrected confidence interval, which is also regarded as a non-parametric percentile method [111,112]. In order to make an interval estimation, the Bootstrap test has become a necessary methodology in mediation effect verification. The 3100 samples in this study could meet the sampling requirements of usual statistical inferences. And Bootstrap approach is to repeatedly extract samples from these 3100 samples, generating a new Bootstrap samples group after the repeat sampling of N times (n = 500 in this case). The estimated values of the coefficient $\beta_2 \times \beta_5$ of these (3100 + n) samples are sorted from small to large, the 97.5th and 2.5th percentile will form a 95% confidence interval for the coefficient of $\beta_2 \times \beta_5$, where the confidence interval does not contain '0' means the coefficient of $\beta_2 \times \beta_5$ is significant [112].

The results of the Bootstrap test are shown in Table 11. The indirect effect does not contain '0', and the confidence interval of deviating correction at the 95% level is (0.00850, 0.01106), implying the mediating effect of ESG performance is valid. The mediating effect of 3.40% is consistent with the result of the Sobel test in Table 10. Moreover, a large confidence interval indicates the fluctuating parameter estimates in the Bootstrap test, implying a multicollinearity problem in the model. The above results also prove no serious multicollinearity in this study. Under the premise that all results are significant, the conclusion of the "causal steps approach" would also be more reliable than that of the Bootstrap test [91]. Ultimately, since all of the confidence intervals do not contain '0' in Table 11, the coefficient $\beta_2 \times \beta_5$ is significant, the indirect mediation effect of our ESG indices has been revalidated in the Bootstrap test.

Table 11. Bootstrap results.

Variable	Obs.	Coef.	Bias.	Std. Err.	95% Conf. Interval
Indirect effect (P)	3100	0.000056	0.000001	0.000017	(0.0000259, 0.0000904)
Indirect effect (BC)	3100	0.000056	0.000001	0.000017	(0.0000281, 0.0000911)
Direct effect (P)	3100	0.001603	0.000017	0.000311	(0.0010192, 0.0022461)
Direct effect (BC)	3100	0.001603	0.000017	0.000311	(0.0009986, 0.0022380)
Proportion of total effect that is mediated			3.40%		

Notes: (P) indicate percentile confidence interval, and (BC) indicate bias-corrected confidence interval; Bootstrap = 500.

6. Conclusions

6.1. Policy Implications

Our results show that green innovation can significantly improve ESG scores of GEM's listed companies in China during the period 2014 to 2019. Both green innovation and ESG performance can improve the financial performance of GEM-listed companies, and ESG performance plays an indirect mediating role within the improvement of green innovation on financial performance. The external factors of political relations' strengths and regional innovation capabilities can negatively moderate the promotion of green innovation on financial performance. In this study, ESG performance plays a partial mediating role between independent and dependent variables, which may confuse with the moderating variables of corporate political relationships and regional innovation capabilities to some extent. Therefore, some of the mediating effects of ESG indicators are mediated by mediators, and our conclusions and policy recommendations also start from the interaction of ESG performance, political connections, and regional innovation capabilities. From the perspective of enterprises, their feedback depends upon managers' understanding of the applicability and feasibility of the ESG algorithm, including the economic benefits of improving ESG scores [16]. Policy guidance would inspire decision-makers to make these adjustments based on profitability factors and policy requirements. Thus, our results are congruent with the actual situation of enterprises seeking to maximize their profits from promoting green innovation and ESG scores on financial performance after implementing the quantitative indicators of GCG policy. Deng & Cheng [103] also suggested the application of tax incentives and government subsidies to support those companies with outstanding ESG performance. From the government's point of view, related departments should create a more scientific supervision mechanism for sustainable development. As for providing a favorable green policy, the Chinese government ought to take the variance of enterprises and innovations into consideration: requiring all listed companies to disclose the specific pollutant emissions and strictly examine environmentally-friendly patents to gain a differentiated subsidy. As for the reviewing process of green innovation, the weight of functional indicators in the green patent examination should be increased. The actual effect of green patents should be evaluated based on the transformation of practical application and other functional aspects to avoid approving green innovation without market demands. In order to form a fair competition mechanism between green industries, polluting industries, and others, the green innovation from environment-related enterprises should be examined and granted discriminatively.

On the other hand, the reverse regulation mechanism of political connection on the relationship between financial performance and eco-innovation can also be regulated through the green financial policy (i.e., First, reviewing the green patent of listed companies with a higher political association disclosure by a stricter standard, and the GEMs should be a good entry point for the pilot of such green policy, prompting those start-ups to drive China's future economic growth by more innovative activities. Second, providing more credit subsidies to GEMs who have a large proportion of young technicians and middle-aged backbone holding senior positions. The influence of the age structure on innovation ability and corruption cost is another key factor for China's future science and technology growth. Finally, retired cadres and senior executives in government departments could be appropriately guided to the less-developed area to make more contributions to balancing the regional economic differences and developing green industry in these areas. Moreover, Sun & Hou [113] proposed an overall layout of an innovation platform to attract more talents to the underdeveloped areas, strengthening the support of intellectual resources by matching the counterpart assistance from developed areas). Further, the regional innovation capacity of the eastern and central areas in China has appeared to be an upward trend, while there is a downward trend in the western and north-eastern regions [83]. Deepening the green financial policy is an effective way and opportunity to deal with this unbalanced trend. For example, an extended green policy for young talents can attract more professionals to start businesses or find jobs in west and north China to develop green innovation and a green

economy based on the local characteristics in these areas (for instance, In order to maximize the actual marketing impact of green innovation, implementing exploratory Mergers and Acquisitions (M & A) is more beneficial for firms to pursue a stronger green image and operate within a high green subsidy environment [114]. In addition to the M & A between green firms and large companies, those environmental enterprises who transferred to the less-developed areas should also be given more favourable green credit support; those environmental enterprises are not limited to green industries and polluting industries). The findings of this study also provide policy inspiration for China to deepen the industrial transformation and promote green development: (1) Companies should have mutually collaborated if managers value green performance and green innovation, and it will make a further contribution to the environment meanwhile consumers use more green innovative products [115]. Green financial policies should change the mechanism of scientific resource allocation from the mode of government-guided to a market-oriented mechanism for those green innovations, regulating the transformation of green innovation, as well as actively leading the trends of the market demands in a macroscopic view. (2) Policymakers should further strengthen the supervision of resource allocation, actively balancing resources of green enterprises and related talents to the underdeveloped areas, therefore narrowing the gap of regional innovation capacity and developing the green economy in the western districts. (3) Compared with the traditional technological innovation, green technological innovation is more difficult to be evaluated, so the relevant regulatory authorities should establish a more scientific green innovation evaluation system, and standardize the quantitative indicators of financial policies such as the exemption and subsidy of green innovation based on ESG information disclosure.

6.2. Sustainable Development

Theoretic models can explain mechanisms and incentives of the economic behavior; according to the above mechanism and the effect of sustainable development indicators on financial performance, GEM-listed companies must overcome some of their own weaknesses in order to win the competition from these emerging markets. Firstly, GEMs should prioritize medium and long-term strategies against short near-term corporate growth. It is more reasonable for those emerging markets and products to shift into a new business model, especially when considering the reality of sustainability development. Secondly, the Chinese government also needs to encourage GEMs via policies and regulations to eliminate the traditional management mode and bring balance to the economy, society, and environment. Thus, China's GEMs should be more strategically driven to pursue new products that meet market demands and adapt to new investment trends and financial policies. Finally, investors have raised concerns about the social values of listed companies; they expect financial institutions to go beyond their primary role of maximin-profits and initiate the sustainable development of these emerging economies. The ESG algorithm can generally reflect the major strategic risk in the portfolio investment [116]. It is difficult to reduce such risks based solely on the market mechanism [117]. That may be because investors, rating agencies, financial analysts, and other market participants have already perceived the impact of ESG ratings on company value. However, the shortage in common standards or algorithms would continue to impede the competition of ESG scores and other environmental management indices. For this reason, stakeholders of GEM-listed companies have to face dual pressures from social and environmental management. Moreover, asset managers are responsible for trillions in investments, and these investors have integrated ESG factors into their lending strategies. Hence, local banks, public entities, and individual investors should adopt a more sustainable investment strategy and firmly believe that improving society and the environment is more important than earning a short-term profit, which means investors should focus on sustainable financial performance.

Nowadays, with the rapid development of big data technology, people have begun to move towards a new era of smart society with artificial intelligence. Digital information technology plays a critical role in emerging social media, and the application of the digital

environment would also greatly impact traditional social systems. The rapid growth of ESG evaluating agencies in recent years has caused many traditional production methods to be gradually phased out or replaced. The academic research on the concept of Industry 4.0 was focused more on Cyber-Physical Systems (CPS) than on the Internet of Things (IoT) in the 2010s [118]. Global economic integration in the post-industrial 4.0 development context is coming soon, and the ESG database of listed companies will also be established based on these data technologies. Significantly, the construction and development of the ESG database will be a data disclosure issue that all listed companies need to face in the near future. However, the current ESG database is still in its infancy, and the construction of the ESG database should start from the investor's perspective. The ESG evaluation system would be a benchmark, which will help investors to identify a better-listed company from non-financial factors. For example, COVID-19 is a stress test for those GEM-listed companies. When the economy begins to recover from the epidemic, investors will favor those companies that performed well during COVID-19 in ESG aspects. Therefore, the construction and development of China's current ESG industrial database will focus on future economic development.

6.3. Limitations and Future Research

There are several limitations and future research opportunities related to this topic. Our samples could not represent other companies in various industries, so the other scholars will be encouraged to investigate companies in other sectors. Due to the limited data on green innovation, we evaluated green innovation from dimensions of quantity and quality, other aspects such as the maintenance period of patents could also be employed to explore more effects of green innovation. Meanwhile, since the availability of environmental and ESG indicators, Cao et al. [119] have explored a new ESG database construction system according to the environmental-based standards, and the research of Escrig-Olmedo et al. [120] also examined the criteria to set the ESG scores over 10 years across various international rating agencies. With the development of big data and data exchange technology in the future, governments will strengthen the regulations on ESG information disclosure to improve the disclosure of social responsibility and environmental information comprehensively. ESG score is a green comprehensive assessment value that focuses more on environmental factors; it is highly limited by the current availability of high-quality and company-level environmental data. We encourage future researchers to introduce more professional environmental indicators into the empirical regression analysis, and researchers can also measure ESG-related performance from more detailed secondary indicators and algorithms. Finally, based on the mechanism and effectiveness of external environmental factors on corporate performance, the results of this study can be re-verified by other models and methodologies, such as the nonlinear model, factor analysis, etc. Different methodologies or research objects may obtain various conclusions, and a more reliable conclusion will be acquired based on comparative and comprehensive analysis. More recently, Chinese president Xi Jinping has vigorously advocated "green and innovation" development; thus, the ESG score has a particularly significant impact on all listed companies; it will certainly play a critical role in the sustainable development of China's emerging industries and GEMs. Considering the three levels of investment needs, risk-hedging and compliance trends, it is urgent to build a localized ESG evaluation system in China. As more and more enterprises participate in the ESG evaluation system for commercial or other purposes, the ESG scoring system will continue to evolve and upgrade. Relevant data and secondary subdivision indicators of the ESG algorithm would have more theoretical support, which would benefit from improving the quality of current ESG databases. Based on this macro trend, more ESG databases could be further developed into public and authoritative databases. Furthermore, with the coordinated development of the Industrial Internet of Things (IIoT) and company-level database, the industrial database of ESG ratings should be the key factor for China to become a manufacturing powerhouse. In conclusion, relevant databases should continue to be improved and upgraded along

with integrating IIoT and IT technology, aiming to form an industry-level ESG database suitable for China's industrial system. In the era of big data and IIoT, future work would break through these common limitations in existing research with the development of mainstream databases.

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Appendix A

Table A1. Variable definitions.

Type	Factors	Variable Name	Symbol	Calculation Method
Dependent variable	Financial Performance	Return on Assets	ROA	Net Profit/Total Assets
Independent variable	Green Innovation	Forward Citations of Green Patent	FCGP	Number of citations of green patents
Mediating variable	Environment, Social, Governance Ratings	Environmental Indicator	SEC	Total Standard Energy Consumption of Industry *GDP* of Industry
		Corporate Social Responsibility	CSR	Collected CSR scores manually from HeXun Database
		Corporate Governance	CG	Principal component analysis from supervision, incentives and decision-making
Moderating variable	Entrepreneurial Political Connection	Political Connection Strength	PCS	Obtain from CSMAR, filter by the highest level in the same firm
	Regional Differences	Regional Innovation Index	RII	Manually collate from "China Regional Innovation Capability Evaluation Report"
Control variable	Corporate Financial Indicators	Board Size	BS	The Natural Log of Board Size
		Independence Board	ID	The Proportion of Independent Directors
		Ownership Concentration	OC	The Ownership of the Largest Shareholder
		Corporation Characteristics	CC	Private Enterprise = 1, Else = 0
		Firm Size	SIZE	The Natural Log of Total Assets
		Fixed Investment Growth Rate	FIGR	Growth Rate of Fixed Investment Newly Added to the Industry
		Asset Liability Ratio	ALR	Total Liabilities/Total Assets

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