

Innovation Effect of "Green Signaling": Exploration on Whether Enterprises' ESG Disclosure Facilitates Innovation Based on Empirical Analysis of A-share listed companies on SSE and SZSE

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Abstract. This paper intended to study the impact of enterprises' ESG information disclosure on their innovation and further examines the heterogeneous role of power centralization as well as ownership through heterogeneity analysis. All the data adopted for analysis were from the A-shares listed companies traded on the two Chinese stock exchanges, the Shanghai Stock Exchange (SSE) and the Shenzhen Stock Exchange (SZSE) from 2008 to 2018. Through empirical analysis, the paper found that with other condition unchanged, enterprises' ESG disclosure significantly contributes to corporate innovation. In other words, an increase in ESG disclosure will promote more proactive innovation behavior. In terms of the heterogeneity analysis, the paper concluded that other things being equal, companies with highly centralized power or less confidence can see that ESG disclosure more significantly promotes innovative behavior. Besides, for non-state-owned enterprises, ESG disclosure will also significantly promote innovative behavior. In the end, the paper corroborated the consistency of the three findings through lagged variable regressions and instrumental variable (IV) regressions, and affirmed the robustness of the conclusions in the previous section. Finally, based on these findings, the paper proposed corresponding policy recommendations and insights.

Keywords: enterprises' ESG; information disclosure; enterprise innovation; centralization degree of power; ownership system.

1. Introduction

Enterprises' ESG information disclosure mainly spotlights the results of activities and behaviors in three areas: environmental protection, social responsibility and internal governance. A high-quality ESG management helps improve the governance of listed companies and achieve the integration of corporate value and social value. In terms of real cases, with the terms carbon peak and carbon neutrality being proposed, corporate ESG information disclosure has been vigorously promoted and developed in China. In 2018, the Asset Management Association of China issued the *Green Investment Guidelines (Trial)*, which put forward the ESG information disclosure framework for listed companies for the first time and started a new process of ESG investment practice in China. With the policy implementation and government's supervision and regulation, the quantity of ESG information disclosure reports of listed companies have been increased constantly and the quality of such reports has been improved. According to incomplete statistics, as of early November 2021, the total number of ESG reports disclosed by listed companies in China has reached 1101, with the disclosure ratio of CSI 300 reaching 83%. From theoretical studies, with the increase of ESG information disclosure, listed companies will continue to intensify ESG information disclosure and enhance the transparency, effectiveness and relevance of information disclosure. Zhang (2011) [1] found that to improve the quality of ESG information disclosure for contributing the increase in enterprise value and expected cash flows, there are mainly two ways, or, two types of effect to rely on, namely, the economic benefit effect and the social identity effect. The former indicates that the information disclosed allows investors to better anticipate the development and operation of the company and the latter states that the environmental information disclosed by the company reflects the reporting of the capital market funding for the company's social image. Meanwhile, Xuan TIAN, the associate dean at PBC School

of Finance, Tsinghua University, argues that ESG is a "win-win" approach for shareholders and stakeholders. Therefore, enterprises' disclosure of ESG information can build up social capital and establish trust for companies, gain stakeholder support, and obtain higher market value.

In the context of China's comprehensive shift to a high-quality development stage, enterprises' innovation plays a crucial role in transforming the economic development mode and achieving innovation-driven endogenous economic growth. On the one hand, China has formulated various policies to encourage enterprises to innovate. The Fifth Plenary Session of the 19th Central Committee of the Communist Party of China (CPC) regarded innovation as a core task in the overall situation of modernization and explicitly proposed to "enhance the technological innovation capability of enterprises", and China's R&D expenditure has steadily increased from RMB 1,567.676 billion in 2016 to RMB 2,439.311 billion in 2020, with an average annual growth rate of over 10%. In 2020, the proportion of R&D expenditure to domestic GDP is 2.4%, and the gap between it and developed countries is gradually narrowing. Therefore, HU Zhijian, President of Chinese Academy of Science and Technology for Development, stated that in the future, China's national innovation system can be built and improved by effort in strengthening original innovation, supporting the building of production capacity, and giving innovation priority. On the other hand, innovation promotes sustainable development of enterprises. In the new stage of high-quality economic development, more enterprises pursue and set it a goal to achieve high-quality, efficient and more sustainable development. As the market competition becomes fiercer, enterprises hope to enhance their core competitiveness by adopting science and technology innovation to gain greater market efficiency, establish the awareness of science and technology innovation and promote the development of core technology. Based on this, enterprises should adhere to the implementation of science and technology innovation-driven development strategy, attempt to innovate independently, enhance their own scientific and technological innovation capacity and comprehensive strength, and promote the progress of China's scientific and technological development.

Enterprises' innovation is a key factor in determining the direction, speed and scale of their development. According to Li (2021) [2], problems in Enterprises' innovation include information asymmetry and agency conflict. On the one hand, the inherent characteristics of enterprise innovation itself, such as high uncertainty, can exacerbate the degree of information asymmetry; on the other hand, enterprise innovation makes it difficult for investors to monitor the innovation process of managers. If companies can disclose ESG information properly, it can not only facilitate the implementation of the concept of green innovation, but also help companies establish close relationships with stakeholders, reduce information asymmetry, lower financing costs, and provide financial security for R&D and innovation. Therefore, this paper investigated whether enterprises' ESG information disclosure can promote innovation.

The current research on ESG disclosure focuses on enterprise performance and investor concerns, but there are few studies on how ESG disclosure influences innovation. Therefore, in the current context, it is urgent to study the relationship between enterprises' ESG information disclosure and innovation, and to figure out the mechanism of the role of corporate ESG information disclosure and corporate innovation from the perspective of power concentration and ownership.

The rest of this paper is organized as follows: Chapter 2 reviews the literature for reference; Chapter 3 raises the research hypotheses; Chapter 4 presents the modeling, variables and data source; From Chapter 5 to Chapter 7, an empirical analysis, a heterogeneity test, and a robustness test are depicted respectively; Chapter 8 draws the conclusion of this study and makes relevant proposals.

2. Literature Review

The existing literature focuses on the impact of ESG disclosure in three aspects: environmental performance, social responsibility and enterprise governance. First, in terms of environmental performance, the dominant view is that environmental information disclosure is positively related to enterprise value. Zhou (2021) [3] believes that The more ways a company can choose for

environmental information disclosure, the better its environmental performance will be in the following year. Clarkson et al.[4] analyzed the five most polluting industries in the United States and found that there is a positive relationship between environmental performance and the level of environmental disclosure, which is consistent with the predictions of economic disclosure theory. Hu (2011) [5] Hu adopted one unit of sewage charges and its annual increment as a proxy variable for environmental performance, and concluded that there is a significant positive relationship between environmental performance and financial performance. As for the study of FILBECK [6], aiming at analyzing the electric utilities, it found that environmental performance is negatively correlated with financial returns according to his measurements.

From the perspective of social responsibility, the opinions also vary in two sides. Some found that corporate social responsibility (CSR) performance has a significant positive impact on the increase of market value of listed companies. Samet et al. (2018) [7], through the study of STOXX Europe, found that CSR can help companies improve the efficiency of investment at the firm level by addressing problems with agency and information asymmetry. Besides, for institutional investors, the better the social responsibility performance of a listed company, the more shares it holds (Zhou, 2020) [8]. By contrast, some researchers believe that if enterprises increase their spending on social responsibility, they will be at a competitive disadvantage. With regard to social governance, Ye (2016) [9] studied on the level of corporate governance of non-financial A-share listed companies on SSE and SZSE and concluded that the higher the quality of internal management, the higher the financial performance of the enterprise. Zhu (2010) found that excellent corporate governance will lead to higher financial security of the company in the future and make investors willing to pay a higher premium for it. However, Kruger (2015) [10] argued that effective ESG may be utilized as self-interest tool of management level and reduce investment efficiency.

Research on corporate innovation has been conducted in terms of both the external environment and the internal company environment. As for the external environment, the subsidy provided by government is mostly studied. Guo (2018) [11] reached a conclusion that the subsidy for innovation from the government will promote the increase of R&D investment and substantial innovation output of the enterprises based on the study of A-share listed companies on SSE and SZSE. As for Xiao(2014) [12], he believed that municipal government subsidy policies can influence the mechanism of enterprises' investment decisions and weaken their effect of encouraging innovation. Apart from these studies, tax incentive is another popular research object. Liu et al. (2020) [13] found that tax incentives will lead to a significant increase in invention authorizations and improve the quality of innovation for enterprises in stage of maturity. Lin (2021) [14] found that for China's SMEs, the intervention of tax incentives can stimulate enterprises to increase the intensity of R&D investment and enhance their ability to withstand business risks and external risks. Meanwhile, Qing et al. (2022) [15] discovered that enterprises' innovation can be influenced by both domestic and foreign market incentives. Besides, both domestic sales scale and export scale significantly promote enterprises' innovation and development. For studies about the external environment, some studies targeted at the enterprise governance. According to Zheng et al. (2021) [16], the centralization of interlocking director network has a significant effect on innovation input and output capacity, and innovation transformation. In terms of R&D investment, Wang et al. (2021) discovered that R&D investment influences on enterprise innovation with various effect and degree. When the size of enterprises is quite large or relatively small, the effect of R&D investment on promoting enterprise innovation performance is more obvious. Meanwhile, Ye et al. (2021) [17] stated that financing constraints and the level of corporate innovation show a significantly negative relation, while the level of corporate risk-taking is significantly positively related to corporate innovation.

The contributions of this paper are reflected in the following aspects. Firstly, it supplements the research on the factors influencing corporate innovation and for the first time takes into account the perspective of corporate ESG information disclosure as well as its heterogeneous role in the power concentration and ownership dimensions. This paper explains the driving forces of corporate innovation at a deeper level and makes up for the deficiencies of the previous literature. Secondly,

the study further clarifies the economic consequences of corporate ESG disclosure and explains its impact on corporate innovation behavior. Through heterogeneity analysis, it explores more on the context of its effects and expand the margins of related research. Thirdly, the study delves into corporate ESG disclosure and explain the strength and heterogeneity of corporate ESG information disclosure on corporate innovation, which has strong practical significance. It fills the gap of related literature, and extends the research boundary.

3. Theoretical Basis and Research Hypothesis

Corporate ESG disclosure includes the three main issues: environmental performance, social responsibility and corporate governance. According to Tang (2021), the increase of environmental information disclosure shows that enterprises are willing to be supervised by the public and relevant institutions. Enterprises can observe environmental risks and take active measures to avoid them through prudent research and investigation when disclosing environmental information, which can effectively reduce the operational risks of enterprises. Meanwhile, measures for using resources more effectively and improving operational efficiency can reduce the environmental costs (waste disposal sewage treatment, etc) to provide a good environment for enterprise innovation [18]. Moreover, environmental information disclosure itself requires companies to employ safer, more advanced, energy-efficient and environmentally friendly production procedures, which helps companies to carry out innovative activities and promote the development of innovation. Liu (2021) stated that the disclosure of environmental information is beneficial to the establishment of corporate green social responsibility image of enterprises, and enterprises with a good green reputation will receive government encouragement and support, such as tax breaks, environmental subsidies, interest-free or low-interest loans, etc[19]. Besides, expanding enterprises' financing channels is conducive to providing stable and continuous R&D funds for innovation and development. In terms of corporate governance, a higher level of corporate ESG information disclosure means that enterprises have a more complete corporate governance mechanism, which can effectively monitor and restrain the behavior of management, thus reducing the generation of agency problems(Gao, 2021)[20]. In addition, more effective incentive and disciplinary mechanisms for executives drive executives to be more diligent and responsible, so executives will help investors to grasp corporate information and eliminate information asymmetry by disclosing more information about ESG. Corporate information includes both financial and non-financial information, while the non-financial information is a good indicator of the future business status, which is able to enhance their willingness to invest, alleviate the problem of corporate financing constraints, and obtain more research funds, thus promoting the development of corporate innovation. From the perspective of social responsibility, ESG disclosure gives investors signals that companies are willing to take on environmental and social responsibility, and it helps enterprises accumulate ethical and reputational capital. In this regard, the media will cover positive news for enterprises that fulfill social responsibility, while analysts will get first-hand information and conduct in-depth analysis and interpretation with refined information analysis ability. On the one hand, analysts, as information intermediaries, can help monitor and regulate the sentiment of the capital market and promote investors to focus on enterprises with good social responsibility performance, making it easier for them to raise funds in the primary and secondary markets. On the other hand, analysts can improve information efficiency by delivering more information, which will effectively reduce the degree of stock price synchronicity. The lower it is, the weaker the degree of market resource mismatch, so it is less possible to overvalue an enterprise's stock price, and the risk of a stock price collapse is diminished (Xu, 2022) [21]. Therefore, corporate innovation can be promoted by increasing access to finance and efficiency, as well as by reducing the risk of share price collapse. With the aforementioned analysis, this paper puts forward the following hypothesis: Enterprises' ESG information disclosure will contribute to their innovation.

4. Model Establishment, Variables and Data

4.1 Model Establishment

$$RD_{it} = \beta + \beta_1 * ESG_{it} + CV_{sit} + \mu_{it}$$

In this formula, RD_{it} refers to surplus management level of corporate i in the t^{th} year; ESG_{it} denotes the financial risks of corporate i in the t^{th} year; CV_{sit} represents the controlled variables.

4.2 Variables Design

Table 1. Variables Design

Variable	Sign	Description
Corporate Innovation	<i>RD</i>	Total R&D expenditure
ESG Disclosure Index	<i>ESG</i>	This paper adopted ESG disclosure score given by Bloomberg for measurement.
Power Concentration	<i>BOTH</i>	The chairman and general manager of a listed company are both dummy variables, and if one person takes the two positions, the value is one; else, 0.
Scale of the Enterprise	<i>SIZE</i>	Ln(total asset)
Asset-liability Ratio	<i>LEV</i>	Total liabilities/total assets
Profitability	<i>ROA</i>	Net profit/total assets
Scale of the Board	<i>BOARD</i>	Ln(Number of board members)
Executive shareholding ratio	<i>SR</i>	Proportion of shares held by executives
Nature of Property	<i>STATE</i>	Valued as 1 if it is state-owned; else, 0.

4.3 Data Source and Processing

In this paper, all A-share listed companies from 2008 to 2016 were selected as sample selection. The following processing were done: (1) Listed companies operating finance, insurance, and real estate business were excluded. (2) The paper removed the samples with missing key variables based on the data on China Stock Market & Accounting Research Database (CSMAR) and the author's compilation. (3) To mitigate the effect of extreme values, this paper winsorized the main continuous variables in the analysis at the 1% and 99% levels.

5. Empirical Analysis

5.1 Descriptive Statistics

Table 2. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
RD	5635	37.361	145.002	0	1860.1
ESG	5635	20.391	6.536	1.24	61.722
SIZE	5635	22.906	1.303	19.198	28.509
LEV	5635	0.456	0.226	0.008	8.009
ROA	5635	0.045	0.136	-3.911	7.445
BOARD	5635	2.176	0.2	1.099	2.89
BOTH	5635	0.217	0.412	0	1
SR	5635	0.095	0.176	0	1.692
STATE	5635	0.475	0.499	0	1

In this paper, all listed companies in China A-shares and Hong Kong stocks are selected as the research sample, and the original sample is processed as follows: (1) All companies in the financial

sector are removed due to a high leverage ratio that makes them different from other sectors. (2) Samples without relevant data were removed. (3) Research R&D investment has a large value, so it is adjusted in millions. Finally, 5635 sample observations were obtained. Table 2 shows the results of descriptive statistics of the main variables. The maximum R&D investment in the sample enterprises is 18601 million yuan, the minimum 0 yuan, which indicates that there is a large difference in R&D investment for innovation among different enterprises. The maximum of ESG index is 61.722, the minimum 1.24, the standard deviation 6.536. In terms of variables controlling, the size of the sample enterprises and the scale of the board of directors have a larger standard deviation.

5.2 Correlation Analysis

Table 3 demonstrates the correlations between the variables, with a positive correlation coefficient of 0.304 between the explanatory variables RD and ESG, where the sign of the coefficient is consistent with the research hypothesis. The correlation coefficients between the other control variables are basically less than 0.5, so the issue of multicollinearity will not be considered in this paper.

Table 3. Correlation Analysis

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) RD	1								
(2) ESG	0.304	1							
(3) SIZE	0.493	0.448	1						
(4) LEV	0.185	0.178	0.461	1					
(5) ROA	-0.007	-0.012	-0.051	-0.349	1				
(6) BOARD	0.021	0.105	0.207	0.114	-0.013	1			
(7) BOTH	-0.027	-0.111	-0.155	-0.12	0.066	-0.181	1		
(8) SR	-0.089	-0.202	-0.331	-0.267	0.068	-0.207	0.25	1	
(9) STATE	0.114	0.237	0.353	0.255	-0.075	0.276	-0.312	-0.489	1

5.3 Baseline Regression Analysis

Table 4. Baseline Regression Analysis Results

	(1) RD	(2) RD
ESG	2.02*** (0.24)	1.81*** (0.24)
SIZE		19.41*** (2.18)
LEV		-6.55 (6.32)
ROA		5.65 (6.08)
BOARD		6.8 (7.27)
BOTH		-2.71 (2.95)
SR		12.74 (11.99)
STATE		-0.01 (7.40)
_cons	-4.97 (4.92)	-457.80*** (50.64)
Year Fixed Effects	YES	YES
Corporate Fixed Effects	YES	YES
N	5587	5587
R ²	0.829	0.832

Note: Standard deviations are shown in parentheses; *, **, *** indicate the significance at the 10%, 5%, and 1% levels, respectively. (Hereafter the same)

In this paper, regression analysis is conducted on ESG and corporate R&D investment, and the results are shown in Table 4. The regression uses a time-point individual fixed effects model to control the corporate fixed effects and the year fixed effects. Column (1) regresses ESG on RD only, while column (2) controls the regression results of the variables. The coefficients of ESG are 2.02 and 1.81, respectively, which are both significant at the 1% significance level, indicating that a good corporate ESG disclosure can promote the corporate innovation. Therefore, the empirical results support the hypothesis.

5.4 Heterogeneity Analysis

5.4.1 Comparison of the Impact of ESG Disclosure on Corporate Innovation for Enterprises with Different Levels of Power Centralization

Table 5. Regression Results of Whether Corporate Power is Centralized

	(1) RD Centralized Power	(2) RD Decentralized Power	(3) RD Centralized Power	(4) RD Decentralized Power
ESG	4.11*** (0.49)	1.68 (0.29)	3.85*** (0.49)	1.45*** (0.29)
SIZE			20.24*** (4.44)	22.53*** (2.88)
LEV			-8.88 (17.13)	-8.3 (7.68)
ROA			9.63 (6.19)	-7.3 (13.57)
BOARD			-17.93 (14.99)	8.38 (9.02)
SR			-4.28 (17.36)	39.35** (18.54)
STATE			-2.43 (27.36)	0.75 (9.73)
_cons	-48.80***	3.21	-457.04*** (100.06)	-527.92*** (66.76)
Year Fixed Effects	YES	YES	YES	YES
Corporate Fixed Effects	YES	YES	YES	YES
N	1115	4341	1115	4341
R ²	0.818	0.828	0.823	0.832

Previously, the corporate centralization is determined by whether the general manager and the chairman are the same person. If they are the same person, the power is more concentrated. The paper divides the sample into same and non-same. The results are presented in Table 5. Column (3) indicates that the coefficient of ESG is 3.85 when the general manager and the chairman of the board are the same, which is significant at 1% level of significance, indicating that the power is more concentrated in the case of dual roles. Under such circumstances, it is possible to have a better unification of the company and have more power for innovation. Column (4) indicates that the general manager and the chairman are not the same, with an ESG coefficient of 1.45, which is significantly less than 3.85. Power concentration plays an important role in the corporate R&D decision. The more power a manager has, the more difficult it is for shareholders to monitor, the less constrained he/she is in the business decision, and the more resources he/she can control. Therefore, ESG disclosure can better promote the innovation of enterprises with concentrated rights (Liu Yiqing 2020) [22]. On the contrary, if the power is not centralized, projects with higher risks and longer-term benefits may require multiple discussions and studies, and thus may slow down the pace of innovation, resulting in a less significant impact of ESG disclosure. Therefore, the more centralized the power is, the more effective the ESG disclosure is in boosting corporate innovation.

5.4.2 Comparison of the Impact of ESG Disclosure on Corporate Innovation for Enterprises with Different Levels of Confidence

Table 6. Regression Results for Different Levels of Confidence

	(1) RD Overconfidence	(2) RD Lack of Confidence	(3) RD Overconfidence	(4) RD Lack of Confidence
ESG	0.70*** (0.24)	2.56*** (0.43)	0.48** (0.24)	2.42*** (0.43)
SIZE			17.51*** (2.14)	23.77*** (4.41)
LEV			-18.42** (8.19)	-2.85 (9.71)
ROA			-5.49 (11.74)	7.09 (8.75)
BOARD			16.40** (7.30)	6.92 (13.37)
BOTH			-0.10 (2.68)	-1.02 (5.86)
SR			-1.42 (10.92)	34.77 (25.41)
STATE			-0.10 (6.53)	5.40 (16.04)
_cons	12.50*** (4.80)	-7.01 (9.09)	-407.04*** (48.24)	-573.64*** (104.03)
Year Fixed Effects	YES	YES	YES	YES
Corporate Fixed Effects	YES	YES	YES	YES
N	2657	2719	2657	2719
R-sq	0.861	0.843	0.866	0.846

In this paper, the CON variable is defined as whether the pay ratio of the top three highest paid senior executives is higher than their median. If it is higher, then CON is 1, and the opposite is 0. The paper argues that if the pay ratio of the top three senior executives is too high, it will lead to the overconfidence, thus generating optimistic cognitive deviations and psychological deviations, which will have a significant impact on business decision making. Since overconfident managers are more likely to overestimate innovation projects and underestimate the risk of project failure, they will pursue projects with higher uncertainty and risk and prefer to keep increasing innovation investment (Wang Ping, et al. 2022) [23]. To assess the difference caused by overconfidence, the research sample was divided into two groups, overconfidence and moderate confidence to conduct regression. The group test results are shown in Table 6. Column (3) presents the regression results for overconfidence with an ESG coefficient of 0.48, which is significant at the 5% level of significance; column (4) shows the regression results for moderate confidence with an ESG coefficient of 2.42, which is significant at the 1% level of significance. In addition, the difference between the coefficients of overconfident and underconfident enterprises is larger, and the impact of ESG on corporate innovation is more significant in underconfident enterprises. It can be seen that underconfident enterprises tend to have lower innovation capability due to their own reluctance to pursue innovation projects with high uncertainty and risk, which can be compensated by ESG disclosure so as to facilitate the development and progress.

5.5 Robustness Test

5.5.1 Comparison of the Impact of ESG Disclosure on Corporate Innovation for Enterprises with Different Ownership Systems

As in the previous analysis, corporate innovation is affected by factors such as government taxes, financial subsidies, etc. To assess their differences, the research sample is divided into two groups,

state-owned enterprises and non-state-owned enterprises to perform regressions. Table 7 presents the results of the group test. The ESG coefficients of both SOEs and non-SOEs are positive and significant at the 1% significance level without controlling variables. Column (3) shows the regression results for SOEs after controlling variables, with an ESG coefficient of 1.35 that is significant at the 1% significance level; column (4) presents the regression results for non-SOEs after controlling variables, with an ESG coefficient of 2.19, which is similar to that of SOEs, significant at the 1% significance level. Although non-SOEs may slow down innovation due to lack of taxation, subsidy policies, etc., ESG disclosure is a more effective way to address the issue of innovation for private companies. In conclusion, the regression results in this paper are robust.

Table 7. Regression Results for Enterprises with Different Ownership System

	(1) RD SOE	(2) RD Non-SOE	(3) RD SOE	(4) RD Non-SOE
ESG	1.63*** (0.45)	2.83*** (0.19)	1.35*** (0.44)	2.19*** (0.19)
SIZE			35.78*** (4.67)	13.35*** (1.68)
LEV			-11.34 (17.75)	-4.06 (4.20)
ROA			14.96 (9.36)	-3.78 (7.31)
BOARD			14.59 (13.60)	1.60 (6.00)
BOTH			-4.50 (6.40)	-1.17 (2.15)
SR			-138.14 (159.62)	3.20 (7.05)
_cons	13.66 (9.88)	-20.61*** (3.69)	-843.09*** (110.62)	-318.61** (38.02)
Year Fixed Effects	YES	YES	YES	YES
Corporate Fixed Effects	YES	YES	YES	YES
N	2635	2932	2635	2932
R ²	0.810	0.810	0.816	0.887

6. Discussion

In terms of the model built in the paper, endogeneity problems may arise due to the causality between corporate innovation and ESG disclosure. Corporate ESG disclosure can foster innovation through corporate governance, environmental performance, social responsibility, etc. Meanwhile, the vigorous innovation will create more value for companies to take social responsibility, focus on corporate governance, and thus perform higher-quality ESG disclosure. Therefore, to solve the endogeneity problems it brings, two methods are used in this paper, using lagged regression to test the contemporaneous endogeneity and using instrumental variable regression to examine the existence of heterogeneous endogeneity.

6.1 Lagged Term Regression

Due to the possibility of contemporaneous endogeneity, the author runs regressions with a one-period-lag independent variable, and the regression results are shown in Table 8. With controlling variables, the results in column (2) indicate that the coefficient of the one-period-lag ESG is positive, significant at the 1% significance level, proving the model is robust and that corporate ESG disclosure is beneficial to corporate innovation.

Table 8. Lagged Term Regression Results

	(1) RD	(2) RD
ESG1	2.21*** (0.27)	2.01*** (0.27)
SIZE1		19.39*** (2.56)
LEV1		-9.35 (10.05)
ROA1		1.96 (12.68)
BOARD1		-18.69** (8.21)
BOTH1		-4.22 (3.28)
SR1		9.59 (13.83)
STATE1		1.44 (8.28)
_cons	-5.37 (5.50)	-399.96*** (58.74)
Year Fixed Effects	YES	YES
Corporate Fixed Effects	YES	YES
N	4515	4515
R ²	0.865	0.868

6.2 Instrumental Variable Regression

An ideal instrumental variable must satisfy two basic requirements. One is that the instrumental variables are significantly correlated with the endogenous explanatory variables, and the other is that the instrumental variables are independent of the residual terms given the existing control variables.

Table 9. Instrumental Variable Test

	City Average	Provincial Average	Industrial Average &Provincial Average
Anderson-Rubin Wald test	4.24**	14.30***	17.23***
Endogeneity test	2.721*	9.364***	10.849***
SW F test	11.44***	38.13***	25.62***
overidentification test (Sargan statistic)			0.156 (p=0.693)

In the paper, the average value of ESG disclosure of cityenterprises excluding the firm (CityIV), the average value of ESG disclosure of provincial enterprises excluding the firm (ProIV), and the average value of ESG disclosure of provincial enterprises excluding the firm and the average value of ESG disclosure of industry excluding the firm, are selected as instrumental variables (InIV& ProIV) simultaneously, totally three instrumental variables. For the first condition, if the average value of ESG disclosure of a firm's proximity increases, investors will pay more attention to its proximity, and thus more government subsidies will be provided with the enhancement of ESG disclosure. Therefore, enterprises should increase their competitiveness by improving the ESG disclosure. Meanwhile, the regression results in the first part of the two-step method also show that the regression coefficients of instrumental variables are positive and all three instrumental variables are significant at the 1% level. A weak instrumental identification test was also conducted, whose original hypothesis H0 is that instrumental variables are not correlated with endogenous variables. The results of the weak instrumental identification test are shown in Table 9, which indicates that the p-value of the city ESG average is less than 5%, significant at the 5% level, while the provincial ESG average and InIV & ProIV are significant at the 1% level. Therefore, the three instrumental variables selected in this paper

are correlated with endogenous variables that are not weak instrumental variables. To satisfy the second condition, the paper argues that the city average and provincial average are irrelevant to the errors, which means that both city average and provincial average can only influence corporate innovation through affecting individual corporate ESG disclosure. At the same time, when the author performs an over-identification test with both InIV and ProIV as instrumental variables for ESG, the p-value is 0.693, higher than 0.1, so the original hypothesis that the instrumental variables are exogenous is accepted.

Table 10. Instrumental Variables Regression Results

	(1) Phase I Regression	(2) Phase II Regression	(3) Phase I Regression	(4) Phase II Regression	(5) Phase I Regression	(6) Phase II Regression
	ESG	RD	ESG	RD	ESG	RD
City Average ESG(IV)	0.11*** (0.03)					
Provincial Average ESG(IV)			0.31*** (0.05)		0.31*** (0.05)	
Industrial Average ESG(IV)					0.21*** (0.06)	
ESG		9.38* (5.45)		9.16*** (2.90)		8.64*** (2.48)
STATE	0.80* (0.48)	-5.76 (9.90)	0.83* (0.45)	-5.84 (8.44)	0.81* (0.45)	-5.46 (8.27)
SR	2.51*** (0.76)	-3.39 (19.75)	2.27*** (0.73)	-3.69 (14.70)	2.33*** (0.73)	-2.55 (14.17)
LEV	-0.25 (0.41)	-4.53 (7.58)	-0.29 (0.39)	-5.10 (6.97)	-0.26 (0.39)	-5.25 (6.89)
SIZE	0.97*** (0.14)	11.54* (5.96)	0.85*** (0.13)	12.92*** (3.49)	0.86*** (0.13)	13.39*** (3.21)
BOARD	-1.20* (0.48)	18.19* (11.03)	-0.99** (0.44)	14.38* (8.52)	-1.03** (0.44)	14.20* (8.33)
BOTH	-0.11 (0.19)	-2.39 (3.60)	-0.09 (0.18)	-2.03 (3.25)	-0.07 (0.18)	-2.06 (3.22)
ROA	0.43 (0.38)	2.95 (7.43)	0.23 (0.37)	3.53 (6.73)	0.22 (0.37)	3.62 (6.64)
Year Fixed Effects	YES	YES	YES	YES	YES	YES
Corporate Fixed Effects	YES	YES	YES	YES	YES	YES
N	5041	5041	5579	5579	5573	5573
R-sq		-0.159		-0.165		-0.137

Finally, considering that the OLS regression is more effective than the instrumental variable regression, it is found that, in the endogeneity test, the city average is significant at the 10% level and the provincial average and InIV & ProIV are significant at the 1% level, indicating that the ESG is endogenous. Therefore, the instrumental variable regression is more effective. Table 10 presents the results of the instrumental variables regression, the ESG estimates using three different instrumental variables are positive, all significant at 1% level, indicating that the model is robust and that corporate ESG disclosure is beneficial to corporate innovation.

7. Conclusions and Suggestions

The Outline of the People's Republic of China 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035 points out the direction for carbon peaking and carbon neutrality, and the ESG is gradually emerging as a guide for corporate innovation. Meanwhile, corporate innovation has a crucial impact on transforming the economic development

mode and achieving innovation-driven endogenous economic growth. Therefore, a combination of theoretical and empirical analysis is used in this paper and A-share listed companies in China from 2008-2016 are selected as samples to study the influence of ESG disclosure on corporate innovation growth. The conclusion that ESG disclosure has a direct impact on corporate innovation is obtained based on the empirical data, and heterogeneity as well as robustness analysis is conducted with the following findings.

7.1 Positive Impact of ESG Disclosure on Corporate Innovation and Development

The author conducted regression analysis by using R&D investment as the dependent variable, ESG as the independent variable, and corporate power concentration, enterprise scale, assets and liabilities ratio, profitability, board size, executive shareholding ratio, and property ownership nature as control variables. The results show that ESG disclosure is significantly and positively related to corporate innovation. In addition, the author regressed on enterprises with different ownership, and found that ESG disclosure has a positive impact on the development of both state-owned and non-state-owned enterprises' innovation. Meanwhile, to prevent endogeneity problems, instrumental variables and lagged terms are applied in the regressions, and it is found that the model is quite robust and that ESG disclosure can promote corporate innovation.

7.2 ESG Heterogeneity Analysis of Information Disclosure

Since innovation faces huge investment and high feedback uncertainty, enterprises are prone to internal conflicts and disagreements. Therefore, enterprises with more centralized power can better integrate innovation perceptions of teams and eventually make innovation strategy decisions, so as to promote the corporate innovation. Empirically, ESG affects innovation more in enterprises with more concentrated power and less in those with less concentrated power. In addition, the impact of overconfidence on innovation is investigated in the paper. Since innovation activities are long-term in nature and various risk challenges may lie in the innovation process, managers are required to have strong psychological quality. Moreover, failures may occur in the innovation process, so strong psychological capacity is required. Combined with the empirical results, it is proved that the impact of ESG disclosure on overconfident enterprises is smaller. Therefore, ESG disclosure can be used to compensate for the lack of self-confidence and increase innovation behavior.

7.3 Findings and Significance

For the government, corporate ESG disclosure as a government tool can help better corporate governance and lay a foundation for achieving economic sustainability, while improving the corporate ESG disclosure mechanism can help promote the innovation of China. Therefore, the government should gradually complete ESG disclosure principles and establish regulatory policy framework according to the characteristics of China's market and industry. For investors, ESG disclosure offers more information on corporate governance and environmental performance to help alleviate problems such as information asymmetry, facilitate the development of China's financial market, and satisfy the diverse needs of different investors. At the same time, institutional investors should fully play their role in green finance, helping the government to improve the ESG disclosure guidelines with a unified standard as soon as possible and to further improve the quality of ESG information. For enterprises themselves, especially non-state enterprises and enterprises lacking self-confidence, they should pay more attention to ESG disclosure, so as to improve the quality of ESG information and promote their sustainable innovation activities.

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