

The Impact of ESG Rating Discrepancies on Corporate Green Innovation

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Abstract. Green innovation has become an important way for companies to achieve high-quality development under the supervision of the country's "dual carbon" goals. But the cost of funding is high, and the return on investment for green innovation is uncertain. ESG ratings have had discrepancies that are becoming more frequent lately, making it harder for businesses to make decisions about what they should do. The study takes Chinese A-share listed companies from 2014 to 2024 as samples to experimentally investigate how ESG rating divergence impacts corporate green innovation. From the results of this research we can see that ESG rating difference greatly promotes corporate green innovation; analysts' attention partially mediates the relationship between them; the level of corporate governance positively moderates the relationship between ESG rating difference and green innovation; good corporate governance can enhance the positive promoting effect of rating difference on green innovation. To assist businesses in dealing with ESG rating differences and improving their ability to innovate greenly, this paper provides a theoretical basis and relevant references.

Keywords: ESG rating divergence, green innovation, corporate governance level, digital transformation

1. Introduction

Green innovation has become a major strategy for businesses to modernize, transform, and move towards high-quality development under the guidance of the "dual carbon" goal. It helps with restoring nature and lowers the cost of doing business over time, making companies better competitors. Enterprises must choose it if they want to develop sustainably. But green innovation itself has features such as high investment, long cycle, and high uncertainty. Its progress is limited by many factors. In recent years, ESG (Environment, Society and Governance) concept has become popular. ESG rating divergence means that there are big differences in how different rating organizations evaluate a company's sustainable performance in terms of environment, society and governance. This indicator has received considerable attention from investors, management teams and consumers. But actually, different rating agencies usually give different scores to the ESG performance of the same company. The uncertainty caused by rating divergence will have a negative impact on enterprises and limit their green innovation efforts. Research on the impact of ESG rating differences on corporate green innovation has already been quite extensive.

Mainstream theories [1] mostly see rating differences as a "negative signal" or "external pressure", and have proven their mechanism for promoting strategic green innovation in manufacturing and heavily polluting industries. But the existing theories do not explore deeply enough the mediating role of analysts' attention and the moderating effect of corporate governance level on green innovation. Analysts, who play an important part in the investment market, could act as a link between ESG rating disparities and green innovation; at the same time, the degree of corporate governance impacts a firm's capacity to understand ESG ratings and its reaction approaches. According to this, this paper introduces analysts' attention as a mediating variable and corporate governance level as a moderating variable so as to further enrich the theoretical framework of ESG rating discrepancy and green innovation and promote the development of related research in this field.

To achieve the above-mentioned research objectives, this study examines how ESG rating disparities affect businesses' green innovation by analyzing Chinese A-share listed companies from 2014 to 2024. Mechanism analysis: Take the level of corporate governance as a moderating variable to deepen our understanding of this mechanism, and introduce analyst attention as an intermediary variable to show the transmission path through which ESG rating discrepancies influence enterprises' green innovation. Under the framework of the "dual carbon" goals, the aforementioned study provides a new perspective for business growth and assists businesses in effectively addressing the adverse effects of ESG rating disparities on green innovation.

2. Theoretical analysis and research hypotheses

2.1. ESG rating discrepancies and green innovation

According to the signal theory and stakeholder theory, ESG ratings differences will cause enterprises to improve their green innovation capabilities. Existing studies [2] indicate that there are impacts of ESG rating difference on enterprise's access to capital market financing as well as competitive resources acquisition in markets; also intensifying management's performance pressures. And thus they push companies up for bettering how much of a greener innovator they are when dealing with possible operations troubles. From stakeholder point of view [3], ESG rating difference would lead different stakeholders worry about the company. Inconsistency in the evaluation outcomes would worsen the information imbalance between the firm and its investors which would result in a sequence of consequences like creditors asking for more risk compensation and supply chain partners' confidence going down. These reactions make the company need to change strategies so that these bad effects can be lessened.

Based on theories of information asymmetry and signaling [4], ESG ratings differences will increase information asymmetry between firms and outside stakeholders. It is hard for outsiders (investors, regulators, public) to know what really ESG does companies have, making them face more outside pressure and reputation trouble. In order to reduce such uncertainties and send out good signals of being environmentally friendly to the market, companies should proactively take actions to show where they stand. Empirical studies [5] proved that if the degree of ESG rating difference increases then it will decrease the green innovation efficiency of an enterprise and the debt capital cost plays a partial mediating role. According to Reputation Theory [6], the difference in ESG ratings will increase the risk of reputation for companies, which affects their social image. A good corporate reputation can help with running daily business operations. Therefore, companies would do everything possible to make their green innovations look good and continue receiving

money. This will reduce the rating gap, decrease the risk to reputation, and ultimately lead to more green inventions. The study concludes with the following hypothesis:

H1: ESG rating differences greatly enhance corporate green innovation.

2.2. The mediating role of analyst attention

As important information intermediaries in the capital market, analysts' actions have a direct impact on how companies develop. ESG rating divergence raises the degree of information uncertainty and task difficulty for analysts. When various rating organizations give conflicting opinions about a firm's ESG performance, analysts struggle to depend entirely on these ratings for their investment analyses and suggestions; as a result, they carry out additional research and evaluation of the company to make precise evaluations. Analysts are an important part of the capital market because they help reduce the gap between what people know and don't know, which makes the market work better. Studies show that differences in ESG scores can draw more attention from analysts, prompting businesses to perform green tech innovations [7]. High analyst attention means there is stronger outside watching over the company. Analyst attention is a kind of outside watch that makes firms invest in greens [8]. Analysts publish research reports and raise questions, bringing corporate green innovation results to the public's notice, forcing managers to place emphasis on ESG matters and thus affecting the corporation's green innovation capacity. The greater the level of analyst attention, the greater the performance and reputation pressure experienced by the company, causing it to be more inclined towards improving its corporate image and increasing long-term value via green investments.

Analysts' interpretation and spread of corporate green plans assist external investors in grasping corporate green invention, hence furnishing easier financial aid and resource assurance for green invention activities [9]. Green innovation has long investment cycle, large amount of capital required, high risk, it is hard to show its value through financial indicators in the short term. External investors have considerable information obstacles concerning the actual extent of corporate green innovation and its possible benefits; such information disparity might cause investor dissatisfaction with corporate green innovation efforts. Analysts' attention can solve this problem. Using their professional ability to process information, analysts convert green information into investment recommendations that investors can understand, allowing the market to correctly recognize a company's potential value. To sum up, we put forward Hypothesis H2:

H2: ESG rating divergence promotes corporate green innovation by increasing analyst attention

2.3. The moderating role of corporate governance

The corporate governance capability reflects the level of institutional construction in terms of internal control, supervision and incentives, and is a key factor determining whether a company can achieve high-quality development. A well-established internal control system helps to reduce the financing and operational risks of the company, and at the same time enhances the green innovation performance. Good corporate governance can also effectively mitigate the adverse effects caused by ESG rating disagreements [10].

High-level corporate governance is characterized by a high degree of transparency and strict information disclosure; major corporate decisions must be disclosed, which helps external investors understand internal corporate information and breaks down information barriers. High-level corporate governance possesses oversight and incentive capabilities; when management recognizes that ESG rating discrepancies may lead to reputational risks and financing constraints, effective

corporate governance can prompt the company to take measures to improve its current situation. Sound corporate governance effectively curbs short-sighted behavior by management. Green innovation projects are characterized by high investment requirements and significant uncertainty. When companies face discrepancies in ESG ratings, executives—operating within limited tenures and motivated by the need to protect their professional reputations and short-term interests—typically opt for low-investment, short-cycle projects, reducing investment in green innovation initiatives and thereby stifling corporate development [11]. Sound corporate governance can effectively prevent this phenomenon. Furthermore, when corporate governance capabilities are strong, companies can view ESG rating discrepancies rationally and avoid interrupting or scaling back green innovation activities due to short-term rating fluctuations, thereby maintaining the stability and sustainability of such initiatives. In summary, we propose Hypothesis H3:

H3: The higher the level of corporate governance, the stronger the positive impact of ESG rating discrepancies on green innovation

3. Model construction

3.1. Data sources and processing

This study used A-share listed companies from 2014 to 2024 as the original sample and performed the following screening steps: (1) Remove companies that received ST or *ST treatment during the sampling period and financial companies; (2) Remove companies with severe missing data on important variables, resulting in a final count of 31,635 valid observations; (3) Trim all continuous variables at the 1% and 99% quantiles. All of the above information was obtained from the CSMAR database.

3.2. Variable definitions

3.2.1. Explanatory variables

ESG Rating Discrepancy (ESGdif). Based on existing research methods [12], this paper selected ESG rating results from six institutions: China Securities Index (CSI), WIND, Shangdao Ronglv, Menglang FIN-ESG, Bloomberg, and FTSE Russell. All rating results were standardized: the nine-tier ratings (C to AAA) from Huazheng, WIND, and Menglang FIN-ESG were assigned values from 1 to 9, respectively, while the ten-tier ratings (D to A+) from Shangdao Ronglv were assigned values from 0 to 9, respectively. To ensure that the final value ranges of the six rating categories were comparable, Bloomberg's ESG ratings were multiplied by 10% and rounded to the closest whole number, while FTSE Russell's ESG scores were multiplied by 200%. This ensures that when calculating disparities, the weights of each rating system are equal. In order to quantify ESG rating disparities, this study computes the standard deviation of each company's six ESG ratings for the specified year.

3.2.2. Dependent variable

The following is the approach used to calculate this variable in this study: Total the number of green utility model and green invention patents that the company independently filed in a given year. After adding one to the total, calculate the natural logarithm.

3.2.3. Mediating variables

Analyst Attention (*Inatten*). According to the existing research [13], the method of measuring analysts' attention in this study is as follows: Add 1 to the total number of analysts who have carried out follow-up analysis on the company within a year, and then take the natural logarithm.

3.2.4. Moderating variables

Corporate Governance Level (*Govern*). Based on the method of building a comprehensive corporate governance index [14], this paper uses principal component analysis to analyze nine indicators from three aspects.

3.2.5. Control variables

The control variables selected for this study mainly include: enterprise size (*Size*), debt-to-asset ratio (*Lev*), profitability (*ROA*), years of listing (*Age*), cash flow ratio (*Cashflow*), and equity concentration (*Top10*). Additionally, the paper also incorporates fixed effects for years and industries.

Table 1. Variable definitions

<i>Variable Type</i>	<i>Variable Name</i>	<i>Variable Symbol</i>	<i>Description</i>
<i>Dependent variable</i>	<i>Green Innovation</i>	<i>GI</i>	<i>Ln (number of independently submitted green utility model applications in the current year + number of independently filed green invention applications in the current year + 1)</i>
<i>Explanatory Variable</i>	<i>ESG Rating Discrepancy</i>	<i>ESG-dif</i>	<i>Once the ESG rating scores from six institutions have been assigned values, compute the standard deviation: Bloomberg, FTSE Russell, WIND, Shangdao Ronglv, Menglang, and China Securities</i>
<i>Intermediary variable</i>	<i>Analyst Attention</i>	<i>Inatten</i>	<i>ln(Total number of analysts + 1)</i>
<i>Moderator variable</i>	<i>Corporate Governance Level</i>	<i>Govern</i>	<i>Composite indicators based on the principal component analysis framework</i>
<i>Control variables</i>	<i>Company size</i>	<i>Size</i>	<i>Natural logarithm of total assets</i>
	<i>Debt-to-Asset Ratio</i>	<i>Lev</i>	<i>Total Liabilities / Total Assets</i>
	<i>Profitability</i>	<i>ROA</i>	<i>Net Income / Total Assets</i>
	<i>Years Listed</i>	<i>Age</i>	<i>ln(Year of Listing + 1)</i>
	<i>Cash Flow Ratios</i>	<i>Cash Flow</i>	<i>Cash Flow from Operating Activities / Current Liabilities</i>
	<i>Shareholding Concentration</i>	<i>Top 10</i>	<i>Shareholding Ratio of the Top 10 Shareholders</i>

3.3. Model construction

To examine the impact of ESG rating discrepancies on enterprises' green innovation, this study has constructed the following model (1):

$$GI_{i,t} = \alpha_0 + \beta_1 ESGdif_{i,t} + \sum Controls_{i,t} + \sum Year + \sum incodeI + \varepsilon_{i,t} \quad (1)$$

To verify the mediating role of analyst attention, we construct Models (2) and (3):

$$Inatten_{i,t} = \alpha_0 + \beta_1 ESGdif_{i,t} + \sum Controls_{i,t} + \sum Year + \sum incode + \varepsilon_{i,t} \quad (2)$$

$$GI_{i,t} = \alpha_0 + \beta_1 ESGdif_{i,t} + \beta_2 Inatten_{i,t} + \sum Control_{i,t} + \sum Year + \sum incode + \varepsilon_{i,t} \quad (3)$$

To test the moderating effect of corporate governance level, this study constructed Model (4):

$$GI_{i,t} = \alpha_0 + \beta_1 ESGdif_{i,t} + \beta_2 Govern_{i,t} + \beta_3 ESGdif_{i,t} \times Govern_{i,t} + \sum Controls_{i,t} + \sum Year + \sum incode + \varepsilon_{i,t} \quad (4)$$

Here, Controls denotes all control variables, and includes year and industry dummy variables.

4. Empirical analysis

4.1. Descriptive statistics

The primary variables' descriptive statistics are shown in Table 2. From the standpoint of indicators relating to green innovation, the mean values of GI1 and GI2 are 0.430 and 0.310, respectively, suggesting that listed businesses in China have comparatively low levels of green innovation overall. ESG rating divergence (ESGdif) has a mean of 1.610, a standard deviation of 0.740, a minimum of 0.130, and a maximum of 3.590. This implies that there are some variations in how various rating agencies evaluate the ESG performance of Chinese listed companies, and that these variations vary greatly between different businesses. All of the remaining variables' descriptive statistics satisfy the study's fundamental requirements.

Table 2. Descriptive statistics of key variables

Variable	Sample	Mean	Standard Deviation	Minimum	Median	Maximum
GI1	30,820	0.430	0.870	0	0	6.850
GI2	30820	0.310	0.740	0	0	6.330
ESGdif	29,977	1.610	0.740	0.130	1.580	3.590
InAtten	30,843	1.580	1.100	0	1.610	3.810
Govern	29,660	0.0800	1	-1.810	-0.0200	2.310
Size	31,563	22.43	1.330	19.96	22.23	26.49
Lev	31,470	0.410	0.200	0.0600	0.400	0.890
ROA	31,635	0.0400	0.0700	-0.270	0.0400	0.210
Age	30,755	2.030	0.930	0	2.080	3.400
Cash Flow	31,194	0.260	0.400	-0.580	0.170	2.050
Top 10	31,406	59.70	15.18	24.49	60.40	92.10

4.2. Regression results

The regression coefficient of ESGdif in Table 3's (1) column is 0.0233, indicating a substantial positive association at the 1% level. This finding suggests that the ESG rating differential significantly encourages green innovation in businesses. As a result, hypothesis H1 is confirmed.

4.3. Mediating and moderating effects

The test findings of the mediating impact that the analysts are worried about are shown in Table 3's second and third columns. The ESG rating divergence might increase the analysts' focus on the company, as shown by the second column's regression coefficient of ESGdif, which is 0.0264 and considerably positive at the 1% level. The third column shows that the ESGdif coefficient is 0.0221 (still significant at the 1% level) and the InAtten coefficient is 0.0467 (significantly at the 1% level). These findings corroborate Hypothesis H2 by confirming that the analysts' attention partially mediates the relationship between the ESG rating discrepancy and green innovation. The fourth column displays the moderating impact test. The degree of corporate governance has a positive moderating influence on the association between ESG rating divergence and green innovation, as indicated by the interaction term's coefficient (ESGdif × Govern) of 0.00144, which is statistically positive at the 5% level. As a result, Hypothesis H3 is confirmed.

Table 3. Regression results

<i>Variables</i>	(1)	(2)	(3)	(4)
	<i>GII</i>	<i>InAtten</i>	<i>GII</i>	<i>GII</i>
<i>ESGdif</i>	0.0233*** (0.00654)	0.0264*** (0.00735)	0.0221*** (0.00653)	0.0175** (0.00710)
<i>InAtten</i>			0.0467*** (0.00517)	
<i>Govern</i>				-0.0124** (0.00584)
<i>ESGdif*Govern</i>				0.00144** (0.000663)
<i>Size</i>	0.193*** (0.00532)	0.485*** (0.00598)	0.170*** (0.00588)	0.195*** (0.00570)
<i>Lev</i>	0.209*** (0.0340)	-0.347*** (0.0382)	0.226*** (0.0340)	0.206*** (0.0351)
<i>ROA</i>	0.579*** (0.0877)	5.356*** (0.0986)	0.329*** (0.0919)	0.580*** (0.0906)
<i>Age</i>	-0.102*** (0.00711)	-0.211*** (0.00800)	-0.0926*** (0.00719)	-0.108*** (0.00751)
<i>Cash Flow</i>	-0.0558*** (0.0144)	0.0177 (0.0162)	-0.0567*** (0.0144)	-0.0582*** (0.0147)
<i>Top 10</i>	-0.00259*** (0.000374)	-0.00355*** (0.000420)	-0.00242*** (0.000374)	-0.00259*** (0.000388)
<i>Ind</i>	Yes	Yes	Yes	Yes
<i>Year</i>	Yes	Yes	Yes	Yes

Table 3. continued

<i>Constant</i>	-3.933*** (0.128)	-8.665*** (0.144)	-3.528*** (0.136)	-3.954*** (0.138)
<i>N</i>	29,548	29,561	29548	28,494
<i>Adjusted R²</i>	0.192	0.348	0.194	0.196

4.4. Robustness tests

This study used the technique of substituting the dependent variable for the test in order to guarantee the robustness of the regression results. A fresh regression analysis was carried out using GI2 (the natural logarithm of the number of independently applied green invention patent applications in the current year + 1) in place of the green innovation indicator. Table 2 displays the regression findings. At the 5% level, the ESGdif coefficient of 0.0140 is significantly positive. This coefficient's direction has not altered, although having a little lower significance level than the baseline regression. As a result, the notion that ESG rating divergence positively promotes green innovation may be verified.

Table 4. Robustness test

	<i>GI2</i>
<i>ESGdif</i>	0.0140** (0.00559)
<i>Size</i>	0.175*** (0.00455)
<i>Lev</i>	0.114*** (0.0291)
<i>ROA</i>	0.433*** (0.0750)
<i>Age</i>	-0.0783*** (0.00608)
<i>Cash Flow</i>	-0.0413*** (0.0123)
<i>Top 10</i>	-0.00206*** (0.000319)
<i>Ind</i>	Yes
<i>Year</i>	Yes
<i>Constant</i>	-3.577*** (0.110)
<i>N</i>	29,548
<i>Adjusted R²</i>	0.169

4.5. Heterogeneity analysis

4.5.1. Pollution levels

There are significant differences in environmental constraints and stakeholder concerns across different industries. Heavy-polluting industries may face greater pressure regarding environmental issues, thereby weakening stakeholders' investment preferences, which may affect the effectiveness of ESG rating divergence on green innovation. The sample businesses in this study were split into two groups: high-pollution businesses and non-high-pollution businesses. Table 4's first and second columns display the aggregated regression's findings. The non-high-pollution enterprise group's ESGdif coefficient is 0.0259, which reaches the 1% significance level, but the high-pollution enterprise group's coefficient is 0.0223, which is significant at the 10% level. The ESG rating divergence has a favorable boosting influence on green innovation, according to both sets of regression results. On the other hand, the non-high-pollution business has higher significance levels and larger coefficient values.

4.5.2. Degree of digital transformation

A company's capacity to recognize and address ESG rating disparities may be impacted by digital transformation, which can also increase corporate productivity, decrease resource waste, and foster high-quality corporate development. The sample was split into high and low groups according to the median level of enterprise digital transformation. For every group, a separate regression analysis was carried out. Table 5's columns (1) and (2) display the findings. The ESGdif coefficient was 0.0286 in the high digital transformation group, which was substantially positive at the 1% level, and 0.0167 in the low digital transformation group, which was similarly significantly positive at the 5% level. The ESG rating disparity considerably boosted green innovation, according to both regression results; however, the impact coefficient in the high digital transformation group was much higher than that in the low group.

Table 5. Heterogeneity by group

Variables	(1)	(2)	(3)	(4)
	High-polluting enterprises	Non-Heavy Polluting Enterprises	High digital transformation	Low digital transformation
	<i>GII</i>	<i>GII</i>	<i>GII</i>	<i>GII</i>
<i>ESGdif</i>	0.0223* (0.0125)	0.0259*** (0.00762)	0.0286*** (0.0107)	0.0167** (0.00776)
<i>Control</i>	Yes	Yes	Yes	Yes
<i>Constant</i>	-3.957*** (0.212)	-3.934** (0.144)	-4.706*** (0.233)	-2.958*** (0.150)
<i>Ind</i>	Yes	Yes	Yes	Yes
<i>Year</i>	Yes	Yes	Yes	Yes
<i>N</i>	6423	23,125	14,385	15,163
<i>Adjusted R²</i>	0.159	0.199	0.222	0.165

5. Conclusion

The purpose of this study is to investigate how ESG rating disparities affect businesses' green innovation. According to a number of empirical analysis findings, the stimulating influence on green innovation increases with the degree of ESG rating differences. This indicates that rating agency evaluation disparities do not stifle businesses' green innovation efforts; rather, they encourage businesses to enhance their ESG performance and boost investment in green innovation. From the standpoint of the mechanism of action, analysts' focus partially mediates the relationship between green innovation and disparities in ESG ratings. In particular, ESG rating disparities will draw analysts' attention to the businesses, and this focus will further encourage the businesses' green innovation. Additionally, the relationship between the two is positively moderated by the corporate governance level. The improvement of analysts' attention, a crucial information transmitter in the capital market, helps to reduce the information asymmetry between businesses and investors, improves the external understanding of the efficacy of the businesses' green innovation, and encourages management to prioritize ESG issues and increase investment in green innovation. As for moderating effect, effective corporate governance helps business convert outside pressure into inside innovation drive and make it easier for outsiders to access internal firm info and control managers from doing short term stuff so that we get long lasting green innovations. Positive effects of ESG rating difference is especially seen in non-polluting companies as well as companies having a lot of digital transformation according to heterogeneity studies.

Based on the above results, this paper puts forward some policy suggestions: (1) Regulatory bodies need to support various kinds of development in ESG evaluation systems but also have rules about how these evaluations work; ESG rating differences are not bad news – they can even push firms to do better. Regulators should promote openness in rating systems, demand that ratings agencies publish details on their operations, remove pointless disparities, and preserve useful distinctions; (2) Firms ought to appreciate the external supervisory function performed by analysts and enhance their links with the exterior; This would result in more regularized and open company actions, leading analysts to make more precise appraisals. At the same time, companies must constantly improve their own corporate governance capabilities, establish sound and complete internal supervision systems, enhance the capacity to address issues where ESG ratings fail to meet expectations, transform external pressures into internal motivations, and foster high-quality corporate growth; (3) Investors should treat the differences between different rating agency's opinions reasonably, no single one means anything negative. Investors could take all those pieces of information given out by different groups, put them together with what the company has been doing around being greener and making new things, then decide which way to invest your money best.

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