

Navigating ESG Disagreement: Effects on Corporate Green Innovation in China

Lin Shen *

International Business College, Dongbei University of Financial and Economics, 116025, China

* Corresponding Author Email: 1704332554@qq.com

Abstract. ESG performance is a key non-financial metric for corporate sustainability, yet significant rating divergence exists across agencies due to methodological and contextual differences. Using 2010–2021 panel data of Chinese A-share listed firms, this study examines ESG rating divergence's impact on corporate green innovation (proxied by green patent grants) and the mediating role of financing constraints (measured via the SA Index). ESG rating divergence is calculated as the standard deviation of standardized scores from five agencies. Results confirm a significant negative relationship between ESG rating divergence and green innovation. Financing constraints partially mediate this link: divergence exacerbates information asymmetry, reduces capital allocation efficiency, and weakens policy support, tightening constraints and indirectly inhibiting green innovation. The inhibitory effect is more pronounced for high-pollution and high-tech firms. This study enriches ESG and corporate innovation literature by uncovering the underlying micro-mechanism, offering policy implications for standardizing ESG rating frameworks, improving green finance systems, and enhancing corporate ESG management to reduce divergence and boost green innovation.

Keywords: ESG Rating Divergence; Green Innovation; Financing Constraints; Mediating Effect; Heterogeneity Analysis.

1. Introduction

ESG performance has become an influential non-financial metric for evaluating corporate sustainability and long-term value creation. As capital markets increasingly integrate sustainability considerations, ESG ratings provided by various agencies have grown in importance. Yet substantial discrepancies—commonly referred to as ESG rating divergence—persist across providers due to heterogeneous indicator selection, weighting schemes, and data-processing methods (Berg et al., 2022). These methodological inconsistencies are further compounded by incomplete and selective ESG disclosures as well as contextual differences between developed and emerging markets (Christensen et al., 2021). As a result, firms may receive markedly different ESG assessments despite similar underlying performance.

Prior work shows that divergence increases information asymmetry, weakens price efficiency, and clouds the credibility of firms' sustainability signals (Pedersen et al., 2021). In the environmental domain, inconsistent ratings may distort green performance signals and induce misallocation of sustainability-related capital, potentially encouraging symbolic environmental behaviors or "greenwashing" (Delmas & Burbano, 2011). However, the mechanisms through which ESG divergence influences firms' innovation behavior—particularly green innovation—remain insufficiently theorized. This gap is particularly salient in the Chinese context, where ESG disclosure practices remain uneven and international methodologies may not fully capture local institutional realities.

Building on these observations, this study argues that financing constraints represent a central mechanism through which ESG rating divergence affects green innovation. When investors face conflicting ESG assessments, evaluating firms' environmental risks becomes more difficult, which in turn raises external financing costs and limits resources available for long-cycle, high-risk green R&D



(Hottenrott & Peters, 2012). Moreover, inconsistent ratings heighten uncertainty about the authenticity of firms' green strategies, thereby reducing their ability to obtain policy support and stakeholder trust (Flammer, 2021). We therefore propose that ESG rating divergence suppresses firms' green innovation by tightening financing constraints, contributing to both the theoretical understanding of ESG's micro-level effects and the ongoing discussion on ESG standardization.

2. Literature Review

2.1. The Impact of ESG Rating Divergence on Corporate Green Innovation Performance

As sustainability becomes a global priority, ESG criteria have emerged as a key framework for assessing firms' long-term development capabilities. Strong ESG performance is widely recognized for enhancing corporate reputation, strengthening stakeholder relationships, and promoting green innovation (Zheng, Khurram, & Chen, 2022). However, ESG ratings often diverge across agencies due to differences in indicator selection, weighting schemes, data-processing methods, and contextual or cultural perspectives (Berg, Kölbl, & Rigobon, 2022; Christensen, Serafeim, & Sikochi, 2022; Zhu, Yang, & Zhong, 2023). Such divergence complicates the interpretation of ESG performance and impedes consistent market recognition of firms' green innovation activities.

First, ESG rating divergence reduces external validation of corporate green initiatives. Conflicting assessments make it difficult for investors, consumers, and partners to evaluate the authenticity and potential of firms' green innovations, weakening reputational benefits and lowering incentives for green investment (Kim & Park, 2023). Second, from a capital market perspective, rating divergence increases uncertainty about future green performance. When investors face inconsistent ESG signals, they tend to demand higher risk premiums or reduce investment, constraining resources available for green R&D and ultimately reducing green innovation output (Zhu, Yang, & Zhong, 2023).

H1: Higher ESG rating divergence is associated with lower corporate green innovation.

2.2. Transmission Mechanism: How ESG Rating Divergence Influences Green Innovation via Financing Constraints

ESG rating divergence can hinder firms' green innovation, primarily through financing constraints, which act as a key mediating mechanism. Green innovation is typically capital-intensive, involves long development cycles, and carries substantial uncertainty, making access to sufficient and low-cost external financing essential (Zheng, Khurram, & Chen, 2022). ESG rating divergence exacerbates financing constraints in several ways. First, conflicting ESG scores increase information asymmetry, making it harder for investors and banks to assess firms' sustainability-related risks, which may raise financing costs or reduce investment (Kim & Park, 2023). Second, divergence reduces the efficiency of green capital allocation. Institutional investors relying on ESG ratings may adopt conservative strategies when ratings conflict, favoring firms with more consistent scores and leaving genuinely innovative green firms underfunded (Berg, Kölbl, & Rigobon, 2022; Zhu, Yang, & Zhong, 2023). Third, ESG divergence can weaken policy support, as governments often reference ESG ratings when distributing green subsidies or tax incentives; large discrepancies may reduce firms' access to such benefits, dampening managerial incentives for long-term green R&D (Christensen, Serafeim, & Sikochi, 2022).

Based on this reasoning, the following hypotheses are proposed:

H2: Higher ESG rating divergence increases firms' financing constraints.

H3: Financing constraints mediate the relationship between ESG rating divergence and corporate green innovation.

3. Research Design

3.1. Sample Selection and Data Sources

This study uses panel data from Chinese A-share listed firms over the period 2010–2021. ESG rating data are obtained from Wind, SynTao Green Finance, and Bloomberg. Data on green collaborative innovation, including green patent information and investor interaction metrics, are sourced from the China Research Data Service Platform (CNRDS). Firm-level financial indicators—such as firm size, leverage ratio, current ratio, and quick ratio—are collected from the China Stock Market and Accounting Research (CSMAR) database.

The sample construction follows several steps. We exclude firms designated as ST or PT, as well as all financial-sector firms. Observations with missing values for major variables are removed. All continuous variables are winsorized at the 5% level in both tails to mitigate the influence of outliers. The final dataset contains 27,397 firm-year observations.

3.2. Variable Definitions

3.2.1. Dependent Variable: Green Innovation (GI)

Following prior studies, green innovation is proxied by the number of green patent grants, which reflects a firm's realized technological outcomes in environmental protection, clean production, and resource-efficiency enhancement. This measure captures successful green innovation outputs rather than mere application efforts, thereby providing a more accurate indicator of substantive innovation performance.

3.2.2. Independent Variable: ESG Rating Divergence (ESG_diff)

Consistent with Christensen, Serafeim, and Sikochi (2022) and Berg, Kölbel, and Rigobon (2022), ESG rating divergence is measured as the standard deviation of ESG scores assigned to the same firm by multiple rating agencies. In this study, ESG ratings are obtained from five sources: China Securities Index (CSI Huazheng), Wind, SynTao Green Finance, CNRDS, and Bloomberg. To ensure comparability, all numeric or letter-based ratings are standardized to a unified 1–9 scale. For firms with ratings from only one agency, the divergence value is set to zero to preserve sample completeness. The standard deviation across all available ratings for a firm-year serves as the proxy for ESG rating divergence.

3.2.3. Mediating Variable: Financing Constraints (SA)

Financing constraints are measured using the absolute value of the SA Index, which relies solely on firm size (Size) and firm age (Age). Compared with alternative measures such as the KZ or WW indices, the SA Index is less sensitive to firm-specific financial characteristics (e.g., cash flow, leverage, dividend payouts), providing a more stable and exogenous proxy. Higher absolute values indicate more severe financing constraints (Hadlock & Pierce, 2010).

3.2.4. Control Variables

To mitigate concerns regarding omitted variable bias, the regression models include a comprehensive set of firm-level control variables commonly employed in corporate finance and ESG research. These include firm size (Size), leverage ratio (Lev), liquidity measures such as the current ratio (Liquid) and quick ratio (Quick), and internal cash-generating ability (CashFlow). Corporate governance characteristics are also considered, including board size (Board), CEO duality (Dual), and ownership concentration measured by the shareholding ratio of the top ten shareholders (Top10). In addition, operational and market characteristics such as market capitalization, Tobin's Q (TQ), firm age (FirmAge), and workforce size (Employee) are controlled for. Incorporating these variables helps ensure unbiased estimation by accounting for factors known to influence corporate innovation and financial outcomes.

3.3. Model Specification

$$GI_{i,t} = \alpha_0 + \alpha_1 ESG_diff_{i,t-n} + \alpha_i \sum Controls_{i,t-n} + Year + Industry + \varepsilon_{i,t} \quad (1)$$

$$SA_{i,t} = \alpha_0 + \alpha_1 ESG_diff_{i,t-n} + \alpha_i \sum Controls_{i,t-n} + Year + Industry + \varepsilon_{i,t} \quad (2)$$

$$GI_{i,t} = \alpha_0 + \alpha_1 ESG_diff_{i,t-n} + SA_{i,t} + \alpha_i \sum Controls_{i,t-n} + Year + Industry + \varepsilon_{i,t} \quad (3)$$

This study constructs three sets of mediating effect test models: the baseline regression model takes green innovation $GI_{i,t}$ as the dependent variable, ESG rating divergence $ESG_diff_{i,t-n}$ as the core explanatory variable, controls for lagged control variables $Controls_{i,t-n}$ as well as year and industry fixed effects, with $\varepsilon_{i,t}$ as the random error term; the regression model with a mediating variable incorporates financing constraints $SA_{i,t}$ into the baseline model to examine the direct effect and mediating effect; the mediating effect model uses $SA_{i,t}$ as the dependent variable and $ESG_diff_{i,t-n}$ as the core explanatory variable, with consistent control variables and fixed effects as the previous two models. All three models cluster standard errors at the firm level, alleviate endogeneity through lagged terms, and some may include lagged terms of the core explanatory variable to analyze dynamic effects.

4. Empirical Analysis

4.1. Descriptive Statistics

Table 1 presents the descriptive statistics for the main variables. The average number of green invention patents (GI) is 1.734 with a standard deviation of 16.656, indicating that the overall level of green innovation output among sample firms is relatively low, while substantial heterogeneity exists across firms. The mean SA index is -3.830 , suggesting that the sample firms generally face low financing constraints. For standardized ESG divergence (ESG_diff) and firm size (Size), the difference between their maximum and minimum values exceeds twofold, with standard deviations of 0.942 and 1.362, respectively. This indicates that the sample includes firms with relatively high ESG divergence and larger sizes, but overall, significant variation exists across the sample, reflecting considerable dispersion.

Table 1 Descriptive Statistics of Variables

Variable	Obs	Mean	Std.dev.	Min	Max
GI	20,707	1.73400	16.65635	0	961
SA	20,709	-3.82977	0.28693	-5.75766	-1.45543
ESG_diff	20,710	5.98754	0.94185	1	8.57364
Size	20,709	22.46869	1.36215	14.94164	28.63649
Lev	20,709	0.45869	0.21231	0.00708	1.95656
Liquid	20,709	2.31874	3.88114	0.02569	204.74210
Quick	20,709	1.82237	3.48375	0.01919	179.57830
CashFlow	20,709	0.04588	0.07463	-1.07722	0.65232
Board	20,709	2.15730	0.19992	0	2.89037
Dual	20,709	0.20382	0.40285	0	1
Top10	20,709	0.55923	0.15586	0.01310	0.98588
MarketCap	20,709	2.72E+10	1.04E+11	0	2.99E+12
Employee	20,709	7311.879	23167.35	0	552810
FirmAge	20,709	2.92892	0.35442	0	4.21951
TobinQ	20,709	2.10093	5.73193	0	715.9448

4.2. Baseline Regression

The impact of standardized ESG divergence on the total number of green invention patents is reported in Table 2. Column (1) presents results from a regression including firm and year fixed effects but excluding control variables. The coefficient of standardized ESG divergence is -1.1838 and is significant at the 1% level, indicating that as ESG divergence decreases, the total number of green invention patents increases. Column (2) incorporates control variables but does not include firm or year fixed effects. Here, the coefficient of standardized ESG divergence is -0.6330 and significant at the 10% level, suggesting a negative relationship between ESG divergence and green invention output. Column (3) presents results with both control variables and firm and year fixed effects. The coefficient of standardized ESG divergence is -0.8801 , significant at the 10% level, confirming that higher ESG divergence is associated with lower green innovation output. Overall, the baseline regression employs three different model specifications to ensure robustness and consistently supports Hypothesis H1, demonstrating a significant negative effect of ESG divergence on firms' green invention output.

Table 2 Main Regression Results

	(1)	(2)	(3)
	GI	GI	GI
ESG_diff	-1.18381 (0.33669)	-.63298 (.12171)	-.88014 (.28186)
Size		-.45331 (.11312)	.03899 (.49549)
Lev		-2.11055 (.61458)	-1.72318 (.91618)
Liquid		-.16478 (.15688)	-.06103 (.07734)
Quick		.18537 (.17531)	.07544 (.09071)
CashFlow		-3.72804 (1.43543)	-1.83398 (1.12904)
Board		.65743 (.53572)	-1.65966 (1.45563)
Dual		.06661* (.26107)	-.14501 (.21280)
Top10		-1.14511 (.72240)	2.08256 (2.01802)
MarketCap		1.25e-11 (1.78e-12)	2.15e-11 (1.35e-11)
Employee1		.00029*** (7.91e-06)	.00009*** (.00011)
FirmAge		1.45559 (.31589)	5.22538 (4.47980)
TobinQ		-.02373 (.01842)	-.01073 (.01301)
_cons		9.39825 (2.86853)	-7.03771 (13.77101)
N	20705	20705	20705
R ²	0.68360	0.21250	0.68910
Time Fixed Effects	Yes	No	Yes
Firm Fixed Effects	Yes	No	Yes

Note: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively; values in parentheses are standard errors.

4.3. Robustness Checks

To ensure the robustness and reliability of the empirical findings, several additional tests are conducted. Column (1) replaces the dependent variable with the number of green patent applications to verify whether the results remain consistent when using an alternative measure of green innovation. Column (2) re-estimates the model using a one-period lag of the key independent variable to address potential endogeneity concerns. Column (3) restricts the sample to observations prior to 2020 to mitigate the influence of recent regulatory and market shocks. All specifications include firm and time fixed effects and continue to employ the four regression models used in the baseline analysis. Across all tests, the coefficient signs and significance levels remain stable, confirming the robustness and credibility of the main conclusions.

Table 3 Robustness Check Results

	(1)	(2)	(3)
	GA	GI	GI
ESG_diff	-2.19439*** (0.48652)		
ESG_diff_L1		-5.90939*** (1.39775)	
ESG_diff			-0.38101*** (0.16114)
_cons	-30.06398*** (0.02702)	-29.85303** (0.14877)	-30.41508** (0.17573)
N	20705	20705	20705
R ²	0.71710	0.71780	0.71840
Control	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes

Note: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively; values in parentheses are standard errors.

4.4. Mediation Effect Analysis: Financing Constraints

The previous results demonstrate that higher ESG rating divergence is associated with lower green innovation levels among firms. Theoretical analysis further suggests that reducing ESG divergence can promote green innovation by alleviating financing constraints. Based on this premise, we test the mediating role of financing constraints in the relationship between ESG divergence and green innovation, following the mediation analysis procedure outlined by Wen et al. (2004).

Table 4 presents the results of the mediation analysis. Column (1) reproduces the baseline regression and confirms that reducing ESG divergence positively affects firms' green innovation output. Column (2) examines the effect of ESG divergence on the SA index, the proxy for financing constraints. The coefficient is 0.0164 and statistically significant at the 5% level, indicating that ESG divergence contributes to higher financing constraints, thus allowing for mediation analysis. Column (3) includes both ESG divergence and the SA index in the regression predicting green innovation. The results show that the SA index has a significant negative effect on green innovation (coefficient = -0.5796), and the coefficient of ESG divergence decreases from -1.1838 in the baseline regression to -0.5796, a reduction of 0.6042. This indicates a partial mediating effect of financing constraints: ESG

divergence indirectly affects green innovation through its impact on firms' financing conditions. These findings provide empirical support for Hypothesis H2.

Table 4 Mediating Effect Analysis Results

	(1)	(2)	(3)
	GI	SA	GI
ESG_diff	-1.18381*** (0.34726)	0.01639*** (0.34567)	-0.57956** (0.00160)
SA			-18.30516*** (5.74060)
_cons	8.82247** (7.33965)	3.25510*** (18.28001)	52.52778** (17.89362)
N	20705	20705	20705
R ²	0.68360	0.97590	0.69150
Control	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes

Note: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively; values in parentheses are standard errors.

4.5. Heterogeneity Analysis

While reducing ESG divergence generally enhances firms' green innovation capabilities, the strength and significance of this effect may vary under different conditions and environments. To examine this, we conduct heterogeneity analyses by classifying firms based on pollution intensity, technological level, and regional location, incorporating the financing constraint framework to explore potential moderating effects. The results are presented in Table 5.

From the perspective of pollution intensity, firms are divided into high-pollution and non-high-pollution categories. Column (1) shows that ESG divergence has no significant effect on green innovation for non-high-pollution firms. In contrast, column (2) indicates that ESG divergence significantly reduces green innovation in high-pollution firms, with a coefficient of -0.7600 .

Regarding technological level, firms are categorized as high-tech and non-high-tech. Column (3) shows that ESG divergence negatively affects green innovation in non-high-tech firms via financing constraints, with a coefficient of -0.7600 . Column (4) indicates an even stronger negative effect for high-tech firms. This may be because high-tech firms are more motivated to obtain favorable ESG ratings to attract investors or enhance stakeholder confidence, whereas non-high-tech firms are less proactive in ESG engagement.

Overall, the heterogeneity analysis suggests that the inhibitory effect of ESG divergence on green innovation is more pronounced among high-pollution, high-tech, and southern-region firms, highlighting the importance of firm-specific and contextual factors in shaping ESG-related outcomes.

Table 5 Heterogeneity Analysis Results

	(1)	(2)	(3)	(4)
	Non-High-Pollution	High-Pollution	Non-High-Tech Firms	High-Tech Firms
	GI	GI	GI	GI
ESG_diff	-0.40638** (0.06508)	-0.76003*** (0.11175)	-0.76003** (0.11175)	-0.21973*** (0.15841)
_cons	50.28308*** (1.51188)	26.70858** (10.27538)	26.70858** (10.27538)	85.33708*** (19.0389)
N	15310	9655	9,655	11012
R ²	0.54640	0.80350	0.80350	0.58310
Control	Yes	Yes	Yes	Control
Time Fixed Effects	Yes	Yes	Yes	Time Fixed Effects
Firm Fixed Effects	Yes	Yes	Yes	Firm Fixed Effects

Note: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively; values in parentheses are standard errors.

5. Conclusion and Policy Implications

Amid the global shift toward sustainable development, the ESG (Environmental, Social, and Governance) framework has emerged as a comprehensive measure of corporate sustainability, receiving increasing attention from investors and financial institutions. Using data from A-share listed companies in China from 2010 to 2021, this study systematically examines the impact of ESG rating divergence on firms' green innovation performance and the underlying transmission mechanisms. ESG divergence not only reflects the complexity of ESG information disclosure and the absence of unified standards, but also exerts a substantive influence on corporate behavior.

Theoretical and empirical analyses yield several key findings. First, higher ESG rating divergence is associated with lower green innovation levels. High-divergence ESG ratings create an uncertain informational environment, making it difficult for investors and creditors to accurately assess a firm's true ESG performance and associated risks. This uncertainty adversely affects investment decisions related to long-term, high-risk green innovation projects. Second, ESG divergence increases the difficulty of environmental risk assessment for investors, raising external financing costs and limiting firms' ability to allocate resources to green innovation. Moreover, inconsistent ESG evaluations amplify market skepticism regarding the authenticity of firms' green strategies, reducing firms' incentives to pursue green innovation to gain policy support or stakeholder trust.

This study contributes to the literature by filling the gap in the micro-level mechanisms linking ESG ratings to corporate innovation behavior, providing a new perspective on addressing financing constraints for green innovation. Based on these findings, we propose several policy recommendations. First, efforts should be made to standardize ESG evaluation frameworks by establishing unified, authoritative ESG rating standards, thereby reducing divergence caused by fragmented criteria and improving the transparency and comparability of ESG disclosures. Second, the green finance system should be enhanced. Financial institutions offering green loans, bonds, and other services should consider firms' ESG performance holistically while accounting for the risks associated with ESG rating divergence, and develop more robust and scientific evaluation mechanisms. Finally, firms themselves should strengthen ESG management practices and engage proactively with rating agencies to reduce information asymmetry and minimize ESG rating divergence.

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