



The Impact of ESG Rating Discrepancies on Corporate Green Innovation

—An Analysis of the Moderating Effect Based on Carbon Finance Allocative Efficiency

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Abstract. This paper takes China's Shanghai and Shenzhen A-share listed companies from 2015 to 2021 as the research sample to empirically test the impact of ESG rating divergence on corporate green innovation. The carbon financial allocation efficiency is measured using the SBM-DEA model to explore the moderating effect of carbon financial allocation efficiency on ESG rating divergence and corporate green innovation. The results of the study show that ESG rating divergence can promote corporate green innovation, while carbon finance allocation efficiency has a negative moderating effect in this process. This paper provides new perspectives to explore the impact of ESG rating divergence on corporate green innovation and provides practical guidance for decision-making of relevant stakeholders.

Keywords: ESG rating divergence, green innovation, carbon finance allocative efficiency

1 Introduction

ESG, which stands for E (environment), S (social) and G (government), is a comprehensive evaluation index of corporate environmental governance, social responsibility and management capability, and has gradually become an effective tool and method for reflecting the sustainable development capability of enterprises and measuring their sustainable operation and management^[1]. In reality, however, there are often differences in ESG ratings for the same company^[2]. There are two main reasons for the divergence of ESG ratings. On the one hand, there are rating agency factors, and from the aspect of rating agencies, there are significant differences between different agencies in terms of assessment standards, methodology, data sources and weight settings^[3]. On the other hand, it is the disclosure of ESG-related information by enterprises, and most of the rating agencies base their ratings on ESG public reports, social responsibility reports, carbon disclosure reports and other related public reports, in which some enterprises have disclosure preferences, or there are discontinuous and incomplete disclosure of information, which makes the ESG ratings of the same listed enterprise by

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different rating agencies differ from each other^[4]. This divergence weakens the value of corporate ESG information, interferes with stakeholder decision-making, and obscures corporate green capabilities^[5].

Corporate green messaging is an important way for companies to demonstrate to the outside world their ability to be sustainable, and for an organization to be sustainable, it should make a breakthrough in green innovation^[6]. At the same time, green innovation has a double externality, which will bring economic benefits to enterprises and at the same time put forward higher requirements and stricter tests on the management decision-making and capital status of enterprises. The R&D and application of green technologies require high technological level and innovation capability^[7]. For many enterprises, the lack of sufficient technological accumulation and stable sources of finance is one of the main internal obstacles they face. However, Green technology innovation^[8], as an important way to achieve corporate economic growth and environmental protection, can optimize corporate ESG performance and reduce corporate ESG rating divergence. In addition, corporate ESG performance is closely related to the allocation efficiency of carbon finance, and enterprises can use carbon finance tools to promote corporate green innovation from the financial level and improve corporate ESG performance^[9].

Therefore, it is important to explore the impact of ESG rating divergence on corporate green innovation and the moderating role of carbon finance allocation efficiency between the two for sustainable corporate development. Based on this, this paper selects A-share listed companies in Shanghai and Shenzhen as research samples to explore the impact of ESG rating differentiation on corporate green innovation from the perspective of corporate risk, and to explore the moderating role of carbon finance allocation efficiency between ESG rating differentiation and corporate green innovation, so as to enrich the related research on the impact of ESG rating differentiation on corporate green innovation.

2 Theoretical Background and Hypothesis Development

2.1 ESG Rating Divergence and Corporate Green Innovation

The initial goal of ESG ratings as non-financial corporate disclosures is to reduce information asymmetry between companies and stakeholders^[10]. The divergence in ESG ratings has resulted in ESG information not only failing to alleviate information asymmetry, but also creating a “noise effect” that exacerbates information asymmetry. Such disagreements often raise concerns among stakeholders and the general public about the validity of ESG ratings, and instead of reducing the information asymmetry between external stakeholders and companies, they increase external skepticism about the authenticity and legitimacy of a company's ESG performance^[11]. This may reduce the ability of enterprises to access financial resources and the green investment preferences of relevant stakeholders, and make government environmental regulations more stringent^[12], thereby increasing business risk^[13]. In order to avoid business risks, companies should take the initiative to make strategic responses to maintain the legitimacy of their

ESG information^[7]. When external stakeholders and financial institutions, find it difficult to judge corporate green information through ESG ratings, corporate green innovation provides them with an additional reference^[14]. Through positive green innovation behaviors, companies can send positive signals to external stakeholders and providers of green financial resources^[15]. Demonstrating that the content of their business meets ESG requirements, Green Innovations can demonstrate ESG compliance with the content of its business, thereby satisfying the legitimacy requirement for corporate ESG information and helping companies to address the business risks associated with divergent ESG ratings^[16]. Based on the above analysis, hypotheses 1 of this paper are proposed:

Hypothesis 1 (H1): ESG rating divergence can promote corporate green innovation.

2.2 The Moderating Role of Allocative Efficiency in Carbon Finance

Green innovation is characterized by high investment, high risk and a long payback period, and therefore often faces a limited supply of funds and financing difficulties^[17]. When corporate carbon finance is efficiently configured, it can help corporate green innovation by making it possible to effectively alleviate the dilemma of financial shortages in corporate green innovation. However, when there is ESG rating divergence, the efficiency of firms' carbon finance allocation may play a different role. In terms of short-term impacts, it is difficult to cope with the negative impact of ESG rating divergence in a timely manner due to characteristics such as the large investment in green innovation and the long cycle^[18]. It is highly likely that companies will first allocate carbon finance resources to projects that can enhance the company's green information more quickly. The allocation of carbon finance resources will prioritize the allocation of carbon finance resources to projects that can enhance the company's green information more quickly, in order to achieve the purpose of quickly restoring the company's reputation. For example, a large amount of green funds are used to publicize a company's immature green emission reduction projects, rather than being used for green project operations or upgrading the company's green technology, as a way of proving that the company is operating actual ESG-related projects and carrying out ESG-related green emission reduction work. However, the use of this publicity resource will cause resource crowding on enterprise green innovation, which is not conducive to enterprise green innovation. Shell, for instance, exaggerates corporate investments in non-fossil fuel energy resources in advertisements, misleading consumers into believing that they are making significant efforts to reduce their carbon footprint when in fact they are not reducing their fossil fuel production and development.

From the perspective of long-term impact, when enterprises face ESG rating disagreement, they will take the initiative to take strategic measures to hedge the negative impact of ESG rating disagreement, increase more green information disclosure^[6], and improve the efficiency of green governance of the company, which can help enterprises reduce the bad impression of ambiguous green information caused by ESG rating disagreement in the minds of financial institutions and other relevant stakeholders, effectively help enterprises obtain carbon financial resources, and enhance the enterprises' carbon financial allocation efficiency. Improved allocation efficiency of carbon finance

can promote the development of green projects and strengthen the incentives for green innovation in enterprises^[19], while alleviating the shortage of funds in the process of green innovation, thus making the ESG rating divergence amplify the impact of the promotion of corporate green innovation. Based on the above analysis, the second hypothesis is proposed in this paper:

Hypothesis 2a (H2a): In the short run, carbon finance allocation efficiency will diminish the positive impact of ESG rating divergence on corporate green innovation.

Hypothesis 2b (H2b): In the long run, carbon finance allocation efficiency will increase the positive impact of ESG rating divergence on corporate green innovation.

3 Methodology and Data

3.1 Regression Model

This paper constructs the following time province fixed effects model to examine the impact of ESG rating divergence on firms' green innovation:

$$GIT_{i,t} = \alpha_0 + \alpha_1 ESGdif_{i,t} + \alpha_2 Z_{i,t} + Province + Year + \varepsilon_{i,t} \quad (1)$$

Where i and t refer to firm and year, respectively. $GIT_{i,t}$ represent enterprise i 's green innovation in year t . $ESGdif_{i,t}$ stands for company i 's ESG disagreement in year t . $Z_{i,t}$ contains a set of control variables, $\varepsilon_{i,t}$ is the residual item. In Eq. (2), this study introduces an interaction term among $ESGdif$ and eff to test the potential moderating effects:

$$GIT_{i,t} = \beta_0 + \beta_1 ESGdif_{i,t} + \beta_2 eff \times ESGdif_{i,t} + \beta_4 Z_{i,t} + Province + Year + \varepsilon_{i,t} \quad (2)$$

3.2 Variable Measurement

1) Dependent Variable. Enterprise green innovation (GIT). This paper measure of green innovation^[18], which uses the natural logarithm of the sum of the number of green invention patent applications and green utility model patent applications filed independently by an enterprise + 1 to measure the enterprise's green innovation.

2) Independent Variable. ESG rating divergence (ESGdif). This paper measure corporate ESG rating divergence using the standard deviation of the ESG ratings assigned to six agencies, namely Bloomberg, CSI, Syn Tao Green Finance, Vanguard, FTSE Russell, and Allied Wave.

3) Moderating Variables. Carbon financial allocation efficiency (eff). On the basis of the input and output indicators, we add carbon productivity as one of the output indicators, and use the SBM-DEA non-expected output model to measure the carbon financial allocation efficiency. Specifically, the input variables are Level of human resources in finance, Government support for financial development efforts, Level of development of financial intermediation, R&D Investment Efforts. The output variables are financial outputs, carbon productivity.

4) Control Variables. In this paper, we use the control variables corporate gearing ratio (Lev), corporate return on assets (Roa), listing time (ListAge), proportion of shares held by the first largest shareholder (Top1), growth rate of operating income (Growth), and size of the board of directors (Board). We add province-level control variables, the degree of government intervention (Gov), and the level of urbanization (Urb).

3.3 Data Collection and Processing

Given the availability of ESG rating data, the data samples in this paper are selected from the 2015-2021 data of Shanghai and Shenzhen A-share listed companies, excluding the samples of companies with ESG ratings rated by less than two organizations; excluding the samples of companies with missing values of key variables; excluding the samples of ST and PT companies; excluding the samples of companies in the financial industry and the insurance industry; and shrinking the upper and lower 1% levels of all variables. ESG ratings data using six institutional ESG ratings agency ratings data from Bloomberg, CSI, Syn Tao Green Finance, Vantage, FTSE Russell and Allied Wave, with the rest of the data coming from Wind, Cathay Pacific (CSMAR), WI.com, and the Statistical Year book.

4 Empirical Results and Discussion

4.1 Benchmark Results

This paper tests the theoretical hypotheses presented in the theoretical analysis part of the paper based on the baseline regression (1) equation, and the specific regression results are shown in Table 1. The empirical results show that the estimated coefficients of ESG rating divergence are all significantly positive at the 1% level. ESG rating divergence can positively promote corporate green innovation. Preliminary test of hypothesis 1 of this paper.

Table 1. The results of benchmark regression.

	(1)	(2)	(3)	(4)	(5)
ESGdif	0.0790*** (0.0206)	0.0762** (0.0207)	0.0616** (0.0207)	0.0585*** (0.0195)	
ESGdif×eff					-0.0943**

					(0.0463)
_cons	1.1656***	0.9568**	1.0555**	-1.6526*	-1.8152*
	(0.0275)	(0.0499)	(0.0742)	(0.8848)	(1.0073)
Year FE	NO	YES	YES	YES	YES
Pro.FE	NO	NO	YES	YES	YES
Controls	NO	NO	NO	YES	YES
N	8764	8764	8764	8764	8764
R-Squared	0.0015	0.0074	0.0333	0.1531	0.1535

Note: Standard errors are given in parenthesis. We use ***, **, * to denote significance at 1%, 5%, and 10% level, respectively.

4.2 Robustness Tests

1) Replacement of Dependent and Independent Variables. In order to attenuate the endogeneity problem that may arise from the measurement error of the variables, this paper will use the number of green invention patents independently filed by enterprises (GIT2) and the number of green invention patents jointly filed by the group in which the enterprise is located (GIT3) as the new explanatory variable. Generally speaking, (GIT2) focuses more on the autonomous innovation capacity of firms, while (GIT3) emphasizes cooperation and resource integration, which may lead to higher quality of innovation and wider application prospects. The standard deviation of the year-end average ratings of the four rating agencies, CSI, Wind, Xindao Green Finance and Allied Wave, is used to calculate the standard deviation of ESG rating deviation (ESGdif4). The empirical results are shown in the results in columns (1)-(3) of Table 2, and the results of the benchmark regression still hold after replacing the explanatory and interpretive variables.

2) Heckman Test. Considering the possibility of sample selection bias, Heckman test approach was chosen to test the endogeneity problem due to sample selection bias, and the results are shown in column (4) of Table 2.

5 Mechanism Analysis

5.1 Moderating Mechanism Analysis

Based on the above theoretical analysis, carbon finance allocation efficiency will affect the relationship between corporate ESG rating divergence and green innovation. Therefore, the cross-multiplier term $ESGdif \times eff$ of ESG rating divergence and carbon financial allocation efficiency is constructed to test the moderating effect of carbon financial allocation efficiency on ESG rating divergence and corporate green innovation. This study then reports the results of these estimates in column 5 of Table 1.

The coefficient of the cross-multiplier term between ESG rating divergence and carbon financial allocation efficiency in column (5) of Table 1 is negative and significant

at the 5% level, and the result confirms that carbon financial allocation efficiency shows short-term moderation in the relationship between ESG rating divergence and corporate green innovation. That is, the higher the carbon financial allocation efficiency in the short term, the smaller the promotion effect of ESG rating divergence on corporate green innovation. Hypothesis 2a of this paper was tested

6 Conclusion

As an important ESG performance of enterprises, the divergence of ESG ratings will affect the sustainable development planning of enterprises. Based on the data of A-share listed enterprises in Shanghai and Shenzhen, this paper empirically analyzes the impact and mechanism of ESG rating divergence on corporate green innovation. It is found that corporate ESG rating divergence can effectively promote corporate green innovation. The mechanism test shows that carbon financial allocation efficiency shows short-term moderating effect in the impact of ESG rating divergence on corporate green innovation, and enterprises usually prioritize carbon financial resources for the promotion of corporate green information, which helps them avoid the impact caused by ESG rating divergence. The study provides several practical implications for policy makers and enterprises, firstly, the government should strengthen the standardization and uniformity of corporate ESG information disclosure, and improve the quality of corporate ESG information; secondly, enterprises should improve their internal control, make full use of the iqye carbon financial resources, improve their allocation efficiency, and help them to develop high-quality green development.

Table 2. Robustness tests

	(1) GIT2	(2) GIT3	(3) GIT	(4) GIT
ESGdif	0.0756*** (0.0164)	0.0184** (0.0094)		0.0710*** (0.0197)
ESGdif4			0.0584** (0.0186)	
IMR				0.7044*** (0.2158)
_cons	-0.9925 (0.7713)	-1.2049** (0.5435)	-1.6068* (0.8840)	-2.4739*** (0.8944)
Year FE	YES	YES	YES	YES
Pro. FE	YES	YES	YES	YES
Controls	YES	YES	YES	YES
N	8764	8764	8764	8711
R-Squared	0.1242	0.0919	0.1532	0.1557

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