Research in International Business and Finance 71 (2024) 102475

Contents lists available at ScienceDirect

Research in International Business and Finance

journal homepage: www.elsevier.com/locate/ribaf

# The information environment and ecological environment perspectives: Capital market openness and firm ESG rating divergence☆

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ARTICLE INFO

*Keywords:*
Firm ESG rating divergence
Capital market openness
Information environment
Ecological environment

ABSTRACT

Amid increasing demands for green economic growth, firms must adapt their business models and development strategies. However, most of the studies on this topic focus on examining the economic consequences of differences in firms' environmental, social, and governance (ESG) ratings and ignore the external influences that lead to differences in information environments. This paper explores the impact of capital market openness on firm ESG rating divergence and conducts a related mechanism analysis. It is found that capital market openness creates an information environment concern effect that is generated by analysts' concerns, audit quality, and investors' concerns, which in turn exacerbates firm ESG rating divergence. A moderating effect test shows that the pressure created by government and public concerns regarding the ecological environment generates an ecological environment concern effect on firm ESG performance and effectively decreases the firm ESG rating divergence caused by the information concern effect.

## 1. Introduction

In recent years, China's economy has gradually entered a stage of sustainable development under dynamic structural adjustment. Accelerating the establishment and improvement of a green, low-carbon, and circular economy system has become one of the core strategies of China's new economic normal (Feng et al., 2022; Cheng et al., 2024). This theme of green development has gradually become an important strategic element of economic construction in China. At the core of ecological and environmental issues are development modes and lifestyles. Therefore, studies that explore the factors that drive green economic and social development attract much attention and have great practical value (Cheikh et al., 2021; Zhuo, 2023). In the context of green economic development, firms

☆ This work was supported by the National Social Science Foundation (NSSF) under Grant No. 20BJY189; the National Social Science Foundation (NSSF) under Grant No. 21BJY054; the National Social Science Foundation (NSSF) under Grant No. 22BJY041; the Provincial Social Science Foundation (PSSF) under Grant No. 21NDJC037YB; the Provincial Soft Social Science Foundation (PSSSF) under Grant No. 2022C35015; Zhejiang University of Technology Social Science Basic Research Foundation (ZJUTSSBRF) under Grant No. GB202303002. We thank these organizations for their support and contributions to the research process. The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors and do not necessarily represent the views of the funding bodies.

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https://doi.org/10.1016/j.ribaf.2024.102475
Received 22 April 2024; Received in revised form 27 June 2024; Accepted 30 June 2024
Available online 2 July 2024
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are not only participants in market activities but are also the primary drivers of production processes and of carbon emissions. Freeman (1984) put forward the stakeholder theory, which states that firm managers must both pay attention to the interests of firm shareholders and must fully understand the needs of stakeholders, and must then strategically balance the benefits of multiple stakeholders to maximise the interests. As a result, in their strategic planning, modern firms have begun to progressively consider environmental, social, and governance (ESG) practices to accelerate the establishment and improvement of business ecosystems and to realise the co-creation and delivery of value with and to stakeholders (Anwer et al., 2023; Konietzko et al., 2020). ESG, a firm evaluation index focusing on non-financial performance and the concept of responsible investment, aims to promote firms' sustainable development by reinforcing the concept of environmental protection, urging managers to fulfil their social responsibilities, and strengthening internal governance mechanisms (Galletta et al., 2023; Yu et al., 2018). An ESG evaluation index can practically reflect whether a company's commitment, performance, business model, and structure are consistent with the United Nations' (UN) Sustainable Development Goals (SDGs) (Pastor et al., 2021). Strong ESG performance can effectively enhance a company's business performance and predict its long-term capital value and sustainable development status (Fatemi et al., 2015; Yu et al., 2018).

However, several studies argue that there are strong negative externalities of environmental and social responsibility in firm ESG practices and that there is a possibility that ESG practices are chosen by firm management as a tool for firm greenwashing (Atan et al., 2018, Duque-Grisales, Aguilera-Caracuel, 2021). Although ESG reporting may effectively enhance external investors' understanding of firms' ESG value information, as ESG disclosures are not regulated, too much voluntary disclosure may instead exacerbate third-party rating agency differentiation (Christensen et al., 2022; Pedersen et al., 2021). In particular, the standardisation of environmental information disclosures and the external ESG evaluation system for listed firms in China are still being improved, which enhances the subjectivity of third-party ESG ratings and strengthens some firms' greenwashing motives and behaviours. Therefore, clarifying the mechanism of influence concerning firms' greenwashing motivations and the realisation path of improvement based on this firm ESG rating divergence will enhance the understanding of the sustainable operation modes of Chinese listed firms and further contribute to the development of China's green economy.

Most of the research on firm greenwashing that adopts the firm ESG perspective focuses on examining the economic consequences of firm ESG rating divergence. In contrast, research on the factors influencing firm ESG rating divergence are generally centred on firm disclosures, leaving a gap in the analysis concerning the external factors that cause these differences in the information environment. More critically, the research on the realisation path of improvement for firm ESG rating divergence requires further exploration. Therefore, based on stakeholder theory, this paper introduces an external shock and information environment effect of capital market openness and analyses the impact of capital market openness on firm ESG rating divergence. This paper does this by establishing a theoretical research framework that includes external environmental pressure to provide theoretical support for China's ESG practices and development. Specifically, this paper takes Chinese listed firms as the main research object and adopts a difference-in-differences (DID) model to statistically test the effect of capital market openness on firm ESG rating divergence. The statistical results are subjected to a series of robustness tests, such as parallel trend tests and placebo tests, to confirm the scientific estimation of the impact effect of capital market openness by alleviating the endogeneity problem. Furthermore, this paper effectively identifies the mechanism of influence of information environment concern and improves the logical chain of firm information disclosure. In addition, this paper incorporates government environment concern and public environment concern into the theoretical research framework to effectively test the moderating effect of external environmental pressure. The results of this paper deepen the understanding of firm green performance and provide an effective realisation path for the improvement of green firm behaviour.

The main marginal contributions of this paper are as follows. First, based on stakeholder theory, this paper incorporates the external shock of capital market openness into the theoretical analysis framework, effectively complementing the research on firm strategic management under the internationalisation perspective (Chin et al., 2022; Wang et al., 2012; Zhang et al., 2023). Second, based on the impact effect of firm information disclosure, this paper incorporates the information environment mechanism into the theoretical analysis framework and explores the mechanism path through which capital market openness affects firm ESG rating divergence at the theoretical level. This complements the analysis of external influences on firm greenwashing behaviour (Guo et al., 2024; Yu et al., 2020). Third, this paper incorporates government environment concern and public environment concern into the theoretical research framework based on the heterogeneity of regional characteristics, thus complementing the theoretical literature on firm governance from an external environmental regulation perspective. The findings of this study enhance the systematic understanding of the firms' ESG practices and ESG rating divergence in China (Ivaninskiy and Ivashkovskaya, 2022; Yu et al., 2020).

The remainder of the paper is structured as follows. Section 2 presents the policy background and research hypotheses. Section 3 outlines the research design, focusing on sample selection and the empirical model. Section 4 presents the empirical analysis and baseline results. Section 5 presents further research. Section 6 provides the conclusions of the paper.

## 2. Policy background and research hypotheses

The China Securities Regulatory Commission (CSRC) announced the launch of an interconnection mechanism between the Shanghai Stock Exchange (SSE) and the Stock Exchange of Hong Kong (SEHK) in 2014 and between the Shenzhen Stock Exchange (SZSE) and the Stock Exchange of Hong Kong (SEHK) in 2016. These mechanisms allow investors to buy and sell underlying stocks within the prescribed scope through local securities firms (or brokers). These mechanisms thus break through the limitations of the original Qualified Foreign Institutional Investors/Renminbi Qualified Foreign Institutional Investor (QFII/RQFII) system for foreign institutional investors, which included investment channels and qualification and investment quota. Before the implementation of the 'Shanghai–Shenzhen–Hong Kong Stock Connect schemes' (SHSZ&HKSC), there was no trading mechanism in China's capital market to connect the stock markets of the Chinese mainland and Hong Kong, and foreign investors could only indirectly hold the shares of listed

firms in China through the QFII. The SHSZ&HKSC, through the introduction of foreign institutional investors, facilitated the flow of capital between the Chinese mainland and Hong Kong. Therefore, the SHSZ&HKSC is regarded as an important measure to promote the deep integration of the capital markets of the Chinese mainland and Hong Kong, which is conducive to further opening China's capital market to the outside world.

Increased capital market openness means that foreign institutional investors and individual investors can enter China's domestic capital market. Foreign institutional investors may optimise the overall investor structure after entering China's capital market, providing indirect economic benefits to improve the investment environment. Observed increases in the information content concerning stock prices and the efficiency of capital operation corroborate this view (Chari and Henry, 2008; Kacperczyk et al., 2021). In addition, from the macroeconomic perspective, capital market openness may also promote the improvement of the financial transaction system and financial infrastructure to a certain extent, thus reducing the systemic friction of financial transactions. It has been argued that the direct economic benefits of capital market openness are increased investment opportunities in the domestic market and assistance for the development of listed firms by alleviating financing constraints (Zhang et al., 2023). Wang et al. (2023) findings support the above view. Capital market openness leads to a significant increase in firms' ESG ratings. In particular, firms with stricter financial constraints can achieve more significant improvements in their ESG performance (Wang et al., 2023). Furthermore, capital market openness can also enhance firm value by improving the ESG performance of listed firms (Huang and Duan, 2024).

### 2.1. Information environment concern effect

Because of their information advantages, foreign investors in developed capital markets usually have more professional information collection and processing ability and more rational value investment thinking than domestic investors (Chen et al., 2013). Therefore, foreign investors' information demands on firms will further affect the behaviour of information intermediaries in China's capital market. Analysts, as information mediators between firms and investors, play a crucial role in the transmission of information in the market and have an important impact on investors' investment philosophies and decision-making processes (Chen et al., 2021). Analysts elucidate the financial information of listed firms by publishing research reports and disseminate this information rapidly in the capital market, thus creating a favourable external information environment market (Irani and Oesch, 2013; Andrade et al., 2013). Therefore, along with capital market openness, the entry of foreign investors strengthens the information demand in China's capital market, which in turn affects the number of analysts tracking the underlying listed firms. This analyst-induced information environment attention effect enhances firms' own information disclosures to a certain extent.

Additionally, because of rational value investment considerations, foreign investors are more inclined to choose firms with lower information asymmetry when making investment decisions. This gives listed firms a potential pandering incentive to attract more international capital by reducing the information asymmetry between the firm and the market (Doukas and Wang, 2013; Sha et al., 2022). Because of the level of firm governance in China's capital market, subject firms usually send positive signals to the outside world through high-quality audits. For example, Zhao et al. (2021) find that listed firms with foreign shareholdings are more likely to engage Big Four international accounting firms to improve their audit quality. Therefore, along with capital market openness, the entry of foreign investors into the market strengthens the information supply in China's capital market, which in turn affects the audit quality of the underlying listed firms. This audit quality–induced information environment concern effect also enhances firms' own information disclosure to a certain extent.

In addition, the entry of foreign investors makes other investor groups pay increased attention to the disclosure behaviour of firms. The main reason for this is that other investors are aware of the value investment philosophy of foreign investors, and thus, the underlying firms selected by these investors based on this philosophy may provide important signalling for other investments (Chen et al., 2013; Kacperczyk et al., 2021). This impact manifests itself in the capital market as a state of followership by other investors concerning the entry of international capital. Thus, along with capital market openness, the entry of foreign investors increases the information concern pressure of other investors. This information environment concern effect enhances firms' degree of information disclosure to a certain extent.

Increased attention to the information environment has created an internal incentive for firms to narrow internal and external information gaps. Combined with the policy impact of the SHSZ&HKSC, which also requires subject firms to strengthen the standardisation of their own disclosures, firms further improve their own disclosure processes to cope with the pressure of the external information environment.[1] Although these increased disclosures may effectively improve the information transparency of the capital market, they may also contribute to firm ESG rating divergence. The key reason for this is that the subjective nature of ESG information may cause firms to enhance their disclosures while expanding the opportunities for different interpretations of the information. Based on the sociological view presented by Lamont (2012), multiple ratings may occur in emerging areas where evaluation rules and norms are not yet mature. Therefore, the direct influencing factor of firm ESG rating divergence most likely stems from differences in the interpretation of the information provided in firm disclosures by third-party rating agencies (Cookson and Niessner, 2020). Christensen's (2023) study of firm ESG rating divergence from the ESG disclosure perspective supports this viewpoint. Based on the above analysis and prior studies, this paper proposes the following research hypotheses:

$H_1$: The external shock of the implementation of the SHSZ&HKSC have an information environment concern effect on China's

[1] In November 2014, the SSE issued the 'Notice on Strengthening Information Disclosure of Shanghai Stock Exchange Listed Companies in the Business of Shanghai-Hong Kong Stock Connections and Related Matters', in which the SSE clearly states that 'Shanghai stock connecting companies should pay attention to and adapt to the changes in the external environment and further standardize information disclosure'.

capital market and widen firm ESG rating divergence.

### 2.2. Ecological environment concern effect

The lack of a consensus on good performance and evaluation criteria concerning firm ESG performance may exacerbate ESG firm rating divergence caused by disclosure. In particular, the lack of standardisation and maturity of evaluation systems related to firm ESG performance is seen as a major driver of divergent outcomes. Research on the outcome of ESG segmentation deliberations strongly supports this assertion (Christensen et al., 2022; Goodell et al., 2024; Pandey et al., 2024). This is primarily because firms with greenwashing motives usually make overly qualitative disclosures in their annual firm or social responsibility reports, focusing on the firm's concerns or plans for green development and environmental protection to avoid discussion of practical outputs (Zhang, 2023). This increases the difficulty for external organisations to screen and capture practical information. It also increases the room for external rating agencies to choose their owns methods of dealing with industry average effects, which in turn leads to greater ESG rating divergence.

According to stakeholder theory, there is an endogenous drive to consider other stakeholders, including government departments and the public, in firm ESG practices (Freeman, 1984). Therefore, when local governments provide firms with formal or informal ecological requirements, firms usually form sustainable development goals that are consistent with local government requirements. At the same time, public concern for the ecological environment and social participation may enhance the quality of environmental decision-making and sustainable development (Li et al., 2022). Based on the above theories, we incorporate the external institutional requirements of local governments and the environmental concerns of the local public into the analytical framework for the moderating effect.

Institutional theory focuses on the interactions between institutions and organisations, emphasising the influence of external environmental systems on firm behaviour (North, 1990, 1991). Institutional theory suggests that organisations are influenced by their social and institutional environments and must conform to institutional norms and expectations to gain legitimacy and stakeholder support (Dacin et al., 2007; Peng et al., 2008; Scott, 1995). The level of governmental concern for the ecological environment may increase pressure on firms, and firms' ecological performance may in turn influence local governments' resource commitments to firms (Cai et al., 2015; Sheng et al., 2012). This external ecological pressure causes firms to increase their emphasis on ecological and social performance and to focus on actual ESG practices rather than solely on ordinary economic returns (Kohtamäki et al., 2020). In addition, public environment concern may have indirect and broad institutional effects. For example, the public may exert external pressure on polluting firms by exposing illegal emission activities, enhancing environmental activities and green behaviours in the region (Chen et al., 2015; Li et al., 2022). As a result, when facing comprehensive external ecological concerns, firms usually display actual environmental efficiency drivers rather than simple greenwashing behaviours (Song et al., 2022). In particular, external environmental constraints cause firms to enhance their willingness to innovate and promote the green transformation of production processes (Fabrizi et al., 2018; Jiang et al., 2020). This effectively enhances the outcome output of firms' ESG practices and thus conveys more accurate and objective positive signals to external organisations or third-party rating agencies. Based on the above analysis and existing research, this paper proposes the following research hypothesis:

$H_2$: Pressure from the government and the public to pay attention to the ecological environment has an ecological concern effect on the ESG performance of firms, which in turn effectively decreases firm ESG rating divergence induced by the information concern effect.

To summarize the hypotheses, we present the theoretical framework in Fig. 1.

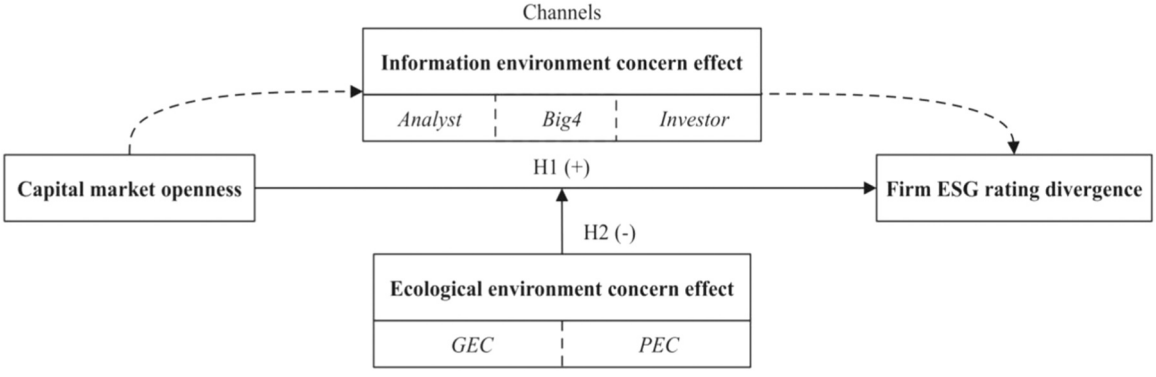


**Fig. 1.** The theoretical framework.

## 3. Research design

### 3.1. Measurement methodology

This paper selects data on 1124 A-share listed firms from 2011 to 2020 as the initial research sample used to test the relationship between capital market openness and firm ESG rating divergence. The paper excludes sample data from the financial industry, sample data from ST-type listed firms during the sample period, and sample data with missing key variables, resulting in 9770 observations. To avoid the influence of extreme values on the findings, this paper winsorises all of the continuous variables at 1 % and 99 %. The financial data of listed firms primarily come from the CNRDS database, the CSMAR database, the WIND database, government annual work reports, and the Baidu search engine index.

### 3.2. Variable definitions

#### 3.2.1. Dependent variable: firm ESG rating divergence (ESG_diff)

In reference to existing research methods, this paper takes the difference between the standardised firm ESG disclosure scores and firm ESG performance scores as a proxy for firm ESG rating divergence (Hu et al., 2023; Zhang, 2022). As the number of subject firms examined by third-party ESG rating agencies varies widely and the initial year is not uniform, to ensure the relative validity of the statistical results, this paper selects the Bloomberg ESG ratings to measure firm ESG disclosure performance and selects the Huazheng ESG ratings to measure firm ESG performance scores. This indicator therefore also reflects firm greenwashing motives to some extent (Hu et al., 2023; Zhang, 2022).

#### 3.2.2. Independent variable: capital market openness (Treatpost)

Within the sample years, this variable takes a value of 1 in the year of implementation and thereafter for the subject firms included in policy implementation after the implementation of the Shanghai–Shenzhen or Shanghai–Hong Kong Stock Connects, and 0 otherwise.

#### 3.2.3. Mechanism variable: analyst attention (Analyst)

In reference to the methodology of Irani and Oesch (2013), this paper uses the number of analyst follow-up analyses received by a firm on an annual basis as a proxy variable to measure the amount of analyst attention received by a firm. **Firms' audit environment (*Big4*)**: In reference to the research methodology of Zhao et al. (2021) this paper uses a dummy variable for whether a firm is audited by a Big Four firm as a proxy variable for the audit environment to which the firm is subjected. **Investor attention (*Investor*):** Following Wen et al. (2019), this paper uses the annual search statistics for Baidu keywords related to firms as a proxy variable to measure the investor attention received by firms.

#### 3.2.4. Moderating variable: government environment concern (GEC)

In reference to the methodology of Chen et al. (2018), this paper uses word frequency statistics from the provincial government environment concern work report as a proxy variable for government environment concern. **Public environment concern (*PEC*)**: In reference to the methodology of Li et al. (2022), this paper uses the public daily average search statistics from the Baidu search engine for keywords at the prefecture-level city level as a proxy variable for public environment concern. More detailed information on the text analysis keywords is provided in Appendix.

#### 3.2.5. Control variables

To improve the precision of this study, this paper selects a series of control variables to capture the characteristics of the firms, which reduces the model bias caused by omitted variables (Hu et al., 2023; Zhang, 2022). The definitions of the variables are presented

**Table 1**
Definitions and descriptions of key variables.

| Variables | Definitions |
|---|---|
| (1) *ESG_diff* | Firm ESG rating divergence, using rating differences between firm ESG disclosure and performance. |
| (2) *Treatpost* | Capital market openness, using the policy shock created by the implementation of SHSZ&HKSC. |
| (3) *Analyst* | Analyst focus, using the natural logarithm of the number of analysts focusing on a firm. |
| (4) *Big4* | Firm audit environment, measured by whether a firm is audited by PwC, DTT, KPMG, and EY. |
| (5) *Investor* | Investor attention, using the natural logarithm of the Baidu search index concerning the underlying company for the year. |
| (6) *GEC* | Government environment concern, using the natural logarithm of the frequency of environmental words in government work reports. |
| (7) *PEC* | Public environment concern, using the natural logarithm of the average daily searches for environmental terms by the public in the region. |
| (8) *Disclosure* | Whether a firm discloses internal control evaluation reports. |
| (9) *Staff* | The logarithmic value of the number of employees in the firm. |
| (10) *Lev* | The ratio of total liabilities to total assets. |
| (11) *Size* | The logarithmic value of a firm's business revenue. |
| (12) *TobinQ* | The ratio of a firm's market capitalisation to asset size. |
| (13) *Roa* | The ratio of a firm's net profit to asset size. |
| (14) *Age* | The logarithmic value of the age at which a firm is listed. |

in Table 1.

### 3.3. Model design

Drawing on the DID research method adopted by Chen et al. (2021) and Lu and Cheng (2023), this paper sets out the following benchmark regression model and clusters firm-level robust standard errors to enhance the robustness of the empirical model, as shown in Eq. (1).

$$ESG\_diff_{i,t} = \alpha_0 + \alpha_1 Treatpost_{i,t} + \lambda_{i,t}\sum X_{i,t} + \mu_i + \tau_t + \varepsilon_{i,t} \quad (1)$$

where $ESG\_diff_{i,t}$ is the dependent variable representing firms' ESG rating divergence. $Treatpost_{i,t}$ is the independent explanatory variable and represents capital market openness. $X_{i,t}$ is a set of control variables. $\mu_i$ is the firm fixed effect and $\tau_t$ is the year fixed effect, which mitigate the potential bias caused by omitted variables. $\varepsilon_{i,t}$ is the random disturbance term. In Eq. (1), this paper focuses on the $\alpha_1$ coefficient, which is a measure of the net effect of capital market openness on firm ESG rating divergence.

Further, this paper seeks to capture the mechanism path and external adjustment effect of capital market openness. This paper draws on the research methods of Bai (2022) and Chen et al. (2021) to set the following regression model, as shown in Eqs. (2) and (3).

$$Mechanism_{i,t} = \beta_0 + \beta_1 Treatpost_{i,t} + \lambda_{i,t}\sum X_{i,t} + \mu_i + \tau_t + \varepsilon_{i,t} \quad (2)$$

$$ESG\_diff_{i,t} = \gamma_0 + \gamma_1 Treatpost_{i,t} \times Moderating_{i,t} + \gamma_2 Moderating_{i,t} + \gamma_3 Treatpost_{i,t} + \lambda_{i,t}\sum X_{i,t} + \mu_i + \tau_t + \varepsilon_{i,t} \quad (3)$$

where $Mechanism_{i,t}$ is the mechanism variable for analyst attention, firm audit environment, and investor attention. $Moderating_{i,t}$ is the moderating variable for government environment concern and public environment concern. In Eq. (2), this paper focuses on the coefficient $\beta_1$, which measures the mechanism path effect of capital market openness. In Eq. (3), this paper focuses on the coefficient $\gamma_1$, which is a measure of the moderating effect of the regulating variables. $\gamma_2$ and $\gamma_3$ are direct effects that have no practical economic significance in the statistical test.

## 4. Empirical results

### 4.1. Descriptive statistics

Table 2 presents the descriptive statistics for the main variables in this paper. The data results show that the minimum value of firm ESG rating divergence (*ESG_diff*) is −2.315, the maximum value is 3.444, and the sample standard deviation is 1.153, with a mean value of −0.004. These results indicate that there is a large amount of individual variation over the observation period, which provides a useful research sample with which this paper analyses the firm ESG rating divergence and its influencing factors. The independent variable, capital market openness (*Treatpost*), has a minimum value of 0.000, a maximum value of 1.000, a mean value of 0.356, and a sample standard deviation of 0.479.

### 4.2. Benchmark regression results

Table 3 reports the benchmark regression results. According to Model (1), capital market openness (*Treatpost*) is significantly and positively correlated with firm ESG rating divergence (*ESG_diff*) ($\alpha_1 = 0.083$, $P < 0.05$) when the differences in firms' characteristics and the individual and time two-way fixed effects are controlled. This paper also conducts a strength test for capital market openness based on firm ESG performance, and the test results are shown in Model (2) and Model (3). When the differences in firms'

**Table 2**
Descriptive statistics of main variables.

| Variable | Obs | Mean | S.D. | Min | p25 | p50 | p75 | Max |
|---|---|---|---|---|---|---|---|---|
| (1)*ESG_diff* | 9770 | -0.004 | 1.153 | -2.315 | -0.809 | -0.112 | 0.645 | 3.444 |
| (2)*Treatpost* | 9770 | 0.356 | 0.479 | 0.000 | 0.000 | 0.000 | 1.000 | 1.000 |
| (3)*Analyst* | 8208 | 2.300 | 0.910 | 0.693 | 1.609 | 2.398 | 3.045 | 4.331 |
| (4)*Big4* | 9770 | 0.115 | 0.319 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 |
| (5)*Investor* | 9764 | 13.024 | 0.769 | 0.000 | 12.523 | 12.967 | 13.452 | 17.191 |
| (6)*GEC* | 9770 | 0.947 | 0.252 | 0.367 | 0.769 | 0.914 | 1.126 | 1.920 |
| (7)*PEC* | 9393 | 5.084 | 1.102 | 0.000 | 4.352 | 5.258 | 5.803 | 7.151 |
| (8)*Disclosure* | 9770 | 0.040 | 0.195 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 |
| (9)*Staff* | 9770 | 8.389 | 1.280 | 3.714 | 7.547 | 8.380 | 9.228 | 11.088 |
| (10)*Lev* | 9770 | 0.477 | 0.203 | 0.057 | 0.320 | 0.487 | 0.631 | 1.073 |
| (11)*Size* | 9770 | 22.396 | 1.431 | 16.947 | 21.394 | 22.337 | 23.346 | 25.263 |
| (12)*TobinQ* | 9770 | 1.917 | 1.302 | 0.878 | 1.123 | 1.473 | 2.159 | 8.794 |
| (13)*Roa* | 9770 | 0.042 | 0.065 | -0.357 | 0.015 | 0.037 | 0.070 | 0.278 |
| (14)*Age* | 9770 | 2.472 | 0.647 | 0.000 | 2.197 | 2.639 | 2.944 | 3.296 |

**Table 3**
Benchmark regression results.

| | (1) | (2) | (3) |
|---|---|---|---|
| Variables | *ESG_diff* | *ESG_PB* | *ESG_HZ* |
| *Treatpost* | 0.083** | 0.010*** | 0.063* |
| | (0.040) | (0.002) | (0.036) |
| *Disclosure* | -0.124*** | -0.012*** | -0.050 |
| | (0.047) | (0.003) | (0.041) |
| *Staff* | -0.108*** | 0.005*** | 0.197*** |
| | (0.034) | (0.002) | (0.036) |
| *Lev* | 0.639*** | -0.005 | -0.761*** |
| | (0.138) | (0.007) | (0.133) |
| *Size* | 0.001 | 0.004* | 0.054 |
| | (0.036) | (0.002) | (0.036) |
| *TobinQ* | 0.010 | 0.002** | 0.013 |
| | (0.014) | (0.001) | (0.012) |
| *Roa* | 0.075 | 0.012 | 0.056 |
| | (0.225) | (0.010) | (0.219) |
| *Age* | 0.064 | 0.001 | -0.052 |
| | (0.073) | (0.004) | (0.066) |
| Constant | 0.007 | 0.039 | 1.962*** |
| | (0.674) | (0.041) | (0.653) |
| Firm | YES | YES | YES |
| Year | YES | YES | YES |
| Observations | 9770 | 9770 | 9770 |
| R-squared | 0.122 | 0.282 | 0.039 |

* $p<0.1$
** $p<0.05$
*** $p<0.01$

characteristics and the individual and time two-way fixed effects are controlled, capital market openness (*Treatpost*) is significantly and positively correlated with firm ESG performance (*ESG_PB*, *ESG_HZ*) ($\alpha_1 = 0.010$, $P < 0.01$; $\alpha_1 = 0.063$, $P < 0.10$). The above benchmark results suggest that capital market openness both significantly enhances firm ESG performance and strengthens firm ESG rating divergence. $H_1$ is thus supported.

### 4.3. Robustness tests

The following scientific estimation methods are used to re-examine the benchmark regression model to further verify the unbiasedness of the estimated coefficients and the robustness of the research results.

#### 4.3.1. Parallel trend test

The benchmark regression model in this paper adopts the DID estimation method. This method alleviates the endogeneity problem to a large extent, provided that the treatment group and the control group satisfy the parallel trend assumption. This paper therefore adopts a research methodology for the parallel trend test (Beck et al., 2010). In this paper, the control group and the year before the shock event are taken as the baseline observations, and the flexible estimation results of the state of affairs research method are plotted as dynamic results containing coefficients and confidence intervals. As shown in Fig. 2, the confidence intervals of the estimated

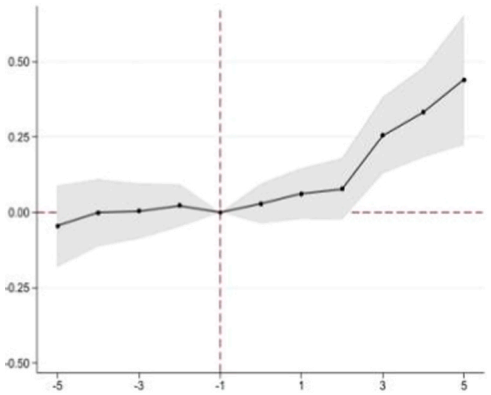


**Fig. 2.** Parallel trend test (ESG_diff).

coefficients in the statistical tests before the policy shocks contain zero values and do not display a clear linear dynamic trend. This indicates that the treatment and control groups in the research sample satisfy the identification assumption by having a common trend ex ante. In addition, the parallel trend plots for the strength tests of firm ESG performance on capital market openness are shown in Figs. 3 and 4.

#### 4.3.2. Placebo test

This paper conducts a placebo test to verify that unobservables and omitted variables do not seriously affect the results of the benchmark regression in this paper. In reference to Ferrara et al. (2012) and He et al. (2022), this paper utilises a placebo test with random sampling. In this test, randomly sampled individuals constitute a new dummy treatment group, and the reliability of the conclusions are judged based on the values of the pseudo-policy dummy variable coefficients. The regression model results for the placebo test in this paper are consistent with the baseline regression model results. In addition, this paper repeats the process 500 times to further increase the effectiveness of the placebo test.

The distribution of the estimated coefficients of the placebo test is shown in Fig. 5. The values of the pseudo-policy dummy variable coefficients are centrally distributed around the value of zero. This implies that important, influential factors are not omitted from the benchmark modelling of this paper and that the benchmark regression results of this paper are not seriously impacted by other unobservable factors. The results of this test therefore enhance the robustness of the paper's conclusions.

#### 4.3.3. Other robustness tests

*4.3.3.1. Propensity score matching (PSM).* PSM is used in this paper to eliminate differences in characteristics between the treatment and control groups (Gao et al., 2022; He et al., 2022). A key reason to conduct this test is that the assumption of a common trend between the treatment and control groups may be confounded by other omitted or unobservable factors. The PSM approach, however, does not help us to solve or mitigate the above problems and does not provide robust support for potential common trends ex ante. The PSM method is chosen in this paper to screen the control group based on propensity score values only, which provides a certain degree of weakly robust support for the coefficient estimation of the benchmark regression. In addition, considering the validity of the regression results and the transparency of the treatment, this paper uses intra-calliper nearest neighbour matching ($k = 8$, $\varepsilon = 0.01$), which can be used without loss of generality. This is the primary way to obtain the propensity score values based on covariates, as all of the control variables in the baseline regression are selected as covariates.

Fig. 6 shows the standardised deviation rate results for the covariates. The standardised deviation rates of all of the covariates are significantly reduced after matching, clustering around 0. These results indicate that after propensity score matching, the characteristics of the variables in the treatment and control groups are largely the same and can be tested for differences based on the matching results. Table 4 shows the regression results of PSM–DID. According to Model (1), capital market openness (*Treatpost*) demonstrates a significant and positive correlation ($\alpha_1 = 0.069$, $P < 0.10$) with firm ESG rating divergence (*ESG_diff*). These results indicate that capital market openness still significantly increases firm ESG rating divergence in the study sample after PSM. This finding is consistent with the benchmark regression results and enhances the robustness of the paper's findings.

*4.3.3.2. Adjustment of sample years.* The COVID-19 pandemic, which began in 2020, has affected the global economy to varying degrees. The negative effects of the pandemic are likely to cause changes in firm business strategy models, particularly for firm ESG practices with negative externalities. This paper therefore excludes year data that may bias the estimation results. The panel data are re-screened from 2011 to 2019 and the sample is re-estimated with the rest of the settings unchanged. In Model (2), capital market openness (*Treatpost*) exhibits a significant and positive correlation with firm ESG rating divergence (*ESG_diff*) ($\alpha_1 = 0.082$, $P < 0.05$). This result indicates that capital market openness still significantly strengthens firm ESG rating divergence based on the study sample even after partial year exclusion. This finding is consistent with the benchmark regression results and enhances the robustness of the

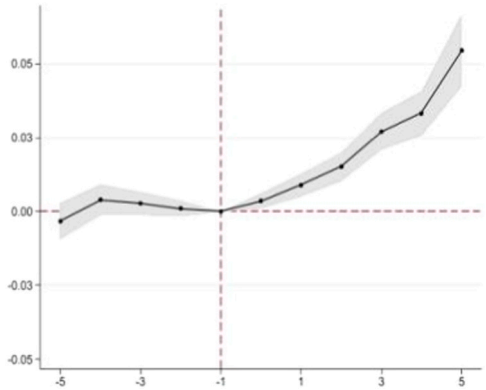


**Fig. 3.** Parallel trend test (ESG_PB).

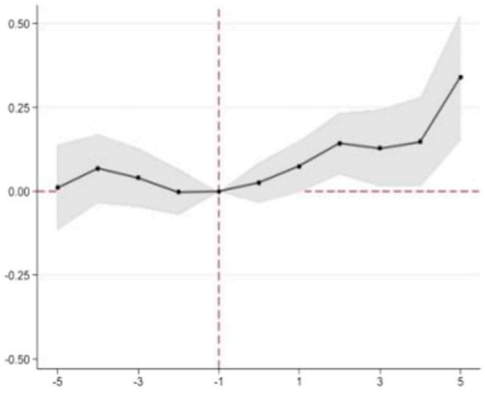


**Fig. 4.** Parallel trend test (ESG_HZ).

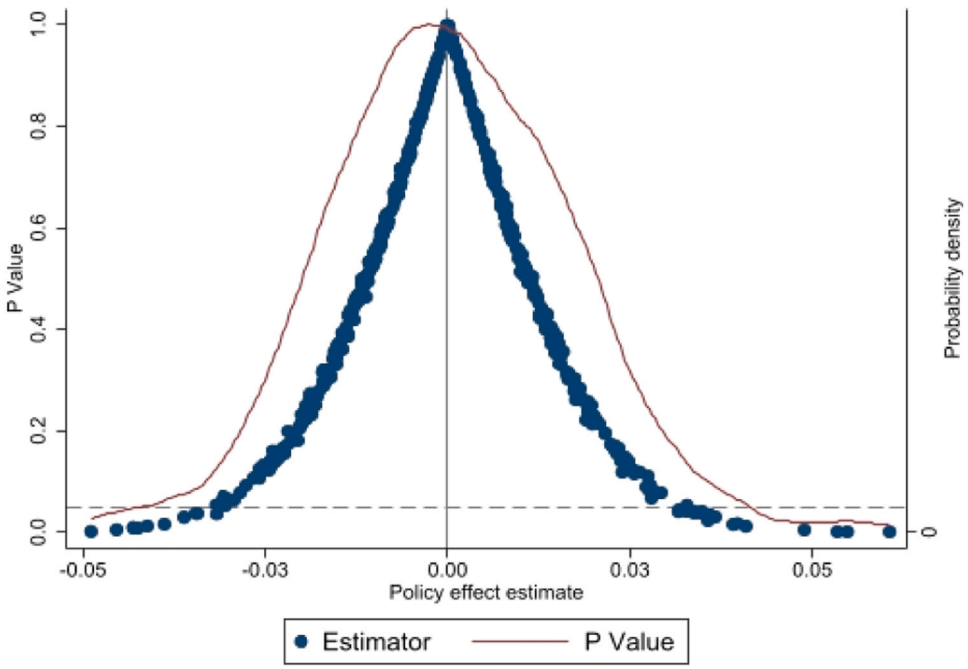


**Fig. 5.** Placebo test effect plot.

paper's findings.

*4.3.3.3. Consideration of time trend effects in the industry.* Firm ESG rating divergence may be affected by other factors at the industry level in addition to factors that affect firms' own characteristics. The independent variable of this paper is the external shock of capital market openness, which is likely to result in the existence of other co-determinants in the random perturbation term, which in turn may result in a backdoor path effect. This paper therefore considers the time trend effect of the industry to reduce the potential bias caused by omitted variables. In Model (3), capital market openness (*Treatpost*) has a significant and positive correlation ($\alpha_1 = 0.079$, $P < 0.05$) with firm ESG rating divergence (*ESG_diff*). The above results indicate that capital market openness still significantly increases firm ESG rating divergence based on the study sample after the time trend effect of industry is incorporated. This is consistent with the benchmark regression results and enhances the robustness of the paper's findings.

## 5. Further research

### 5.1. Information environment mechanism

Table 5 reports the results of the tests concerning the information environment mechanism. The following tests all control for

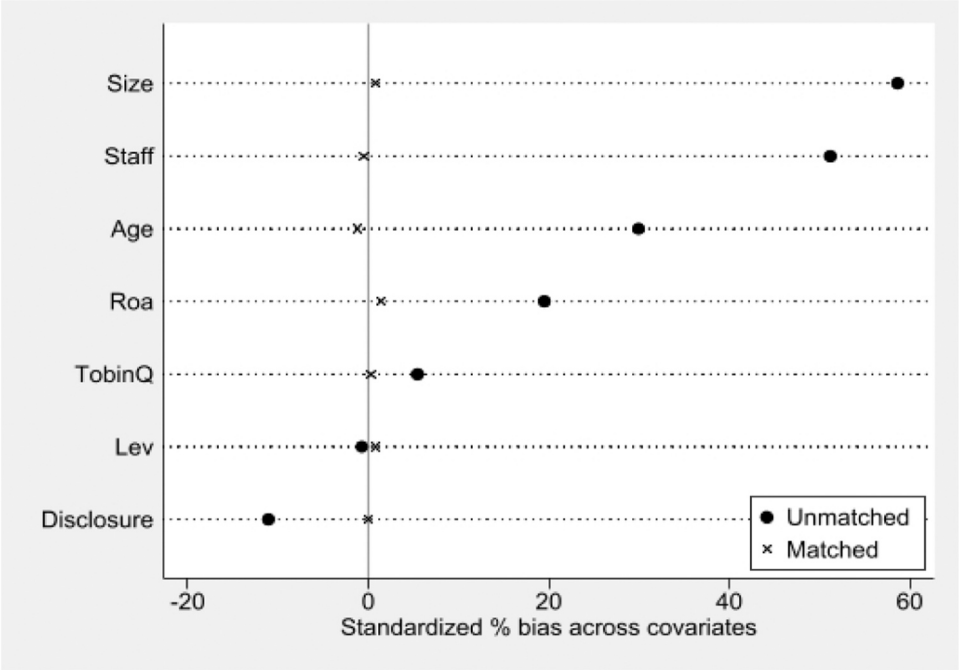


**Fig. 6.** Plot of standardized deviation rate analysis of covariates.

**Table 4**
Robustness test results.

| | (1) | (2) | (3) |
|---|---|---|---|
| Variables | *ESG_diff* | *ESG_diff* | *ESG_diff* |
| *Treatpost* | 0.069* | 0.082** | 0.079** |
| | (0.041) | (0.039) | (0.040) |
| *Disclosure* | -0.109** | -0.104** | -0.115** |
| | (0.052) | (0.046) | (0.048) |
| *Staff* | -0.107*** | -0.117*** | -0.104*** |
| | (0.036) | (0.034) | (0.034) |
| *Lev* | 0.688*** | 0.599*** | 0.679*** |
| | (0.152) | (0.136) | (0.140) |
| *Size* | -0.001 | 0.012 | -0.009 |
| | (0.038) | (0.035) | (0.036) |
| *TobinQ* | 0.012 | 0.009 | 0.006 |
| | (0.013) | (0.014) | (0.014) |
| *Roa* | 0.135 | 0.287 | 0.161 |
| | (0.236) | (0.237) | (0.223) |
| *Age* | 0.066 | 0.058 | 0.057 |
| | (0.081) | (0.075) | (0.072) |
| Constant | 0.041 | -0.165 | 0.531 |
| | (0.716) | (0.670) | (1.058) |
| Firm | YES | YES | YES |
| Year | YES | YES | YES |
| Industry | No | No | YES |
| Observations | 8943 | 8665 | 9770 |
| R-squared | 0.117 | 0.121 | 0.139 |

* p<0.1.
** p<0.05
*** p<0.01

differences in firms' characteristics as well as for individual and time two-way fixed effects. In Model (1), capital market openness (*Treatpost*) is significantly and positively correlated with analyst attention (*Analyst*) ($\beta_1 = 0.159$, $P < 0.01$). This indicates that capital market openness effectively increases analyst attention. In Model (2), capital market openness (*Treatpost*) and firm audit environment (*Big4*) are significantly and positively correlated ($\beta_1 = 0.013$, $P < 0.10$). This indicates that capital market openness effectively enhances the firm audit environment. In Model (3), capital market openness (*Treatpost*) and investor attention (*Investor*) have a

**Table 5**
Mechanism test results for the information environment.

| | (1) | (2) | (3) |
|---|---|---|---|
| Variables | *Analyst* | *Big4* | *Investor* |
| *Treatpost* | 0.159*** | 0.013* | 0.112*** |
| | (0.031) | (0.008) | (0.020) |
| *Disclosure* | -0.063* | 0.012 | -0.002 |
| | (0.036) | (0.010) | (0.024) |
| *Staff* | 0.077** | -0.000 | 0.077*** |
| | (0.030) | (0.006) | (0.016) |
| *Lev* | -0.452*** | 0.018 | -0.026 |
| | (0.121) | (0.020) | (0.064) |
| *Size* | 0.353*** | 0.006 | 0.082*** |
| | (0.033) | (0.009) | (0.021) |
| *TobinQ* | 0.162*** | -0.001 | 0.044*** |
| | (0.011) | (0.003) | (0.007) |
| *Roa* | 2.140*** | 0.044 | -0.150 |
| | (0.232) | (0.030) | (0.096) |
| *Age* | -0.205*** | 0.008 | 0.189*** |
| | (0.054) | (0.016) | (0.033) |
| Constant | -5.715*** | -0.042 | 10.077*** |
| | (0.608) | (0.191) | (0.401) |
| Firm | YES | YES | YES |
| Year | YES | YES | YES |
| Observations | 8208 | 9770 | 9764 |
| R-squared | 0.232 | 0.006 | 0.547 |

* p<0.1
** p<0.05
*** p<0.01

**Table 6**
Moderation test results for ecological environment concern.

| | (1) | (2) |
|---|---|---|
| Variables | *ESG_diff* | *ESG_diff* |
| *Treatpost×GEC* | -0.178* | |
| | (0.102) | |
| *Treatpost×PEC* | | -0.060* |
| | | (0.032) |
| *GEC* | 0.075 | |
| | (0.070) | |
| *PEC* | | -0.047 |
| | | (0.056) |
| *Treatpost* | 0.260** | 0.400** |
| | (0.114) | (0.180) |
| *Disclosure* | -0.125*** | -0.123*** |
| | (0.047) | (0.048) |
| *Staff* | -0.109*** | -0.109*** |
| | (0.034) | (0.035) |
| *Lev* | 0.645*** | 0.660*** |
| | (0.138) | (0.142) |
| *Size* | -0.000 | 0.007 |
| | (0.036) | (0.037) |
| *TobinQ* | 0.009 | 0.009 |
| | (0.014) | (0.014) |
| *Roa* | 0.078 | 0.179 |
| | (0.224) | (0.230) |
| *Age* | 0.062 | 0.081 |
| | (0.073) | (0.074) |
| Constant | -0.027 | 0.015 |
| | (0.672) | (0.719) |
| Firm | YES | YES |
| Year | YES | YES |
| Observations | 9770 | 9393 |
| R-squared | 0.123 | 0.122 |

* p<0.1.
** p<0.05
*** p<0.01

significant and positive correlation ($\beta_1 = 0.112$, $P < 0.01$). This indicates that capital market openness effectively increases investor attention. These mechanism test results indicate that capital market openness significantly strengthens the information environment in which firms are located, which in turn enhances firms' own ESG performance. This, however, inevitably enhances firms' incentives to engage in greenwashing practices and increases firm ESG rating divergence.

### 5.2. Ecological environment concern

Table 6 reports the results concerning the moderating effects of ecological concern. The following tests all control for differences in firms' characteristics as well as for individual and time two-way fixed effects. In Model (1), the interaction term between capital market openness and government environment concern (*Treatpost* × *GEC*) is significantly and negatively correlated with firms' ESG rating divergence (*ESG_diff*) ($\gamma_1 = -0.178$, $P < 0.10$). This suggests that government environment concern may negatively moderate the facilitating effect of capital market openness on firm ESG rating divergence. In addition, the coefficient of (*GEC*) is 0.075, which is not statistically significant. And the coefficient of (*Treatpost*) is 0.260, achieving statistical significance at 5 %. In the moderating analysis, the base term coefficients represent direct effects, indicating the effect when the value of the other base variable is 0.

In Model (2), the interaction term between capital market openness and public environment concern (*Treatpost*×*PEC*) has a significant and negative correlation ($\gamma_1 = -0.060$, $P < 0.10$) with firm ESG rating divergence (*ESG_diff*). This suggests that public environment concern may negatively moderate the facilitating effect of capital market openness on firm ESG rating divergence. The above results suggest that pressure on firms concerning environmental issues, regardless of whether the pressure comes from the government or the public, decreases the firm ESG rating divergence induced by capital market openness. In addition, the coefficient of (*PEC*) is −0.047, which is not statistically significant. And the coefficient of (*Treatpost*) is 0.400, achieving statistical significance at 5 %.

## 6. Conclusion

To better understand firm sustainability in the context of green economic development, this paper adopts the DID regression model to capture the effect of capital market openness on firm ESG rating divergence. The empirical results from a sample of 9770 listed firms in China from 2011 to 2020 support the hypotheses of this paper. The results show that the external shock of the implementation of SHSZ&HKSC create an information environment concern effect, which significantly increases the ESG rating divergence of firms and intensifies the incentives for firms to engage in greenwashing behaviours. This effect is mitigated by increased pressure from the government and the public concerning the ecological environment. That is, the more that firms are influenced by government and public environment concern, the weaker the effect of capital market openness is on firm ESG rating divergence. The excessive deviation between ESG disclosure and performance also reflects the greenwashing motivations of enterprises to a certain extent. Therefore, local governments need to strengthen their focus on the ecological environment. In particular, relevant environmental regulations departments should consider monitoring ESG practices by incorporating external environmental concerns from stakeholders such as the public. The findings of this paper contribute to the study of the drivers of firm ESG rating divergence and provide important empirical evidence regarding the mitigation of the effects of external influences on firms' greenwashing behaviours.

## CRediT authorship contribution statement

**Zhennan Sun:** Writing – original draft, Methodology, Formal analysis. **Tianle Yang:** Writing – original draft, Validation. **Zhongyuan Li:** Validation, Software, Methodology. **Anna Min DU:** Writing – review & editing, Supervision, Resources, Project administration, Conceptualization. **Qunyang Du:** Investigation, Funding acquisition, Data curation, Conceptualization.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Data availability

Data will be made available on request.

## Appendix

**Moderating variable: government environment concern (*GEC*).** The main keywords from the work report are 'environmental protection', 'environmental protection', 'pollution', 'energy consumption', 'emission reduction', 'sewage', 'ecology', 'green', 'low carbon', 'low carbon', 'low carbon', 'low carbon', 'low carbon', 'low carbon', 'low carbon', 'low carbon', 'low carbon', 'low carbon', 'low carbon', 'air', 'chemical oxygen demand', 'sulfur dioxide', 'carbon dioxide', 'PM10', and 'PM2.5'. **Public environment concern (*PEC*)**: The main keywords for environmental terms are 'environmental pollution' and 'haze'.

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