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Summary

This paper aims at analyzing the impact of corporate environmenral information disclosure from the perspective of investors. To that end, we have collected environmental information disclosure data of all Chinese listed companies from 2004 to 2020 and controlled the impacts of annual reports on investor response. We apply the Fama-French five-factor model to calculate the accumulative abnormal returns of stocks during the event window period. Our results suggest that environmental information disclosure can have a significant negative response among investors when we take the impacts of annual reports into consideration. Moreover, we find that heavy-polluting companies and companies with high institutional shareholding are more likely to have negative reactions from investors. Notably, the negative response is found significant after the Ambient Air Quality Standard was revised in 2012. Furthermore, high environmental expenditure and strict environmental regulation will result in negative investor responses, while the political connection can alleviate the negative impacts of environmental information disclosure. The results remain robust in different ways. The findings suggest that listed companies may lack the incentive to engage in environmental management and are reluctant to disclose environmental information. Consequently, the government should formulate a mandatory disclosure policy and provide administrative support to environmental-friendly companies. Besides, companies should improve innovation technology to cut down environmental costs. Meanwhile, investors should be aware of the importance of corporate environmental behaviors and realize the long-term benefits of environmental management of listed companies.

Keywords: Environmental information disclosure; Investor response; Corporate annual reports;

Fama-french five factor model; China's capital market.

JEL Classification: L24, 03.

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Corporate Environmental Information Disclosure and Investor Response: Empirical Evidence from China's Capital Market

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Abstract: This paper aims at analyzing the impact of corporate environmenral information disclosure from the perspective of investors. To that end, we have collected environmental information disclosure data of all Chinese listed companies from 2004 to 2020 and controlled the impacts of annual reports on investor response. We apply the Fama-French five-factor model to calculate the accumulative abnormal returns of stocks during the event window period. Our results suggest that environmental information disclosure can have a significant negative response among investors when we take the impacts of annual reports into consideration. Moreover, we find that heavy-polluting companies and companies with high institutional shareholding are more likely to have negative reactions from investors. Notably, the negative response is found significant after the Ambient Air Quality Standard was revised in 2012. Furthermore, high environmental expenditure and strict environmental regulation will result in negative investor responses, while the political connection can alleviate the negative impacts of environmental information disclosure. The results remain robust in different ways. The findings suggest that listed companies may lack the incentive to engage in environmental management and are reluctant to disclose environmental information. Consequently, the government should formulate a mandatory disclosure policy and provide administrative support to environmental-friendly companies. Besides, companies should improve innovation technology to cut down environmental costs. Meanwhile, investors should be aware of the importance of corporate environmental behaviors and realize the long-term benefits of environmental management of listed companies.

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JEL Classification: Q48; Q53; Q58; P28; G14

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1 Introduction

With the continuous development of Chinaôs capital market and the enhancement of investorsô investment consciousness, the role of corporate environmental information disclosure in affecting investor response has received much attention among researchers in recent years (Giannarakis et al., 2016; Istrate et al., 2017; Yu et al., 2021a). The environmental dimension has gradually become one of the most important aspects for investors when evaluating a companyôs corporate social responsibility performance and appears to be one of the important competitive factors in modern society (Flammer, 2013; Lee et al., 2016; Liu et al., 2021). As a prerequisite for companies to create relationships with the natural environment and an obligation of each company to protect the social environment, corporate environmental responsibility (CER) is becoming an integral part of corporate social responsibility (CSR) and has drawn increasing attention (Eding and Scholtens, 2017; Lee, 2021; Fukuda and Ouchida, 2020). As non-financial information, CER can convey attributes of a company to the public that can be interacted with financial indicators to evaluate corporate performance, thereby providing valuable information and reference for managers and investors in the context of social volatility and economic uncertainty. Thus, many investors regard CER information as an important indicator when making investment decisions (Cai et al., 2015; Fisk and Good, 2019).

In this case, to further strengthen the construction of ecological civilization and facilitate the investment efficiency of investors, many countries have begun to formulate legal systems to regulate listed companiesô environmental information disclosure. While China adopted the information disclosure system relevantly late and has gradually established a formal social responsibility reporting system for listed companies since 2006, this led the importance and influence of environmental information disclosure to be ignored by the majority of Chinese listed companies. Moreover, according to the *Evaluation Report on Environmental Responsibility Information Disclosure of Listed Companies in China*, almost 74.31% of listed companies have not released their environmental responsibility reports, social responsibility reports, and sustainable development reports among the total of 4418 listed companies in China in 2020[1]. However, according to the *Guidance on building*

[1] Data resource: *Evaluation Report on Environmental Responsibility Information Disclosure of Listed Companies in China (2020).*

a green financial system released by the People's Bank of China and the other seven departments in 2016, the Chinese government is making every effort to formulate mandatory environmental information disclosure for listed companies. Moreover, under China's new commitments to carbon emissions peak before 2030 and carbon neutrality before 2060, companies are expected to have to abide by more stringent regulator standards and bear higher environmental protection costs, which is undoubtedly a huge challenge for China's listed companies. Previous research have also demonstrated that with the degradation of environmental quality[2] and the enhancement of environmental protection awareness of investors, CER information disclosure can inevitably have significant effects on investor response by influencing financial performance, risk management, and social attention of listed companies (Horbach, 2012; Zhou et al., 2018; Beji et al., 2020; Long et al., 2020). Therefore, driven by policy requirements and social concerns about the environment, it is of both scientific interest and highly policy relevance to analyze the effects of the CER information disclosure on investor response for corporate sustainable development and improvement of China's capital market efficiency.

As more and more managers integrate CER activities into their business operations over the past decade, CER has aroused great interest from regulators and academics. In recent years, there has been an increasing amount of literature on CER information disclosure and investor response. Many researchers hold the view that CER information disclosure can reduce the risk level, facilitate innovation activities, and improve corporate reputation, thereby attracting investors and enhancing their investment intention (Albuquerque et al., 2019; Mayberry, 2020; Beji et al., 2020; Lončar et al., 2020; Hernández et al., 2020). However, there still exist views and research indicating that CER information disclosure can have no effects or even negative effects on investors' decisions. They maintain that engaging in environmental behaviors means higher environmental costs which may lower the company's profitability from the resource-constrained perspective (Li et al., 2017; Verbeeten et al., 2016; Deswanto and Siregar,2018). While previous research always focus on specific environmental disclosure events, which leads to insufficient research samples. Moreover, when evaluating the impacts of environmental information disclosure, some researchers have not excluded the influences of

[2] According to the data released by the World Health Organization (WHO), more than 80% of people live in areas where air pollution exceeds the WHO guideline limits. Moreover, millions of people globally lack adequate available water and consequently suffer from multitudes of preventable illnesses. Data resource: https://www.who.int/

corporate annual reports. Furthermore, the time when companies disclose their CER will also exhibit significant impacts on investors (Choudhary et al., 2015; Edmonds et al., 2017). In this paper, therefore, we collect a relatively larger research sample and control the possible impacts of the releasing time of CER. Also, we exclude the influences of corporate annual reports on investors. Specifically, (1) We collect environmental information disclosure data of all Chinese listed companies from 2004 to 2020, which is a relatively comprehensive sample, thus drawing more general conclusions. (2) We include companies that only publish financial reports as the control group and eliminate the impacts of annual reports. Moreover, we take the releasing time of CER and corporate financial reports into consideration and control their impacts in our regression model. As investors are presenting considerable importance in determining firms' CER policies (Ng and Zheng, 2018; Albuquerque et al., 2019), this paper analyzes the impact of CER information disclosure from the perspective of investors' responses. To that end, Fama-French five-factor model, which shows the highest explanatory power of the assets returns from theory and practice (Fama and French, 2015; Jareno et al., 2018; Bertomeu et al., 2018; Cox and Britten, 2019), is used in this paper to measure investor response when discussing the relationships between CER and investor response, thus making up for the limitations of the pricing models in previous literature and describes companies' characteristics more comprehensively.

By analyzing the impact of corporate environmental information on investor response, we find that the disclosure of environmental information tends to have significant negative impacts on the investors when we controlled the impact of corporate annual reports, which decreases the investor's investment intention and firm value. This study further shows that heavy polluting companies and companies with higher institutional shareholding are more likely to be negatively affected by investors significantly when disclosing environmental information. Moreover, the negative effects are found significant after the Ambient Air Quality Standard (AAQS) policy was implemented in 2012, as the AAQS policy results in higher environmental expenditure and environmental violation risk. We then explore the influential mechanisms of investor response to environmental information disclosure. We confirm that high environmental expenditure and strict environmental regulation will result in negative investor response, while the political connection can alleviate the negative impacts of environmental information disclosure. The negative relationship between environmental information disclosure and investor response

survives a series of robustness tests. The results of our study will provide evidence for the government to formulate policies on environmental regulation and mandatory information disclosure.

The remainder of this paper is organized as follows. Section 2 briefly describes the literature on CER and puts forward the hypotheses. Section 3 constructs the specific model, the data collection, and the variables. Section 4 reports the empirical results and the robustness tests. Heterogeneity tests are carried out in Section 5. Section 6 further analyzes the specific mechanisms of the impact of environmental information disclosure on investor response. The final section summarizes the main conclusions and policy implications.

2 Literature Review and Hypotheses Development

Many pieces of research have suggested that the environmental dimension seems to be one of the most important aspects for stakeholders when evaluating a company's CSR performance. As a prerequisite for companies to create relationships with the natural environment and an obligation of each company to protect the social environment, which represents the targets of sustainable development in operation and production, CER appears to be one of the important competitive factors in modern society (Flammer, 2013; Cai et al., 2015). In recent years, researchers have demonstrated that environmental responsibility can have positive influences on investor reactions. Specifically, much of the research has emphasized that CER information disclosure can reduce the risk level, facilitate innovation activities, and improve corporate reputation, thereby attracting investors and enhancing their investment intention (Albuquerque et al., 2019; Mayberry, 2020; Beji et al., 2020; Lončar et al., 2019; Hernández et al., 2020).

Firstly, CER behaviors exhibit significant influences on reducing companies' financial risk and increasing firm value by improving information transparency and risk management level (Cai et al., 2015; Albuquerque et al., 2019; Mayberry, 2020). Moreover, Oikonomou (2012) finds that companies that engage in environmental behavior are associated with lower levels of financial risk during times of moderate social volatility. Further, according to the risk-reduction hypothesis, CER engagement may have a negative association with company risk due to insurance-like protection (Cai et al., 2015; Beji et al., 2020). Therefore, disclosing CER information can reduce corporate risk and provide market appeal to investors,

thus exerting positive impacts on investor response.

Besides, CER can have a positive impact on investor response by promoting corporate innovative activities and enhancing financial performance. Concretely speaking, to participate in CER management and have positive environmental effects, companies need to create new products or new technology to complete environmental protection targets, thereby promoting corporate technological progress and cost-saving innovations (Horbach, 2012; Lončar et al., 2019; Kraus et al., 2020). More importantly, as environmental-protection technologies may enable companies to reduce unit production costs and enhance sales, in the long run companies investing earlier in CER may have greater financial advantages, such as the improvement in ROA and ROE, which would make the stocks of the listed companies more attractive to investors (Flammer, 2015; Lee et al., 2016; Zhou et al., 2018; Singh et al., 2020; Fu et al., 2020).

Last but not least, corporate reputation and goodwill get significantly promoted with the fulfillment of CER. According to social identity and social exchange theories, participation in social responsibility can promote corporate image and consumer satisfaction, as well as brand attachment and brand trust, thus enhancing the consumer brand passion, purchase intention, and price premium, which can have positive reactions among investors and bring large financial profit to the company (Wang, 2018; Gilal et al., 2020). Moreover, as consumers increasingly expect to be empowered in corporate management, the environment and community involvement behaviors can positively affect product market perception, improve consumers' autonomy-need and competence-need satisfaction (Kull and Health, 2016; Tao, 2020; Bardos et al., 2020). Such effects are conducive to forming a virtuous circle of environmental behavior and investor response of the companies (Jo, 2014; Kunz, 2020; Long et al., 2020), which can be beneficial to raise corporate comprehensive capacities and ultimately, capture investors' attention.

In conclusion, many pieces of research imply that the practice in CER can indeed reduce the risk level, stimulate innovation activities, and improve corporate reputation, thereby exerting a positive impact among investors and increasing investors' purchase intention. Consistent with this, we propose the following hypothesis:

Hypothesis 1： *CER information disclosure can have positive impacts on investor response.*

However, with the improvement of environmental protection awareness and the

requirements for meeting worldwide emission reduction targets under the Paris Agreement, China has committed to achieving its carbon emissions peak before 2030 and carbon neutrality before 2060. Under this circumstance, companies are under greater pressure and environmental cost, which may have negative impacts on their business operations and financial performance. Much of the research that incorporates environmental behaviors also demonstrated that CER information disclosure can have negative effects on investors' decisions (Li et al., 2017; Verbeeten et al., 2016; Deswanto and Siregar,2018).

Firstly, companies have to bear high costs when engaging in environmental behaviors (Ervin et al., 2013; Wu, 2014; Brouwers et al., 2018). The environmental responsibility investment raises capital costs and labor costs, especially for small and medium-sized enterprises (Ee et al., 2018; Gjergji et al., 2021). Besides, although some researchers argue that environmental information disclosure can lower debt costs and financing costs (Morrone et al., 2021; Raimo et al., 2021), the cost-reducing effects of environmental information disclosure may only exist in long-term liabilities, on the contrary, taking environmental responsibilities can even inhibit corporate short-term borrowing ability (He et al., 2019). Moreover, that firms' involvement incorporates social and environmental responsibility activities can lead to costs stickiness, implying that it is difficult to scale down environmental costs instantly even when the environmental activities decline (Habib and Hasen, 2016). In other words, it will take a relatively long time for companies to benefit from the reductions of environmental costs (Jo et al., 2015). On the other hand, researchers have found that companies that invest in greenness cannot create firm value. Specifically, companies are exposed to environmental violation risk when they engage in environmental behaviors, which lead to lower valuations and thereby decrease the purchase intention of investors (Dobler et al., 2015; Fernando et al., 2017).

Besides, the motivator of CER disclosure may not be improving environmental quality. We cannot deny that a chronic wave of firm scandals has weakened society's trust in CER over recent years (Antonetti et al., 2019). Consequently, corporate hypocrisy has received great attention in recent academic research. Some researchers even maintain that hypocrisy may be one of the elements of modern business. According to socio-political theories, corporate environmental disclosure is a function of a firm's exposure to social and political pressure (Gray et al., 1995; Parker, 2005; Clarkson et al., 2008). Studies show that reallocating corporate

resources in socially conscious ways, such as taking environmental protection measures, can help enterprises establish an extraordinarily disciplined image and promote interactions between companies and investors, thus improving the corporate image and the trust of investors. Therefore, corporate behaviors, such as charity donations and environmental protection are probably a sign of obedience to social pressure (Jo et al., 2015; Albuquerque et al., 2019; Wang et al., 2020). Furthermore, companies that are close-to-consumer will have a greater focus on reputational benefits. Some of them regard environmental information disclosure as a particular business strategy to obtain the reputation of investors and society, but not intrinsic altruism (Haddock-Fraser and Tourelle, 2010; DellaVigna et al., 2012). Moreover, researchers have demonstrated that the report content and narrative tone of CER become the vital dimension for consumers to estimate the authenticity and reliability of CER information disclosure. Moreno (2020) pointed out that self-promotional tone and inauthentic information disclosure will significantly increase consumers' skepticism about the companies, thus creating a negative impact on firm value. Besides, in the current financial market, the CER information disclosure of many listed companies is full of deferment and evasion, which are the two potential modes of corporate hypocrisy. Some companies only disclose the positive efforts they have made to environmental protection while turning a blind eye to the negative impacts they have brought about to the environment. Hence, investors tend to exhibit negative responses to the CER information disclosure (Christensen et al., 2020).

More importantly, the Chinese government has paid great efforts to promote investors' environmental awareness and support environmental-friendly behaviors of listed companies in the current capital market. The disclosure of environmentally detrimental conducts and illegal behaviors, such as pollutant emissions and environmental penalties, have led some environmentalist investors to reduce the investment intention (Flammer, 2013; Brunk and Boer, 2018). However, although part of green investors exhibits punishment reactions to the companies that conduct environmental unfriendly behaviors, most investors still attach great importance to corporate financial performance but not their environmental performance and will not pay the bill of expensive corporate environmental costs for the companies with poor financial performance (Holm and Rikhardsson, 2008; Li et al., 2016; Espahbodi et al., 2019). Furthermore, the phenomenon of hypocrisy does not only belong to companies. Consumers' investment behaviors are also not always consistent with their initial purchase intentions. They usually overstate their willingness to support

socially responsible companies (Carrington et al., 2014). Therefore, investors tend to exhibit negative responses to the companies with CER information disclosure.

From the above studies about the CER information disclosure and investor response, we can find that investors may also exhibit negative responses to environmental information disclosure due to high environmental costs, lack of trust in CER, and insufficient environmental awareness. Therefore, we state the following hypothesis:

Hypothesis 2： *CER information disclosure can have negative impacts on investor response.*

3 Research Design

In this section, we firstly discuss the Fama-French five-factor model and the factor definitions in Section 3.1, and then describe the data collection in Section 3.2. Section 3.3 gives a specific introduction to the variables used in the Fama-French five-factor model and finally, Section 3.4 presents the empirical models.

3.1 Factor pricing models

3.1.1 Fama-French five-factor model

In this paper, we apply the Fama-French five-factor model put forward by Fama and French in 2015 to measure average returns of companies' stocks, which is the extension and improvement of the capital asset pricing model (CAPM) (Sharpe, 1964; Lintner, 1965) and Fama-French three-factor model (Fama and French, 1993). Extensive research has manifested the reasonability and predictability of the Fama-French five-factor model from theory and practice (Jareno et al., 2018; Bertomeu et al., 2018). Some researchers also found that the Fama-French five-factor model shows the highest explanatory power of the assets returns and consistently performs better than the three-factor model (Foye, 2018; Cox and Britten, 2019). Furthermore, with the rapid development of the capital market in China, investment activities are consequently strengthened due to the need for risk management and business diversification. The market impact, company size, firm value, investment activities, and profitability are all crucial factors to evaluate the returns on stocks. Consequently, we adopt the Fama-French five-factor model to calculate the expected return on each stock.

In the Fama-French five-factor model, the expected return on the stock is

determined by the following equation:

$$R_{it} - R_{ft} = \alpha_i + \beta_i (R_{mt} - R_{ft}) + s_i SMB_t + h_i HML_t + r_i RMW_t + c_i CMA_t + \varepsilon_{it} \quad (1)$$

where R_{it} is the return for stock i at period t, R_{ft} is the risk-free rate for market portfolio assets at period t. To avoid the impact of industry characteristics on stock returns of different industries, we apply the weighted average return of circulation market value of different industries. Thus, R_{mt} is the return on circulation market value-weighted portfolio of different industries at period t. SMB_t (size factor) represents the returns on a diversified portfolio of small stocks minus the returns on a diversified portfolio of big stocks. HML_t (value factor) measures the difference between the value-weighted returns on a diversified portfolio of high book-to-market equity stocks and the value-weighted returns on a diversified portfolio of low book-to-market equity stocks. RMW_t (profitability factor) measures the difference between the expected returns on market portfolios of robust stocks with profitability and those with weak profitability. CMA_t (investment factor) measures returns on diversified market portfolios of the stocks with conservative and aggressive investment activities. While β_i represents systematic risks, α_i is the intercept term, and ε_{it} is the random error term. Should the Fama-French five-factor model perfectly fits all the variation of stock returns, the intercept term α_i will be zero for all stocks and portfolios.

However, the asset pricing model can hardly perfectly fit the variation of returns in each stock. The intercept term can hardly be zero in most cases. Hence, the abnormal return (AR) on each stock can be defined by the following formula:

$$AR_{it} = (R_{it} - R_{ft}) - (\alpha_i + \beta_i (R_{mt} - R_{ft}) + s_i SMB_t + h_i HML_t + r_i RMW_t + c_i CMA_t) \quad (2)$$

where AR_{it} is the abnormal return of stock i at period t, $R_{it}, R_{ft}, R_{mt}, SMB_t, HML_t$, RMW_t, CMA_t, α_i and β_i are defined as before.

3.1.2 Factors definitions

In this paper, we apply the 2*3 sorts approach proposed by Fama and French (2015) to calculate the average returns. The 2*3 sorts approach combines the three factors (the market factor, the size factor, and the value factor) in the Fama-French three-factor model with the profitability factor (RMW_t) and investment factor (CMA_t) proposed in the Fama-French five-factor model. In concrete, the size factor is

divided into small group (S) and big group (B) according to the median market value, while the value factor is classified into three groups of a high group (H), neutral group (N), and low group (L) according to the 30% and 70% of B/M value percentiles. In this way, six portfolios of SH、SN、SL、BH、BN、BL are produced. Similarly, the profitability and investment factor are divided in the same way as the value factor. Consequently, the profitability groups of robust (R), neutral (N), or weak (W), and the investment groups of conservative (C), neutral (N), or aggressive (A) are generated. Thus, another twelve groups of SR、SN、SW、BR、BN、BW、SC、SN、SA、BC、BN、BA are produced. By calculating the value-weighted average return of each group at each period and the difference between different portfolio returns, the four factors in the Fama-French five-factor model are constructed. The specific factors construction method is given in Table 1.

Table 1

Factors construction method.

Groups	Factors	Factors construction method
2*3 sorts approach	*SBM*	$SMB_{BM} = \frac{SH + SN + SL}{3} - \frac{BH + BN + BL}{3}$ $SMB_{OP} = \frac{SR + SN + SW}{3} - \frac{BR + BN + BW}{3}$ $SMB_{Inv} = \frac{SC + SN + SA}{3} - \frac{BC + BN + BA}{3}$ $SMB = \frac{SMB_{BM} + SMB_{OP} + SMB_{Inv}}{3}$
	HML	$HML = \frac{SH + BH}{2} - \frac{SL + BL}{2}$
	RMW	$RMW = \frac{SR + BR}{2} - \frac{SW + BW}{2}$
	CMA	$CMA = \frac{SC + BC}{2} - \frac{SA + BA}{2}$

3.2 Data collection

In this study, we select the companies listed on the Chinese Shenzhen and Shanghai Stock Exchange from 2004 to 2020 as a research sample. As most of the listed companies release their annual reports and CER reports at the same time, we, therefore, select the companies that only disclose the annual reports as our control group to exclude the investors' response towards the annual reports' information. Moreover, to ensure the reliability and accuracy of the calculation of CAR, we

eliminate the companies under special treatment and samples within six months before and after the IPO.

Also, we eliminate the data with too many missing values. All the data are standardized and dimensionless, and we winsorize the continuous variables at the 1% and 99% quantiles. After screening, this paper constructs a dataset including 34658 separate observations. Specifically, there are 3198 environmental disclosure events released by 505 companies and 31460 annual disclosure events released by 2948 companies in our sample.

We collect environmental information data from the website of cninfo[3], which is the listed company information disclosure website designated by *China Securities Regulatory Commission* (CSRC). Besides, all data are collected from authoritative Chinese databases such as the CSMAR[4] database and Chinese Research Data Services Platform (CNRDS)[5] to ensure reliability and authenticity.

3.3 Variables

3.3.1. Dependent variable: CAR

The impact of information disclosure on investor response is directly reflected in the variability in stock price (Flammer, 2013). Many pieces of research have demonstrated that the variation in stock yield can be applied to evaluate the effects of corporate information disclosure on investor response (Mayberry, 2020; Marhfor, 2020). Positive investor response may increase the price premium and trigger a rising trend of the stock price, while negative investor response would reduce the purchase intention and depress the stock price.

Therefore, the dependent variable in our research is the aggregate abnormal return (CAR_{it}) of each stock, which is defined as the aggregation of the difference between the actual and expected returns and can reflect the volatility in stock value during the event window period. Furthermore, in terms of the research method, we apply the event study approach (Konar and Cohen, 1997; Dasgupta et al., 2006) to see the extent to which investors react to the disclosure of CER. The event day is the date that the company discloses its annual report, CER report, and CSR report, while the event window is set as eleven days of trading before and after the event

[3] Data resource: http://www.cninfo.com.cn
[4] Data resource: https://www.gtarsc.com
[5] Data resource: https://www.cnrds.com

day (-5,5), which is a relatively long event window to calculate the expected return. Besides, 90 trading days is used to estimate the coefficients in our pricing model (Miyajima and Yafeh, 2007). Specifically, the CAR is calculated as follows:

$$R_{it} - R_{ft} = \alpha_i + \beta_i (R_{mt} - R_{ft}) + s_i SMB_t + h_i HML_t + r_i RMW_t + c_i CMA_t + \varepsilon_{it}$$

$$t \in [-100, -11], i = 1, 2, \ldots N \quad (3)$$

The regression model (3) provides the estimator $\hat{\alpha}_i, \hat{\beta}_i, \hat{s}_i, \hat{h}_i, \hat{r}_i,$ and $\hat{c}_i$ during the estimation window, which can be used to measure the abnormal return during the event window. Thus, the abnormal return during the event window can be calculated by the difference between the realized return and the expected return:

$$AR_{it} = (R_{it} - R_{ft}) - (\hat{\alpha}_i + \hat{\beta}_i (R_{mt} - R_{ft}) + \hat{s}_i SMB_t + \hat{h}_i HML_t + \hat{r}_i RMW_t + \hat{c}_i CMA_t)$$

$$t \in [t_1, t_2] \quad (4)$$

where t_1 and t_2 represent the beginning and the end of the event window, respectively. In this paper, we define the event window as [-5, 5], that is, five days before and five days after the environmental information disclosure. The cumulative abnormal return (CAR_{it}) represents the cumulative influence of an event over the event window period by summing up the abnormal returns from the time t_1 to t_2:

$$CAR_{it} = CAR_{i(t_1, t_2)} = \sum_{t_1}^{t_2} AR_{it}, where\ t \in [t_1, t_2] \quad (5)$$

3.3.2. Independent variables: CER

This study uses dummy variables (CER_{it}) to represent the disclosure of environmental information. If the company discloses the environmental information and social responsibility reports at year *t*, the independent variable (CER_{it}) is set to 1. If the company only discloses the annual report but does not disclose the environmental information and social responsibility reports at year *t*, then the independent variable (CER_{it}) is set to 0.

3.3.3. Control variables

Except for the environmental information variable, several other variables may influence variation in the firm value of the listed companies. Referring to the studies of Kahn and Siddiqui (2013) and Mayberry (2020) on CER and stock price, this study selects some variables as control variables in the empirical model. The control variables include total assets (***Asset***), leverage (***Lev***), return on equity (***ROE***),

operating profit ratio (***OPR***), the ratio of institutional shareholding (***Ihld***), earnings per share (***EPS***), the shareholding ratio of top 10 shareholders (***Shrholder10***), the shareholding ratio of directors, supervisors, management (***Dsmhld***), the numbers of directors (***Drcnum***), the proportion of independent directors (***Indrcrat***), and the corporate ownership ***(SOE)***. The control variables can reflect the overall financial condition, ownership concentration, and management situation of a company. Specifically, the control variables are defined as follows:

(1) Total assets (***Asset***) is expressed as the logarithm of the total assets of the company.

(2) Leverage (***Lev***) is expressed as the ratio of total liabilities to total assets.

(3) Return on assets (***ROE***) is expressed as the ratio of net profit to equity.

(4) The operating profit ratio (***OPR***) is expressed as the ratio of operating profit to operating revenue.

(5) The ratio of institutional shareholding (***Ihld***) is expressed as the ratio of shares held by institutional investors to circulation shares.

(6) Earnings per share (***EPS***) is expressed as the sum of profit available to ordinary shareholders.

(7) The shareholding ratio of the top 10 shareholders (***Shrholder10***) reflects the ownership concentration of the company.

(8) The shareholding ratio of directors, supervisors, management (***Dsmhld***) describes the ratio of shareholding ratio of directors, supervisors, management of the company.

(9) The numbers of directors (***Drcnum***) describe the scale of the directors of the company.

(10) The proportion of independent directors (***Indrcrat***) describes the proportion

of independent directors of the company.

(11) Corporate ownership ***(SOE)*** describes corporate ownership. ***SOE*** is set to 1 if the company is a state-owned company, while it is set to zero if not.

Table 2 shows the details of these variables.

Table 2

Description of all variables.

Types	**Variables**	**Symbols**	**Definitions**

Dependent variable	Cumulative abnormal return	***CAR***	It is defined as the difference between the actual and expected returns and can reflect the volatility in stock value.
Independent variables	The disclosure of environmental information.	***CER***	It is set to one if the company has disclosed environmental information, while it is set to zero if not.
Control variables	Total assets	***Asset***	The logarithm of the total assets of the company.
	Leverage	***Lev***	The ratio of total liabilities to total assets.
	Return on equity	***ROE***	The ratio of net profit to equity.
	Operating profit ratio	***OPR***	The ratio of operating profit to operating revenue.
	Institutional shareholding	***Ihld***	The ratio of shares held by institutional investors to circulation shares.
	Earnings per share	***EPS***	The sum of profit available to ordinary shareholders.
	Shareholding ratio	***Shrholder10***	The shareholding ratio of the top 10 shareholders of the company
	Management shareholding	***Dsmhld***	The ratio of shareholding ratio of directors, supervisors, management of the company.
	Directors	***Drcnum***	The numbers of directors of the company.
	Independent directors	***Indrcrat***	The proportion of independent directors of the company.
	Corporate Ownership	***SOE***	It is set to one if the company is a state-owned company, while it is set to zero if not.

3.4 Empirical models

According to the literature review in Section 2, CER information disclosure may have positive effects on investors by reducing the risk level, facilitating innovation activities, and improving corporate reputation. Also, it can bring negative investor response because of high environmental costs, lack of trust in CER, and insufficient environmental awareness of investors. To examine our hypotheses, we construct the following regression model (6):

$$CAR_{it} = \beta_0 + \beta_1 CER_{it} + \lambda X_{it} + \theta_i + \gamma_t + \omega om_t + dow_t + \varepsilon_{it} \quad (6)$$

where CER_{it} represents corporate CER information disclosure. CER_{it} is set to 1 if

the company *i* disclosure environmental information at time *t*, while it is set to 0 if the company *i* only disclose the annual reports. X_{it} is the control variables which include the total assets (***Asset***), leverage (***Lev***), return on equity (***ROE***), operating profit ratio (***OPR,*** unit: %), the ratio of institutional shareholding (***Ihld,*** unit: %), earnings per share (***EPS***), shareholding ratio of top 10 shareholders (***Shrholder10***), the ratio of shareholding ratio of directors, supervisors, management (***Dsmhld,*** unit: %), the numbers of directors (***Drcnum***), the proportion of independent directors (***Indrcrat,*** unit: %), and the corporate ownership (***SOE***). β_1 is the key parameter that reflects the change of stock price before and after the environmrntal information disclosure. β_0 is the intercept term. θ_i is the firm fixed effect, γ_t is the year fixed effect. Moreover, the previous discussions have demonstrated that disclosure timing impacts informational differences across investors so that the publishing time of the annual report and environmental information will also have a significant influence on investors (Choudhary et al., 2015; Edmonds et al., 2017). Thus, we control the fixed effects for weeks-of-the-month (wom_t) and days-of-the-week (dow_t) to avoid the extra influence induced by publishing time. ε_{it} is the random error. Besides, standard errors were clustered at the industry level.

4 Empirical Results

4.1. Descriptive statistics and sample comparisons

Table 3 provides descriptive statistics of the research sample. Table 4 and Table 5 provide the CAR significance of different groups and the sample comparisons, respectively. From Table 3, we can see that CAR of all listed companies is 0.070, indicating that companies that disclose the annual report or environmental report tend to have a positive return. Moreover, the results of Table 4 have demonstrated that companies that disclose CER information and the ones that only disclose annual reports all have significant positive CAR, however, the former has a lower return compared to the latter. We further compared the CAR of the two different groups in Table 5 and find that the CAR of the companies that disclose CER information is lower than the ones that only disclose annual reports at the 1% significant level.

Table 3

Descriptive statistics of all variables.

Variable	Obs	Mean	Std. Dev.	Min	Max
CAR	34,658	0.070	0.103	-0.201	0.458
CER	34,658	0.092	0.289	0	1
Asset	34,658	22.075	1.372	19.623	27.139
Lev	34,658	0.444	0.212	0.051	0.945
Roe	34,658	6.082	13.800	-79.74	35.72
OPR	34,658	8.292	18.948	-95.89	60.05
Ihld	34,658	34.933	24.621	0.01	88
EPS	34,658	0.361	0.523	-1.3	2.54
Shrholder10	34,658	0.592	0.151	0.233	0.911
Dsmhld	34,658	5.083	12.015	0	57.474
Drcnum	34,658	9.657	2.757	4	19
Indrcrat	34,658	38.382	9.564	0	66.667
SOE	34,658	0.436	0.496	0	1

Table 4

The significance of CAR in different groups.

Variable	Treatment	Contorl
CAR	0.065***	0.070***
	(38.85)	(120.68)
Observations	3198	31460

Note: ***, ** and * are respectively significant at the 1%, 5%, and 10% level, and in () are t-statistics.

Table 5

Sample comparisons.

Variable	*Treatment*		*Control*		MeanDiff
	Obs	Mean	Obs	Mean	
CAR	3198	0.065	31460	0.070	-0.006***
Asset	3198	22.868	31460	21.994	0.874***
Lev	3198	0.455	31460	0.443	0.013***
Roe	3198	8.635	31460	5.823	2.812***
OPR	3198	11.550	31460	7.960	3.590***
Ihld	3198	44.162	31460	33.995	10.167***
EPS	3198	0.515	31460	0.345	0.170***
Shrholder10	3198	0.583	31460	0.592	-0.009***

Dsmhld	3198	4.748	31460	5.117	-0.369*
Drcnum	3198	10.031	31460	9.619	0.412***
Indrcrat	3198	39.050	31460	38.314	-0.737***
SOE	3198	0.448	31460	0.434	0.013

Note: ***, ** and * are respectively significant at the 1%, 5%, and 10% level.

Furthermore, we analyze the change of CAR of the companies that disclose environmental information compared to the ones that only disclose annual reports using the event study method. Specifically, we apply the following model to observe the investor response towards environmental information disclosure during the event window:

$$AR_{it} = \beta_0 + \sum_{t=-5}^{5} \beta_1 CER_{it} + \lambda X_{it} + \theta_i + \gamma_t + \omega om_t + dow_t + \varepsilon_{it} \quad (7)$$

where *t* represents each day during the event window, AR_{it} represents the abnormal return of each day during the event window, and other variable definitions are the same as the model (6). The results are shown in Fig. 1. We can find that before the environmental information disclosure, the confidence intervals of all coefficients contain zero and we cannot refuse the hypothesis that the coefficients are significantly different from zero, which indicates that there exist no significant differences in market reaction between the two different groups of companies. However, the coefficients are significantly negative on the third day and fourth day after the environmental information disclosure, which implies that companies that disclose environmental may induce lower market return and relatively negative investor response.

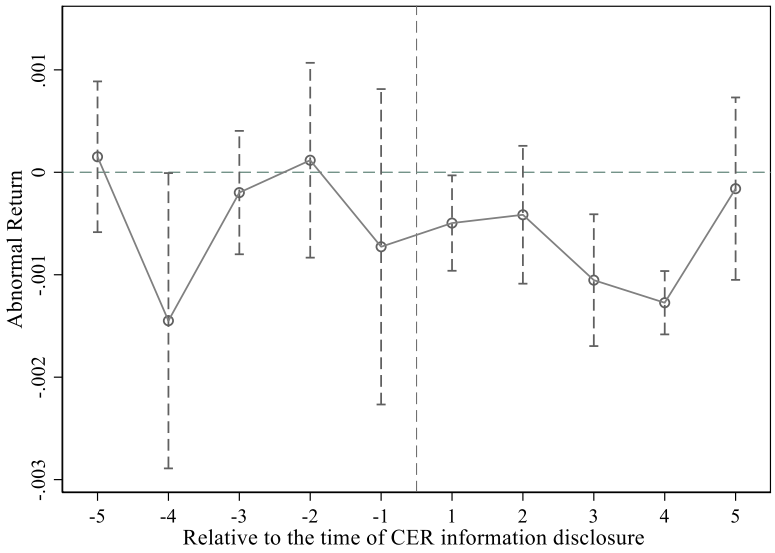

Fig. 1 The change of CAR relative to the time of environmental information disclosure

4.2. The regression results of CER information disclosure

Table 6 shows the regression results of the impact of CER information disclosure on investor response. We control the firm fixed effects and year fixed effects to control the missing variables that cannot be observed. Moreover, we control the weeks-of-the-month fixed effects and days-of-the-week fixed effects to eliminate the influence of releasing time on investors. Control variables in Table 6 refer to all the control variables in Table 2. We can find that the estimated coefficient of column (1) is -0.010 and the estimated coefficient of column (2) is -0.008, which indicates that the disclosure of environmental information will reduce the corporate market return by 1% and 0.8%, respectively. The results are significant at the 1% level. According to the regression results, we can say that environmental information disclosure is found to exert a negative impact on stock return compared to the companies that only disclose annual reports.

These results reveal the investors' behavior when facing CER information disclosure and provide persuasive evidence to ***Hypotheses 2***. Although companies always obtain positive reactions when publishing environmental information, however, we draw a totally different conclusion when we eliminate the impacts of disclosing annual reports, that is, investors can be negatively affected when companies disclose environmental information compared to the ones that only disclose annual reports.

Table 6
The impacts of the CER information disclosure on the investor response.

Variables	**(1)**	**(2)**
	CAR	***CAR***
CER	-0.010***	-0.008***
	(-5.50)	(-3.62)
Constant	0.071***	0.214***
	(405.64)	(4.24)
Control variables	NO	YES
Company FE	YES	YES
Year FE	YES	YES
Weeks-of-the-month FE	YES	YES
Days-of-the-week FE	YES	YES

Observations	34,658	34,658
R^2	0.160	0.162

Note: ***, ** and * are respectively significant at the 1%, 5%, and 10% level, and in () are t-statistics.

4.3 Robustness test

4.3.1 Capital asset pricing model

As is discussed in Section 3.1, various asset pricing models have been developed to explain stock returns. Hence, the regression results may be sensitive to the selection of the pricing model. Consequently, in this subsection, we apply the Capital Asset Pricing Model (CAPM) to construct the robustness test to further improve the robustness of our conclusions.

The CAPM is defined as follow：

$$R_{it} - R_{ft} = \alpha_i + \beta_i (R_{mt} - R_{ft}) + \varepsilon_{it} \quad (8)$$

where R_{it} is the return for stock i at period t, R_{ft} is the risk-free rate for market portfolio assets at period t, R_{mt} is the return on value-weighted portfolio at period t, β_i represents systematic risks, α_i is the intercept term, and ε_{it} is the random error term. Therefore, the abnormal return (AR_{it}) on each stock can be defined by the following formula:

$$AR_{it} = (R_{it} - R_{ft}) - (\alpha_i + \beta_i (R_{mt} - R_{ft})) \quad (9)$$

Thus, we can get the result of the abnormal returns of each stock. The regression results of CER information disclosure on the stock return calculated by CAPM are provided in Table 7. Column (1) and column (2) in Table 7 give the regression results on the impact of environmental information disclosure on the investor response.

The estimated coefficient of column (1) is -0.009 and the estimated coefficient of column (2) is -0.007, respectively. The results are significant at the 1% level. We can find that the results are consistent with the results in Table 6 whether to consider the control variables or not. Environmental information disclosure is proved to have negative effects on investors. Thus, we can find that there do not exist significant differences compared to the results in Table 6. These results indicate that the setting of pricing models has little influence on the abnormal return of the stocks, which further suggests the robustness of the calculation of the abnormal return on stocks.

Table 7

The impacts of the CER information disclosure on the investor response calculated by CAPM.

Variables	(1) *CAR*	(2) *CAR*
CER	-0.009***	-0.007**
	(-3.40)	(-2.36)
Constant	0.067***	0.194***
	(280.36)	(4.72)
Control variable	NO	YES
Company FE	YES	YES
Year FE	YES	YES
Weeks-of-the-month FE	YES	YES
Days-of-the-week FE	YES	YES
Observations	34,658	34,658
$\mathbf{R^2}$	0.178	0.180

Note: ***, ** and * are respectively significant at the 1%, 5%, and 10% level, and in () are t-statistics.

4.3.2 Alternative event window

In this paper, we apply the event study method to calculate CAR. As we have discussed before, the event window is set as eleven days (-5,5) of trading before and after the event day. Thus, the selection of event window may also influence the results of CAR, thereby affecting the regression results (Jong et al., 2014; Choudhary et al., 2015). We therefore select seven days of trading before and after the event day (-3,3) as an alternative event window in this subsection to calculate the CAR of listed companies. The regression results of the CER information disclosure on the stock return using the new event window are shown in Table 8.

The estimated coefficient of column (1) is -0.004 and the estimated coefficient of column (2) is -0.003 and the results are significant at the significant levels of 1% and 10%, respectively. The CER information disclosure still exhibits negative effects on investors, although there is a decrease in the significance level of the coefficient in column (2). Thus, we can find that there do not exist significant differences compared to the results in Table 6. These results indicate that the selection of event window also has little influence on the market return, which further suggests the robustness of the calculation of the abnormal return on stocks.

Table 8

The impacts of the CER information disclosure on the investor response under different event windows.

Variables	(1) *CAR*	(2) *CAR*
CER	-0.004***	-0.003*
	(-3.62)	(-1.93)
Constant	0.044***	0.132***
	(430.05)	(3.26)
Control variable	NO	YES
Company FE	YES	YES
Year FE	YES	YES
Weeks-of-the-month FE	YES	YES
Days-of-the-week FE	YES	YES
Observations	34,658	34,658
$\mathbf{R^2}$	0.141	0.142

Note: ***, ** and * are respectively significant at the 1%, 5%, and 10% level, and in () are t-statistics

4.3.3 Propensity score matching

From Table 4 we can see that there exist significant differences in terms of the characteristics between the companies that disclose environmental information and the ones that only disclose annual reports. The selection bias of our sample may lead to the inaccuracy of the regression results. Consequently, we apply propensity score matching (PSM) to solve this problem, which places the samples into a nonrandom assignment and thus controls self-selection biases and causal interferences (Wellalage and Fernandez, 2019; Cole et al., 2021). Specifically, we apply the logit model and the nearest neighbors matching method. We match the sample by year and industry.

The covariates we used of PSM are shown in Table 9. Specifically, the covariates include total assets (***Asset***), capital expenditure (***Capexp,*** unit: CNY), leverage (***Lev***), return on assets (***ROA***), cash flow (***CF,*** unit: CNY), the ratio of institutional shareholding (***Ihld,*** unit:%), the shareholding ratio of the top 10 shareholders (***Shrholder10***), the numbers of directors (***Drcnum***), the proportion of independent directors (***Indrcrat,*** unit: %), listed age of companies (***Lst_age***), and the

corporate ownership ***(SOE)***.

The results of the balancing assumption test of PSM are shown in Table A1. Besides, Fig. A1 and Fig. A2 show the standardized bias across covariates and the kernel density before and after matching, respectively. The balancing assumption test results and the change of standardized bias and kernel density before and after matching all demonstrated that the bias of the treatment group and control group have been reduced greatly after matching.

Table 9

Description of PSM covariates.

Variable	**Symbols**	**Definitions**
Total assets	***Asset***	The logarithm of total assets of the company.
Capital expenditure	***Capexp***	The amount of capital expenditure of the company.
Leverage	***Lev***	The ratio of total liabilities to total assets.
Return on asset	***ROA***	The ratio of net profit to the asset.
Cash flow	***CF***	The size of the cash flow of the company.
Institutional shareholding	***Ihld***	The ratio of shares held by institutional investors to circulation shares.
Shareholding	***Shrholder10***	The Shareholding ratio of the top 10 shareholders of the company
Directors	***Drcnum***	The numbers of directors of the company.
Independent directors	***Indrcrat***	The proportion of independent directors of the company.
Listed Age	***Lst_age***	The time since the company went public.
Ownership property	***SOE***	SOE is set to 1 if the company is state-owned, or it is set to 0.

The regression results after matching are shown in Table 10. The estimated coefficient of column (1) is -0.009 and the estimated coefficient of column (2) is -0.006 The results are both significant at the 1% significant level. We can find that there do not exist significant differences compared to the results in Table 6. The CER information disclosure still exhibits negative effects on investors after matching the suitable control group. These results indicate that the negative response of investors towards the environmental information disclosure is still robust after we eliminate the selection bias of our sample, which further suggests the robustness of our regression results.

Table 10

The impacts of the CER information disclosure on the investor response after PSM.

Variables	(1) *CAR*	(2) *CAR*
CER	-0.009***	-0.006***
	(-6.52)	(-3.70)
Constant	0.073***	0.214***
	(237.70)	(5.20)
Control variable	NO	YES
Company FE	YES	YES
Year FE	YES	YES
Weeks-of-the-month FE	YES	YES
Days-of-the-week FE	YES	YES
Observations	11,782	11,782
$\mathbf{R^2}$	0.247	0.249

Note: ***, ** and * are respectively significant at the 1%, 5%, and 10% level, and in () are t-statistics.

4.3.4 Placebo test

Although we have controlled the systematic differences by controlling corporate characteristic variables such as total asset, leverage, and ROE, there may still exit unobservable factors that will interfere with the regression results (Wei and He, 2021). Therefore, we apply the placebo test to construct a series of counterfactual tests that makes contrary assumptions about the impact of a policy or event to examine the robustness of the regression results. If the impact of environmental information disclosure on investor response is still negatively significant under the counterfactual conditions, it means that the negative impacts come from the unobservable factors, but not from the disclosure of environmental information.

Specifically, we use bootstrap to randomly select the disclosure date of environmental information for each company, and repeat the experiments 10000 times according to model (6). The regression results are reported in Fig.2. The dashed line in Fig.2 represents the real regression coefficient of the model (6). We can find that the estimator of the coefficient is nearly normally distributed and mostly around 0. Moreover, the probability of counterfactual treatment effect is

0.005, which means that the hypothetical event may have a relatively small probability that the regression coefficient of environmental information disclosure will be significant. Hence, the counterfactual treatment effect of environmental information disclosure does not exist.

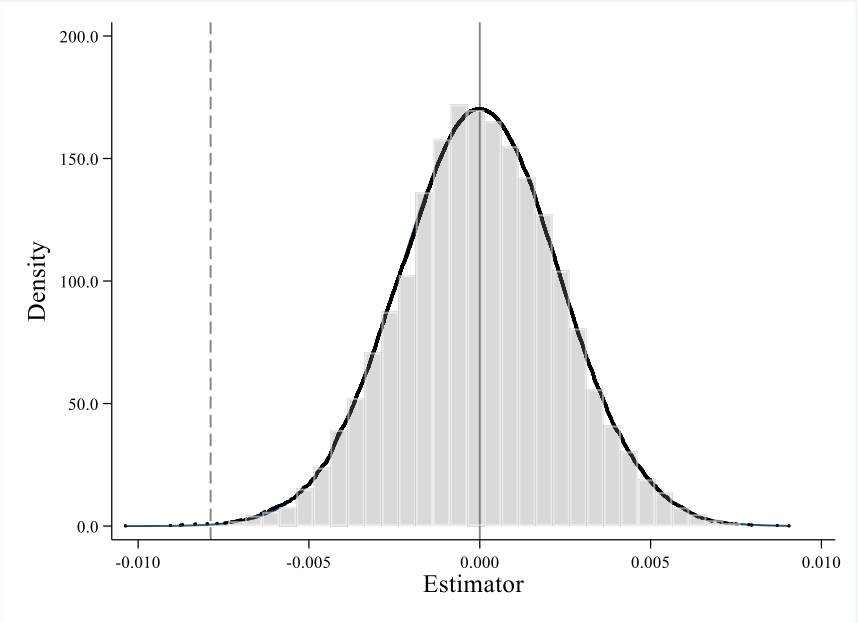

Fig. 2 Bootstrap results of placebo test

5 Heterogeneity Test

5.1 Institutional shareholding

Previous studies have demonstrated that there exist great differences between institutional investors and individual investors in terms of access to information, investment decisions, and institutional constraints (Bailey et al., 2009; Chuang and Susmel, 2011; Li et al., 2018). Thus, we analyze the market reaction of corporate environmental information disclosure according to the difference of shareholding ratio of institutional investors. The results are shown in Table 11.

Column (1) and column (2) in Table 11 show the results of the impact of CER information disclosure on the investor response with a high institutional shareholding ratio, while column (3) and column (4) show the results with low institutional shareholding ratio. The estimated coefficient of column (1) is -0.015 and the estimated coefficient of column (2) is -0.012. The results are both significant at the 1% significant level. However, the estimated coefficients of the group with a low institutional shareholding ratio are not significant at each significant level. More

importantly, the results of the Chow test showed that there exist significant differences between the two groups in regression coefficient significance.

These results indicate that the higher the shareholding ratio of institutional investors is, the more likely companies are to be negatively affected by environmental information disclosure. Researchers have demonstrated that companies with green behaviors cannot create shareholder value. Institutional investors do not regard environmental engagement as strictly value-enhancing activities (Harjoto et al., 2015), so institutional investors tend to shun the stocks with environmental risk exposure, thus reducing the holding shares of their stocks (Fernando et al., 2017). Moreover, some short-term institutional investors will pay more attention to short-term earnings, thus lacking incentives to support corporate environmental behaviors (Garc á-Meca1 and Pucheta-Mart ínez, 2018). Therefore, institutional investors exhibit a significant negative response to CER information disclosure. In contrast, individual investors are less sophisticated and less informed than institutional investors (Grinstein and Michaely, 2005), thus showing an insignificant response to the environmental information disclosure.

Table 11

The impacts of CER information disclosure on investor response of companies with different institutional shareholdings.

Variables	***High***		***Low***	
	(1)	**(2)**	**(3)**	**(4)**
	CAR	***CAR***	***CAR***	***CAR***
CER	-0.015***	-0.012***	-0.002	0.001
	(-6.40)	(-5.03)	(-0.55)	(0.10)
Constant	0.073***	0.210***	0.068***	0.218***
	(280.00)	(4.67)	(298.09)	(3.11)
Control variable	NO	YES	NO	YES
Company FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Weeks-of-the-month FE	YES	YES	YES	YES
Days-of-the-week FE	YES	YES	YES	YES
Observations	19,551	19,551	15,105	15,105
$\mathbf{R^2}$	0.147	0.148	0.178	0.181

Note: ***, ** and * are respectively significant at the 1%, 5%, and 10% level, and in () are t-statistics.

5.2 Industrial differences

According to the *Environmental Information Disclosure Guidelines for Listed Companies*, sixteen industries, including steel, cement, coal, and chemicals, are heavily polluting industries. Therefore, this paper divides our sample into heavy polluting industries and non-heavy polluting industries and analyzes the impact of environmental information disclosure on different industries. The results are shown in Table 12.

Column (1) and column (2) in Table 12 show the results of the impact of CER information disclosure on investor response of heavily polluting industries, while column (3) and column (4) show the results of non-heavy polluting industries. The estimated coefficient of column (1) is -0.018 and the estimated coefficient of column (2) is -0.016. The results are both significant at the 1% significant level. However, the estimated coefficients of non-heavy polluting industries are insignificant at each significant level after the control variables are included in the regression model.

The results have demonstrated that the negative relationship between environmental information disclosure and investor response is more significant in heavily polluting industries. Heavy polluting companies are more likely to engage in environmental protection and pollutant emissions, such as clean energy, sewage treatment, and energy-saving projects. Consequently, they generally have higher environmental risk exposure and environmental costs to control their pollutant discharge. Moreover, companies may get negative reactions and be shunned by investors whose sole objective is profit maximization once the environmental investments that enhance the environmental responsibility exceed legal requirements and risk management rationales (Fernando et al., 2017). Hence, the heavy polluting companies are more easily to be negatively affected by environmental information disclosure.

Table 12

The impacts of CER information disclosure on investor response of companies in different industries.

Variables	***Heavy polluting industries***		***Non-heavy polluting industries***	
	(1)	**(2)**	**(3)**	**(4)**
	CAR	***CAR***	***CAR***	***CAR***
CER	-0.018***	-0.016**	-0.007*	-0.004
	(-10.14)	(-5.47)	(-1.98)	(-0.96)

Constant	0.072***	0.193	0.070***	0.217***
	(384.24)	(2.67)	(237.00)	(4.02)
Control variable	NO	YES	NO	YES
Company FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Weeks-of-the-month FE	YES	YES	YES	YES
Days-of-the-week FE	YES	YES	YES	YES
Observations	10,242	10,242	24,414	24,414
R^2	0.150	0.152	0.168	0.170

Note: ***, ** and * are respectively significant at the 1%, 5%, and 10% level, and in () are t-statistics.

5.3 Policy impact

The Ambient Air Quality Standard was revised in 2012 by China Ministry of Environmental Protection, and the air quality index for monitoring fine particulate matter (PM2.5) was added. After that, the whole society began to attach great importance to air quality and corporate pollution behaviors (Xing et al., 2019). Thus, we divide our sample into two groups according to the time when the policy of AAQS has been implemented. The regression results are shown in Table 13.

Column (1) and column (2) in Table 13 show the results of the impact of CER information disclosure on the investor response before and after the AAQS has been implemented. The estimated coefficient of column (1) is -0.007, but not significant. However, the estimated coefficient of column (2) is -0.007 and it is significant at the 5% significant level. These results have implied that the negative relationship between environmental information disclosure and investor response is significant after the AAQS policy has been implemented. The companies have to bear higher environmental expenditure and face a higher risk of environmental violation under more strict environmental regulation, thereby reducing their competitiveness in the capital market.

Table 13

The impacts of CER information disclosure on the stock price before and after the AAQS policy.

Variables	**(1)**	**(2)**
	Year before 2012	***Year after 2012***
CER	-0.007	-0.007**

	(-1.35)	(-2.21)
Constant	0.368***	0.328***
	(4.72)	(5.17)
Control variable	YES	YES
Company FE	YES	YES
Year FE	YES	YES
Weeks-of-the-month FE	YES	YES
Days-of-the-week FE	YES	YES
Observations	12,415	22,011
R^2	0.187	0.210

Note: ***, ** and * are respectively significant at the 1%, 5%, and 10% level, and in () are t-statistics.

6 Influential Mechanisms

6.1 Environmental cost

We have discussed in Section 2 that high environmental costs can have negative impacts on investor response. Consequently, to further confirm the influence of environmental cost of the listed company and investor response, we construct the following model:

$$CAR_{it} = \beta_0 + \beta_1 CER_{it} + \beta_2 cost_{it} + \beta_3 CER_{it} * cost_{it} + \lambda X_{it} + \theta_i + \gamma_t + \omega om_t + dow_t + \varepsilon_{it} \quad (10)$$

where $cost_{it}$ represents the environmental cost of the listed companies and other variable definitions are the same as the model (6). β_3 is the key coefficient to analyze the impacts of environmental cost in affecting environmental information disclosure and investor response. In our research, we use environmental expenditure and pollution fees to measure environmental costs. Specifically, environmental expenditure refers to the environmental protection investment, greening cost, and environmental taxes. While pollution fees refer to the cost of discharging pollutants. The data are collected from corporate annual reports, CER reports, and CSR reports.

The results of the impact of environmental cost on investor response to environmental information disclosure are shown in Table 14. The estimated coefficient of the interaction term in column (1) and column (2) is -0.015 and -0.013, which are significant at the 1% significant level and the 5% significant level,

respectively. These results have implied that companies with higher environmental costs will indeed have lower market returns and negative investor responses when disclosing environmental information. Companies have to bear the raised capital cost and labor costs when engaging in environmental activities. More importantly, the scale of environmental costs is difficult to cut down in short-term and it usually takes a long time for companies to benefit from environmental expenditure (Jo et al., 2015; Habib and Hasen, 2016; Gjergji et al., 2021), thus reducing the purchase intention of investors.

Table 14

The impacts of environmental cost in affecting environmental information disclosure and investor response.

Variables	***(1)***	***(2)***
	environmental expenditure	***pollution fees***
CER	-0.008***	-0.008***
	(-3.63)	(-3.42)
cost	-0.002**	-0.019***
	(-2.35)	(-2.92)
CER* cost	-0.015***	-0.013**
	(-4.39)	(-2.47)
Constant	0.214***	0.212***
	(4.26)	(4.25)
Control variable	YES	YES
Company FE	YES	YES
Year FE	YES	YES
Weeks-of-the-month FE	YES	YES
Days-of-the-week FE	YES	YES
Observations	34,658	34,658
R^2	0.162	0.162

Note: ***, ** and * are respectively significant at the 1%, 5%, and 10% level, and in () are t-statistics.

6.2 Environmental regulation

Companies that disclose environmental information have to bear tremendous pressure under strict environmental regulation, not only do they have to accept the environmental penalties but also face the damage of corporate image once the

environmental performance does not meet public expectations (Chen et al., 2019). This section, therefore, analyzes the impact of environmental regulation on investor response towards corporate environmental information disclosure.

We construct the environmental regulation intensity index to analyze the impacts of CER information disclosure on investor response (Wu et al., 2020). Specifically, we construct the environmental regulation intensity index (ER_{it}) by using the industrial sulfur dioxide removal rate and industrial dust removal rate at the city level. Firstly, we standardize the industrial sulfur dioxide removal rate and industrial dust removal rate:

$$pollutant_{ij} = \frac{pollutant_{ij} - min(pollutant_{ij})}{max(pollutant_{ij}) - min(pollutant_{ij})} \quad (11)$$

where $pollutant_{ij}$ represents the removal rate of pollution j of city i, $min(pollutant_{ij})$ and $max(pollutant_{ij})$ represent the minimum and maximum of pollution j of city i. Then we can get the pollution weight of each city:

$$w_{ij} = \frac{pollutant_{ij}}{\sum_i pollutant_{ij}} / \frac{gdp_i}{\sum_i gdp_i} \quad (12)$$

where $pollutant_{ij} / \sum_i pollutant_{ij}$ represents the proportion of pollutant j of the city i to the pollutant j in the whole country, while $gdp_i / \sum_i gdp_i$ represents the GDP of the city i to the national GDP, and the weight value w_{ij} is the ratio of the two proportions. Finally, we get the environmental regulation intensity index (ER_{it}) of city i:

$$ER_{it} = \sum_{j=1}^{2} w_{ij} pollutant / 2 \quad (13)$$

To analyze the influence of environmental regulation on investor response, we construct the following model:

$$CAR_{it} = \beta_0 + \beta_1 CER_{it} + \beta_2 ER_{it} + \beta_3 CER_{it} * ER_{it} + \lambda X_{it} + \theta_i + \gamma_t + \omega om_t + dow_t + \varepsilon_{it}$$

(14)

where ER_{it} represents the intensity of environmental regulation and other variables' definitions are the same as the model (6). β_3 is the key parameter we focus on. The regression results are shown in Table 17. We lose some observations because the data of ER_{it} are missed in several years.

Table 15 shows the results of the impact of environmental regulation on investor response towards corporate environmental information disclosure. The

estimated coefficient of the interaction term in column (1) and column (2) is -0.083 and -0.078, respectively, which are both significant at the 1% significant level. These results have implied that strict environmental regulation can aggravate investors' negative response to environmental information. The announcement and implementation of environmental regulation can bring closer investor attention to environmental information disclosure (Guo et al., 2019). Moreover, strict environmental regulation requires companies to disclose their environmental information in reality and detail, thus bringing additional expenditure to listed companies and violating the objective purpose of firms to maximize profits. Therefore, environmental policies may significantly hurt investors' investment returns of listed companies reduce their investment intention (Palmer et al., 1995; Ramiah et al., 2013; Jiang et al., 2020).

Table 15

The impacts of environmental regulation on CER information disclosure and investor response.

Variables	**(1)**	**(2)**
	CAR	***CAR***
CER	-0.012**	-0.009**
	(-2.73)	(-2.15)
ER	-0.006	-0.009
	(-0.37)	(-0.46)
CER*ER	-0.083***	-0.078***
	(-3.24)	(-3.15)
Constant	0.092***	0.289***
	(280.37)	(4.31)
Control variable	NO	YES
Company FE	YES	YES
Year FE	YES	YES
Weeks-of-the-month FE	YES	YES
Days-of-the-week FE	YES	YES
Observations	16,546	16,546
R^2	0.170	0.172

Note: ***, ** and * are respectively significant at the 1%, 5%, and 10% level, and in () are t-statistics.

6.3 Political connection

Political connection is proved to have a significant impact on corporate environmental information disclosure and environmental performance. Companies can benefit from the political connection by reducing information asymmetry and discrimination in accessing political resources, such as political subsidies, tax breaks, and financing constraints (Yao and Xu, 2014; Chen et al., 2014; Dai and Cheng, 2015;). Moreover, companies with stronger political connections have more incentive to disclose environmental information and better environmental performance (Lin et al., 2015; Zhang, 2017). To further analyze the influence of political connection of the listed company on investor response, we construct the following model:

$$CAR_{it} = \beta_0 + \beta_1 CER_{it} + \beta_2 political_{it} + \beta_3 CER_{it} * political_{it} + \lambda X_{it} + \theta_i + \gamma_t + \omega om_t + dow_t + \varepsilon_{it} \quad (15)$$

where $political_{it}$ represents the political connection of the listed companies and other variable definitions are the same as the model (6). We use the ratio of corporate government subsidies to operating revenue to measure the political connection. Specifically, the $political_{it}$ is defined as follows:

$$political_{it} = \frac{Subsidy_{it}}{Operation\_Revenue_{it}} \quad (16)$$

Table 16 shows the results of the impact of political connection on investor response to corporate environmental information disclosure. The estimated coefficients of the interaction term in column (1) and column (2) are 0.073 and 0.068, respectively, which are both significant at the 1% significant level. These results have implied that political connection can alleviate the negative response of investors to environmental information. For one thing, the strong political connection can alleviate the financing constraints and reduce the environmental violation risk of some listed companies, enabling investors to have more confidence in the operating activities and future development (Li et al., 2019; Farag and Dickinson, 2020). For another, politically connected companies are more likely to obtain green subsidies than non-connected firms (Lin et al., 2015). Furthermore, political connections enable companies to have more tax reduction and corporate tax avoidance activities (Zhang, 2017; Yu et al., 2021b). All these factors can cut down corporate environmental costs and thus have positive impacts on investors.

Table 16

The impacts of political connection on CER information disclosure and investor response.

Variables	(1) *CAR*	(2) *CAR*
CER	-0.011***	-0.008***
	(-4.40)	(-3.27)
political	0.032*	0.034*
	(1.87)	(1.94)
CER*political	0.073**	0.068**
	(2.40)	(2.24)
Constant	0.070***	0.267***
	(288.51)	(5.73)
Control variable	NO	YES
Company FE	YES	YES
Year FE	YES	YES
Weeks-of-the-month FE	YES	YES
Days-of-the-week FE	YES	YES
Observations	24,137	24,137
R^2	0.194	0.196

Note: ***, ** and * are respectively significant at the 1%, 5%, and 10% level, and in () are t-statistics.

7 Conclusions

In recent years, with the growing public concerns on environmental and social issues, corporate environmental responsibility (CER) has aroused widespread attention from academics. Accordingly, the influences of CER information disclosure on corporate sustainable development have become one of the critical subjects in the relevant field. This study, therefore, explores the impacts of CER information disclosure from the perspective of investors. We collect a relatively comprehensive sample of Chinese listed companies from 2004 to 2020 to analyze the impact of environmental information disclosure on investor response. Moreover, we control the influences of corporate annual reports and the releasing time on investors in our regression model. On these basis, we apply the Fama-French five-factor model, which shows the highest explanatory power of the assets returns to measure the abnormal return on each stock of the listed coal companies.

Based on the above discussion, we have found that companies that disclose environmental information can receive a positive investor response. However, when we consider the impact of the corporate annual reports, we can see that the companies that disclose environmental information obtain a significantly lower market return compared to those that only disclose annual reports, indicating that investors tend to exhibit a negative response to environmental information disclosure. The results are robust after a series of robustness tests. Furthermore, we find that companies with higher institutional shareholding can have a significant negative response to environmental information, as institutional investors do not regard environmental engagement as strictly value-enhancing activities and are inclined to shun the stocks with environmental risk exposure compared to individual investors. Besides, heavy polluting companies are more likely to engage in environmental protection and pollutant emission, which will incur higher environmental risk exposure and environmental costs to control its pollutant discharge. Hence, such companies may get negative reactions from investors whose sole objective is profit maximization. Moreover, the negative effects are found significant after the AAQS policy was implemented in 2012, as the policy results in higher environmental expenditure and face higher environmental violation risk. Furthermore, this paper explores the influential mechanisms and confirms that costly environmental expenditure and strict environmental regulation will result in a negative investor response, while the stronger political connection can alleviate the negative impacts of environmental information disclosure.

Our findings suggest important policy implications. Firstly, the results of this paper have demonstrated that investors tend to exhibit a negative response to corporate environmental information disclosure, thus making companies lack the incentive to disclose environmental information. However, government subsidies can alleviate the negative reaction of investors. Hence, for one thing, the government should increase the supervision of corporate environmental behaviors and formulate mandatory environmental information disclosure policy, especially for heavily polluting industries. For another, the government could support the environmental policy and give financial support to help environmental-friendly companies to cut down the environmental costs and environmental violation risk, thus encouraging the companies to undertake the environmental responsibility voluntarily. Also, the government should supervise the corporate environmental behaviors and strengthen punishment of environmental violations (Li, et al., 2016), so as to jointly achieve the

purpose of regulating corporate environmental behavior through administrative punishment and investor response.

Second, our findings suggest that strong environmental regulation and expensive environmental expenditure will aggravate the negative response of investors to environmental information disclosure. Therefore, companies should focus on promoting environmentally innovative activities and improving production methods. To participate in CER management, new products or new technology is needed to meet with environmental protection targets, thereby promoting corporate technological progress and cost-saving innovations (Horbach, 2012; Kraus et al., 2020). Hence, engaging in technological innovation activities can increase the productivity of the company and cover the cost of environmental protection measures, thus improving the profitability and presenting better financial performance to investors. Besides, companies should also pay attention to improving the structure of investors and alleviate the negative reactions from institutional investors to environmental information.

Finally, the environmental awareness of investors should be improved. The conclusions above have indicated that most investors are inclined to neglect the efforts of the companies to improve the environment. Moreover, they still pay close attention to corporate financial performance and regard the environmental behaviors as nonprofitable behavior, thus presenting a negative response to environmental disclosure, which suggests the lack of environmental awareness of investors. Consequently, the government should continue to formulate policies on environmental administrative penalties and support the companies that engage in environmental management (Bae and Yu, 2018), and make investors realize the long-term benefit of environmental behaviors, thereby improving the corporate image and brand value of the environmental-friendly companies.

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Appendix

Table A1

Balancing assumption test of PSM covariates.

Variable	Matched	Treated	Control	%bias	%reduct bias	t-test	p-value
Asset	Unmatched	22.425	22.004	29.6		20.99	0.000
	Matched	22.392	22.404	-0.9	97.1	-0.46	0.644
Capexp	Unmatched	77.216	82.150	-0.9		-0.52	0.602
	Matched	65.328	61.881	0.6	30.1	1.09	0.276
Lev	Unmatched	0.457	0.448	2.7		1.76	0.079
	Matched	0.440	0.443	-1.0	63.4	-0.83	0.405
ROA	Unmatched	4.477	3.470	5.9		3.55	0.000
	Matched	4.828	5.027	-1.2	80.2	-0.57	0.572
CF	Unmatched	-29.444	5.544	-4.2		-2.54	0.011
	Matched	-12.596	-16.996	0.5	87.4	0.59	0.553
Ihld	Unmatched	37.738	34.069	14.8		10.44	0.000
	Matched	37.967	38.154	-0.8	94.9	-0.39	0.697
Shrholder10	Unmatched	0.586	0.595	-5.5		-3.85	0.000
	Matched	0.586	0.586	0.1	97.5	0.07	0.943
Drcnum	Unmatched	9.741	9.633	3.8		2.70	0.007
	Matched	9.697	9.679	0.6	83.3	0.33	0.740
Indrcrat	Unmatched	38.747	38.350	4.1		2.90	0.004
	Matched	38.735	38.574	1.7	59.6	0.86	0.392
Lst_age	Unmatched	16.292	15.074	16.7		11.22	0.000
	Matched	16.004	16.150	-2.0	88.0	-1.11	0.268
SOE	Unmatched	0.432	0.435	-0.7		-0.49	0.623
	Matched	0.434	0.440	-1.2	-68.5	-0.60	0.549

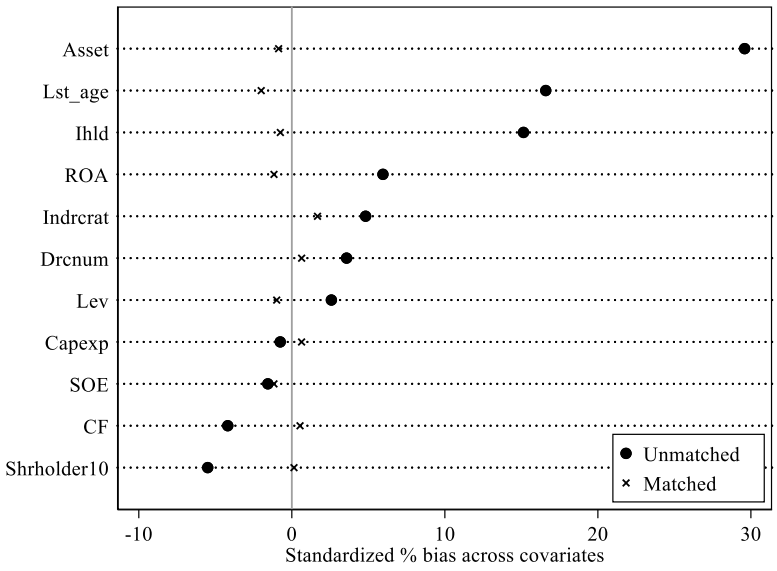

Fig.A1 Standardized bias across covariates before and after matching

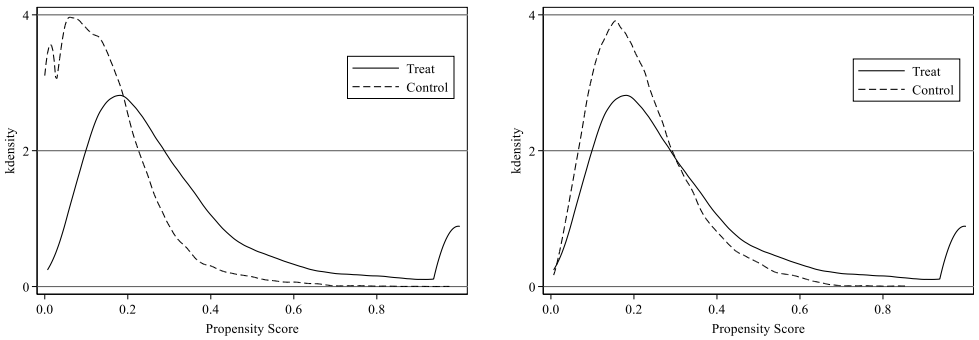

Fig.A2 Kernel density before and after matching

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