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Corporate ESG Performance, Digital Transformation and Climate Risk Disclosure

[Abstract]: This paper uses the data of all Chinese A-share listed companies from 2010 to 2022, and adopts text analysis to construct corporate climate analysis disclosure indicators to verify the relationship between corporate ESG rating and climate risk disclosure. The results show that: (1) Enterprises with higher ESG rating will be more active in climate risk disclosure. (2) ESG rating mainly promotes climate risk disclosure through three channels: strengthening environmental information disclosure, reducing agency costs, and improving commercial credit. In addition, digital transformation plays a moderating role in the facilitation of ESG performance to climate risk disclosure. (3) Heterogeneity test found that the promotion effect of ESG performance on climate risk disclosure was more significant in companies with male ceos and non-overseas backgrounds and those located in low-carbon pilot cities. This paper not only broadens the impact of ESG rating, but also puts forward a new path to promote enterprises' climate risk disclosure, which makes a significant contribution to enterprises' sustainable development strategy.

[Keywords]: ESG; Digital transformation; Climatic risk

1. Introduction

In recent years, many parts of the globe have experienced various forms of extreme weather events. According to a statistical report released by the World Meteorological Organisation, between 1970 and 2021, 11,778 disasters triggered by extreme weather, climate and water-related events were reported across the globe, resulting in more than 2 million deaths and economic losses of up to $4.3 trillion. For example, when Hurricane Ian hit the United States and Cuba in September 2022, it caused the largest climate disaster loss of the year, amounting to US$100 billion; in 2018, the southwestern Indian state of Kerala suffered its worst floods since 1924, displacing more than a million people and killing hundreds more. It can be seen that these climate disasters pose a great threat to the safety of human life and property and hinder the normal functioning of society and economy. Due to the widespread nature of climate disasters, the financial system will also be affected to varying degrees. Although government departments in various countries have introduced various policies to respond to them, numerous

uncertainties have led to slow progress in policy implementation. It is therefore critical that organisations such as business, as a key player in achieving the SDGs, are able to respond to climate change and seize the opportunities for transformation in the process.

To this end, international organisations such as the Global Reporting Initiative (GRI) and the Global Financial Stability Board (FSB) have successively proposed the Environment, Social, Governance (ESG) and Task Force on Climate-related Financial Disclosures (TCFD). Financial Disclosures (TCFD).In 2017, the TCFD released a report intended to propose a framework to help companies disclose climate-related financial information, so that investors can better understand the climate risks and opportunities of companies and make sound investment and credit decisions.The TCFD broadly divides the disclosure framework into four parts, which are Governance, Strategy, Risk Management, Indicators and Targets. Compared to climate risk indicators such as greenhouse gas emissions and rainfall, the framework helps companies identify and manage relevant climate risks from a corporate financial perspective. In addition to climate risk disclosure, companies can also seize development opportunities in terms of mitigating climate risk and adapting to climate change, such as more efficient production methods and transport processes, and research and development innovations adapted to changing customer preferences. The implementation of the Climate Risk Disclosure Framework (CRDF) can improve the information transparency and sustainability of companies, and gain the trust and support of stakeholders.In 2022, the proportion of companies adopting the TCFD's recommended disclosure will be 58 per cent, which is a 40 per cent increase compared to 2020, but there is still room for improvement. However, there are still many problems with the implementation of the TCFD, such as the unavailability of climate data, inconsistent methods of data collection and processing, and "greenwashing", leading to a large number of blind spots in the current climate risk disclosure. The ESG concept was proposed earlier than the TCFD disclosure framework, and the standards are more complete, which is a reference for TCFD. On the one hand, the environmental (E) and social costs (S) of the enterprise reflect the overall technology and management level of the enterprise; on the other hand, the enterprise's control of extreme weather is reflected in the climate risk management and technology, such as site selection, architectural design, and response capacity to extreme weather and natural disasters. S

Therefore, while focusing on ESG (Environment, Society, Governance), companies will also consider climate risk in an integrated manner. In their strategies to increase green innovation and reduce social costs, companies also think about how their climate risk management is reflected in their financial reporting to drive sustainable development. While investment decisions rely on the valuation of companies, climate risk disclosure has changed the consideration of asset value, making the valuation of companies more comprehensive. The past valuation model that only focused on financial performance has become obsolete, and climate risk disclosure of companies has become an important non-financial performance indicator that should be included in the scope of valuation assessment. Based on this, the purpose of this paper is to find out whether corporate ESG ratings can be used as an influencing factor to promote corporate climate risk disclosure.

According to the existing literature, most of the research on climate risk focuses on its economic consequences, mainly in terms of various types of markets at the macro level: including agriculture, electricity, financial markets, etc.; as well as the impacts on corporate financial indicators and investors at the micro level. However, very little literature has examined the impact of corporate ESG ratings on climate risk and disclosure, and from the perspective of measurement indicators: including greenhouse gas emissions (Noh J H.,2018), climate policy uncertainty index (Zhao et al.,2024) and other indicators to measure climate risk from a macro perspective, it is evident that climate risk metrics are still highly controversial. These indicators do not involve enterprise-level information, and cannot enable enterprises to establish an effective link with investors, therefore, this paper measures climate risk at the enterprise level based on the annual reports of A-share enterprises, using the method of calculating the word frequency share in the word set after text analysis and machine learning (Du Jian et al.,2023), which is a better way of reflecting the financial information of the enterprise, and provides a reference to the investment and credit decision-making of the stakeholders.

The marginal contributions of this paper are that (1) most of the existing studies discuss climate risk in terms of its economic consequences, and this paper investigates the relationship between corporate ESG ratings and corporate climate risk disclosure, which enriches the

research on the factors influencing climate risk disclosure. Moreover, under the premise of increasingly serious global climate risks and the urgent need to improve the existing climate risk disclosure framework system, this paper investigates whether there is an impact of ESG ratings on corporate climate risk disclosure, which provides a policy guideline direction for promoting corporate climate risk disclosure. (2) This paper finds that ESG ratings will promote corporate climate risk disclosure through three mechanism paths: reducing agency costs, promoting corporate environmental information disclosure, and improving business credit, which can further explore the challenges of ESG practice in the field of climate risk, and provide theoretical support for corporations to better identify and manage climate risks, and safeguard stakeholders and their own interests. (3) Digital transformation is crucial to the operational efficiency and quality of modern enterprises, and it is found that corporate digital transformation has a positive moderating effect on the relationship between corporate ESG and climate risk disclosure. This paper enriches the theories related to digital transformation, and suggests that it is important for enterprises to do a good job of digital transformation, and it is recommended that it be incorporated into the company's decision-making.

2. Literature review

In order to better understand the relationship between climate risk and corporate ESG, this paper conducts a theoretical derivation based on combing the literature related to corporate ESG and climate risk, and then proposes research hypotheses.

2.1. Studies related to the impact effect of ESG ratings on firms

Regarding the impact effect aspect of ESG, it can be broadly categorised into three perspectives: environmental, social and governance. From the environmental perspective, ESG can improve firms' ability to grow sustainably, especially in terms of the environment (Bagh et al.,2024); ESG can also stimulate firms to innovate by easing financing constraints, lowering labour costs, and increasing institutional shareholdings (Zhang et al.,2024), and it can also be targeted to promote green TFP, green technological efficiency and green technological progress (Niu et al.,2024), facilitating green transformation (Tan et al.,2024) and reducing pollution. From

a societal perspective, ESG affects social equity, which, in terms of pathways, is mainly achieved by influencing firms' skill premiums (Zhang et al.,2024); at the same time, ESG affects the stock market, specifically, ESG ratings significantly improve stock liquidity (He et al.,2023) and stock price synchronisation (Hu et al.,2023) ESG also fosters employee self-esteem and commitment, which in turn enhances employee retention (Kim et al.,2024); and good ESG ratings reduce analysts' optimism bias (Wang et al.,2023). From a governance perspective, firms adhering to the concept of environmental social governance (ESG) can effectively increase their own value (Chen et al.,2024), reduce the pricing bias of their stocks (Khan et al.,2024), and attract more investors and consumers; at the same time, good ESG ratings will also inhibit firms from managing their surpluses and preventing them from self-interested behaviours (Sun et al.,2024) and short-sighted fraudulent behaviours (Su et al.,2024).ESG enhancement also prevents various risks of firms, for example, ESG ratings play an important role in mitigating systemic risk (Bax et al.,2024); also, firms are at risk of financial distress, which can be predicted with a high degree of accuracy by ESG (Song et al.,2024); the higher the ESG rating, the lower the risk of stock pledging and the lower the risk of default (Bai et al.,2024), which shows that firms actively participating in ESG ratings have more ways to disclose corporate information, such as analysts' attention (Wu et al.,2024), and their corporate organisational resilience is significantly improved (Liu et al.,2024). al.,2024), and are better able to identify and manage various risks. In terms of debt governance, ESG enhancement can enable firms to obtain more debt financing (Guo et al.,2024), but also significantly improve the debt structure of firms, reallocating their sources of financing from public debt (bond issuance) to private debt (bank loans) (Panagiotis et al.,2023); in terms of investment management, appropriate ESG ratings can well improve firms' organisational resilience (Liu et al.,2024), and better identify and manage various risks. ratings can well improve the investment efficiency of firms (Seda et al.,2024), especially their low-carbon investments (Lu et al.,2024). According to the literature combing of the economic effect of ESG, the articles studying the environmental effect of ESG are relatively few, and most of them are analysed from the perspective of corporate innovation; the relatively more direction is the social and governance direction, which indicates that the research on the social effect and corporate governance effect of ESG is relatively perfect.ESG, as a concept put forward at the beginning of the twentieth century, can help organisations to do a good job of their social responsibility,

corporate governance It can also improve their awareness of environmental protection, and the disclosure framework has been more perfect, in recent years, the climate risk events have gradually increased, in the promotion of the concept of ESG enterprises will be better climate risk identification and management. Based on this, this paper clarifies the relationship between corporate ESG ratings and climate risk disclosure to help companies better cope with the impact of climate risk and achieve sustainable development.

2.2. Determinants of corporate climate risk disclosure

As the influence of climate risk on the financial system gradually increases, the economic consequences of various factors on climate risk have gradually been incorporated into the considerations of the government and enterprises in formulating strategies, which are mainly researched from the perspectives of external factors and internal factors. Firstly, from the perspective of internal factors, the type of industry of enterprises has a close relationship with climate risk disclosure, and operating in environmentally sensitive areas significantly affects climate risk disclosure (George, 2016). For example, firms that are more carbon-intensive have higher levels of climate risk disclosure (Borghei Zahra et al., 2024), and as a result firms need to undergo a carbon-technology transition, and firms at this stage have higher transition risks and are more likely to expose them (Broccardo et al.,2024). Corporate executives also have an impact on corporate disclosure, with entrepreneurial visibility influencing corporate climate risk disclosure through media attention (Li, 2024); from the perspective of basic corporate information, there is a significant correlation between financial performance, financial reporting and risk management and climate risk disclosure from a financial management perspective (Megeid ,2024). The corporate organisational structure perspective also affects its climate risk disclosure, for example, size and performance, as well as the nationality of origin of employees have a significant facilitating effect on corporate climate risk disclosure (Kouloukoui et al.,2019); the cultural atmosphere within the enterprise also promotes its disclosure disclosure effect, especially the Confucian culture that advocates the harmonious coexistence of human beings and nature (Guo Wenwei et al.,2023). For listed firms with proprietary brands, the items they disclose will be more compared to other firms (Danuta, David, 2022), and for banks, the

independence and diversity of the board of directors has a facilitating effect on climate risk disclosure (Ahseon Lee et al., 2024), and if the banks are in environmentally friendly developed countries, their disclosure quality will be further improved (Jérôme, 2020). Second, from the perspective of external factors, stakeholder field research significantly affects the disclosure capabilities of firms, including climate risk disclosure (Song,Xian,2024). Strict regulatory enforcement and adequately guided systematic reporting frameworks are needed to improve the transparency of climate risk disclosure (Borghei Zahra et al.,2024), and thus efforts have been made by relevant organisations globally, and their influence is growing. The Climate Disclosure Standards Board (CDSB) has shaped corporate climate risk disclosure in terms of accounting (Thistlethwaite, 2015), and on CDP, the world's leading climate risk disclosure platform, companies contracted with it are more proactive in disclosing information about climate risks and can subsequently lead to lower carbon emissions (Shira et al.,2023), while the adoption of the The number of companies adopting TCFD's climate risk disclosure framework is also increasing year by year (Angel, Teresa, 2022). At the same time, the implementation of national policies, such as green credit policy, can also reduce corporate climate risk and promote its disclosure (He, 2024); the above studies fully illustrate that in the environment of gradually increasing global climate risk, modern enterprises have identified and managed climate risk from different perspectives, and the state has formulated policies to assist them, which has a positive effect on corporate climate risk disclosure and the identification of opportunities for development, and also has a positive effect on a country's financial sector. This has had a positive effect on corporate climate risk disclosure and identification of development opportunities, and has had a significant impact on the stability of a country's financial markets. Although many literatures have studied the impact of climate risk disclosure from various perspectives of enterprises, the mechanism of ESG on climate risk, as an important indicator of corporate sustainability in recent years, has not yet been explored. This paper links ESG with corporate climate risk, makes a new theoretical and empirical analysis, and also opens up academic horizons for the influencing factors of climate risk.

3. Theoretical analyses and research hypotheses

Corporate environmental, social and governance (ESG) performance is recognised in today's financial research as an important indicator of long-term corporate sustainability, and the ways in which ESG factors can contribute to corporate disclosure of climate risks has become a focus of attention in both academia and practice. First, firms that implement high levels of ESG standards typically enhance their management and disclosure of environmental and climate-related issues. For example, companies may actively address climate change and environmental impacts by establishing environmental management systems, setting carbon emission targets, and participating in environmental impact assessments, which are disclosed in detail in ESG reports. Firms with higher ESG ratings mostly have a higher reputation among investors (Sun Hui, Zhu Shusen et al., 2023), and investors and stakeholders are more inclined to invest and do business with firms that are highly responsible for ESG issues because they are perceived to have better long-term sustainability. Based on signalling theory, companies with good ESG ratings are mostly among those that actively send positive signals to the market to demonstrate their sustainability capabilities. Under this market expectation, companies tend to demonstrate the results of their ESG efforts through transparent and comprehensive climate risk disclosure to demonstrate their ability to manage and be responsible on climate issues. Further, good ESG performance is also seen as a strategic advantage for companies in addressing future climate-related risks and opportunities. As society and government concerns about climate change increase, corporate disclosure of climate risks is not only a compliance requirement, but also a strategic choice. Through detailed and accurate climate risk disclosure, companies are able to establish their leadership position in the market and attract more investments and partners. With the increase of ESG investment and the popularisation of ESG standards, the future efforts of companies on climate risk disclosure will be more in-depth and systematic, further driving the global economy towards a more sustainable direction. Based on this the first hypothesis of this paper is proposed:

Hypothesis 1: Improved corporate ESG ratings will promote their climate risk

disclosure

Agency theory suggests that in the presence of incomplete contracts and moral hazard, the separation of corporate ownership and operation may lead to principal-agent problems, which can have a direct impact on the management and strategic decisions of the enterprise.One of the core concepts of ESG is to focus on corporate governance, so focusing on ESG ratings can help to improve corporate governance by effectively monitoring and incentivising the behaviour of managers in order to enhance the enterprise's transparency and accountability. The essence of the agency problem is that controlling shareholders may exploit the interests of small and medium-sized shareholders. Major shareholders influence corporate decisions through connected transactions, capital appropriation, loan guarantees, and other means, sometimes leading to reduced resources and lower allocation efficiency. Meanwhile, small and medium-sized shareholders may adopt short-term economic interest-oriented behaviours and neglect long-term interests due to information asymmetry.ESG ratings can alleviate the information disadvantage of small and medium-sized shareholders to a certain extent, inhibit their short-term behaviours, and act as a constraint on the misbehaviours of large shareholders. When agency costs are reduced, the interests between corporate managers and shareholders are more aligned, and managers are more motivated to safeguard the long-term value and reputation of the firm. This motivates firms to be more objective and fair in disclosing climate risk information, avoiding misleading statements or concealing important information. At the same time, lower agency costs also mean that managers are more likely to be effectively monitored and incentivised to handle the climate risk disclosure process more carefully and ensure that the information disclosed is true, accurate and complete. For this reason the second hypothesis of this paper is proposed:

Hypothesis 2: Corporate ESG increases their climate risk disclosure by reducing agency costs

In the context of the global promotion of green and sustainable development, enterprises with better ESG ratings, on the one hand, want to win the attention of more stakeholders, and

will actively disclose environmental information to show their potential for green development (Dawkins, 2011). On the other hand, enterprises will incur costs when disclosing information, but enterprises with good ESG performance will have more stable cash flow (Cheng Xi et al, .2023), which can provide financial support for enterprises, so that enterprises can disclose environmental information with high efficiency and high quality. At the same time, in the case of global climate risks, investors need to better identify and price climate risks, otherwise it will lead to significant losses (Alessi et al,.2021), therefore, the asymmetry of investors' information on climate risks will have a push effect on enterprises to disclose environmental information while also taking climate risk-related information into account. proactively disclose climate risk information, increase the information transparency of enterprises, and ensure the stable appreciation of assets. To sum up, enterprises with higher ESG ratings, on the one hand, will actively disclose environmental information and form a good social image; on the other hand, out of the consideration of reducing the impact of climate risk on the value of assets, enterprises will actively disclose environmental information by including climate-related risks. Based on this this paper proposes a third hypothesis:

Hypothesis 3: Corporate ESG promotes their climate risk disclosure through enhanced environmental disclosure

An important aspect of ESG is its consideration of social impact. Studies have shown that excellent ESG performance on the one hand conveys a positive signal of sustainable business operations in society, attracts the attention of professional analysts, helps to reduce the risk of information asymmetry, reduces the risk of information asymmetry further facilitates access to financing, and improves the efficiency of upstream suppliers in the supply chain in monitoring the enterprise, effectively controlling the risk of commercial credit financing. On the other hand, enterprises with high ESG ratings are able to gain significant exposure in the capital market (Wang Bo and Yang Maojia, 2022), prompting investors to analyse their unique information in-depth and disseminate it widely, which not only enhances the transparency of corporate information, but also contributes to the smooth conduct of financing activities. In summary, according to the signalling theory, good ESG performance helps firms to establish a good social

image, reduce information asymmetry, and improve operational efficiency, which in turn enhances stakeholders' and investors' or suppliers' trust and business credit support for the firm (Luo et al,. 2023). A higher level of business credit can bring more financing opportunities for enterprises, enabling them to better focus on and respond to climate risks, and this focus not only promotes the disclosure of climate risks, but also establishes a positive image of the enterprise through fuller disclosure of information. At the same time, high business credit conditions create an adverse selection mechanism that pushes firms to actively engage in climate risk disclosure in order to maintain their high business credit levels. Such a cycle continuously promotes enterprises to improve the quality of their disclosure and enhance their credibility and competitiveness in the capital market.

Hypothesis 4: Corporate ESG facilitates their climate risk disclosure by increasing business credits

Firms investing in ESG activities can gain the trust of stakeholders and build solid long-term co-operation, however, in the short term, this does not directly generate profitability. On the contrary, it requires additional resources, which may lead to a lack of motivation to invest in ESG activities. Especially in the current environment of "dual-carbon" targets, digital transformation of enterprises not only enhances economic efficiency, but also strengthens social value. With the advent of the digital economy, it is easier for enterprises to attract the attention of governments and investors if their digital transformation is in line with the direction of national policies. Digital technology can improve the information disclosure process and reduce information asymmetry, which leads to higher expectations of stakeholders for enterprises to fulfil their social responsibilities (Pagani et al,. 2017). Under this internal and external pressure, firms will be more aware of their responsibilities and thus improve their ESG performance. In addition, due to the strategic significance, long-term impact and systemic characteristics of digital transformation, integrating its development model into the corporate governance structure will help improve corporate governance and promote optimal reform of the organisational structure. Corporate digital transformation relies on advanced digital technologies, which provide the necessary knowledge and resource support for climate risk disclosure, enhance the quality and

transparency of corporate climate risk disclosure, and help corporations avoid the risk of climate-related uncertainty, thus directly enhancing corporate performance in climate risk responsibility. The fifth hypothesis of this paper is therefore proposed:

Hypothesis 5: There is a positive moderating effect of corporate digital transformation in the relationship between corporate ESG and climate risk disclosure.

4. Research design

4.1. Sample selection and data sources

This paper selects the annual reports of A-share listed companies from 2010-2022 as the research samples, the data of company financial indicators, corporate governance and audit opinions are from Cathay Pacific database (CSMAR), and the annual reports are sourced from Juchao Information Network: (1) financial industry companies and companies marked as ST, *ST and PT during the sample period are excluded, because these companies with special treatment by the regulatory layer may harbor financial risks and the authenticity of their financial data may be doubtful; (2) to ensure the representativeness of the sample, the data of companies listed after 2010 are removed; (3) samples with incomplete data on key variables are excluded; and (4) all continuous variables are subjected to an upper and lower 1% shrinkage to avoid the potential impact of extreme values on the results of the study. After this series of processing, 18,379 firm-year observations were finally obtained.

4.2. Meaning of variables

4.2.1 Explained variables

Corporate climate risk disclosure: Referring to Du Jian's (2023) study, the ratio of the number of climate risk keywords in the annual report to the total number of words in the annual report is used to measure the climate risk disclosed by corporations. The construction method is

as follows: annual reports of Chinese A-share listed companies from 2007 to 2022 are collected as the research object, and the Chinese "climate risk" lexicon (containing 98 words in total) is identified through text analysis and machine learning methods, and the total number of words in the extended lexicon of "climate risk" is calculated by calculating the number of words in "climate risk" and the total number of words in the extended lexicon. Finally, by calculating the ratio of the total word frequency of "climate risk" extended word set to the total word frequency of the annual report, a climate risk indicator is obtained. The larger the value of this indicator, the greater the climate risk that the company needs to disclose. Jian Du (2023), Venky Nagar and Jordan Schoenfeld have used textual analysis to measure corporate climate risk disclosure and validated its effectiveness. Table 1 shows the climate risk dictionary, which contains three types of risks.

Table 1:Words list in Chinese Pinyin

Risk type	Words
Severe risk	zaihai, dizhen, taifeng, haixiao, hanlao, jiduan, elie, neilao, dafeng, shachen, jufeng, shuangdong, sguizai, fengbao, nishiliu, huapo, lingdong, xuezai, hanzai, honglao, baoyu, longjuanfeng, bingbao, honglao, yuxue, bingdong, baoxue, donghai, ganhan, hanqing, qiangjiangyu, hongshui, yanhan fengsha (34)
Chronic risk	qihou, tianqi, chaoshi, shuiwen, jiangwen, hanleng, qiwen, jiangyu, wendu, yushui, yuji, yuqing, jiangshui, yinyu, duoyu, jihan, dongji, xunqi, gaoshi, shuiqing, shuiwei, guangzhao, queshui, gaohan, hanchao, chenjiang, dixiashui, xunqing, dibiao, xushui (30)
Transaction risk	jieneng, nengyuan, qingjie, shengtai, huanjing, zhuanxing, taiyangneng, shengji, xunhuan, liyonglv, hedian, fengdian, tianranqi, zengxiao, ranyou, xiaolv, zaisheng, jianpai, huanbao, lvse, ditan, jianghao, ranliao, jieshui, guangfu, gaoxiao, gaizao, youhao, dianhao, nenghao, fengdian, guangfu, xiaoneng, jiyue (34)

4.2.2 Explanatory variables

esg performance: drawing on Tan Jinsong et al. (2022), the ESG performance of firms is measured by dividing the ESG composite score in the CSI by 100. The CSI ESG composite score ranges from 0 to 100, so dividing it by 100 yields a range of [0,1] for the ESG performance rating (ESG). Compared with the ESG rating assignment method customarily used in the existing

literature, this ESG score has higher information content and can more accurately portray corporate ESG performance.

4.2.3 Moderating variables

Digital transformation: this paper draws on the research of Wu Fei et al. (2021) to construct the indicators in a step-by-step manner. Based on the data pool formed by Python's text extraction of the annual reports of listed enterprises, search, match and count word frequencies based on the feature words in the graph, and then classify and aggregate the word frequencies of the key technological directions and form the final summed up word frequencies, so as to construct the index system of digital transformation of enterprises.

4.2.4 Mediating variables

①Quality of environmental information disclosure. Referring to the research of scholars such as Kong Dongmin (2021), Liao Guoping (2023), and Zhang Xin (2023), the information disclosed by enterprises is classified according to whether it is monetised or not, and is mainly classified in five dimensions, namely, environmental management, environmental certification, environmental carriers, environmental liabilities, and environmental performance and governance, among which environmental liabilities, environmental performance, and governance belong to the monetised disclosure, and the assigned value of the quantitative disclosure is 2, and the qualitative disclosure is Environmental management, environmental certification, and environmental carriers are non-monetised disclosures with an assigned value of 2 for disclosure and 0 for non-disclosure.The annual scores for each firm are summed and the natural logarithm of the summed values is then used to measure environmental disclosure. ② Business credit. Referring to the study of Zhang Xinmin (2012), net commercial credit (NTC) = (accounts payable + notes payable + advance receipts) - (accounts receivable + notes receivable + advance receipts). ③ Agency Costs. Expressed as overheads divided by operating income for the same period.

4.2.5 Control variables

The control variables in this paper are selected with reference to the research design of existing literature (He, Qing and Zhuang, Pontao, 2023).LEV is the financial leverage ratio, which is equal to the total liabilities at the end of the year divided by the total assets at the end of the year.ROE is the return on equity, which is measured by dividing the net profit at the end of the year by the net assets at the end of the year.Size is the size of the firm, which is measured by the number of employees of the firm plus one to take the natural logarithm.Top10 is the shareholding concentration, which is measured by the proportion of shares of the firm accounted for by the top ten shareholders. Age is the number of years the company has been in existence, which is the natural logarithm of the current year minus the year of the company's establishment plus 1. Tobinq is the Tobin's Q value, which is the sum of the market capitalisation of the outstanding shares, the market capitalisation of the non-official shares and the book value of liabilities divided by the total assets. pb is the price to book ratio, which is the price per share divided by the net assets per share. growth is the growth rate of the company's business, which is measured by the current year's revenue divided by the previous year's revenue minus 1. indep is the growth rate of the company's business. Indep is the proportion of independent directors, measured by the ratio of the number of independent directors to the total number of directors on the board of directors.The main variables are defined in Table 2.

Table 2 Variable definition and description

Variable description	Variables name	Definition
explanatory variable	CRD	Climate risk indicators are obtained by calculating the ratio of the total word frequency of the extended word set "climate risk" to the total word frequency of the annual report
explanatory variable	ESG	Measurement of ESG performance of companies by dividing the ESG composite score in the CSI by 100
control variable	LEV	Total year-end liabilities divided by year-end total assets
	ROE	Year-end net profit divided by annual net assets
	Size	Add 1 to the number of employees in the enterprise to take the natural logarithm
	Top10	The top ten shareholders account for the proportion of the company's shares.
	Age	The year of the year minus the year of

		establishment of the company plus 1 takes the natural logarithm.
	TobinQ	The sum of the tradable stock market value, the market value of non-tradable shares and the carrying amount of liabilities divided by total assets
	PB	Price per share divided by net assets per share
	Growth	The result of the current year's operating income divided by the previous year's operating income minus 1
	Indep	The ratio of the number of board members to the total number of board members
intermediary variable	Eidq	Quality of environmental information disclosure
	NTC	Net commercial credit = (accounts payable + notes payable + advances) - (accounts receivable + notes receivable + advances)
	Mgtexp	Administration expense divide by Contemporaneous operating income

4.3. Modelling

To validate the relationship between corporate ESG and climate risk disclosure and the moderating role of digital transformation, the following model is constructed:

$$CRD_{i.t} = \beta_0 + \beta_1 ESG_{i.t} + \beta_{i,t} Controls_{i,t} + \delta_i + \varepsilon_t + e_{i,t} \quad (1)$$

$$CRD_{i.t} = \beta_0 + \beta_1 ESG_{i.t} + \beta_2 ESG_{i.t} * DCG_{i,t} + \beta_{i,t} Controls_{i,t} + \delta_i + \varepsilon_t + e_{i,t} \quad (2)$$

where the explanatory variable is corporate climate risk disclosure CRD, the explanatory variable is corporate ESG ratings, Controls denotes control variables that may affect corporate climate risk disclosure, δ and ε represent individual and year fixed effects, respectively, and e is the error term.

5. Empirical results and analyses

5.1. Descriptive statistics

Table 3 reports the descriptive statistics for the main variables. Table 2 presents the descriptive statistics of the variables of interest. In particular, ESG rating has a mean of 4.0539 and a standard deviation of 1.1401, which implies that there is a large variation in ESG ratings across firms. The mean value of the corporate rent-seeking variable (Rent) measured by excess overheads is 0.0002 and the median is -0.0063, which means that listed companies have more corporate rent-seeking behaviours and have more than normal overheads, and the standard deviation is 0.0483, which means that there is a difference in the cost of rent-seeking across firms. In addition this paper also conducted a correlation test on the main variables, and the results show that excess management costs are significantly negatively correlated with ESG ratings, which preliminarily suggests that corporate rent-seeking behaviours can inhibit ESG performance.

Table 3: Descriptive statistics

	count	mean	sd	min	p50	max
ESG	18379	0.7283	0.0534	0.5757	0.7299	0.8407
CRD	18379	0.0018	0.0014	0.0002	0.0013	0.0078
LEV	18379	0.4919	0.2043	0.0510	0.4993	0.8978
ROE	18379	0.0590	0.1404	-0.6269	0.0666	0.3679
Size	18379	22.6179	1.3727	19.8991	22.4938	26.1316
Top10	18379	54.6532	15.4557	23.3260	54.2265	90.3111
Age	18379	2.9929	0.3056	1.7918	3.0445	3.5264
TobinQ	18379	1.9433	1.4024	0.0000	1.4921	8.5201
PB	18379	3.1812	3.1354	0.0000	2.2569	19.1283
Growth	18379	0.1536	0.4094	-0.5551	0.0878	2.2872
Indep	18379	37.3987	5.4613	33.3300	33.3300	57.1400
Mgtexp	18379	0.1492	0.1288	0.0133	0.1113	0.6913
Eidq	18379	1.9927	1.0421	0.0000	2.1972	3.6376
DCG	18379	1.1520	1.2834	0.0000	0.6931	5.0499
NTC	18379	0.0183	0.1305	-0.3457	0.0098	0.3734

5.2. Benchmark regression results

Table 4 presents the benchmark regression results for corporate ESG and climate risk disclosure. The results show that the coefficients of ESG on corporate climate risk disclosure are

significantly positive across multiple models, which validates Hypothesis 1: higher ESG ratings indeed promote corporate climate risk disclosure. In column (1) of the model, without any control variables or fixed effects, the ESG coefficient is significantly positive, initially confirming the positive role of ESG ratings in promoting corporate climate risk disclosure. In column (2), control variables are added, while individual and time fixed effects are gradually introduced in columns (3) and (4). The ESG coefficients remain significantly positive, further supporting the notion that higher ESG ratings help enhance corporate climate risk disclosure. These results indicate that corporate ESG performance positively influences climate risk disclosure, regardless of whether industry effects are considered, thereby supporting Hypothesis 1 of this study.

Table 4 Basic regression

	(1)	(2)	(3)	(4)
	A1	A2	A3	A4
VARIABLES	CRD	CRD	CRD	CRD
ESG	0.0029***	0.0007***	0.0011***	0.0011***
	(14.1047)	(3.3926)	(6.5782)	(6.8603)
LEV		-0.0001***	-0.0004***	-0.0002***
		(-2.6495)	(-5.8277)	(-3.8645)
ROE		-0.0003***	0.0000	0.0001**
		(-4.8295)	(1.0392)	(2.5201)
Size		0.0002***	0.0002***	0.0002***
		(23.6666)	(13.1733)	(10.6651)
Top10		0.0000***	0.0000***	0.0000***
		(4.3918)	(7.6391)	(5.6352)
Age		0.0005***	0.0016***	0.0002
		(13.2081)	(34.9610)	(1.2050)
TobinQ		-0.0001***	-0.0000*	-0.0000***
		(-7.3491)	(-1.8147)	(-2.8509)
PB		0.0000	0.0000**	0.0000
		(1.5577)	(2.0301)	(1.5855)
Growth		-0.0000	0.0000	-0.0000
		(-0.6208)	(0.0076)	(-0.9057)
Indep		-0.0000***	0.0000	0.0000
		(-8.1119)	(0.3356)	(0.2739)
Constant	-0.0003**	-0.0051***	-0.0088***	-0.0036***
	(-2.2556)	(-21.7160)	(-29.1152)	(-6.9403)
year	N	N	N	Y
stock	N	N	Y	Y

Observations	18,379	18,379	18,377	18,377
R-squared	0.0115	0.0971	0.7558	0.7651

Robust t-statistics in parentheses

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

5.3. Robustness test

(1) Replacement of independent variables

The CSI ESG Rating classifies corporate ESG performance into nine grades from low to high: C, CC, CCC, B, BB, BBB, A, AA, AAA, and assigns a value of 1 to 9 to measure corporate ESG performance. The larger the value, the better the corporate ESG performance. The results, as shown in column (1) of Table 5, remain significant at the 1% level.

(2) Replacement of the dependent variable

Replacing the climate risk terms in the full annual report with the climate risk terms in the management section of the annual report, the results are shown in column (2) of Table 5, where the contribution of ESG to climate risk remains significant at the 1% level.

(3) Excluding samples

Considering that the new crown epidemic will cause a large shock to firms' financial data and lead to biased regression results, the sample interval is shortened to 2010-2019 and the regression is re-run. The results, as shown in Table 5 column (3), show that the contribution of ESG to climate risk remains significant.

(4) Addition of control variables

The personal characteristics of the CEO are introduced as a control variable in the analysis. According to the top echelon theory, the personal traits of a firm's management team have a significant impact on firm decision-making (Hambrick and Mason, 1984), which includes how a firm discloses climate risk as an important business decision-making behaviour, and thus such disclosure behaviour may also be affected by the personal traits of the CEO. To explore this, we

include factors such as the CEO's gender, age, and other personal traits in the base model, and as the results presented in column (4) of Table 5 show, the positive impact of ESG on climate risk is still evident even after taking these factors into account.

Table 5 Robustness test result

VARIABLES	(1) CRD	(2) CRDmd	(3) CRD	(4) CRD
ESG		0.0016***	0.0008***	0.0011***
		(2.7111)	(4.3435)	(6.8349)
esg	0.0000***			
	(5.8194)			
CEOSEX				0.0001***
				(3.8384)
CEOAGE				-0.0000**
				(-2.1278)
Constant	-0.0030***	-0.0053***	-0.0023***	-0.0036***
	(-5.9263)	(-2.8106)	(-3.7244)	(-7.0819)
CV	Y	Y	Y	Y
year	Y	Y	Y	Y
stock	Y	Y	Y	Y
Observations	18,377	18,377	14,166	18,377
R-squared	0.7649	0.6815	0.7786	0.7653

Robust t-statistics in parentheses

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

5.4. Endogeneity test

(1) Instrumental variable method. This paper focuses on the impact of ESG performance on climate risk disclosure, and we reference the methodologies employed by Xianming Fang and Ding Hu (2023), as well as Hongjun Xie and Xue Lü (2022) , selecting the the number of shares held (FHn) and market value of shares held by "general ESG funds" (FHmv) as instrumental variables. Table 6 shows the estimation results of the panel instrumental variable in detail, and columns (1) and (2) indicate the first and second stage estimation results of this instrumental variable, which are all significant at the 1% level. At the same time, we used various statistics to test the validity of the instrumental variables, with Underid values and F values of 26.53, 27.47,

24.12, and 24.98, respectively, which rejected the null hypothesis of weak instruments at a high level of significance.It indicates that this instrumental variable is a suitable instrumental variable that is highly correlated with ESG ratings, and the basic conclusion that corporate ESG performance has a significant positive contribution to climate risk disclosure remains unchanged and consistent with theoretical expectations after dealing with potential endogeneity issues.

(2) PSM matching method. Considering that the existence of the endogeneity problem of sample selection bias makes the causal identification in this paper inaccurate, this section applies 1:1 nearest neighbour matching to find the unique corresponding control group with similar basic characteristics for the experimental group, and the choice of control variables is consistent with the above. The results of the PSM matching test are detailed in column (3) of Table 6, and the results indicate that the estimated coefficient on ESG is negative and significant at the 1% level, so the basic conclusion that corporate ESG performance has a significant positive contribution to climate risk disclosure remains unchanged and consistent with theoretical expectations.

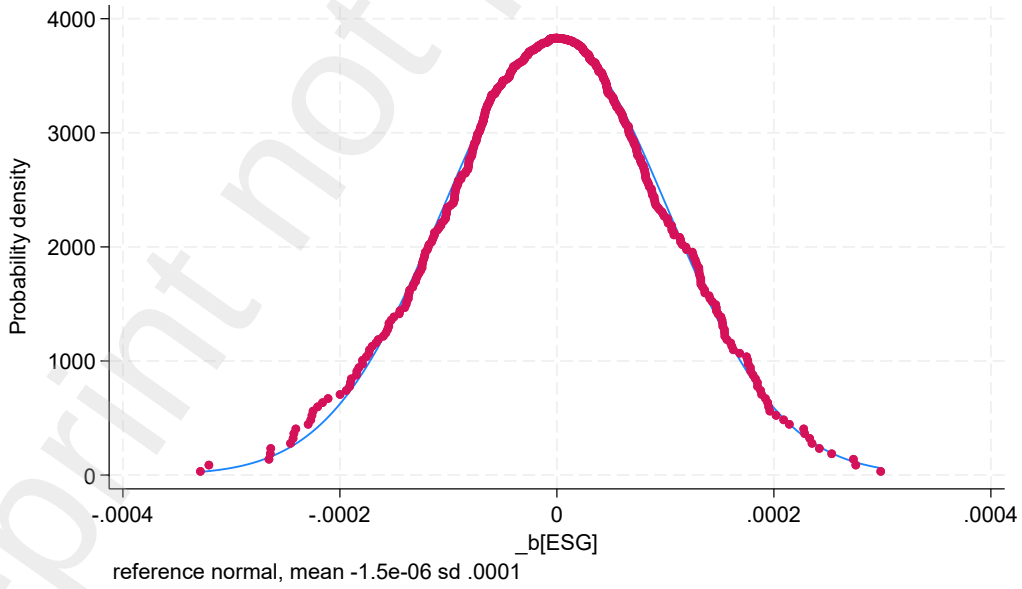
Table 6 Endogeneity test result

	(1)	(2)	(3)	(4)	(5)
			IV		PSM
VARIABLES	ESG	CRD	ESG	CRD	CRD
FH_n	0.0002***				
	(4.8459)				
ESG		0.0335***		0.0320***	0.0010***
		(4.2870)		(4.3092)	(3.9931)
FH_mv			0.0002***		
			(4.9422)		
Constant	0.4294***		0.4298***		-0.0023***
	(16.4597)		(16.4749)		(-2.6610)
CV	Y	Y	Y	Y	Y
year	Y	Y	Y	Y	Y
stock	Y	Y	Y	Y	Y
Observations	17,394	17,394	17,394	17,394	8,820
R-squared	0.5935		0.5935		0.7784

Robust t-statistics in parentheses

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

(3) Placebo test. This paper considers the inclusion of control variables that may affect climate risk disclosure and also fixes individual time effects. However, it still cannot exclude the influence of unobservable factors on the empirical results, such as the impact of the Paris Agreement in 2015 or the United Nations Framework Convention on Climate Change Conference of the Parties (COP) held in previous years. Based on this, this paper refers to Li, Wengui and Lu, Jun (2022), and adopts the following steps to conduct a placebo test: randomly disrupt the explanatory variables as a new set of explanatory variables, and repeat the process 500 times to ensure that the randomised treatment does not have an impact on climate risk disclosure. The results are shown in Figure 1: none of the t-values derived from the 500 times randomisation process reached or exceeded the t-values of the true explanatory variables, and most of them were clustered around the 0-value, i.e., the corresponding regression coefficients were not statistically significant. The above test results indicate that the regression results of this paper have not received the influence of other unobservable factors and have good robustness.



Picture 1 placebo test

6. Further analysis

6.1. Mechanism testing

The empirical evidence that corporate ESG promotes corporate climate risk disclosure has been obtained in the previous section, and this part will focus on analysing the mechanism of action of ESG ratings to promote corporate climate risk disclosure. Based on the theoretical framework of the previous section, the three mechanism paths proposed in the hypothesis section above are verified using the mediation effect model. The first step tests whether ESG ratings are significant for each mediating variable, while the second part tests whether the effect of each mediating variable on corporate climate risk disclosure is significant.

6.1.1 Reduction of agency costs

In order to test whether corporate ESG ratings can promote corporate climate risk disclosure by reducing agency costs, this paper measures agency costs by dividing administrative expenses by operating income over the same period. According to the results in column 1 of Table 7, it can be seen that the coefficient of corporate ESG on agency cost is significantly negative, indicating that corporate ESG improvement can reduce agency cost. Meanwhile, from the results in column 2, it can be seen that the coefficient of agency cost (Mgtexp) on climate risk disclosure is also negative, which indicates that corporate ESG can reduce the agency cost to increase the degree of climate risk disclosure, and Hypothesis 2 is verified.

6.1.2 Improvement of environmental information disclosure

In order to test whether corporate ESG ratings can promote corporate climate risk disclosure by improving the quality of environmental information disclosure, this paper refers to the studies of scholars such as Kong Dongmin (2021), Liao Guoping (2023), and Zhang Xin (2023), where a total of 25 indicators are scored from seven aspects such as environmental management, environmental regulation and certification, and environmental performance and governance, and the total score is added to one to take the natural logarithm. According to the results in column 3 of Table 7, it can be seen that the coefficient of corporate ESG on the quality of environmental disclosure is significantly positive, which indicates that the improvement of

corporate ESG can improve the quality of environmental disclosure. Meanwhile, from the results in column 4, it can be seen that the coefficient of environmental disclosure quality (Eidq) on climate risk disclosure is also positive, which indicates that corporate ESG can improve the quality of environmental disclosure to improve the degree of climate risk disclosure, and hypothesis 3 is verified.

6.1.3 Commercial credit

To test whether corporate ESG ratings can promote corporate climate risk disclosure by improving business credit. Referring to the practice of Zhang Xinmin of Accounting Research to measure net commercial credit: NTC = (accounts payable + notes payable + accounts receivable in advance) - (accounts receivable + notes receivable + accounts receivable + accounts receivable in advance), it can be seen that the coefficient of corporate ESG on commercial credit is significantly positive based on the results of the 5th column of Table 7, which suggests that the improvement of corporate ESG can promote corporate commercial credit. Meanwhile, from the results of column 6, it can be seen that the coefficient of business credit (NTC) on climate risk disclosure is also positive, which indicates that corporate ESG can promote business credit to improve the degree of climate risk disclosure, and Hypothesis 4 is verified.

Table 7 Intermediate effect test

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Mgtexp	CRD	Eidq	CRD	NTC	CRD
ESG	-0.0666***		1.5395***		0.0651***	
	(-4.6246)		(11.4320)		(3.7715)	
Mgtexp		-0.0005***				
		(-6.0953)				
Eidq				0.0002***		
				(16.5403)		
NTC						0.0002***
						(2.7223)
Constant	0.8449***	-0.0026***	-3.1495***	-0.0026***	-0.3358***	-0.0030***
	(17.4358)	(-5.2894)	(-7.2792)	(-5.3960)	(-5.9724)	(-6.0023)
CV	Y	Y	Y	Y	Y	Y
year	Y	Y	Y	Y	Y	Y
stock	Y	Y	Y	Y	Y	Y

Observations	18,377	18,377	18,377	18,377	18,377	18,377
R-squared	0.7799	0.7649	0.6957	0.7684	0.6856	0.7645

Robust t-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1

6.2. Moderating effects

In order to test the moderating effect of digital transformation on the relationship between corporate ESG and climate risk disclosure, this paper constructs two digital transformation indicators:①Dig:Referring to Yuan Chun et al. (2021), firstly, a dictionary of corporate digitisation terms is constructed, and 30 important national-level digital economy-related policy documents processed by Python are finally screened to obtain 197 frequency greater than or equal to 5 times of the enterprise digitisation-related terms, which constitute the enterprise digitisation term dictionary of this paper; then, based on the machine learning method, the text analysis of the annual report related segments, and statistically obtain the frequency of 197 enterprise digitisation-related terms appearing in the annual report; finally, after extracting and obtaining the frequency of each keyword in the annual report of each listed company each year, divide the total frequency of enterprise digitisation-related words by the Finally, after extracting the frequency of each keyword in the annual report of each listed company, the digital transformation index is obtained by dividing the sum of the frequency of enterprise's digital related words by the length of the annual report. ② DCG: Refer to Wu Fei (2021). The empirical results are shown in Table 8, which shows that the coefficients of the interaction terms of DCG and ESG in Column (1) are significant at 1% significance level, as well as the coefficients of the interaction terms of Dig and ESG in Column (2) are significant at 1% significance level, which suggests that the digital transformation of firms plays a positive moderating role on the relationship between corporate ESG and climate risk disclosure.

Table 8 Moderating effect test result

VARIABLES	(1) CRD	(2) CRD
ESG	0.0010***	0.0010***
	(6.0744)	(6.5327)
DCGesg	0.0001***	
	(6.5893)	
Digesg		0.0000**

		(2.4435)
Constant	-0.0032***	-0.0035***
	(-6.3841)	(-6.9322)
CV	Y	Y
year	Y	Y
stock	Y	Y
Observations	18,377	18,372
R-squared	0.7657	0.7651

Robust t-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1

6.3. Heterogeneity test

6.3.1 CEO personal characteristics

To test whether there are heterogeneous differences in the effect of ESG ratings on climate risk disclosure in terms of internal characteristics, this paper groups regressions in terms of CEO gender and CEO overseas experience. Gender identity theory states that female CEOs typically exhibit more cautious and conservative personality traits and tend to lack self-confidence. This personality tendency leads to the fact that they are more likely to adopt an avoidance strategy when faced with risk. Specifically, this risk-averse attitude is reflected in firms led by female CEOs, which are typically less leveraged and have relatively few mergers and acquisitions and overinvestments (Huang and Kisgen, 2012; Shigang Li, 2013). As a result, female CEOs tend to actively disclose climate risk information even if the firms do not have a clear strategy to enhance environmental, social, and governance (ESG) performance or if the firms' ESG ratings are not high. In contrast, male CEOs exhibit stronger associations, and they tend to disclose climate risk information more aggressively only when the firm's ESG rating has improved or when a relevant strategy exists. According to the stigma theory, the significant differences between cultural systems mean that the CEO's experience of studying or working abroad constitutes a kind of 'stigmatisation' process. This unique experience not only shapes the CEO's perceptions and abilities to better fit the characteristics of the overseas environment, but also has a profound impact on corporate management. As a result, CEOs with overseas backgrounds may be inclined to utilise the anchor point effect when formulating their corporate development strategies, choosing to focus on either ESG ratings or climate risk disclosure, believing that such a focus is sufficient to encompass key aspects of corporate sustainability.

Table 9 reports the regression results of the heterogeneity analysis of CEO gender and overseas experience for internal characteristics. ESG performance is not significant among firms with female CEOs in column (1), while it is significant at the 1% level among the group of male CEOs in column (2). The results suggest that ESG performance is more significant in promoting climate risk disclosure in firms with male CEOs relative to the female CEO sample group. Firms' ESG ratings are insignificant and negatively correlated in the column (3) with overseas experience group, but ESG performance is significant at the 1% level and positively correlated in the column (4) without overseas experience group. The results suggest that the effect of corporate ESG performance on the contribution to climate risk is more significant in the sample group of male CEOs and those without overseas experience, relative to the sample group of female and CEOs with overseas experience.

Table 9 heterogeneity test result

VARIABLES	(1) WOMAN CRD	(2) MAN CRD	(3) OVERSEA CRD	(4) NON-OVERSEA CRD
ESG	0.0008	0.0010***	-0.0005	0.0011***
	(1.3859)	(5.6619)	(-0.9298)	(6.7570)
Constant	-0.0026	-0.0030***	-0.0033*	-0.0041***
	(-1.1589)	(-5.4279)	(-1.7345)	(-7.5689)
CV	Y	Y	Y	Y
year	Y	Y	Y	Y
stock	Y	Y	Y	Y
Observations	1,355	16,391	1,059	17,249
R-squared	0.8040	0.7745	0.8500	0.7673

Robust t-statistics in parentheses

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

6.3.2 External characteristics

To test whether there are heterogeneous differences in the effect of ESG ratings on climate risk disclosure in terms of external characteristics, this paper groups regressions in terms of whether or not they are low-carbon pilot cities. In low-carbon pilot cities, peer competition is particularly intense in terms of environmental information and climate risk disclosure due to stricter regulatory mechanisms. This competitive dynamic is particularly evident among firms

that implement ESG strategies. As a result, firms located in low-carbon pilot cities, especially those that excel in ESG, are more inclined to actively promote climate risk disclosure.

Table 10 reports the regression results of the heterogeneity analysis of external characteristics. ESG performance is significant at the 1% level in column (1) low carbon pilot cities, while it is not significant in column (2) non-low carbon pilot city group. The results suggest that ESG performance is more significant in promoting climate risk disclosure for firms in low-carbon pilot cities relative to the non-low-carbon pilot city group.

Table 10 External characteristic heterogeneity test result

	(1)	(2)
	LCC	NON-LCC
VARIABLES	CRD	CRD
ESG	0.0014***	0.0004
	(6.6866)	(1.5421)
Constant	-0.0049***	-0.0002
	(-6.6427)	(-0.2094)
CV	Y	Y
year	Y	Y
stock	Y	Y
Observations	10,616	7,719
R-squared	0.8029	0.7659

Robust t-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1

7. conclusions and recommendations

Based on the data of annual reports of A-share listed companies from 2010 to 2022, this paper uses textual analysis to construct indicators that respond to climate risk disclosure at the corporate level. The study examines the influence effect and influence mechanism of corporate ESG ratings on corporate climate risk disclosure from the perspective of corporate green finance, which provides a theoretical basis for revealing the relationship between corporate good ESG and its own climate risk disclosure. This paper finds that corporate ESG ratings have a facilitating effect on their climate risk disclosure, i.e., the higher the corporate ESG rating, the higher the degree of their climate risk disclosure. After using endogeneity tests and treatments such as

633 instrumental variables approach and propensity score matching, a series of robustness tests
634 were also conducted, and the results all proved that the findings of this study are robust. Further
635 analyses revealed that corporate ESG mainly promotes its climate risk disclosure by reducing
636 agency costs, increasing environmental disclosure, and increasing corporate business credit,
637 while its promotional effect is more pronounced among firms whose CEOs are male and have no
638 overseas experience, and are in low-carbon pilot cities. Digital transformation also positively
639 moderates the relationship between ESG and corporate climate risk disclosure. Based on the
640 findings, this paper makes recommendations in terms of both external policy design and internal
641 corporate management to promote green and sustainable development of enterprises and
642 society.

643 It is generally recognised that a company's ESG performance contributes to investors'
644 long-term decision-making. In this context, corporate climate risk disclosure needs to reflect its
645 consistency with relevant policies and future trends, and ensure that the disclosed data are
646 comparable and easy to interpret. Therefore, in addition to establishing a climate risk disclosure
647 system and environmental regulatory policies, the government should also make full use of the
648 facilitating role of the corporate ESG system to promote the organic integration of environmental
649 and climate risk disclosure, and jointly promote the conscious disclosure of high-quality climate
650 risk information by enterprises. At the same time, the government should improve the standards
651 and evaluation system of climate risk disclosure, and implement certain preferential policies and
652 incentives for enterprises that disclose climate risks. Secondly, the government should also
653 introduce policies related to enterprise digitalisation, which can encourage enterprises to invest
654 in the procurement and upgrading of digital technology and equipment through tax incentives,
655 subsidies or capital grants to reduce the cost pressure of enterprise digital transformation; and
656 to invest in the construction or optimisation of digital infrastructure, such as high-speed internet
657 network coverage, data centres, cloud computing services, etc., to support the needs of
658 enterprise digital transformation; It can also provide digital skills training and educational
659 support for enterprise employees and management to help them adapt to new technologies and
660 work styles, and promote digital culture and capacity building within the organisation. From a
661 corporate perspective, the effect of ESG on climate risk disclosure is critical to their

sustainability. Therefore, enterprises should deeply implement ESG concepts and integrate them into their corporate culture. They should actively participate in ESG ratings, seek new opportunities in sustainable development issues, and promote economic transition to green. At the same time, enterprises need to regard climate risk disclosure as one of their core competencies, improve the management and professional capacity of their employees, and set up corresponding incentives and training mechanisms to encourage employees to actively participate in climate risk disclosure and increase their motivation and creativity. Enterprises also need to pay attention to the development of employees' behavioural attitudes and values, and enhance their awareness and ability to withstand climate risks.

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