Climate Risk Disclosure and Corporate Labor Demand ——Evidence from China's A-share Listed Companies

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Abstract. In the process of promoting sustainable development, enterprises' active fulfillment of social responsibilities and proactive response to climate change constitute an important driving force for increasing corporate labor demand and boosting high-quality economic development. This paper employs text analysis methods to extract indicators from the annual reports of companies spanning 2010 to 2023, aiming to examine the impact of climate risk disclosure on corporate labor demand. It is found that corporate disclosure of climate risks can significantly enhance labor demand, with this enhancing effect being more pronounced in high-tech industry enterprises and those whose senior executives have overseas experience. The paper also conducts mechanism tests from two key impact channels: the green technology innovation effect and the production scale expansion effect. It is revealed that climate risk disclosure can effectively improve the level of green technology innovation and expand production scale, thereby promoting the growth of corporate labor demand. The conclusions of this paper provide a new perspective for enterprises to increase labor demand, affirm the positive impact of sustainable development on corporate growth, and point out that disclosing climate risks has crucial policy value in promoting enterprises' green transformation.

Keywords: climate risk disclosure; corporate labor demand; text analysis.

1. Introduction

As global climate change intensifies, climate risk has evolved into a critical factor that cannot be overlooked in corporate operations. Climate risk disclosure mandates enterprises to assess and publicly disclose climate-related challenges they confront, such as extreme weather events, policy shifts, and changes in market demand. Such disclosures may reveal enterprises' potential operational risks, which in turn could impact their recruitment plans, job configuration, and employee stability. Therefore, climate risk disclosure is not merely an information disclosure mechanism but is more likely to emerge as a significant driver reshaping the labor structure of enterprises.

The adjustment of labor demand in this process is closely linked to the stability of the employment market, and employment itself serves as a crucial underpinning for economic development. Our government proposes to implement an employment-first strategy, strengthen employment-first policies, improve employment promotion mechanisms, and advance high-quality and full employment. Against the backdrop of China's concurrent pursuit of the "stable employment" goal and sustainable development objectives, exploring the relationship between climate risk disclosure and corporate labor demand holds certain research value and practical significance. Firstly, in the field of climate risk disclosure, most existing studies focus on macro-level institutional aspects within industries. For instance, there are studies on climate risk disclosure systems in the banking and insurance sectors (Qian Lihua et al., 2021) and research on relevant information disclosure by agricultural listed companies (Xu Zhangyang et al., 2022). Additionally, from the perspective of corporate finance, scholars have explored the impact of institutional investors' shareholding capacity on climate risk disclosure (Du Jian et al., 2023) and how climate risk disclosure influences corporate decision-making behaviors (Kim et al., 2023). In terms of corporate labor demand, the literature relevant to this study primarily examines the impact of green development on corporate employment. Examples include research on the employment effects of ESG advantages (Mao Qilin & Wang Yueqing, 2023), as well as studies on the employment impact of macro-level green development policies such as low-carbon city pilot policies (Wang Feng & Ge Xing, 2022).

To summarize, existing studies lack exploration into the causal relationship and operational mechanisms between the two. This research, by leveraging data from Chinese A-share listed companies spanning 2010 to 2023 and employing text analysis methods, investigates the impact and functioning mechanisms of climate risk disclosure on corporate labor demand at the micro level. It is expected to help fill the research gap in the field of factors influencing corporate labor demand.

Compared with existing studies, this paper may make marginal contributions in the following aspects: First, this paper examines how climate risk disclosure affects corporate labor demand, filling the gap in existing research. Most existing studies on climate risk disclosure focus on macro policy levels, while there is a lack of research on the impact mechanisms at the micro level of enterprises. Second, this paper expands relevant research on examining the labor market from a micro perspective. It investigates the impact mechanism of climate risk disclosure—an active corporate behavior in response to climate change—on labor demand, which serves as a pioneering explanatory angle for employment and the labor market. Third, this paper explores the impact of climate risk disclosure on corporate labor demand under different contexts from the perspectives of industry nature and personal characteristics of corporate executives. This enriches the practical application of the research and facilitates the formulation and proposal of targeted policy recommendations, thereby deepening the understanding of the intrinsic connection between climate risk disclosure and corporate labor demand. Fourth, in terms of policy implications, against the dual backdrop of the "dual carbon" goals and the stable employment strategy, grasping the relationship between climate risk disclosure and corporate labor demand holds significant practical relevance.

2. Theoretical Analysis and Research Hypotheses

Theoretically, the impact of climate risk disclosure on corporate labor demand can be summarized into two effects: the green technology innovation effect and the production scale expansion effect. On one hand, climate risk disclosure prompts enterprises to pay greater attention to environmental responsibilities and sustainable development, driving them to increase investment in green technology R&D and enhance the level of green innovation, thereby creating new labor demand. On the other hand, climate risk disclosure helps enterprises better identify and manage climate-related risks, strengthens investor confidence, and thus enables them to obtain more financing support, which in turn promotes the expansion of production scale. Therefore, this paper will specifically analyze the theoretical mechanism of how climate risk disclosure affects corporate labor demand from these two perspectives.

As non-financial information, climate risk-related information constitutes an important part of corporate information and has attracted attention from stakeholders such as regulatory authorities and investors [3]. Climate risk disclosure reflects enterprises' active measures to address climate change. It is a behavior that enhances information transparency, which can convey to the outside world the enterprises' emphasis on climate change issues, thereby helping to improve their reputation, corporate governance, and employment conditions. In related fields, studies on the employment effect of ESG have concluded that ESG advantages can significantly improve corporate employment levels (Mao Qilin and Wang Yueqing, 2023). In addition, Li, Shan et al. (2024) explored the long-term impact of enterprises' climate change adaptation behaviors on employment, that is, how to adapt to climate risks through innovation and business model adjustment, and they tend to maintain or increase the number of employees to support their long-term strategies. Both ESG, as a new management standard that internalizes green concepts into corporate decision-making and operation processes, and active behaviors to adapt to climate change, reflect the important performance of enterprises in supervising and regulating themselves in the face of sustainable development issues.

Based on the above theoretical analysis, this paper puts forward the following hypothesis to be tested:

Hypothesis 1: Climate risk disclosure can increase corporate labor demand.

2.1.Green Technology Innovation Effect

Green technological innovation directly acts on the production process of enterprises. From the perspective of long-term technological development trends, the improvement of technological innovation level can drive employment growth (Han Mengmeng et al., 2016). With the increasing awareness of environmental issues in China, the introduction of traditional technologies with low efficiency and high energy consumption has been hindered, while the role of independent innovation in green technologies in promoting employment has become more prominent (Wang Guangdong et al., 2012). The independent research and development of green technological innovation requires more investment in funds and resources, as well as an increased demand for high-quality labor, so as to continuously drive employment growth. According to the signal transmission effect, climate risk disclosure can promote corporate innovation through mechanisms such as enhancing reputation capital, strengthening governance structures, and reducing financing costs (L. Feng et al., 2024). The improvement of such reputation capital helps enterprises attract more innovative resources, such as high-quality employees and investors, thereby contributing to an increase in labor demand.

Based on the above theoretical analysis, this paper puts forward the following hypothesis to be tested:

Hypothesis 2: Climate risk disclosure can increase corporate labor demand by improving the level of corporate green technological innovation.

2.2.Effect of Expanding Production Scale

Climate risk disclosure can enhance corporate reputation value (Xie Hongjun & Lü Xue, 2022), thereby boosting consumers' demand for the firm's products and prompting enterprises to expand their production scale. By expanding production scale, enterprises can improve production efficiency and reduce production costs, which in turn elevates employment levels. Meanwhile, climate risk disclosure is also conducive to building sound relationships with stakeholders (Choi et al., 2009), enabling enterprises to acquire more external resources and knowledge, thereby improving operational and production efficiency, expanding production scale, and consequently increasing the demand for labor.

Based on the above theoretical analysis, this paper proposes the following hypothesis to be tested:

Hypothesis 3: Climate risk disclosure can increase labor demand by expanding the production scale of enterprises.

3. Research Design

3.1.Model Specification

This paper studies the impact of climate risk disclosure on corporate labor demand, and thus sets the following basic regression model:

$$Employ_{it} = \alpha + \beta CRR_{it} + \lambda X_{it} + \varphi_i + \mu_i + \varepsilon_{it} \quad (1)$$

Among them, the explained variable $Employ_{it}$ represents the labor demand of enterprises, which is measured by the natural logarithm of the number of employees of listed company i in year t. The core explanatory variable CRR_{it} represents the climate risk information disclosure of listed company i in year t. This paper, following the approach of (Sun, Ci et al. 2024), extracts words related to "climate risk" from the annual reports of companies from 2010 to 2023. These words include but are not limited to "climate change", "greenhouse gas emissions", "extreme weather events", etc. The selection of specific words is based on industry standards or commonly used terms in relevant studies. Meanwhile, the frequency of these words is taken as the natural logarithm to construct the climate risk disclosure index CRR. Among them, a higher CRR value indicates that the company has a higher perception and attention to climate risks. The coefficient β measures the impact of climate risk disclosure on corporate labor demand. If β is greater than 0, it indicates that

more climate risk disclosure leads to higher corporate labor demand, that is, climate risk disclosure can effectively increase corporate labor demand.

X_{it} represents a series of control variables. With reference to existing studies, this paper includes the following control variables in the model: firm age (Age), measured by the difference between the current year and the year the firm was founded; firm growth capacity (TobinQ1), measured by the ratio of the firm's market value to its assets; total asset net profit rate (LEV), measured by the ratio of the firm's total liabilities to total assets; return on assets (ROA), measured by the ratio of the firm's net profit to total assets; total asset turnover (TAT), measured by the ratio of operating income to total assets; CEO duality (DUAL), a dummy variable where 1 indicates duality and 0 indicates non-duality; board size (BOARD), measured by the number of board members; shareholding ratio of the largest shareholder (Top1); shareholding ratio of institutional investors (Inst), measured by the number of shares held by institutional investors divided by the total share capital. In addition, this paper also controls for firm fixed effects φ_i and year fixed effects μ_i, where ε_{it} is the random error term, which is clustered at the firm level.

3.2.Data Sources and Variable Descriptions

This paper takes China's Shanghai and Shenzhen A-share listed companies as the research sample, with data sourced from the CSMAR database and Wind database. The research period selected in this paper is 2010-2023. To avoid the interference of abnormal data, the original data are processed in the following steps with reference to existing studies:

(1) Excluding data from the financial industry; (2) Excluding data of companies with listing status as "ST", "*ST", "suspended listing", "terminated listing" or "delisting period"; (3) Excluding samples with severe missing data of key variables; (4) Excluding samples with outliers;
(5) Performing 1% winsorization on continuous variables.

Table 1 reports the descriptive statistics of the main variables in this paper. On average, the maximum value of corporate labor demand is 13.46, with an average of 7.548; the average climate risk disclosure index is 0.0083, and the maximum value reaches 2.963.

Table 1 Descriptive Statistics of Variables

Variable	Sample size	Mean	Standard Deviation	Minimum value	Maximum value
	(1)	(2)	(3)	(4)	(5)
Employ	43,012	7.548	1.315	0.693	13.46
CRR	43,012	0.0883	0.152	0	2.963
DUAL	43,012	0.303	0.460	0	1
BOARD	43,012	2.116	0.199	1.609	2.708
ROA	43,012	0.0337	0.0718	-0.358	0.198
TAT	43,012	0.594	0.411	0.0465	2.506
TobinQ1	43,012	2.050	1.358	0.854	8.890
Age	43,012	2.916	0.356	0	4.174
Top1	43,012	0.338	0.148	0.0842	0.747
Inst	43,012	0.431	0.248	0.00482	0.925
LEV	43,012	0.420	0.214	0.0518	0.952

4. Analysis of Empirical Results

4.1.Benchmark Regression Results

Table 2 reports the regression results regarding the relationship between climate risk disclosure and corporate labor demand. Column (1) includes only the core explanatory variable while controlling for firm fixed effects and year fixed effects; the results show that the coefficient of CRR is significantly positive at the 1% level. Column (2) further adds some control variables to more

accurately estimate the impact of climate risk disclosure on corporate labor demand. It can be observed that for every 100% increase in Employ, CRR increases by an average of 41.1%, which is also significantly positive at the 1% level. Column (4) presents the regression results with all control variables included, indicating that climate risk disclosure significantly boosts corporate labor demand. All the above tests verify Hypothesis 1.

In terms of control variables, the coefficient of firm age (Age) is significantly positive, indicating that the longer the firm has been in existence, climate risk disclosure will increase the demand for labor; the coefficient of asset-liability ratio (LEV) is significantly positive, suggesting that firms with a higher asset-liability ratio have a greater demand for labor.

Table 2 Benchmark Regression Results

Variable	Employ (1)	Employ (2)	Employ (3)	Employ (4)
CRR	0.464***	0.411***	0.376***	0.347***
	(0.150)	(0.133)	(0.118)	(0.109)
Age		0.295***	0.419***	0.463***
		(0.099)	(0.098)	(0.097)
ROA		0.914***	0.844***	0.707***
		(0.094)	(0.089)	(0.086)
LEV		0.999***	0.970***	0.982***
		(0.078)	(0.072)	(0.070)
TAT			0.231***	0.238***
			(0.039)	(0.038)
TobinQ1			-0.119***	-0.122***
			(0.009)	(0.009)
Top1			0.203	-0.212
			(0.135)	(0.129)
Indboard				0.550***
				(0.169)
Inst				0.780***
				(0.076)
BOARD				0.461***
				(0.059)
DUAL				0.006
				(0.016)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observation	42,637	42,637	42,637	42,637
Adj.R^2	0.871	0.877	0.884	0.888

Note: (1) The values in parentheses are standard errors clustered at the industry level; (2) *p<0.01, **p<0.05, ***p<0.01.

4.2.Robustness Tests

4.2.1 Instrumental Variable Method

Endogeneity mainly arises from omitted variable bias and bidirectional causality. This paper alleviates the endogeneity problem by finding appropriate instrumental variables and using the two-stage least squares (2SLS) method.

Following the approach of Wang Qian and Hui Yuhang (2024), this paper uses the average climate risk disclosure level of the industry where the enterprise is located (mean CRR) as the instrumental variable for the enterprise's climate risk disclosure (CRR) (Wang Qian & Hui Yuhang, 2024). In terms of correlation, the industry-level climate risk disclosure level, as a macro indicator, can

comprehensively reflect the overall disclosure practices and standardized average degree of enterprises in the industry, showing a significant positive correlation. In terms of exogeneity, the industry average climate risk disclosure level is not directly affected by the characteristics of individual enterprises and thus will not directly impact the labor demand of a single enterprise.

The results show that the LM statistic is 15.353 with a P-value of 0.000, indicating that there is no under-identification issue with the instrumental variable. The weak instrumental variable test shows that the F-value is much larger than 10, passing the weak instrumental variable test, which indicates the validity of the selected instrumental variable.

Table 3 reports the 2SLS regression results using mean CRR as the instrumental variable. Column (1) shows the results of the first-stage regression, where the regression coefficient of the instrumental variable mean CRR is significantly positive at the 1% level, indicating a significant positive correlation between the instrumental variable and the independent variable. Column (2) presents the results of the second-stage regression, with the estimated coefficient of climate risk disclosure (CRR) being significantly positive.

The regression results indicate that after controlling for potential endogeneity issues using instrumental variables, the employment-promoting effect of climate risk disclosure remains significant, which further verifies Hypothesis 1.

Table 3 Regression Results of Instrumental Variable Method

	First-stage regression	Second-stage regression
Variable	CRR	Employ
	(1)	(2)
meanCRR	0.669***	
	(0.128)	
CRR		0.479*
		(0.277)
Controls	YES	YES
Firm FE	YES	YES
Year FE	YES	YES
Observations	42,637	42,637

Note: (1) The values in parentheses are standard errors clustered at the industry level; (2) *p<0.01, **p<0.05, ***p<0.01.

4.2.2 Replacing the explanatory variable

To test whether the measurement method of the core explanatory variable in this paper affects the results of the benchmark regression, this paper re-conducts the regression using CRR1, a dummy variable indicating whether climate risk is disclosed, and CRR2, the natural logarithm of the number of climate risk disclosure words, respectively.

The results are shown in columns (2) and (3) of Table 4, and there is no substantial change in the regression results, thus supporting Hypothesis 1 of this paper.

Table 4 Regression Results with Replaced Explanatory Variables

	Employ (1)	Employ (2)	Employ (3)
CRR	0.347***		
	(0.109)		
CRR1		0.040*	
		(0.024)	
CRR2			0.079***
			(0.010)
Control Variables	YES	YES	YES
Firm & Year FE	YES	YES	YES
N	42,637	42,637	42,637
R^2	0.888	0.887	0.888

Note: (1) The values in parentheses are standard errors clustered at the industry level; (2) *p<0.01, **p<0.05, ***p<0.01.

5. Mechanism Test and Further Discussion

5.1.Mechanism Test

5.1.1 Green Innovation Mechanism

Following the approach of Qin Bingtao et al. (2023), this paper selects invention patents, specifically the proportion of annual green invention patent applications of Shanghai and Shenzhen A-share listed companies to their total patent applications, as the indicator to measure green technological innovation (Qin Bingtao et al., 2023). Column (1) of Table 7 reports the regression results of CRR on corporate green technological innovation. The results show that the estimated coefficient of CRR is significantly positive, indicating that climate risk disclosure can promote the improvement of enterprises' green technological innovation level. According to the signal transmission theory, climate risk disclosure sends positive signals to the market about enterprises' green transformation, reflecting the importance enterprises attach to green innovation. Enterprises need to reduce climate risks by investing in green technologies, increasing R&D, or adjusting business models, and improve their competitiveness to offset the costs of complying with regulations. As a result, the demand for talents related to green technologies will increase, absorbing more employment (L. Feng et al., 2024).

5.1.2 Production Scale Mechanism

Following the approach of Wang Feng and Ge Xing (2022), this paper uses the natural logarithm of operating income to measure the production scale of enterprises [6]. Column (2) of Table 6 reports the regression results of CRR on operating income. The results show that the estimated coefficient of CRR is significantly positive at the 1% level, indicating that climate risk disclosure can effectively expand the production scale. Climate risk disclosure reflects enterprises' attention to climate change and sustainable issues. According to the signal transmission theory, enterprises that actively disclose climate risk information send out signals of fulfilling social responsibilities to the outside world, which enhances their reputation value. Consumers will pay more attention to these reputable enterprises and increase the demand for products produced by such enterprises, thus leading enterprises to expand their production scale.

In addition, according to stakeholder theory, climate risk disclosure represents enterprises' initiative to assume more social responsibilities, which helps improve their relationships with external stakeholders. To a certain extent, such good social relationships will be beneficial for enterprises to obtain more external knowledge, technologies and information, enhance their own innovation capabilities and production efficiency, thereby reducing production costs.

Table 6 Regression Results of Mechanism Impact Test

	Enterprise green technological innovation	Enterprise production scale
	(1)	(2)
CRR	0.623***	0.414***
	(0.128)	(0.064)
Control variables	YES	YES
Firm & Year FE	YES	YES
N	42,635	42,637
R^2	0.770	0.925

5.2.Heterogeneity Analysis

5.2.1 Personal Characteristics of Senior Executives

Due to China's relatively late start in climate research and response, there are significant differences among enterprises in their level of attention to and understanding of climate risk disclosure. Such inconsistency in cognition may indirectly affect enterprises' decisions regarding labor demand.

In view of this, in the heterogeneity analysis, this paper starts from the internal organizational structure of enterprises, takes whether the chairman has overseas experience as a key indicator to measure the characteristics of corporate executives, and divides the sample enterprises into two groups for classified regression analysis.

As can be seen from Columns (1) and (2) of Table 7, regardless of whether the chairman has overseas experience, climate risk disclosure has a positive promoting effect on corporate labor demand. However, the number of samples where the chairman has overseas experience is much smaller than that where the chairman has no overseas experience. Even so, the effect is highly significant in the case of the small sample, which can still be interpreted as that the chairman's overseas background can effectively enhance the promoting effect of climate risk disclosure on corporate labor demand.

A possible explanation is that chairmen with overseas experience possess a more comprehensive international perspective and have access to a wealth of successful experiences and techniques in climate risk governance from foreign contexts. They can then apply these insights to their own companies' internal management, improving operational efficiency, which in turn facilitates the expansion of production scale and increases labor demand.

Table 7 Results of Heterogeneity Analysis on Executives' Personal Characteristics

	With overseas experience	Without overseas experience
	(1)	(2)
CRR	0.648***	0.204*
	(0.167)	(0.111)
Control variables	YES	YES
Firm & Year FE	YES	YES
N	3,845	35,934
AR^2	0.938	0.904

5.2.2 High-Tech Industries

This paper classifies the industries of different enterprises into high-tech industries and non-high-tech industries according to the *Statistical Classification Catalogue of High-Tech Industries* in 2002, and conducts separate regressions. As can be seen from the results in Column (1) of Table 8, the labor demand of enterprises in high-tech industries is significantly increased by climate risk disclosure, while such an enhancing effect is not significant for enterprises in non-high-tech industries. A

possible explanation for this is that high-tech industries are characterized by high technology intensity, so they are more sensitive to climate risk disclosure and more likely to increase their own labor demand through technological innovation and green transformation. However, enterprises in non-high-tech industries may currently face greater transformation pressure. For example, traditional manufacturing industries are more likely to encounter pressures in terms of capital and technological upgrading during transformation, resulting in difficulties in employment growth in the short term.

Table 8 Results of Heterogeneity Analysis on High-Tech Industries

	High-tech industry	Non-high-tech industry
	(1)	(2)
CRR	0.311***	0.235
	(0.103)	(0.170)
Control variables	YES	YES
Firm & Year FE	YES	YES
N	25,469	17,123
R^2	0.901	0.900

6. Conclusion and Policy Recommendations

In recent years, China has faced a severe employment market situation after experiencing numerous external shocks such as the pandemic and climate change. As the main micro-subjects for stabilizing employment and creating job opportunities, enterprises play an important role in improving the employment environment and promoting the concept of sustainable development. Based on the data of Chinese A-share listed companies from 2010 to 2023, this paper obtains the climate risk disclosure index by using text analysis method, empirically tests the positive impact of climate risk disclosure on corporate labor demand, and discusses two specific impact mechanisms. The following conclusions and suggestions are drawn: Climate risk disclosure significantly increases corporate labor demand. Mechanism tests show that the green technology innovation effect and the production scale expansion effect are the two main channels through which climate risk disclosure affects corporate labor demand. Heterogeneity tests indicate that climate risk disclosure has a more significant role in promoting labor demand for enterprises in high-tech industries and those with executives having overseas experience.

The research conclusions of this paper have important policy implications. As issues affecting sustainable development such as climate change and environmental pollution become increasingly serious, the country has introduced many policies at the level of environmental regulation. Our government proposes to accelerate the green transformation of the development mode, promote the green and low-carbon development of the economy and society as a key link to achieve high-quality development, and further advance the prevention and control of environmental pollution, and actively and steadily promote carbon peaking and carbon neutrality. However, at present, there are few domestic policies targeting climate risk disclosure, a specific sustainable development issue. A typical example is that in the "2021 TCFD Status Report", for the first time, more than 50% of companies disclosed their climate-related risks and opportunities. Although the number of enterprises disclosing information has grown rapidly, the overall information disclosure work still needs to be further improved. Therefore, China should improve policies related to climate risk disclosure as soon as possible, improve the regulatory and evaluation standards for enterprises in terms of climate risk, learn from foreign practical experience and formulate more targeted policies in combination with the country context. This not only has important policy implications for further stabilizing employment, alleviating the problem of difficult employment, and achieving high-quality economic development and employment goals, but also has important policy significance for enterprises to actively fulfill their social responsibilities, take the initiative to respond to climate change issues, and help the country achieve the "dual carbon" goals.

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