The Employment Effect of Carbon Emission Trading Pilots—Evidence from Chinese Listed Companies

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Abstract. Employment is fundamental to people's livelihoods. In recent years, the Chinese government has been exploring multidimensional approaches to address the coexistence of "difficulty in finding employment" and "difficulty in recruiting workers." Whether environmental protection can serve as a positive variable in improving employment is increasingly gaining policy attention. This paper takes the carbon emission trading pilot as the starting point, treating this market-based environmental regulation policy as a quasi-natural experiment, and employs a difference-in-differences method to systematically examine its impact on corporate employment levels. The baseline regression results show that the policy significantly increases the employment scale of A-share listed companies, and the conclusion remains robust after a series of robustness tests. Heterogeneity analysis reveals that the policy's employment-promoting effect is more pronounced in state-owned enterprises and heavily polluting firms. Further research on employment structure finds that the policy significantly increases the hiring of both high-skilled and low-skilled labor. The findings of this paper provide valuable empirical evidence and policy insights for enterprises to rationally allocate human resources, for governments to improve the employment security system, and for promoting full employment and sustainable economic development within the framework of environmental protection.

Keywords: Carbon Trading Pilot Policy; Corporate Employment; Labor Demand/Supply

1 Introduction

Nowadays, climate change has evolved from an environmental issue into a core variable profoundly shaping the development strategies of nations. Against this backdrop, China made a solemn commitment to the international community in 2020: to strive to peak carbon dioxide emissions by 2030 and achieve carbon neutrality by 2060. Four years later, at the COP29 conference, China further clarified the coverage scope of its Nationally Determined Contributions for 2035—covering the entire economy and all types of greenhouse gases—while maintaining the 2060 timeline for carbon neutrality. This signifies not merely a continuation of policy goals but also sends a clear signal:

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green and low-carbon development has transitioned from a "choice" to a "necessity," and will systematically reshape industrial structures and corporate behavior.

Among the various climate governance tools, the carbon emission trading mechanism is widely regarded as an important means of promoting greenhouse gas emission reduction due to its market-oriented nature and incentive compatibility[1,2,3]. The conceptual origins of this mechanism can be traced back to the "emissions trading" idea proposed by American economist John H. Dales in 1968. It was later formally established as a trading system for carbon dioxide emissions under the Kyoto Protocol in 1997, commonly known as "carbon trading." Since 2013, China has successively launched carbon emission trading pilots in eight regions: Shenzhen, Shanghai, Beijing, Guangdong, Tianjin, Hubei, Chongqing, and Fujian, gradually accumulating experience. From local pilots to the national integrated market, China's carbon market construction has undergone nearly a decade of exploration and consolidation, now serving as a crucial policy tool for promoting emission reductions in key industries.

Running parallel to the green transition is another issue of overarching importance—employment. In recent years, influenced by multiple intertwined factors, China's employment market has faced sustained pressure[4,5]. On one hand, the scale of new urban labor force entrants remains high; on the other, structural contradictions characterized by labor demand-supply mismatches are becoming increasingly prominent. In the first ten months of 2024, China's urban areas added 11.32 million new jobs, with 4.32 million unemployed individuals finding re-employment, while the surveyed urban unemployment rate stabilized at around 5%. Behind these figures lies the enduring reality of simultaneous pressure on total employment volume and structural contradictions. Well-designed environmental regulations may not only fail to harm employment but could instead become a driver of employment growth. Given China's current reality of pursuing the dual strategic goals of "stabilizing employment" and "dual carbon", understanding how the carbon emission trading policy affects corporate employment quantity and structure, and clarifying the underlying mechanisms, has become a pressing and complex practical issue.

This paper focuses on the carbon emission trading pilot policy, using data from Chinese A-share listed companies from 2013 to 2021, and establishes a difference-in-differences model to investigate the policy's impact on corporate employment levels. We find that the carbon trading policy has a significant positive effect on corporate employment levels, a conclusion that remains robust after various robustness checks, including tests for long-term policy effects and heterogeneous treatment effects. Subsequently, we decompose the impact mechanisms into a cost effect and a market expansion effect. We find that the market expansion effect has a significant positive impact on corporate employment, while the negative impact of the cost effect on employment is not significant. Furthermore, through heterogeneity analysis based on ownership type and industry emission levels, the results indicate that the carbon emission trading system increases labor demand to a greater extent in state-owned enterprises and heavily polluting firms.

Compared with existing research, this paper may contribute in the following aspects: First, it provides valuable reference for formulating "employment stabilization" policies, helping policymakers better understand the employment effects of carbon market

policies, thereby finding a balance between environmental protection and employment. Second, it reveals the positive role of the carbon market in prompting firms to increase employment scale and optimize employment structure, confirming that enterprises can achieve employment stabilization, growth, and structural improvement during the process of green and low-carbon development. This holds significant practical guidance for promoting corporate green transformation and achieving the "dual carbon" goals.

2 Theoretical Analysis and Research Design

2.1 Theoretical Analysis

Traditional research generally holds that stricter environmental regulations will increase corporate operating costs, reduce production scale and capital investment, and ultimately lead to a contraction in labor demand[6,7]. In the context of carbon emission trading pilots, to meet compliance requirements in the carbon market, enterprises often need to invest funds in clean technology upgrades or energy efficiency retrofits, which may constrain hiring in the short term. Additionally, some enterprises may need to purchase carbon allowances to cover excess emissions, further adding to their cost burden. However, the carbon trading mechanism inherently embeds incentive logic. By achieving emission reductions through technological innovation, enterprises can not only lower production costs and enhance product competitiveness but also sell surplus allowances in the market for profit. This "innovation compensation" effect significantly increases the expected returns on technological investment[8]. If enterprises can effectively manage their carbon emission costs, they may instead gain a favorable position in market competition, thereby driving production scale expansion and correspondingly increasing labor demand, especially for high-skilled and R&D-oriented positions. Furthermore, from a signaling perspective[9], an enterprise's compliance performance and disclosure behavior within the carbon market have important external effects. Actively participating enterprises can signal their commitment to environmental responsibility and sustainable development, attracting job seekers who identify with green values and injecting new vitality into their own development.

Based on the above analysis, this paper proposes the following research hypothesis:

Hypothesis 1: The impact of the carbon emission trading market on employment levels can be bidirectional. It may promote employment through innovation compensation and market expansion effects, or it may suppress employment due to cost pressures.

2.2 Research Design

Data Sources and Data Cleaning.

This paper takes Chinese A-share listed companies as the research sample. The data is sourced from the CSMAR database, and the study period is selected as 2013 to 2021. Following existing research practices, the raw data underwent the following processing: (1) Excluding companies in the financial industry; (2) Excluding listed companies with the status "ST" or "*ST"; (3) Excluding companies with data for only one year; (4) Winsorizing at the 1st and 99th percentiles.

Variable Selection.

The dependent variable in this paper is $lnemploy_{it}$, represented by the logarithm of the number of employees in listed company i in year t. The core explanatory variable did_{it} represents the policy dummy variable. It is assigned a value of 1 if the province or city where the enterprise is located was a pilot province or city for the carbon emission trading policy in year t, and 0 otherwise. X_{it} represents a set of firm-level control variables, including employee wages, return on total assets, return on equity, revenue growth rate, operating cash flow, fixed assets ratio, institutional investor ownership ratio, and the Herfindahl index for the industry.

Regression Model.

Given the temporal differences in when pilot regions were included in the carbon emission trading pilot program, this paper constructs a staggered difference-in-differences (DID) model to estimate the employment effects generated by the carbon emission trading system. The specific model specification is as follows:

$$lnemploy_{it}=\alpha+\beta did_{it}+\lambda X_{it}+\varphi_i+\mu_t+\eta_c+\varepsilon_{it} \quad (1)$$

This paper controls for firm fixed effects φ_i, city fixed effects η_c, and year fixed effects μ_t, with ε_{it} representing the random error term.

3 Empirical Results and Analysis

3.1 Baseline Regression Results

Table 1. Baseline Regression Results

	(1) *lnemploy*	(2) *lnemploy*
did	0.059***	0.058***
	（2.682）	（2.931）
Constant	7.595***	6.921***
	（912.019）	（81.932）
Controls	NO	YES
Firm-FE	YES	YES
City-FE	YES	YES
Year-FE	YES	YES
N	28057	28057
R^2	0.901	0.934

Note: The values in parentheses are the reported t-statistics; ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Unless otherwise specified, the same applies to the tables below.

Table 1 reports the baseline regression results of the impact of the carbon trading pilot policy on corporate employment levels. In Column (1), only the core explanatory variable is included while controlling for firm fixed effects, region fixed effects, and year fixed effects. Column (2) includes all control variables. The coefficient of the policy

dummy variable is significantly positive at the 1% level. In the regression results of Column (2), the coefficient of the policy dummy variable is 0.058, and it is significantly positive at the 1% level, indicating that, holding other conditions constant, the employment level of enterprises in pilot regions is 5.8% higher than that of enterprises in non-pilot regions. The employment-enhancing effect of the carbon trading policy also demonstrates clear economic significance, thereby addressing the question raised in Hypothesis 1.

3.2 Robustness Tests

Long-Term Policy Effects.

We consider the potential lagged effects of the policy dummy variable on corporate employment. The policy implementation may not immediately affect the number of employees in enterprises; rather, the effects may gradually manifest over a period following policy implementation. We re-estimated the model by lagging the core explanatory variable did by one period. The regression results are presented in **Table 2** Column (1). Furthermore, changes in the number of employees may also not be instantaneous but may gradually adjust over time in response to external policy changes. For instance, enterprises might have begun adjusting their workforce size prior to the implementation of the carbon emission trading policy in anticipation of its impact. This paper further examines endogeneity concerns by leading the dependent variable *lnemploy* by one period and re-estimating the model. The regression results are shown in **Table 2** Column (2). Finally, we simultaneously consider the lagged effect of the explanatory variable and the forward-looking adjustment of the dependent variable by lagging the core explanatory variable did by one period while leading the dependent variable *lnemploy* by one period. The regression results are presented in **Table 2** Column (3). In all three regressions, the did coefficients are significantly positive and consistent with the baseline regression results, confirming the positive effect of the carbon emission trading pilot policy on corporate labor employment.

CSDID Test.

Table 2. Robustness Tests

	(1) *lnemploy*	(2) f_1.*lnemploy*	(1) f_1.*lnemploy*	(2) *lnemploy*
did		0.042**		0.075***
		（2.182）		（2.830）
l_1.*did*	0.046**		0.038*	
	（2.468）		（1.721）	
Controls	YES	YES	YES	YES
Firm-FE	YES	YES	YES	YES
City-FE	YES	YES	YES	YES
Year-FE	YES	YES	YES	YES
N	22317	22317	19837	28057
R^2	0.913	0.923	0.931	0.931

Following the approach of Callaway and Sant'Anna (2021), this paper modifies the econometric model and employs the more robust CSDID estimator. This method distinguishes between different aggregation schemes for policy effects across groups, including aggregating all groups and time periods, aggregating a single group across all time periods, and aggregation using the event study method. Finally, the average treatment effect is derived from all results. **Table 2** Column (4) shows that the regression coefficient (ATT) estimated by CSDID under the average treatment effect is 0.075 and is significant at the 1% statistical level, confirming the positive effect of the carbon emission trading policy on the number of employees in enterprises.

4 Mechanism Analysis and Heterogeneity Analysis

4.1 Mechanism Analysis

This paper uses operating revenue to measure the production scale of enterprises, taking the logarithm of operating revenue (*lnrevenue*), and uses this as the dependent variable for regression. Column (1) of **Table 3** presents the estimation results of did on *lnrevenue*. The estimated coefficient of did is significantly positive, indicating that the carbon trading pilot policy significantly increased the production scale of enterprises. Subsequently, this paper uses employee wages as a cost variable, taking this as the dependent variable for regression. Column (2) of **Table 3** presents the estimation results of did on Wage. The estimated coefficient of did is not significant even at the 10% level. It can be considered that the impact of the carbon trading pilot policy on corporate costs is insufficient to suppress employment levels.

4.2 Heterogeneity Analysis

Existing research indicates that market-based environmental regulation tools have significant advantages in stimulating state-owned enterprises to engage in green innovation. Due to their inherent advantages in resource acquisition, state-owned enterprises can obtain production factors at lower costs, enabling them to more effectively absorb and pass on the costs increased by pollution control when facing environmental regulations. This capability not only enhances their production efficiency but also strengthens their market competitiveness. Therefore, the promoting effect of the carbon emission trading system on labor demand may be more pronounced in state-owned enterprises. This paper conducts group regressions based on different types of enterprise ownership. The regression results are shown in columns (3) and (4) of **Table 3**. The regression coefficient of did for the sample of state-owned enterprises is larger than that for non-state-owned enterprises. This indicates that the carbon emission trading system increased labor demand to a greater extent in state-owned enterprises.

In recent years, with the proposal of the "dual carbon" goals and increased societal attention on sustainable development, heavily polluting enterprises face stricter environmental regulations and receive more attention and supervision from various sectors of society. To explore whether heavily polluting enterprises make greater efforts regarding carbon emissions, this paper conducts heterogeneity analysis based on whether

an enterprise belongs to a heavily polluting industry. Columns (5) and (6) of **Table 3** present the estimation results of the impact of the policy dummy variable on employment levels in heavily polluting enterprises and non-heavily polluting enterprises. The results indicate that the carbon emission trading system increased labor demand to a greater extent in heavily polluting enterprises.

Table 3. Mechanism Analysis and Heterogeneity Analysis

	Mechanism		**Heterogeneity**			
	(1) *Lnrevenue*	(2) *Wage*	(3) *SOE*	(4) *Non-SOE*	(5) *Heavily Polluting*	(6) *Non-heavily Polluting*
did	0.077***	0.040	0.074***	0.053**	0.069*	0.046**
	（3.427）	（1.530）	（2.672）	（2.014）	（1.857）	（2.047）
Controls	YES	YES	YES	YES	YES	YES
Firm-FE	YES	YES	YES	YES	YES	YES
City-FE	YES	YES	YES	YES	YES	YES
Year-FE	YES	YES	YES	YES	YES	YES
N	28057	28057	9322	18735	7931	20050
R^2	0.913	0.923	0.931	0.931	0.942	0.930

4.3 Extended Analysis

Table 4. Extended Analysis

	(1) ***Bachelor's Degree and Above***	(2) ***Associate Degree***	(3) ***High School***
did	0.058***	0.024	0.056*
	（2.795）	（1.114）	（1.781）
Controls	YES	YES	YES
Firm-FE	YES	YES	YES
City-FE	YES	YES	YES
Year-FE	YES	YES	YES
N	22317	22317	19837
R^2	0.913	0.923	0.931

This paper further examines the impact of the carbon emission trading pilot policy on the skill structure of corporate employment, grouping employees according to their education level. Employees are divided into three groups: bachelor's degree and above, associate degree, and high school. On this basis, the paper investigates the policy's impact on the educational structure of corporate employees. Columns (1)-(3) of **Table 4** present the results. The coefficient of the carbon emission trading policy dummy variable is significant at the 5% level for the high-skilled group, possibly because the implementation of the carbon emission trading policy prompts enterprises to realize the

need to better respond to relevant environmental requirements and enhance their competitiveness under the carbon emission trading system. The coefficient is significant at the 10% level for the low-skilled group, possibly because during the implementation of the carbon emission trading policy, some basic, labor-intensive jobs are still undertaken by low-skilled employees with high school education levels.

5 Conclusion and Policy Implications

Due to the impact of the COVID-19 pandemic and the interplay of multiple domestic and international factors, China's current employment situation remains complex and severe. Urban employment pressure persists at a high level, and the structural contradiction characterized by the coexistence of "difficulty in finding employment" and "difficulty in recruiting workers" is becoming increasingly prominent. Enterprises, as key entities in stabilizing employment at the micro level—while undertaking emission reduction actions in the process of achieving the "dual carbon" goals—can they simultaneously promote an increase in employment levels? Based on data from A-share listed companies on the Shanghai and Shenzhen stock exchanges from 2013 to 2021, this paper examines the impact of market-based environmental regulation on corporate employment levels and its underlying mechanisms from a micro perspective. The findings reveal that the carbon emission trading pilot policy significantly increased corporate employment levels, a conclusion that remains robust after various robustness tests. Heterogeneity analysis indicates that the policy's employment-promoting effect is more pronounced in state-owned enterprises and heavily polluting firms. Further examination of the employment skill structure reveals that the policy implementation led to an increase in enterprises' hiring of both high-skilled and low-skilled employees.

The above conclusions offer several implications for policy formulation. First, efforts should be accelerated to replicate and scale up the pilot experiences to the national level, enabling the employment dividends of the carbon emission trading system to benefit a wider range of regions. During this scaling-up process, it is necessary to continuously refine the allowance allocation schemes based on variations in regional industrial structures, industry characteristics, and enterprise differences, ensuring both policy fairness and implementation effectiveness. Second, efforts should focus synchronously on both the labor supply and demand sides to improve the supporting market mechanisms. On one hand, relying on vocational skills training and employment guidance service systems, we can enhance workers' skill reserves and job matching capabilities, thereby supporting enterprises' demand for high-skilled talent. On the other hand, establishing efficient and smooth employment information platforms can guide the orderly cross-regional and cross-industry flow of labor, assisting enterprises with strong labor demand in achieving efficient human resource allocation. Third, targeted support should be strengthened for enterprises most affected by the policy, such as state-owned enterprises, capital-intensive enterprises, and heavily polluting enterprises. This can be achieved through measures such as establishing special subsidies for low-carbon transformation, increasing support for green technology R&D investment, and implementing tax incentives for enterprises that take the lead in energy conservation

and carbon reduction. These measures can alleviate the short-term cost pressures arising from emission reductions and create space for unleashing labor demand.

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