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The Impact and Mechanism of the Creation of China's Ecological Civilization Building Demonstration Zones on Labor Employment

Jingwen Fu[1], Xiangle Shangguan[1*], Yusha Wei[2], Faiza Saleem[2,3]

[1]School of Economics and Management, Northeast Agricultural University, Harbin, Heilongjiang, 150030, China.

[2]Graduate School of Businesss, University Sains Malaysia, Penang, 11700, Malaysia.

[3]Department of Management Sciences, University of Wah, Wah Cantt, 47040, Pakistan.

[*]Corresponding author: Xiangle Shangguan, Email: shangguanxiangle99@163.com

Abstract: Taking the ecological civilization construction demonstration zones (ECCDZ) establishment as a "quasi-natural experiment," this study aims to investigate the impact of establishing ECCDZ on enterprise labor employment using the difference-in-differences (DID) approach. The ECCDZ establishment has markedly constrained enterprise labor employment, as their creation can decrease production scale and amplify environmental governance costs, and this finding has passed a series of robustness tests.This study also explored its impact on enterprise labor employment in different contexts. Overall, the findings are decisive in attaining a fruitful balance between ecological governance and other related factors and stable employment in ecological civilization construction.

Keywords: Ecological civilization construction demonstration zone, Labor employment, Multiphase difference-in-differences (DID) method

1 Introduction

Ecological prosperity serves as the premise for civilization prosperity, and ecological civilization is vital for the sustainable progress of humanity. Economic progress in developing countries is manifested by substantial pollution and active labor force participation. Contrary to soil and river pollution, air pollution exerts a more detrimental impact on human behavior and economic progress owing to its agility and universal nature (Feng, Du, Lin, & Zuo, 2020), particularly fine particulate matter PM2.5 (Wang et al., 2017), which adversely affects people's health, production, and lifestyle (Zheng, Wang, Sun, Zhang, & Kahn, 2019). Regarding environmental pollution, resource constriction, and ecological deterioration (Guo & Xiong, 2023), Xi Jinping stipulated the critical need of Chinese modernization in the 20th Party Congress report, emphasizing nurturing a peaceful coexistence of humans and nature and attaining modernization that supports humans–nature harmony. Accordingly, it is paramount to integrate ecological civilization construction into the entire process of economic, political, cultural, and social construction, and decisively endorse green development (Lin, 2023). The Central Committee of the Communist Party of China (CPC) prioritizes ecological civilization construction, indicating its firm position and strategic implication in the cause of socialism with Chinese attributes in the new era. Nevertheless, as the coupled growth of economy and environment enters a major stage, the articulation of environmental policies warrants considering the heterogeneity of resource and environmental endowments, development stages, and variations in key functions of diverse regions (Zhang & Hu, 2023).

The ecological civilization construction demonstration zone (ECCDZ) is integral to progressing ecological civilization, which is led by human behavior, supported by the natural environment, and the essence of resource flow (Liang, Xiao, & Liu, 2022).The incessant consolidation of ecological civilization construction raises concerns that environmental supervision could affect economic growth, and the most direct indicator is to indirectly influence enterprises' labor employment decisions by influencing workers' marginal utility and other ways. Employment is a fundamental issue to people's livelihoods and, thus, the Party Central Committee has paid great attention to it. Besides strengthening the ecological civilization, it is still essential to consider social and livelihood issues represented by "stable employment" so as to encourage the stable and synchronized

development of the social economy (Huang & Lanz, 2018; Li & Lin, 2022; Liu et al., 2017). The progression of any industrial economy cannot be attained without human work, which constitutes the foundation of economic development. The initial phase of reform and opening-up required enterprises to employ a large number of labor forces for extensive production and large-scale expansion. As the pulling effect of widespread economic growth on the labor force is not feasible for a long period, the combined effect of macro-policies, such as labor employment and environmental protection, has gradually gained momentum. Hence, the response of labor employment to environmental alteration has become a research hotspot among academicians.

Based on the theoretical and practical conditions discussed above, this study examines the correlation between the ECCDZ and labor employment. Theoretically, the prevailing research on the ECCDZ primarily investigates the effect on carbon emission (Wang et al., 2022; Zhang & Wang, 2024), ecological efficiency (Liang et al., 2022; Lu & Xiong, 2020) and level evaluation (Xiong, 2020; Li & Hu, 2015).In addition, research on the relationship between environmental regulations and labor employment generally explores the impact of environmental regulations on variations in enterprise labor demand or the quantity of labor (He et al., 2020; Vona et al., 2018). Most studies on factors influencing enterprise labor demand adopted macro-perspectives, converging on facets like government regulations, economic structure, technological progress, and globalization (Bas & Paunov, 2021; Leblebicioğlu & Weinberger, 2021; Li, Liu, & Sun, 2021) or micro-perspectives, including employee bargaining power, corporate risk management, and financialization of corporations (Blanchard & Giavazzi, 2003; Palumbo & Tridico, 2019; Petreski, 2021). Indeed, some studies optimistically claimed that environmental regulations inspire innovation, offset employment pressure (Anger & Oberndorfer, 2008; Ferris et al., 2014; Gray et al., 2014), and even positively influence employment promotion (Berman & Bui, 2001). Meanwhile, other studies claimed that environmental regulations decrease labor demand by increasing various costs of enterprises (Wang et al., 2022) and expel productive investment (Chen et al., 2018; Cui & Jiang, 2021; Zhang, 2019). The ECCDZ establishment is a multifaceted and methodical process. The existing research does not include the ECCDZ establishment and enterprise labor employment within the same framework, resulting in a scarce investigation of the correlation between the two.

This study aims to empirically examine the correlation between the ECCDZ establishment and labor employment using the difference-in-differences (DID) method by selecting cities and districts included in the ECCDZ list as research samples. Of note, mechanism research comprises factors like environmental governance costs and production scale. From the theoretical viewpoint, this study investigates the impact of the ECCDZ establishment on labor employment, thereby providing a new outlook for related research. Regarding research content and mechanism analysis, this study offers evidence of the impact of the ECCDZ establishment on labor employment through two channels—environmental governance cost and production scale, and explores the variability in the effects of establishing the ECCDZ on labor employment through four dimensions, namely, enterprise scale, ESG rating, factor intensity, and external environmental supervision. Moreover, this study indirectly confirms the scientific validity and efficacy of the ECCDZ establishment, creates an effective match between different policies for establishing the ECCDZ, and thus realizes the resourceful synergy between employment growth and ecological civilization construction, as well as pursues a better development model.

2 Literature Review and Hypothesis Development

The ECCDZ establishment will prompt enterprises to proactively perform innovative activities, create a unique competitive advantage, and thereby promote their employment. With clear assessment indicators, enterprises can flexibly and completely alter production plans or promote technological innovation around indicators. In addition, enterprises must take proactive initiatives to improve conventional production methods and use resources more proficiently to adhere to environmental regulations. Based on Porter's hypothesis, environmental supervision in the ECCDZ can stimulate enterprises to achieve technological innovation[33], thereby causing an innovation compensation effect. In turn, this could improve productivity and technology (He et al., 2020; Morgenstern, Pizer, & Shih, 2002), counterbalance the cost of environmental regulation, increase enterprises' internal demand for environmentally clean technology, boost productivity that enables enterprises to expand their market share (Qiu, Wang, & Liu, 2021), promote enterprises' labor demand (Bezdek, Wendling, & DiPerna, 2008; Horbach & Rennings, 2013), and eventually advance enterprises' productivity, competitiveness, and profits. For example, Ren et al. (2019) and Ren et al. (2020) demonstrated that the environmental regulation scheme implemented in China surged the demand for labor within enterprises.

Besides, to comply with stringent environmental regulations, enterprises need to alter their production processes or install emission-reducing equipment for more efficient resource utilization and, thus, producing less pollution. This step is expected to raise the demand for technical personnel, including environmental protection engineers, ecological management personnel, and environmental inspectors, which will promote the employment of enterprises (Liu & Xiao, 2022). Bezdek et al. (2008) reported that the enactment of stringent environmental standards in the United States stimulated economic development and generated over 300,000 jobs.

The ECCDZ can cause higher production costs, leading to decreased demand for their outputs and, thus, decreased demand for inputs. The comprehensive economic development model in which enterprises depend on factor accretion has been converging. Besides, environmental regulation will compel some heavily polluting enterprises to collapse and transfer or force productive investment through downsizing, which would result in unemployment, turnover, and costly labor transition (Hille & Möbius, 2019;

Walker, 2013; Wang et al., 2022). Hille and Möbius (2019) and Liu et al. (2021) suggested that environmental regulations are more expected to adversely affect labor demand within high-pollution, energy-consuming, and labor-intensive industries. Moreover, rigorous environmental policies might increase enterprises' production costs, forcing them to decrease output and curtail inputs, causing a decline in labor demand (Liu & Zhang, 2021; Liu & Zheng, 2014). Wang et al. (2022) reported that environmental policies amplified the expenses related to pollution control, causing a 6.8% decline in enterprise labor demand. Liu et al. (2021) stated that environmental policies focusing on pollution control caused a 3% decline in labor demand among Chinese manufacturing firms. Kahn and Mansur (2013) and Walker (2013) illustrated that regions/industries facing stricter environmental regulations had a lower employment growth rate (around 10%) than regions/industries under regulation.

Hence, the following hypotheses are proposed:

H_1: The ECCDZ establishment will inhibit labor employment.

During the ECCDZ establishment, the government will oversee enterprises through air and water quality in the assessment indicators of ecological environmental quality improvement, as well as energy consumption, water consumption, and carbon emission intensity in the assessment indicators of resource conservation and utilization. In response to the government's call, enterprises primarily take measures like production scale reduction and executing pollution control activities that might affect their labor employment.

The ECCDZ establishment may boost labor employment by surging the environmental governance cost, which, in turn, are categorized into source governance costs and intermediate governance costs. Regarding source governance costs, emissions are curbed by increasing investment in environmental protection and introducing decontamination devices. In addition, washing and other processes are required before pollutant discharge, further necessitating the focus on the quality of employees and possibly stimulating the labor demand for enterprise operation and maintenance equipment (Bezdek, Wendling, & DiPerna, 2008). Vona et al. (2018) suggested that environmental regulation could surge the demand for highly skilled labor inputs within enterprises. He et al. (2020) demonstrated that environmental regulations can incentivize enterprises to

increase their pollution control staff in alignment with compliance objectives. Porter and van der Linde (1995) claimed that environmental regulations could spur enterprises to participate in innovative activities, adopt cleaner production technologies and equipment, and enhance productivity and competitiveness, thereby expanding production and employment prospects. Regarding intermediate governance costs, significant capital costs, technical costs, and human costs are needed to increase enterprise labor employment if some production lines with serious pollution exceed the standard and reestablish the development mode of production lines. Morgenstern et al. (2002) and Fankhauser and Jotzo (2018) argued that environmental regulations increase enterprises' environmental governance costs, but could also prompt them to adopt cleaner production methods, thereby generating employment opportunities associated with green initiatives.

Considering the governance source, the ECCDZ establishment could constrain labor employment by surging enterprises' environmental governance costs. Such environmental protection inputs, such as investments in pollution reduction equipment and additional personnel, directly raise enterprises' procurement and labor costs. Additional costs might decrease enterprises' profits and affect reinvestment, causing an overall decline in labor demand, which, in turn, could hamper the long-term development prospects of enterprises. From the intermediate governance viewpoint, if the direct closure of a production line with serious pollution exceeds the standard, it will disturb the production efficiency and scale of the enterprise, potentially causing a direct decline in labor demand. Besides, enterprises may attempt to innovate products or develop environmentally beneficial technologies, thereby swelling the demand for technical personnel[29]. Per the theory of regulatory compliance costs, an enterprise will incur increased environmental governance costs regardless of the tactic adopted by it to alleviate environmental pollution, which could restrict its production scale, potentially declining labor demand. Autor et al. (2013) and Curtis (2018) also concur that environmental regulations could impose added costs for pollution control on enterprises, potentially harming their productivity and market competitiveness. Eventually, this situation could result in job losses and adversely affect economic growth.

Hence, the following hypotheses are proposed:

H$_2$: The ECCDZ establishment will inhibit labor employment by surging the environmental governance cost.

The ECCDZ establishment may stimulate labor employment by decreasing the production scale. In the short term, a series of environmental policies introduced by the ECCDZ could adversely affect the enterprise economy, resulting in higher production costs and decreased production scales. In response, enterprises might increase the added value of their products through technological innovation and other tactics to sustain profitability. Moreover, this approach could increase the demand for highly skilled labor. In the long term, it might enhance the local air quality and amend the industrial structure, thereby attracting talent and encouraging enterprise labor employment. For instance, by exemplifying air pollution regulations from the South Coast Air Quality Management District in the United States, Berman and Bui (2001) observed that sterner environmental regulations, despite decreased enterprise production scales, did not constantly result in reduced refinery employment. Actually, in some cases, they might even marginally increase labor demand.

In contrast, the ECCDZ establishment may hinder labor employment by decreasing the production scale. Under the restrictions of environmental regulations, enterprises should assess the economic costs of decreasing the production scale, such as directly reducing operating revenues and inventory add-ons, and decide whether to participate in cleaner production activities. Under the recognized production mode, enterprises must concentrate on pollution control in the short-term production process to fulfill the government-mandated emission levels. One of the fastest methods is to decrease the production scale, causing enterprises to form labor saturation in the short term, thereby decreasing labor employment. Furthermore, environmental regulations affect enterprise labor demand by surging both environmental compliance costs and production costs (Liu, Shadbegian, & Zhang, 2017), extracting production investment or reducing production scale (Walker, 2013), and thus reducing labor demand.

Hence, the following hypotheses are posited:

H$_3$: The ECCDZ establishment will hinder labor employment by decreasing the production scale of enterprises.

3 Materials and Methods

3.1 Research Design

In recent years, the DID approach has become one of the leading methods for policy assessment. The core concept is to treat the implementation of new policies as a "natural experiment" that is external to the economic system. While it could cause differences in enterprise labor employment after the ECCDZ establishment, it might also cause differences in labor employment between demonstration zones and non-demonstration zones concurrently. Using the DID model for estimation can scientifically assess the net impact of policy implementation. Thus, the ECCDZ list is considered a quasi-natural experiment. Accordingly, the following multistage DID model was constructed for testing:

$$Labor_{it} = \phi_0 + \phi_1 Treat \times Post + \omega C_{it} + \alpha_i + \beta_t + \gamma_i + \varepsilon_{it} \quad （1）$$

where $Labor_{it}$ denotes enterprise labor employment; i、t denote cities and time; C_{it} denotes a control variable; ω denotes the parameter to be estimated for the control variable; α_i、β_t、γ_i denotes the fixed effects for industry, time, and province; ε_{it} denotes the random error term; $Treat \times Post$ denotes the virtual variable of the ECCDZ; ϕ_0 denotes the constant term; ϕ_1 denotes the core concern coefficient reflecting the policy impact of the ECCDZ.

3.2 Sample and Data

The initial set of national ECCDZ was revealed in 2017. Subsequent sets, ranging from the second to the sixth, were announced from 2019 to 2022 (collectively referred to as the "List"). The list comprises prefecture-level cities, districts, and counties. Considering the precision of the objects examined, the actual effect of policy implementation, and data availability, we finally selected the administrative units (at the city and district levels) listed between 2017 and 2021 as the research objects. The experimental group comprised 207 cities and districts selected from the list, whereas the control group comprised the other 197 cities and districts on the list, with panel data analyzed for both sets. The data were obtained from the *China City Statistical Yearbook* and the *Provincial and Municipal Statistical Yearbook*, while the absent data were added using the smoothing index method.

In addition, we used the annual data of listed companies during 2007–2022, excluded financial, ST, and *ST listed companies under the classification standard of the China Securities Regulatory Commission (CSRC), and removed samples lacking crucial data. To eliminate the effect of outliers on the robustness of regression results, we used 1% Winsorize for all continuous variables. Finally, 5055 listed companies and 39,999 sample observations were collected. Of note, all enterprise data in this study was collected from the CSMAR database.

3.3 Variables

Explained variable: enterprise labor employment (*Labor*) is denoted by the natural logarithm of the number of employed workers (Wang & Zhou, 2023).

Explanatory variable: the ECCDZ (*Treat×Post*) is equal to the cross-term of the experimental group pseudo-variable *(Treat)* and the experimental period pseudo-variable (*Post*). Of these, *Treat* is the pseudo-variable of the experimental group, which signifies whether it appears in the ECCDZ list. Each batch of zones that appeared in the list of national ECCDZ was set to 1, otherwise to 0. Furthermore, *Post* is a pseudo-variable in the experimental period, that is, the year that appears in the ECCDZ list and the years after that were set to 1, and the remaining were set to 0.

Control variables: the enterprise size is denoted by the natural logarithm of the enterprise's total assets. Typically, larger enterprises tend to employ more labor. Besides, indicators like the asset–liability ratio, return on equity, total asset turnover, quick ratio, and fixed assets ratio were used to evaluate enterprise operations. Of note, asset–liability ratio (*Lev*) = total liabilities/total assets; return on equity (*ROE*) = net profit after tax/average net assets of the enterprise; total assets turnover (*ATO*) = net operating operation revenue/average total assets; quick ratio (*Quick*) = quick assets/current liabilities; fixed assets ratio (*FIXED*) = ending fixed assets/ending total assets. The better the enterprise's operations, the more labor will be employed. In addition, management age and management compensation were used to depict the characteristics of senior executives. While *TMTAge* is denoted by the average age of management, *TMTPay* is denoted by the natural logarithm of the total management salary. Furthermore, board size, proportion of independent directors, and *Dual* were used as depictions of the corporate governance

structure. Notably, *Board* is evaluated by the natural logarithm of the number of directors; *Indep* is equal to independent directors/directors; *Dual* is a dummy variable. If the chairman and general manager were the same person, the value was 1, otherwise it was 0. Regarding macro-economy, the level of economic development (*GDP*) is denoted by the natural logarithm of the gross domestic product (gross domestic product). Besides, we included control variables for industry, year, and province, as shown in Table 1. Table 2 presents descriptive statistics of the variables.

Table 1. Variables

types of variables	variables	symbols	definition
Explained variable	Labor employment in enterprises	Labor	natural logarithm of the number of employed labors
Explanatory variable	Ecological construction	Treat×Post	When the enterprise is located in the first five batches of ecological zones, it is 1, otherwise it is 0.
Control variables	Enterprise size	Size	The natural logarithm of total assets as of the reporting period
	Asset-liability ratio	Lev	total liabilities / total assets
	Return on equity	ROE	net profit after tax / average net assets
	Total assets turnover	ATO	net operating income / average total assets
	Quick ratio	Quick	quick assets / current liabilities
	Management age	TMTAge	average age of management
	Management compensation	TMTPay	natural logarithm of total management salary
	Proportion of fixed assets	FIXED	ending fixed assets / ending total assets
	Economic	GDP	natural logarithm of gross domestic product
	board size	Board	natural logarithm of the number of directors

Proportion of Independent directors	Indep	independent directors / directors
Chair-CEO duality	Dual	If the chairman and general manager are the same, the value is 1, otherwise, it is 0.
Industry	IND	Industry pseudo-variable
Year	YEAR	Year pseudo-variable
Province	PROVINCE	province pseudo-variable

Table 2. Descriptive statistics

Variables	Sample size	Average	Min	Median	Max	SD
Labor	39999	7.564	7.543	2.743	11.164	1.378
Treat×Post	39999	0.311	0	0	1	0.463
Size	39999	22.163	21.980	19.267	27.003	1.342
Lev	39999	3.303	2.307	0.982	19.007	2.892
ROE	39999	0.056	0.070	-0.940	0.503	0.169
ATO	39999	0.648	0.546	0.048	2.714	0.455
Quick	39999	1.876	1.166	0.149	15.485	2.262
TMTAge	39999	49.153	49.220	40.290	56.530	3.208
TMTPay	39999	15.243	15.250	12.292	17.390	0.804
FIXED	39999	0.215	0.182	0.002	0.721	0.163
GDP	39999	47.612	39.065	2.020	129.119	33.062
Board	39998	2.126	2.197	0.693	2.89	0.202
Indep	39999	37.546	36.360	0	100	5.604
Dual	39999	0.271	0	0	1	0.444

4 Results and Discussion

4.1 Reference regression

Using the multistage DID model, we analyzed the impact of the ECCDZ establishment on enterprise labor employment. Table 3 presents the findings, columns (1) and (2) display the impact of the ECCDZ establishment on enterprise labor employment after the progressive introduction of control variables. The findings demonstrated that after accounting for individual, time, region, and industry effects, the coefficient of the interaction term for the ECCDZ, that is, the estimated coefficient of the explained variable (*Treat×Post*), is remarkably negative notwithstanding the addition of control variables. Considering the regression coefficient of the fixed-effects model comprising all control variables in Table 3 [column (2)] as the final result, the estimated coefficient of the explained variable (*Treat×Post*) was −0.059 ($p < 0.01$). This finding suggests that, compared with non-ECCDZ, the ECCDZ establishment exerted a detrimental impact on labor employment, thereby hindering the enhancement of labor employment. Hence, H1 is validated.

Table 3. Results of reference regression

Variables	Labor	
	(1)	(2)
Treat×Post	-0.055**	-0.059***
	(-2.187)	(-3.259)
Size		0.71***
		(41.731)
Lev		-0.003
		(-0.577)
ROE		-0.153***
		(-4.898)
ATO		0.311***
		(10.505)
Quick		-0.027***
		(-4.626)
TMTAge		0.012***
		(3.326)

TMTPay		0.065***
		(4.399)
FIXED		0.694***
		(7.916)
GDP		0.002*
		(1.766)
Board		0.117**
		(2.115)
Indep		0.002
		(1.536)
Dual		0.011
		(0.692)
constant term	8.043***	-10.312***
	(8.647)	(-10.472)
Industry fixed effect	Yes	Yes
time fixed effect	Yes	Yes
region fixed effect	Yes	Yes
N	39999	39998
Adj. R^2	0.087	0.352

Note: ***, **, and * represent significance levels of 1%, 5%, and 10%, respectively. The *t*-value in parentheses is calculated using the clustering robust standard error adjusted at the firm level.

4.2 Robustness test

4.2.1 Parallel trend test

In prior empirical studies, both the experimental and control groups needed to display parallel trends when using the DID model. Before policy implementation, no notable differences were observed in labor employment between the experimental and control groups. Only in this way can the effect coefficient replicate the impact of the national ECCDZ. Hence, based on Beck et al. (2010) following the release of the test roster, the impact of the ECCDZ establishment differed between the experimental and control groups. Considering the year before the list was published (i.e., 2016) as the baseline, Figure 1 shows the findings. In the 8 years leading up to the release of the ECCDZ list, the estimated coefficients were not statistically significant, suggesting that there was no discernible difference in labor employment between demonstration zones and non-demonstration

zones before the publication of the list, thereby validating adherence to the parallel trend hypothesis. Following the publication of the ECCDZ list, it started exerting a visible policy impact, gradually augmenting its overall negative impact, indicating that the ECCDZ establishment exerts a sustainable restraining effect on labor employment.
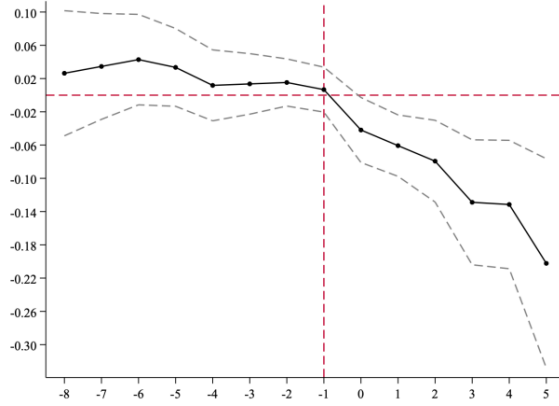

Figure 1. Results of the parallel trend test.

4.2.2 Placebo test

While the baseline regression results indicate that the ECCDZ establishment reduced labor employment, these results might be influenced by additional random factors like environmental conditions and policies. Thus, we obtained the random policy processing group through random sampling and randomly generated the policy implementation year, as well as generated the interaction terms of pseudo-virtual policies for the placebo test (Li, Liang, & Li, 2022).

Regression analysis was performed across 1000 random sampling iterations using model (1) to improve the credibility of the placebo test. Figures 2 and 3 present the placebo test results. Figure 2 shows that the majority of test coefficients are centered around 0.00, suggesting a significant deviation from the estimated coefficient of the benchmark regression (dashed line value = 0.059). Figure 3 shows that the t-values of most random sampling tests are close to 1, suggesting a significant difference from the t-value in the benchmark regression (solid line value = -3.26). Notably, all these results establish that the robustness of baseline regression results is less influenced by other policies or random factors.
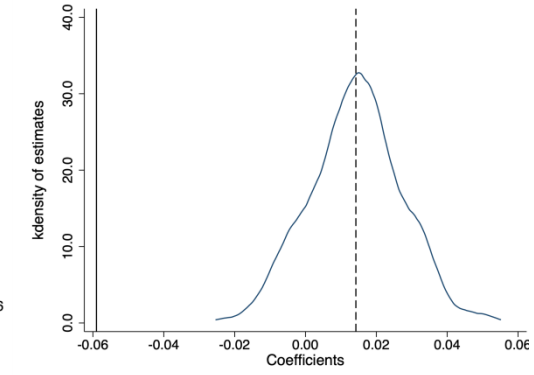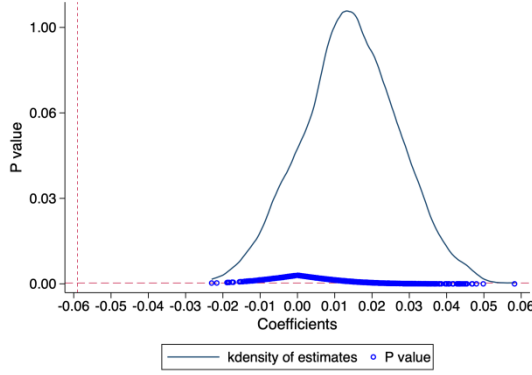
Figure 2. Placebo test coefficient.　Figure 3. The *t* value of the placebo test.

4.2.3 Heterogeneity of DID

In the multistage DID regression analysis, some weights could be negative because of the weighted average of various treatment effects. Considering the heterogeneity of treatment effects, potential bias could exist in the estimation of the bidirectional fixed-effects model. Finally, the estimated treatment effects with bias could even exhibit the opposite sign of the actual treatment effects.

Thus, per Callaway and Sant'Anna (2021), we used the inverse probability weighted least square method to calculate the "heterogeneity-robustness" estimator for further stability tests of benchmark regression. The model is as follows:

$$ATT_{imp}(g,t) = E\left[\left(\frac{G_g}{E[G_g]} - \frac{\frac{p_g(X)C}{1-p_g(X)}}{E\left[\frac{p_g(X)C}{1-p_g(X)}\right]}\right)(Labor_t - Labor_{t-1})\right] \quad （2）$$

$$\theta = \sum_{g\in\varsigma}\sum_{t=2}^{T}\omega(g,t)\times ATT_{imp}(g,t) \quad （3）$$

where ATT_{imp} presents nonparametric estimators under inverse probability weighted least square method; g denotes the group divided per the first treatment time; t is time; $\omega(g,t)$ denotes different weight combinations; θ represents the average treatment effect under different weight combinations.

We calculated the average treatment effect through the four weight combination methods explained in Callaway and Sant'Anna[55]: (1) simple weighted average treatment effect (Simple ATT); (2) group average treatment effect (Group ATT), the average treatment effect of weighted summation grouped per the first treatment time (g); (3)

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dynamic average treatment effect (Dynamic ATT), average treatment effects of weighted summation grouped by time since the first processing; (4) calendar average treatment effect (Calendar ATT), average treatment effect weighted and summed by normal year grouping. Table 4 presents the calculation results, where all the average treatment effects derived from the four methods exhibit considerable negative correlations. Hence, this alignment with the benchmark regression confirms the robustness of the benchmark findings.

Table 4. Robustness results of heterogeneity

Variables	Coefficient	Std. err.	z	P>|z|
Group ATT	-0.144[**]	0.073	-1.97	0.049
Simple ATT	-0.181[**]	0.083	-2.17	0.030
Calendar ATT	-0.139[*]	0.074	-1.87	0.062
Dynamic ATT	-0.234[**]	0.107	-2.19	0.028

4.2.4 Endogeneity

To address endogeneity, we conducted the following study. Table 5 presents (1) The one-period lag of the ECCDZ (*Treat×Post*) was used as the dependent variable for estimation. The regression coefficients of model (1) were significant at the 5% level, indicating a lagged effect of the ECCDZ establishment on enterprise labor employment, which also suggests that the endogeneity issue is not severe at the outset. (2) Ecocity and county construction (*Treat× Post*), which lagged one and two phases, was selected as an instrumental variable for the current ECCDZ (*Treat× Post*) and regressed using the fixed-effects Two Stage Least Square (2SLS) model. The outcomes of model (2) demonstrate that the regression coefficients were significant at the 1% level. (3) Considering that Generalized Method of Moments (GMM) estimation is more effective than 2SLS estimation in the case of autocorrelation and heteroskedasticity in panel data (Lin et al., 2018), we also used the differential GMM method to estimate the dynamic panel model. Model 3 demonstrated that the regression coefficients passed the 5% significance level. Overall, the findings establish that the research hypotheses of this study are further validated after accounting for endogeneity issues.

Table 5. Regression results of endeogeneity

Variables	Labor		
	(1)	(2)	(3)
Treat×Post	-0.033**	-0.082***	-0.048**
	(-1.772)	(-2.628)	(-2.378)
Treat×Post_1	-0.041**		
	(-2.187)		
Control variables	yes	yes	yes
Constant terms	-10.392***	-12.561***	
	(-9.974)	(-78.279)	
Endog statistics		0.673	
（P）		（0.411）	
KP-LM statistics		4387.76***	4387.76***
KP-F statistics		17292.7	10342.07
Hansen J statistics		2.52362	5.681
（P）		（0.1122）	(0.0171)
Industry fixed effect	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes
Region fixed effect	Yes	Yes	Yes
N	35305	31162	30950
Adj. R2	0.33	0.633	0.223

4.2.5 Other robustness tests

(1) *Propensity matching score method* (*PSM-DID*). Owing to the urban characteristic differences among the experimental and control groups in the ECCDZ, we selected enterprise size (*Size*), asset–liability ratio (*Lev*), return on equity (*ROE*), total asset turnover (*ATO*), quick ratio (*Quick*), management age (*TMTAge*), and management compensation (*TMTPay*) as matching variables using radius–kernel matching. The matched samples were computed by regression. Table 6 [columns (1) and (2)] presents the regression results after PSM. The findings revealed that the ECCDZ establishment continues to exert a significant negative impact on labor employment, indicating that the sample selection does not undermine the robustness and significance of the regression results.

(2) *Alter the dependent variable*. We further used the growth rate of enterprise labor employment and the natural logarithm of the total regional labor employment as explanatory variables in the regression analysis. Table 6 [columns (3) and (4)] shows that the coefficients decrease in magnitude when these variables replace the original ones; however, they remain statistically significant at the 1% level. This finding confirms strong robustness in the regression findings.

(3) *Change observation period*. After excluding the effect of the pandemic (2019–2022), the financial crisis (2008–2009), and drawing on the results of Yu et al.[56], the time before and after the list of the first batch of the ECCDZ is consistent (2012–2022). Thus, we reperformed benchmark regression. The regression results in Table 6 [columns (5)−(7)] suggests that across all three periods, the ECCDZ (*Treat×Post*) remains markedly negatively correlated with enterprise labor employment. Notable, this emphasizes the robustness of the regression results.

Table 6. Robustness test results

Variables	PSM-DID		Change the explained variable		Change observation period		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Treat×Post	-0.046**	-0.063**	-0.009***	-0.014***	-0.064***	-0.046***	-0.030*
	(-1.972)	(-2.485)	(-4.304)	(-4.114)	(-4.042)	(-2.613)	(-1.804)
Control variables	yes	yes	yes	yes	yes	yes	yes
Constant terms	-10.462***	-9.767***	-0.215**	5.834***	-10.550***	-10.527***	-10.031***
	(-8.965)	(-8.093)	(-2.563)	(-73.485)	(-14.677)	(-10.537)	(-9.699)
Industry fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	17056	13679	35305	39998	27888	37131	33573
Adj. R^2	0.299	0.292	0.076	0.952	0.499	0.327	0.287

4.3 Analysis of Influence Mechanism

Based on the theoretical analysis, the ECCDZ inception has two key mechanisms to influence enterprise labor employment: (1) the ECCDZ establishment might increase/decrease the environmental governance cost of enterprises, thereby encouraging/inhibiting labor employment. (2) the ECCDZ establishment might expand/reduce the production scale, thereby encouraging/inhibiting labor employment. To test the action mechanism, the following analysis was performed.

4.3.1 Environmental cost mechanism

To validate the hypothesis that environmental costs influence enterprise labor employment, we used green innovation acquisition and environmental protection investment as measures of enterprises' environmental costs and considered them as mediating variables. Of these, green innovation acquisition is measured by logarithmically transforming the count of green patents gained by the listed companies plus 1, which is attained from the National Bureau of Statistics and CSMAR database (Li et al., 2020). In addition, environmental protection investment is measured by the natural logarithm of the expenditure directly associated with environmental protection plus 1 in the line item of construction in progress in the financial statements of publicly traded firms; the data were sourced from the annual reports of publicly listed companies (Zhang et al., 2019). Table 7 presents the regression results. Per the test results of environmental costs, *Treat×Post* coefficients in Table 7 [columns (1) and (3)] are 0.064 and 0.075, respectively ($p < 0.05$), validating that the ECCDZ establishment will surge environmental costs. Moreover, the coefficients of green innovation acquisition and environmental protection investment in Table 7 [columns (2) and (4)] are −0.020 and −0.007, respectively ($p < 0.05$), indicating that the ECCDZ establishment will inhibit labor employment by surging environmental costs. Overall, the ECCDZ establishment will increase the environmental governance cost, which directly declines profits and affects reinvestment, thereby decreasing the labor demand. Hence, H_2 is verified.

Table 7. Environmental cost mechanism

Variables	Green innovation acquisition	*Labor*	Environmental protection investment	*Labor*

	(1)	(2)	(3)	(4)
Treat×Post	0.064***		0.075**	
	-3.241		-2.105	
green innovation acquisition		-0.020**		
		(-2.177)		
environmental protection investment				-0.007***
				(-3.368)
Control variables	yes	yes	yes	yes
Constant terms	-3.991***	-10.372***	14.030***	-10.197***
	(-9.124)	(-10.511)	-24.565	(-10.339)
Industry fixed effect	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes
Region fixed effect	Yes	Yes	Yes	Yes
N	39998	39998	39998	39998
Adj. R^2	0.22	0.351	0.006	0.351

4.3.2 Production scale mechanism

To test the hypothesis that the ECCDZ establishment affects labor employment through the production scale, we measured the production scale as the natural logarithm of operating revenues and inventory additions, which were collected from the CSMAR database and were used as mechanism variables (Zhang et al., 2023). Table 8 presents the regression results. Based on the test results related to the ECCDZ production scale, *Treat×Post* coefficients in Table 8 [columns (1) and (3)] are −0.031 and −0.092, respectively ($p < 0.05$). Hence, the ECCDZ establishment will certainly inhibit the increase of operating revenues and inventory add-ons, and then inhibit the production scale. Meanwhile, the coefficients of operating revenues and inventory additions in Table 8 [columns (2) and (4)] are 0.035 and 0.022, respectively ($p < 0.05$), suggesting that the ECCDZ establishment will inhibit labor employment by decreasing the production scale. Hence, H_3 is verified.

Table 8. Production scale mechanism

variabels	operating revenues	*Labor*	inventory	*Labor*

	(1)	(2)	additions (3)	(4)
Treat×Post	-0.031**		-0.092**	
	(-2.526)		(-2.301)	
operating revenues		0.035***		
		(-3.554)		
inventory additions				0.022***
				(-4.831)
Control variables	Yes	Yes	Yes	Yes
Constant terms	-1.619***	-10.236***	-2.543**	-10.238***
	(-5.186)	(-10.346)	(-2.152)	(-10.465)
Industry fixed effect	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes
Region fixed effect	Yes	Yes	Yes	Yes
N	39998	39998	39998	39998
Adj. R^2	0.208	0.351	0.114	0.353

4.4 Heterogeneity analysis

Baseline regression and multiple robustness tests confirm that the ECCDZ establishment deters labor employment; however, different enterprise sizes, information and performance divulged by the ESG, factor-intensive types, and external supervision could cause differences in effects. Thus, we performed the heterogeneity analysis from the viewpoints of enterprise size, ESG rating, production factors, and external supervision.

4.4.1 Heterogeneity of enterprise size

In previous studies, the enterprise scale expansion resulted in amplified environmental governance costs (Li & Sheng, 2018). As a key indicator of the enterprise scale (Zheng & Wang, 2012), a larger enterprise scale usually correlates with a larger production scale. Thus, the ECCDZ establishment might exert varying degrees of inhibitory impact on enterprises of different sizes, with more pronounced effects noted in large-scale enterprises.

To validate the abovementioned theoretical hypothesis, we divided the sample into large enterprises and small- and medium-sized enterprises per the median size of enterprises and

performed grouped regression analysis. Table 8 [columns (1) and (2)] shows that in large enterprises, the coefficient of *Treat×Post* is −0.080 ($p < 0.01$), while in small- and medium-sized enterprises, the coefficient of *Treat×Post* is negative but not significant. Compared with small- and medium-sized enterprises, the ECCDZ establishment exerts a more pronounced inhibitory effect on labor employment in large-scale enterprises. This correlates with the deviations in environmental governance costs and production scale owing to increases in the enterprise scale, thereby confirming the expectation theory hypothesis.

4.4.2 Heterogeneity of ESG rating

The advantages of the ESG rating can markedly augment the production scale of enterprises and, thus, enhance enterprise labor employment (Mao & Wang, 2023). Concurrently, enterprises with a higher ESG rating will focus more on environmental governance (Tang, Ning, & Wang, 2023) and correspondingly raise their investment in environmental governance.

Thus, considering the impact of the ECCDZ establishment, enterprises with different ESG ratings display more pronounced differences in labor employment. Precisely, enterprises with low ESG ratings exhibit stronger inhibitions on labor employment. In this study, we divided the samples into high and low ratings based on the median ESG rating score and performed subsample regression analysis accordingly. Table 9 [columns (3) and (4)] shows that the coefficient of *Treat×Post* has a substantial negative correlation with low ratings, suggesting that the ECCDZ establishment exerts a more pronounced inhibitory impact on labor employment in enterprises with low ESG ratings. Moreover, environmental regulations reduce the production scale of such enterprises, consequently reducing their demand and appeal for labor, while concurrently increasing their investment in environmental governance, thereby further decreasing their labor employment.

4.4.3 Heterogeneity of factor intensity

Labor-intensive enterprises employ extra labor to expand the production scale[61], thereby earning more benefits, while decreasing labor costs to offset the negative impact of surging environmental governance costs (Li, Shi, & Bai, 2021).

The production scale expansion in capital-intensive enterprises increases the demand for high-skilled labor and needs higher capital investment. In contrast, technology-intensive enterprises have small production scale, low energy consumption, low emissions, and high output (Wang, Wu, & Lin, 2015), primarily rely on advanced science and technology and sophisticated equipment, and seemingly possess high professional technical knowledge and skills.

Thus, the ECCDZ establishment may yield diverse effects on the labor employment of labor-intensive, capital-intensive, and technology-intensive enterprises. Per China's National Economy Industry Classification (GB/T4754-2017) standard and the classification standard of Yang et al. (2014), we categorized sample enterprises into labor-intensive enterprises, capital-intensive enterprises, and technology-intensive enterprises, and performed grouped regression analysis accordingly. The regression results in Table 9 demonstrate that within both labor-intensive and capital-intensive enterprises, the ECCDZ establishment exhibits a considerable negative correlation with labor employment. For labor-intensive enterprises, the ECCDZ establishment decreases the production scale and amplifies the environmental governance cost, thereby decreasing labor employment. For capital-intensive enterprises, the ECCDZ establishment accelerates labor renewal and streamlining. To consider the environmental management cost, part of the capital is transferred to environmental protection investments, thereby decreasing labor employment. Furthermore, enterprise labor employment in technology-intensive enterprises remains unaffected by the ECCDZ establishment, which corroborates the expected theoretical assumptions.

Table 9. Heterogeneity in enterprise size, ESG rating, and factor intensity

Variables	Enterprise size		ESG rating		Factor intensity		
	Large enterprises	Small- and medium-sized enterprises	High	Low	Technology-intensive	labor-intensive	Capital-intensive
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Treat×Post	-0.080***	-0.031	-0.003	-0.119***	-0.025	-0.072**	-0.076**
	(-3.209)	(-1.271)	(-0.136)	(-4.881)	(-1.053)	(-2.245)	(-1.983)
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes

variables							
Constant terms	-7.543***	-12.785***	-7.439***	-11.571***	-11.106***	-9.005***	-10.641***
	(-8.645)	(-14.662)	(-10.182)	(-13.518)	(-9.354)	(-7.272)	(-9.548)
Industry fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	19999	19999	20106	19892	17696	14856	7446
Adj. R^2	0.192	0.308	0.31	0.43	0.364	0.307	0.337
P-value of coefficient difference between groups	0.033		0.000		-		

4.4.4 Heterogeneity of external environment supervision

External environmental supervision can invigorate the implementation of environmental protection policies and assure the efficacy of policies to stimulate enterprises to exhibit positive environmental behavior. Precisely, external environmental supervision can apply public opinion pressure, increase the information exchange between the government and enterprises, reinforce the execution of policies, and enhance environmental regulation. Conversely, external environmental information encourages enterprises to increase investment in environmental protection governance and upgrade their production technology in their original investment plans. Thus, the impact of demonstration zones on enterprise labor employment might vary under diverse external environment supervision forces. Furthermore, the establishment of demonstration zones is more inhibitory to enterprise labor employment under robust external supervision and, contrariwise, less inhibitory under lenient external supervision. To validate the abovementioned theoretical hypotheses, we measured external environmental supervision through two indicators—public attention and media attention.

Public attention, based on Wang et al. (2018) and Wang, Wu, and Lin (2015), we used the annual search index of Baidu for the keyword "environmental pollution" to measure

public concern. Then, subgroup regressions were performed by dividing the sample into high public attention and low public attention per the median of the annual search index. Table 10 [columns (1) and (2)] shows that the coefficient of *Treat×Post* is −0.081 ($p < 0.01$) for high public attention, while it is insignificant for low public attention. This finding indicates that high public attention can enhance the effect of policy implementation and decrease information irregularity during policy implementation. Concurrently, the constraining role of informal environmental regulation (Wu, Yang, & Sun, 2022) renders the ECCDZ establishment a more distinct impediment to enterprise labor employment.

Media attention, based on Yu et al. (2022), we used the overall number of negative news of enterprises in online news headlines in 1 year to measure the media attention of enterprises. The analysis was processed by adding 1 and taking the natural logarithm, and the news data were obtained from the Chinese Research Data Services (CNRDS). Then, subgroup regressions were performed by categorizing the sample into high-media-attention and low-media-attention groups based on the median. Table 10 [columns (3) and (4)] shows that the coefficient of *Treat×Post* is −0.096 for high media attention ($p < 0.01$), whereas it is insignificant for low media attention. This finding indicates that high media attention better influences the pressure of public opinion supervision, attains collaboration with government environmental regulation, and underpins the impediment of the ECCDZ establishment for enterprise labor employment.

Table 10. Heterogeneity of the external environment supervises

Variables	High public attention	Low public attention	High media attention	Low media attention
	(1)	(2)	(3)	(4)
Treat×Post	-0.081***	0.012	-0.096***	-0.005
	(-3.731)	（0.387）	(-3.763)	(-0.199)
Control variables	Yes	Yes	Yes	Yes
Constant terms	-9.298***	-10.504***	-11.570***	-8.965***
	(-13.053)	(-10.908)	(-16.218)	(-5.537)
Industry fixed effect	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes

Region fixed effect	Yes	Yes	Yes	Yes
N	27435	12563	22683	17315
Adj. R^2	0.334	0.323	0.358	0.32
P-value of coefficient difference between groups	0.000		0.001	

4.5 Disscussion of Findings

The correlation between the ECCDZ in China and enterprise labor employment will facilitate an amicable coexistence of humanity and nature, offering a crucial strategic implication for materializing the dual objectives of ecological civilization construction and stable employment. Taking the ECCDZ establishment as a "quasi-natural experiment," this study aims to investigate the impact of establishing ECCDZ on enterprise labor employment using the difference-in-differences (DID) approach. The study sample comprised the data of 404 administrative cities, districts, and listed enterprises in China during 2007–2022. Overall, the ECCDZ establishment has markedly constrained enterprise labor employment, as their creation can decrease production scale and amplify environmental governance costs. The heterogeneity analysis showed that the adverse impact of the ECCDZ establishment on labor employment is more noticeable in large-scale enterprises, labor-intensive enterprises, and capital-intensive enterprises, as well as low ESG rating and robust external environmental supervision. Nevertheless, the impact is not noteworthy in technology-intensive enterprises, with low public attention and low media attention. Besides, this study demonstrates the specific methods of enterprises to manage the ECCDZ establishment and its effect on labor employment in multiple dimensions. Overall, the findings are decisive in attaining a fruitful balance between ecological governance and other related factors and stable employment in the process of ecological civilization construction.

5 Conclusion and Future work

5.1 Research Summary

The ECCDZ intends to execute Xi Jinping's vision of ecological civilization. Accentuating the holistic development of the ecological civilization construction system, endorsing the overall layout of the "Five-in-One," and applying the five development concepts, it is a key initiative to accomplish China's "dual-carbon" objective and an effective method to encourage high-quality economic growth. The primary findings of this study are as follows:

(1) The ECCDZ establishment remarkably inhibited enterprise labor employment, a deduction verified through a sequence of rigorous robustness tests like the parallel trend test, placebo test, heterogeneous DID, endogenous problem, and PSM-DID.

(2) The impact mechanism test demonstrates that the ECCDZ establishment can hinder enterprise labor employment by decreasing production and surging the environmental governance cost.

(3) The heterogeneity analysis illustrates that the production scale and environmental governance cost increase correspondingly in large-scale enterprises, and the ECCDZ establishment remarkably inhibits enterprise labor employment.

Besides, the policy's impediment to labor employment is stronger in enterprises having low ESG ratings, with labor employment in labor- and capital-intensive enterprises responding consistently to the policies, while technology-intensive enterprises exhibit the opposite result.

Notably, robust external environmental supervision can help alleviate the information irregularity between the government and enterprises and encourage enterprises to augment environmental protection and new technology investment, rendering the impact of the ECCDZ establishment to hinder enterprise labor employment more substantial, corroborating the expected theoretical assumptions.

5.2 Implications and Recommendations

5.2.1 Theoretical implications

First, this study reveals the inhibitory effect of the ECCDZ on corporate labour hiring, suggesting that ecological governance measures may affect the labour market by increasing the cost of environmental governance and reducing the scale of production by firms. This provides a theoretical framework for the Asia-Pacific region to help understand how to strike a balance between ecological governance and corporate labor hiring in the process of promoting ecological civilization.

Second, the study shows that there are significant differences in the responses of different types of enterprises to the ECCDZ, such as the more obvious labor employment inhibition effect of large-scale enterprises, labor-intensive enterprises and capital-intensive enterprises. This heterogeneity provides a theoretical basis for policy makers in the Asia-Pacific region to help formulate more targeted policies to respond to the different needs and challenges of different types of enterprises in the process of building ecological civilization.

Finally, the intensity of external environmental monitoring and public concern have a significant impact on the inhibitory effect of corporate labor hiring. This suggests that in the Asia-Pacific region, external monitoring and public concern can act as moderating factors to influence the implementation effects of ecological civilization policies. This theoretical finding contributes to the understanding of how social supervision and public participation can be utilized to enhance the effectiveness and implementation of ecological policies.

5.2.2 Practical implications

First, the ECCDZ establishment should be continued further. Accordingly, preferential policies and projects should be implemented in regions designated as the ECCDZ, reinforce the benchmarking role of demonstration zones, stimulate other regions to proactively engage in the establishment of demonstration zones, harness the crucial role of enterprises in environmental protection, and contribute substantially to accomplish "dual-carbon" objectives. Moreover, based on the overall management procedures of the ECCDZ, tailored implementation policies should be articulated for enterprises of different sizes and factor intensities in the region, and targeted subsidies should be reinforced for special policy funds. While safeguarding the healthy and sustainable progress of large-scale enterprises, we should also harness the role of small and medium-sized enterprises in environmental

protection, enable labor mobility across industries with diverse factors, and capitalize on the value of individual labor.

Second, efforts should be made to increase the impact of the ECCDZ on the optimal allotment of enterprise human resources. The ECCDZ establishment can hinder labor employment, attain optimal allotment of labor resources, stimulate enterprises to fast-track upgrading and iteration of labor employment and encourage the reasonable flow of labor. Accordingly, the first step involves creating and encouraging green jobs so that enterprises can contribute to the establishment of ecological civilization by implementing environmentally friendly technologies and sustainable business practices. In addition, the government can encourage enterprises to conduct research and implement environmental protection technologies by offering them innovation incentives, thereby promoting enterprises' constant innovation in the realm of ecological civilization construction. In the second step, the government can launch training and job transfer programs to equip workers with the skills required in the environmental protection industry, thereby mitigating the employment pressure that could stem from economic reformation. Hence, it is also essential to guarantee that workers are completely protected during ecological civilization construction, including wage protection, working hour limitations, occupational health, and safety, to thwart enterprises from compromising workers' rights and interests in pursuit of economic profits.

Third, external supervision of enterprises should be reinforced. Institutional ratings, public attention, and media attention are used to certify the success of implementing the ECCDZ, decrease information irregularity among enterprises, governments, and policymakers, and build multiparty collaboration to create a green future. Accordingly, the first step involves establishing an information transparency mechanism so that enterprises' environmental protection and social responsibility measures are publicly available, thereby encouraging enterprises to accomplish their social responsibilities more prudently and helping consumers and investors to better select enterprises that support environmental protection and sustainable operations. In the second step, the government can encourage financial institutions to offer more flexible and favorable financing services to enterprises that implement environmental protection measures by providing them incentives like tax

breaks, green finance options, and financial aid, thereby promoting the progress of industries associated with the construction of ecological civilization.

5.3 Limitations and Future Directions

The current research limitations of this paper include: Firstly, the details of the microscopic mechanism are insufficiently revealed. Although the research confirmed that "production scale" and "environmental governance cost" are the main mechanisms, there is a lack of in-depth characterization of the specific transmission paths and micro decision-making processes of these macro mechanisms within enterprises. In addition, the research found that the policy inhibitory effect was more significant under weaker external supervision, which was attributed to the reduction of information asymmetry and the incentives for enterprises' environmental protection investment. However, the research has failed to conduct an in-depth analysis of the specific constituent elements of "effective external environment supervision" and their relative importance, as well as how they precisely affect the internal decision-making chain of enterprises, especially labor employment decisions.

Future research can consider to deeply explore the internal logic and sustainability of technology-intensive enterprises' "counter-trend" increase in employment. The research finds that labor employment in technology-intensive enterprises presents the opposite result to policies. Focus on such enterprises and conduct in-depth analysis of the specific job types where employment has increased, such as environmental protection technology research and development, green production management, etc. Meanwhile, analyze the core factors driving this "counter-trend" growth, such as policy subsidies, transformation of market demand, technological endowment advantages or management strategies, etc., as well as the sustainability of this growth model and its implications for the transformation of the overall employment structure. In addition, explore the optimization of the combination of environmental supervision tools and their differentiated guidance on enterprise behaviors. Based on the finding that "strong external supervision can amplify the inhibitory effect of policies", this study explores how these tools differentially influence the decisions of different types of enterprises in terms of environmental protection investment, technology route selection, and labor employment strategies. Furthermore,

design and simulate the evaluation of the optimal combination of environmental supervision policies, with the aim of minimizing the unexpected impact on employment while achieving strict environmental goals, and even guiding enterprises towards green job creation.

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