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Embedding Party Organization Governance in Energy Management: Effects on Corporate Carbon Emissions in Chinese State-Owned Enterprises

Shiquan Wang and Yu Liang *

School of Business Administration, Northeastern University, Shenyang 110169, China
* Correspondence: 2110461@stu.neu.edu.cn; Tel.: +86-151-4118-1007

Abstract: Theoretical and practical ambiguities concerning the impact of Party organization governance on corporate carbon emissions in China are addressed in this study. Data from A-share-listed state-owned enterprises in Shanghai and Shenzhen (2016–2021) are analyzed to determine how Party organization governance influences corporate carbon emissions. Fixed-effects regression results indicate that Party organization governance significantly reduces emissions. Robustness is established via alternative variable measures, instrumental variable estimation, and the inclusion of supplementary controls. Notably, the effect weakens as privatization intensifies. Conversely, SOEs embedding high-quality Party building into articles of association or situated in regions rich in red cultural resources exhibit amplified emission reductions. The findings enhance comprehension of Party organization governance's environmental role in SOEs and inform the design of low-carbon energy governance frameworks.

Keywords: party organization governance; corporate carbon emissions; corporate privatization; party building into articles of association; regional red culture

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1. Introduction

Rising global temperatures have led to challenges, including reduced production efficiency and increased energy costs, which have adversely affected economic growth [1]. Consequently, carbon emission reduction has emerged as a strategy for mitigating climate change. As the climate crisis escalates, nations have committed to carbon reduction, necessitating strategic planning to achieve net-zero emissions. Socio-political structures and cultural contexts are recognized as fundamental in addressing climate risks [2]. In contrast to Western systems, China's political framework places the Communist Party at the core of state-owned enterprises (SOEs). Increasingly, Chinese enterprises have embedded Party organizations within their governance structures to promote carbon reduction.

For instance, China Petroleum and Chemical Corporation (Sinopec) has implemented a "Party Building + Green Construction" model, integrating Party governance into corporate management. This approach has facilitated the continuous advancement of carbon capture, utilization, and storage (CCUS) demonstration projects in its construction initiatives. According to official statistics, the project reduces approximately one million tons of carbon dioxide annually, providing technical support for China's carbon-peaking and carbon-neutrality goals. Similarly, under Party leadership, State Grid Corporation of China (SG) has optimized its clean-energy transmission network and enhanced the efficiency of new-energy utilization. By 2022, the corporation achieved over 40% clean-energy transmission and maintained new-energy utilization rates above 97%, moderately advancing energy

conservation and carbon reduction efforts. These examples underscore Party organizations' critical role in steering Chinese enterprises toward green, low-carbon development.

Successful practices by Chinese SOEs in optimizing energy structures and promoting energy conservation and carbon reduction validate the important role of Party governance in advancing corporate sustainability. This governance approach not only enhances internal governance [3] but also optimizes resource allocation, fosters green technological innovation, and achieves carbon reduction targets [4,5]. However, the internal mechanisms by which political governance under the Communist Party of China (CPC) influences carbon emissions remain underexplored. This study explores the micro-decision-making processes and mechanisms through which Party governance suppresses corporate carbon emissions.

As major consumers of natural resources and producers of pollution, companies are increasingly focusing on carbon reduction initiatives. The existing literature examines the primary drivers of corporate carbon emissions from two perspectives. From a macro-environmental viewpoint, corporate carbon performance is influenced by governmental regulations, including carbon-trading schemes [6,7], carbon taxes [8,9], green credit [10,11], carbon assessment standards [12], and mandatory and incentive-based policies [13]. From a micro-organizational perspective, governance mechanisms regulate internal power structures and decision-making processes, thus underpinning strategic operations. A growing body of research has explored the nexus between corporate governance and sustainability [14,15]. However, the precise mechanisms by which governance influences carbon emissions remain ambiguous and warrant further elucidation [16]. The relationship between governance mechanisms and carbon emission performance has attracted scholarly attention [17], with studies examining the impact of executive compensation incentives [18], board diversity [19,20], ownership structure [21], and institutional investor oversight [22] on carbon emissions. In the Chinese context, however, the influence of embedded Party organizations on carbon emissions remains underexplored. The mechanisms and channels through which Party organization governance affects carbon emissions remain unclear.

Research into Party organization governance has expanded, revealing its significant influence on corporate decision-making. Although some scholars assert that Party organization governance elevates political costs and may hinder investment and innovation efficiency [23,24], most evidence supports its supervisory role in delivering positive governance outcomes [3]. For instance, Party organization governance has been shown to reduce stock price crash risk [25], prevent financial fraud and misconduct [26], mitigate executive corruption [27], curb excessive executive compensation [28], and enhance firm value creation [29]. However, these analyses predominantly adopt an economic perspective, with limited focus on carbon emissions. The mechanisms through which Party organization governance influences carbon emissions remain to be clarified.

Prior studies have largely examined the positive effects of Party organization governance on firms' economic performance, but few have developed a theoretical framework linking Party organization governance to corporate carbon emissions, indicating a research gap. First, the theoretical framework delineating the relationship between Party organization governance and corporate carbon emissions remains underdeveloped. Existing research on Party organization governance and corporate environmental management has predominantly examined traditional governance mechanisms (e.g., board diversity [20] and managerial incentives [18]) in relation to environmental performance and green innovation but has not explored in depth how the integration of Party organization governance—via policy guidance and cultural leadership—affects corporate carbon emissions. Second, insufficient attention has been paid to firm heterogeneity. Comparative analyses of how Party organization governance influences carbon emissions across different ownership types remain scarce. For example, Gu and Yang [4] examined the impact of Party organization

embedding on green innovation in private firms, but its applicability to state-owned enterprises remains unclear. Third, the interaction effects between Party organization governance and other governance mechanisms have not been adequately investigated. Existing studies often focus on the environmental impacts of individual governance mechanisms—such as government regulation [30] or board governance [19,20]—without systematically exploring how Party organization governance interacts with these mechanisms to produce complementary or substitutive effects on carbon reduction objectives. In summary, although the role of Party organizations in promoting national green development policies and guiding corporate social responsibility has attracted some attention, systematic theoretical and empirical research directly examining how Party organization governance influences corporate carbon emissions—and the mechanisms involved—remains lacking. This research gap provides directions for future academic inquiry and scientific implications for policy formulation and corporate governance practice.

This study addresses the research gap regarding the influence of Party organization governance on corporate carbon emissions and its internal mechanisms within China's distinctive politico-economic framework. Party organizations are embedded in governance via "two-way entry" and "cross-appointments" in SOEs, thereby integrating the norms and core values of the Chinese Communist Party into decision-making, oversight, and management. Amid the drive for socio-economic green transformation, Party organization governance compels firms to adopt environmentally friendly management decisions and ensures their implementation, thus shaping low-carbon behaviors. Furthermore, this study examines governance changes in SOEs during marketization, considering that as privatization intensifies, Party organization influence may be weakened, potentially undermining carbon emission management. Conversely, embedding high-quality Party building into articles of association strengthens Party organization roles in decision-making, oversight, and internal control, thus more effectively promoting green, low-carbon transformation. Additionally, regional red culture—an informal institutional resource transmitted via local patriotic education bases—shapes corporate culture, further reinforcing the inhibitory effect of Party organization governance on carbon emissions. To bridge this gap, the determinants and mechanisms driving corporate carbon emission reduction are empirically examined using data from A-share-listed firms in Shanghai and Shenzhen (2016–2021). Empirical results indicate that Party organization governance significantly reduces carbon emissions. Micro-mechanism analysis reveals that as privatization intensifies, the inhibitory effect of Party organization governance on carbon emissions diminishes; by contrast, higher-quality Party building into articles of association and richer regional red cultural resources significantly strengthen this effect. This gap provides directions for future academic inquiry and essential implications for policy formulation and corporate governance practice.

China has prioritized environmental pollution control and implemented various policies to limit emissions. This study focuses on the relationship between Party organization governance and corporate carbon emissions in SOEs for several reasons. First, SOEs are pivotal for both China and the global economy. In 2021, SOEs contributed approximately 66% of China's GDP and included 95 companies in the Fortune Global 500. As entities controlled by national or local governments, SOEs are expected to remain influential global forces [31,32]. Second, SOEs demonstrate higher responsiveness to policy goals and exhibit superior performance in pollutant control. They are leaders in the development of carbon management systems and serve as exemplary models for energy conservation and emission reduction [33]. Third, adhering to the leadership of the Party constitutes a unique advantage of SOEs. The CPC has endowed the Party organizations of SOEs with legitimacy and effectively integrated them into the corporate governance framework, leveraging the combined advantages of CPC leadership and modern corporate governance. Party organi-

zations are instrumental in supervising management and decision-making, ensuring the effective implementation of CPC policies [3].

The potential contributions of this study can be categorized into three key contributions. First, this work extends the research on Party organization governance by highlighting its important role in environmental protection, which contrasts with the existing literature that predominantly focuses on economic performance. Second, it broadens the scope of research on the relationship between Party organization governance and corporate environmental responsibility. This study constructs a theoretical model linking Party organization governance, the level of privatization, the quality of Party building into articles of association, regional red cultural resources, and corporate carbon emissions. It examines variations in the effectiveness of Party organization governance across different privatization levels and explores the role of informal institutions, such as regional red culture, emphasizing their cultural impact on enhancing governance effectiveness. Third, based on a micro perspective of corporate governance, this study enhances the understanding of the driving factors behind corporate carbon emission reduction. The above findings offer both theoretical and policy implications for strengthening Party organization governance, improving carbon management, and informing new governance reforms in SOEs to achieve the goals of carbon peaking and carbon neutrality.

2. Hypothesis Development

2.1. Party Organization Governance and Corporate Carbon Emissions

Since the integration of Party organizations into corporate governance structures, they have significantly influenced the development direction and decision-making processes of enterprises [34]. On the one hand, Party committees have embedded the concept of sustainable development into various aspects of enterprise operations through meetings and governance activities [28]. This mechanism guides enterprises to focus on public aspirations for a better life, strengthens awareness of environmental responsibility, and enhances corporate awareness of carbon emission reduction responsibilities. Additionally, the implementation of "two-way entry" and "cross-appointments" aids in instilling sustainable development principles [26], thereby establishing a strong foundation for limiting corporate carbon emissions. This assists enterprises in formulating development plans that prioritize carbon reduction by balancing the costs and benefits of pollution. On the other hand, in carbon management practices, management may exhibit a short-term profit orientation, potentially increasing corporate carbon emissions [35]. The supervisory function of Party organization governance compels management to avoid self-interest-based decisions, thus curbing short-sighted tendencies [36]. This ensures that enterprises balance economic and social benefits, fulfill carbon reduction commitments, and manage their carbon emission performance. Based on this analysis, the following hypothesis is put forward:

Hypothesis 1. *Party organization governance in SOEs has a suppressive effect on corporate carbon emissions.*

2.2. Degree of Privatization

Privatization, as a strategic route to economic prosperity and market dynamism, has attracted widespread attention. However, in the absence of the state as a majority shareholder, privatized firms may lack the incentive to pursue governmental environmental objectives, thereby potentially weakening their environmental performance [33]. First, under a governance framework devoid of public policy constraints, divergences in shareholder preferences may engender internal value conflicts [37]. Communication barriers and collaboration challenges within executive teams may impede the effective mobilization

of their respective strengths. In environmental deliberations, managerial perceptual gaps may trigger delays and distortions in internal environmental disclosure, creating bottlenecks in the information flow underpinning carbon management decisions. Conversely, as privatization advances, the trend toward share dispersion can exacerbate principal–agent conflicts [38,39]. And the collective focus and shared objectives of the management team may be eroded by such competitive dynamics among executives, thereby complicating the reconciliation of heterogeneous stakeholder demands [40]. Accordingly, privatization may erode Party organizations' capacity to forge strategic consensus and hinder alignment between economic objectives and low-carbon strategies, thus diminishing their ability to constrain corporate carbon emissions. Based on this reasoning, the following hypothesis is proposed:

Hypothesis 2. *The degree of privatization positively moderates the suppressive effect of SOE Party organization governance on corporate carbon emissions.*

2.3. Party Building into Articles of Association

Embedding Party building activities into corporate decision-making procedures is considered a critical practice for optimizing China's distinctive corporate governance structure. First, Party building into articles of association defines the organizational form, functional roles, and division of responsibilities of Party organizations within corporate governance, thereby establishing their statutory position in a legal context. This formalization further deepens the Party's core principles and enhances members' sense of identity and social responsibility [41], thus providing an organizational foundation for the establishment of corporate carbon management mechanisms. Second, the influence of Party building into articles of association on corporate decision-making has been empirically substantiated [42]. As the quality of Party building into articles of association improves, the governance efficacy of Party organizations is gradually strengthened, hence prompting SOEs to fulfill their environmental responsibilities in a more systematic manner under the national carbon-peaking and carbon-neutrality strategies. Third, increased institutional rigidity helps to enhance social cognition [43]. By embedding Party building into articles of association as a formal constraint, environmental governance is integrated into the corporate decision-making framework, and enhancements in the quality of provisions directly enhance supervisory efficacy concerning carbon emission behaviors. In accordance with the relevant regulations, Party organizations conduct regular evaluations and oversight of corporate carbon management implementation, propose corrective recommendations, and monitor remedial actions, therefore facilitating the effective implementation of low-carbon strategies and intensifying efforts toward emission reduction. Based on the foregoing analysis, the following hypothesis is proposed:

Hypothesis 3. *The quality of Party building into articles of association negatively moderates the suppressive effect of SOE Party organization governance on corporate carbon emissions.*

2.4. Regional Red Culture

Social values embedded in national cultures significantly influence corporate responses to environmental sustainability and climate change challenges [44], shaping organizational attitudes toward environmental issues [45]. Red culture, defined as the precious spiritual wealth and having been developed under the leadership of the CPC through revolutionary struggle, nation-building, and reform practices, plays a crucial role in shaping corporate governance mechanisms [46]. This cultural framework influences organizational value systems and behavioral norms, facilitating the integration of Party organizations into corporate governance structures while promoting bidirectional alignment between

corporate values and national priorities, thereby ensuring that organizational development aligns with strategic national objectives. On the one hand, culture fundamentally shapes individual value cognition and standardizes behavioral choices [47]. Firms operating in regions with rich red culture resources typically develop strategic orientations that prioritize sustainable development and emphasize long-term planning over short-term economic gains [46]. This orientation enhances environmental awareness among organizational members and establishes institutional frameworks promoting harmonious business–environment relationships, ultimately encouraging corporate environmental responsibility and enhanced carbon emission management practices. On the other hand, culture exerts profound influence on individual social behavior patterns [48]. Regarding capabilities for action implementation, abundant red culture resources provide sustained motivation for environmental responsibility fulfillment, compelling executives to systematically allocate environmental governance resources and establish enduring carbon emission control mechanisms throughout operational processes. Consequently, this study posits that firms situated in regions with strong red culture advantages develop more sophisticated sustainability perspectives, creating a virtuous cycle wherein enhanced managerial environmental awareness strengthens Party organization governance effectiveness, which may amplify the mitigating effect of Party organization governance on corporate carbon emissions. According to the above theoretical analysis, the following hypothesis is posited:

Hypothesis 4. *Regional red culture negatively moderates the suppressive effect of SOE Party organization governance on corporate carbon emissions.*

3. Data and Methodology

3.1. Variable Definition

3.1.1. Independent Variable: Party Organization Governance

Existing measures of Party organization participation in corporate governance encompass two dimensions: "two-way entry" and "cross-appointment" [26]. These metrics are derived from (i) the proportion of Party committee members who concurrently serve on the board, supervisory board, and executive team and (ii) the core role of the Party secretary (or deputy secretary). Accordingly, this work defines two variables to reflect Party governance involvement: *Party_enter*: the share of board, supervisory board, and executive team members who are also Party committee members and *Party_cross*: a dummy equal to 1 if the Party secretary (or deputy) concurrently serves as chairman or CEO and is 0 otherwise.

3.1.2. Dependent Variable: Corporate Carbon Emissions

Following Qian and Schaltegger [49], carbon emissions are measured in accordance with the GHG Protocol. Scope I considers the direct emissions from onsite combustion in production; Scope II covers the indirect emissions from purchased electricity and heat, where both Scope I and Scope II must be disclosed mandatorily; and Scope III describes all other value-chain emissions. Under current regulatory frameworks, Scope III disclosure remains noncompulsory.

3.1.3. Moderating Variables

Degree of Privatization: To capture the influence of non-state capital under mixed-ownership reform, the degree of privatization is defined as the proportion of non-state organizations among the top ten shareholders. Following Guan et al. [50], each top shareholder is classified by nature, and subordinate relationships are considered between shareholders;

those acting in concert or controlled by a common ultimate controller are consolidated. Higher values indicate deeper privatization and greater non-state shareholder influence.

Party Building into Articles of Association: Drawing on the research of Huang et al. [42], if the announcement of non-SOEs involves a revision of Party building into articles of association, it is assigned a value of 1, and it is set to 0 otherwise. Based on this research framework, this study then computes the cosine similarity between the charter's Party building text and the benchmark trial regulations for primary-level SOE Party organizations. Firms exceeding the industry-average similarity receive 1, others 0. This quantitative method highlights cross-firm disparities in Party building into articles of association quality, reducing subjectivity and enhancing measurement accuracy.

Regional Red Culture: Patriotic education demonstration bases serve as a tangible embodiment of red culture. Drawing on Wang et al. [46], regional red culture is represented by the number of patriotic education demonstration bases in the firm's registered province. National-level bases, in particular, offer richer archival materials and superior educational functions, thereby amplifying regional red culture resources. To some extent, the provincial base count thus indicates regional disparities in red culture endowment.

3.1.4. Control Variables

Control variables reflecting firms' financial and governance characteristics were incorporated to isolate the effect of Party organization governance on carbon emission behavior. In line with extant studies [12,17], this study includes firm size (*Size*), financial leverage (*Lev*), profitability (*Roa*), growth opportunities (*Growth*), market value (*TobinQ*), and firm age (*Age*) to capture core financial traits; governance controls comprise the managerial–shareholding ratio (*Mshrate*), the proportion of independent directors on the board (*BoardIndep*), the ownership stake of the largest shareholder (*Top1*), and overall ownership concentration (*Balance*). In addition, dummy variables for year (*Year*), industry sector (*Industry*), and province (*Province*) are included to account for temporal, sectoral, and regional heterogeneity. Definitions of all variables are provided in Table 1.

Table 1. Measurement of variables.

Variable	Symbol	Measurement
Two-way entry	*Party_enter*	The number of overlapping members between the Party organization and the board of directors, board of supervisors, and senior management/The total number of members of the board of directors, board of supervisors, and senior management.
Cross-appointment	*Party_cross*	If the secretary (deputy secretary) of the Party committee concurrently serves as the company's chairman or CEO, assign a value of 1; otherwise, assign a value of 0.
Corporate carbon emissions	*CE*	Take the natural logarithm of the sum of the company's direct carbon emissions and indirect carbon emissions after adding 1 to this sum.
Privatization	*SHR*	The proportion of non-state equity in the top ten shareholders is calculated, and further, the nature of the top ten shareholders is strictly differentiated, and the affiliation between shareholders is taken into account.
Party building into articles of association	*PB*	The cosine similarity between the content of Party building into articles of association and that in the trial regulation on the work of primary-level Party organizations of SOEs is calculated. Enterprises with a text similarity higher than the industry average are assigned a value of 1; otherwise, it this is assigned a value of 0.

Table 1. *Cont.*

Variable	Symbol	Measurement
Regional red culture	*ED*	The quantity of patriotic education demonstration bases.
Firm size	*Size*	Logarithm for a company's total assets at the end of the year.
Financial leverage	*Lev*	The total liabilities divided by the total assets.
Profitability	*Roa*	The net income divided by the average total.
Degree of growth	*Growth*	Increase rate of the main business revenue.
Market value	*TobinQ*	The firm market value divided by the replacement value of assets.
Firm age	*Age*	Logarithm for the number of years from the date of establishment to the Tth year of the company.
Managerial shareholding ratio	*Mshrate*	Executive shareholding divided by the firm's total shares.
Independent director ratio	*Boardindep*	Ratio of number of the independent directors to number of directors
Largest shareholder ownership	*Top1*	Ratio of number of shares held by the largest shareholder to total number of shares.
Ownership concentration	*Balance*	Sum of shareholdings of the top five shareholders.

3.2. Model Specification

First, to address the effect of Party organization governance on corporate carbon emissions (H1), Equation (1) contains the following parameters:

$$CE_{i,t} = \alpha_0 + \alpha_1 Party_{i,t} + \varphi \sum_k Controls_{i,t}^k + \varepsilon_{i,t} \quad (1)$$

where $CE_{i,t}$ represents firm i's carbon missions, and the independent variable $Party_{i,t}$ is measured as *Party_enter* and *Party_cross*. The control variables are denoted by $Controls_{i,t}^k$. Meanwhile, the model controls for the effects of industry, year, and province.

Second, this study employs Equation (2) to examine the moderating effect of the degree of privatization, as proposed in Hypothesis 2, on the relationship between Party organization governance and corporate carbon emissions:

$$CE_{i,t} = \beta_0 + \beta_1 Party_{i,t} + \beta_2 SHR_{i,t} + \beta_3 SInter_{i,t} + \varphi \sum_k Controls_{i,t}^k + \varepsilon_{i,t} \quad (2)$$

where $SHR_NONSOE_{i,t}$ is introduced as a new variable that measures the degree of company privatization. Moreover, after centralizing the relevant variables, the interaction term ($SInter_{i,t}$) between Party organization governance ($Party_{i,t}$) and privatization ($SHR_{i,t}$) is incorporated into Equation (1).

And then, the joint effect of Party organization governance and Party building into articles of association on carbon emissions (H3) is addressed by adding an interaction variable to Equation (3). This interaction variable is denoted as $PBInter_{i,t}$, where $Party_{i,t}$ and $PB_{i,t}$ stand for the previously introduced variables for Party organization governance and Party building into articles of association:

$$CE_{i,t} = \beta_0 + \beta_1 Party_{i,t} + \beta_2 PB_{i,t} + \beta_3 PBInter_{i,t} + \varphi \sum_k Controls_{i,t}^k + \varepsilon_{i,t} \quad (3)$$

Finally, in order to verify the impact of regional red culture, this study introduces an interaction term denoted by $EDInter_{i,t}$. Specifically, the interaction term $EDInter_{i,t}$ is

calculated by multiplying Party organization governance ($Party_{i,t}$) and regional red culture ($ED_{i,t}$). In this context, Equation (4) is formulated:

$$CE_{i,t} = \beta_0 + \beta_1 Party_{i,t} + \beta_2 ED + \beta_3 EDInter_{i,t} + \varphi \sum_k Controls_{i,t}^k + \varepsilon_{i,t} \quad (4)$$

3.3. Sample Selection and Data Sources

The 2016 National State-owned Enterprise Party Building Work Conference was convened, further emphasizing and institutionalizing the significance of party organization governance within SOEs. Accordingly, state-owned companies listed on the A-share main boards of the Shanghai and Shenzhen Stock Exchanges and whose ultimate controllers were the State-owned Assets Supervision and Administration Commission (SASAC) at either the central or local government level during 2016–2021 were selected as the primary research sample. Relevant data, including party organization governance, carbon emission behavior, senior management information, and financial indicators, were collected from the CSMAR database, company annual reports, and corporate social responsibility reports. Samples were systematically excluded as follows: (i) state-owned listed companies in the financial industry; (ii) firms designated as ST, *ST, or delisted during the study period; and (iii) firms with missing or unresolvable data. To mitigate the influence of outliers, the main continuous variables were winsorized at the 1% and 99% levels. Ultimately, 6186 company-year observations were retained.

4. Empirical Results

4.1. Descriptive Statistics and Correlations

Table 2 presents the summary statistics. The mean value of the dependent variable, corporate carbon emissions (*CE*), is 12.240, with a standard deviation of 1.578 and a range of 18.590. This indicates significant disparities in carbon emissions among different SOEs. Among the explanatory variables related to Party organization governance, the mean value of "two-way entry" (*Party_enter*) is 0.225. The mean value of "cross-appointment" (*Party_cross*) is 0.054, indicating that 5.4% of SOEs have implemented "cross-appointment", whereby the Party secretary concurrently serves as the CEO. The mean values of the sum of the shareholding ratios of the top ten non-state shareholders and the proportion of senior management appointed by non-state shareholders, reflecting the degree of privatization, are 0.130 and 0.027, with standard deviations of 0.134 and 0.070, respectively. This suggests relatively minor differences in the degree of privatization among the observed samples. Regarding the control variables, the standard deviations of corporate profitability (*Roa*) and the proportion of independent directors (*BoardIndep*) are relatively small. In contrast, the standard deviations of growth opportunities (*Growth*), market value (*TobinQ*), equity concentration (*Balance*), and senior management shareholding (*Mshtate*) are relatively large.

To examine the relationship between Party organization governance and corporate carbon emissions, a Pearson correlation coefficient analysis was initially employed. The correlation coefficient between Party organization governance and corporate carbon emissions is negative, and the sign of this coefficient is generally consistent with the hypothesized expectations. The absolute values of the correlation coefficients among other variables all fall within a reasonable range, indicating that the issue of multicollinearity among these variables is not significant. To further assess multicollinearity among the variables, the Variance Inflation Factor (VIF) method was employed. The average VIF value is substantially below the critical threshold of 10, indicating the absence of significant multicollinearity.

Table 2. Descriptive statistical results of main variables.

Variables	N	Mean	Std. Dev.	Min	Max	Median
CE	6186	12.240	1.578	0.000	18.590	12.110
Party_enter	6186	0.225	0.160	0.000	1.091	0.200
Party_cross	6186	0.054	0.227	0.000	2.000	0.000
SHR	6186	0.130	0.134	0.009	0.795	0.079
PB	6186	0.258	0.438	0.000	1.000	0.000
ED	6186	15.19	5.855	2.000	42.000	17.000
Size	6186	5.994	0.637	3.978	8.381	5.916
Lev	6186	0.504	0.200	0.010	1.037	0.513
Roa	6186	0.044	0.044	−0.050	0.478	0.033
Growth	6186	0.215	1.522	−0.862	82.790	0.097
TobinQ	6186	1.757	1.561	0.688	56.660	1.334
Age	6186	2.913	0.337	0.000	4.787	2.944
Mshrate	6186	0.760	3.494	0.000	57.580	0.001
Top1	6186	0.395	0.151	0.036	0.891	0.386
BoardIndep	6186	0.372	0.060	0.167	0.800	0.333
Balance	6186	0.330	0.182	0.012	0.985	0.301

4.2. Baseline Results

After controlling for other factors, the coefficient of the test variable *Party_enter* in Column (2) is −0.177 and is statistically significant at the 1% level. Similarly, in Column (3), the coefficient of *Party_cross* is significantly negative at the 1% level, indicating that the "cross-appointment" leadership system, in which the Party secretary (or deputy secretary) concurrently serves as the chairman or CEO, also inhibits carbon emissions in SOEs. However, the inhibitory effect is weaker compared to the "two-way entry" system. This may be because when Party building leaders assume economic leadership positions, they are required not only to focus on discipline requirements within SOEs but also to create economic value, which may lead to the neglect of environmental protection. In summary, Party organization governance exerts a significant impact on SOE carbon emissions. A higher degree of Party organization participation in the corporate governance structure is associated with a stronger inhibitory effect on carbon emissions. These findings support Research Hypothesis 1, as shown in Table 3.

Among the control variables, firm size (*Size*), financial leverage (*Lev*), profitability (*Roa*), growth opportunities (*Growth*), firm age (*Age*), and ownership stake of the largest shareholder (*Top1*) are all significantly positively correlated with corporate carbon emissions. This suggests that SOEs with larger sizes, higher leverage, greater profitability, higher growth potential, longer operating histories, and higher shareholding ratios of the largest shareholder tend to exhibit higher carbon emissions. Market value (*TobinQ*), managerial shareholding ratio (*Mshrate*), and the proportion of independent directors on the board (*BoardIndep*) are significantly negatively correlated with corporate carbon emissions, indicating that SOEs with higher market values, greater senior management shareholding, and a higher proportion of independent directors are more effective in inhibiting carbon emissions. The coefficients of the remaining control variables are not statistically significant.

Table 3. Party organization governance and corporate carbon emissions.

Variables	(1)	(2)
	CE	***CE***
Party_enter	−0.1768 *** (−3.7203)	
Party_cross		−0.0860 *** (−2.7801)
Size	2.1954 *** (141.4282)	2.1863 *** (142.3227)
Lev	0.7726 *** (16.0980)	0.7716 *** (16.0692)
Roa	2.9436 *** (15.6883)	2.9609 *** (15.7827)
Growth	0.0324 *** (5.3465)	0.0330 *** (5.4398)
TobinQ	−0.0314 *** (−6.1812)	−0.0312 *** (−6.1391)
Age	0.1225 *** (4.8397)	0.1245 *** (4.9143)
Mshrate	−0.0079 *** (−3.7888)	−0.0073 *** (−3.5207)
BoardIndep	−0.2404 ** (−2.0070)	−0.2359 ** (−1.9681)
Top1	0.5320 *** (7.8736)	0.4971 *** (7.4470)
Balance	−0.0805 (−1.3595)	−0.0706 (−1.1938)
Year	Yes	Yes
Industry	Yes	Yes
Province	Yes	Yes
N	6186	6186
F	1256.4695	1255.0541
Adj_R^2	0.8796	0.8797

Note: ** $p < 0.05$, *** $p < 0.01$.

4.3. Robustness Test

Based on the above results, four specific methods were employed to conduct robustness tests aimed at enhancing the credibility of the conclusions. First, alternative variables were employed to verify the consistency of the research findings; second, instrumental variables were constructed to address the issue of reverse causality; third, additional control variables were incorporated to reduce the risk of omitted variable bias; and finally, one-period lags of key variables were utilized to account for temporal effects and to confirm the stability of the results.

4.3.1. Replacement of Measurement Methods

To mitigate measurement error, the existing measurement method for the explanatory variable was replaced with an alternative approach. First, corporate carbon emissions were evaluated utilizing a novel methodology. Corporate carbon emissions were estimated as

the ratio of industry carbon emissions to operating costs, and the natural logarithm of this ratio, with 1 added, was employed as the new measurement. The regression coefficients of Party organization governance were found to be significantly negative at the 1% level. The regression results are presented in Columns (1) and (2) of Table 4.

Table 4. Replacement of measurement methods.

Variables	Alternate Dependent Variable		Alternate Independent Variable
	(1) *CE*	(2) *CE*	(3) *ACE*
Party_enter	−0.1613 *** (−3.3598)		
Party_cross		−0.0664 ** (−2.0934)	
Party			−0.1661 *** (−5.7268)
Controls	Yes	Yes	Yes
Year	Yes	Yes	Yes
Industry	Yes	Yes	Yes
Province	Yes	Yes	Yes
N	5767	5767	5776
F	1073.9880	1072.5268	196.9630
Adj_R^2	0.8841	0.8840	0.8835

Note: ** $p < 0.05$, *** $p < 0.01$.

Next, the governance of Party organizations was evaluated utilizing an index referred to as the Party. This index was calculated as the average value of four indicators: the concurrent holding of positions by Party organization members on the board of directors, the board of supervisors, and in senior management, along with whether the Party secretary concurrently serves as the chairman. The Party index ranges from 0 to 1, with higher values indicating stronger governance by Party organizations. The regression coefficient for the *Party* index remains negative, indicating that Party organization governance significantly mitigates corporate carbon emissions. The regression results are displayed in Column (3) of Table 4.

4.3.2. Construction of Instrumental Variable

To address the issue of reverse causality, an instrumental variable was constructed using the natural logarithm of one plus the geographical distance between the registered location of SOEs and Beijing, and the two-stage least squares (2SLS) method was applied.

In the first-stage regression, the instrumental variable (Distance) was found to be significantly and positively correlated with the variables related to Party organization governance at the 1% significance level. The partial F-statistics used to test for weak instrumental variables were all significantly higher than the conventional critical value of 10, indicating that the instrumental variable (Distance) possessed strong explanatory power for the endogenous variable, thus confirming the absence of weak instrument issues. In the second-stage regression, the coefficients for the Party organization governance variables were all significantly negative. This suggests that after accounting for the endogeneity factor of geographical distance, Party organization governance can significantly inhibit corporate carbon emissions. The Hausman test was also conducted, further verifying the existence of endogeneity problems in the regression model and confirming that geographical distance functions as an endogenous variable influencing carbon emissions. These results

indicate that, after controlling for endogeneity problems through the instrumental variable of geographical distance (Distance), Party organization governance exerts a significant constraining effect on corporate carbon emissions, as shown in Table 5.

Table 5. Construction of the instrumental variable.

Variables	(1)	(2)
	CE	*CE*
Party_enter	−2.9208 *** (−2.6632)	
Party_cross		−2.2101 *** (−2.8715)
Controls	Yes	Yes
Year	Yes	Yes
Industry	Yes	Yes
Province	Yes	Yes
N	6026	6026
Adj_R^2	0.1685	0.0102
X2-Statistic	9.5740 ***	9.7433 ***
F-Statistic	9.3977 ***	9.9393 ***

Note: *** $p < 0.01$.

4.3.3. Incorporation of One-Period Lagged Data

To address potential endogeneity issues, particularly those arising from reverse causality, one-period lagged data for Party organization governance were incorporated into the regression model to enhance the reliability of the empirical results. The results indicate that the regression coefficients and significance levels of the one-period lagged Party organization governance variables are consistent with the previous findings. The test results are presented in Columns (1) and (2) of Table 6.

Table 6. Other robustness tests.

Variables	Lagged by One Period		Add Omitted Varibles	
	(1) *CE*	(2) *CE*	(3) *CE*	(4) *CE*
Party_enter	−0.1764 *** (−3.4336)		−0.1613 *** (−3.3598)	
Party_cross		−0.0665 * (−1.8171)		−0.0664 ** (−2.0934)
Controls	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
Province	Yes	Yes	Yes	Yes
N	5149	5149	5767	5767
F	1123.6000	1121.5000	1073.9880	1072.5268
Adj_R^2	0.8812	0.8810	0.8841	0.8840

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4.3.4. Inclusion of Omitted Variables

To further enhance the robustness of the empirical test, the issue of omitted variables was addressed through the incorporation of additional control variables. Specifically, five control variables were introduced: political connection degree (*PC*), net profit (*Netpro*), institutional investor shareholding ratio (*InstInvest*), free cash flow (*Cash*), and related party transaction rate (*Realt*) [12,51]. After the inclusion of these control variables, the relationship between Party organization governance and corporate carbon emissions remained negative and significant at the 1% significance level. This indicates that the research conclusions remain consistent. The test results are presented in Columns (3) and (4) of Table 6.

4.4. Moderating Effect Results

4.4.1. Result of Degree of Privatization

The coefficient of the main effect, *Party_enter*, is negative, while the interaction term coefficients (*SInter*) display a significant positive correlation at the 5% level. This indicates that greater privatization significantly attenuates the inhibitory impact of Party organization governance on the carbon emissions of SOEs. China is currently undergoing a comprehensive expansion of industrialization, informatization, marketization, urbanization, and internationalization. This modern, real-economy-based industrial system has established a new trajectory for economic growth. Because Party building is deeply integrated throughout SOEs' production and operations, energy and resource demands—and thus carbon emissions—are likely to experience a temporary increase.

The coefficient of the interaction term *Snter_cross* is negative and statistically insignificant. One possible explanation is that, under ongoing mixed-ownership reform, reduced state equity may strengthen short-term, profit-oriented behavior in the management of SOEs. Furthermore, the executive promotion tournament incentive may prompt firms to prioritize economic growth over environmental planning, thereby weakening the inhibitory effect of Party organization governance on emissions. This tendency to emphasize economic development while neglecting environmental planning further undermines the ability of Party organization governance to constrain emissions. As SOE mixed-ownership reform deepens, decision-making increasingly centers on economic rather than social objectives. Consequently, some SOEs may deviate from low-carbon, environmentally friendly objectives, further weakening the relationship between governance and emissions. These results support Hypothesis 3, as demonstrated in Table 7.

Table 7. Results of moderating effects.

Variables	Privatization		Party Building into Articles of Association		Regional Red Culture	
	(1) *CE*	(2) *CE*	(3) *CE*	(4) *CE*	(5) *CE*	(6) *CE*
Party_enter	−0.1608 *** (−3.3408)		−0.1737 *** (−3.6531)		−0.1761 *** (−3.6887)	
Party_cross		−0.0789 ** (−2.4614)		−0.0842 *** (−2.6985)		−0.0861 *** (−2.7077)
SHR	0.1169 * (1.8312)	0.1080 * (1.7250)				
SInter_enter	1.1526 *** (3.4841)					
SInter_cross		0.2255 (0.7253)				

Table 7. *Cont.*

Variables	Privatization		Party Building into Articles of Association		Regional Red Culture	
	(1) *CE*	(2) *CE*	(3) *CE*	(4) *CE*	(5) *CE*	(6) *CE*
PB			−0.0000 (−0.0012)	−0.0056 (−0.2852)		
PBInter_enter			−0.2083 ** (−2.1218)			
PBInter_cross				−0.0255 (−0.3888)		
ED					0.0022 * (1.6685)	0.0019 (1.4150)
EDInter_enter					−0.0182 ** (−2.4321)	
EDInter_cross						−0.0077 (−1.3900)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Province	Yes	Yes	Yes	Yes	Yes	Yes
N	6186	6186	6186	6186	6186	6186
F	1123.8175	1122.3113	1190.9485	1188.6627	1185.2996	1182.9337
Adj_R^2	0.8818	0.8817	0.8797	0.8795	0.8807	0.8805

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4.4.2. Result of Party Building into Articles of Association

The interaction term (*PBInter*) between Party building into articles of association and Party organization governance is statistically significant and negative in nature. This suggests that in SOEs that contain more comprehensive content regarding Party building into articles of association, Party organizations are better positioned to engage in governance and participate in key decision-making processes. Consequently, the role and influence of Party organizations are enhanced, thereby strengthening their governance effect on mitigating corporate carbon emissions. These results are reported in Table 7.

4.4.3. Result of Regional Red Culture

Regional red cultural resources facilitate the integration of Party culture into corporate culture, guiding executives to align decisions with the sustainable development policies of the CPC. Empirical evidence employs the number of patriotic education demonstration bases in the region of an SOE as a proxy for the strength of regional red culture. The interaction term (*EDInter*) between regional red cultural endowments and Party organization governance is significantly negative, indicating that stronger red cultural resources empower Party organizations to cultivate appropriate value orientations among members, thus amplifying their governance impact on reducing carbon emissions. These regression results are reported in Table 7.

5. Discussion

This study seeks to fill the research gap in understanding how Party organization governance influences corporate carbon emissions and the mechanisms involved, a topic

that has received limited attention in the existing literature. Fixed-effects regressions confirm that Party organization governance mechanisms, operationalized as "two-way entry" and "cross-appointment", significantly reduce corporate carbon emissions. Furthermore, the magnitude of this governance effect is moderated by the degree of privatization, the quality of Party building into articles of association, and the richness of regional red cultural endowments. Specifically, a 1% increase in the "two-way entry" indicator is associated with a 0.1768% reduction in corporate carbon emissions, whereas a 1% rise in the "cross-appointment" indicator corresponds to a 0.0860% decrease. These results indicate that Party organization governance plays a crucial role in mitigating corporate carbon emissions.

The principal innovation of this research lies in its focus on the positive environmental outcomes associated with Party organization governance. It elucidates the critical environmental role of Party organization governance beyond economic performance, thereby addressing limitations identified in previous studies on SOE governance [25–29]. Different from previous studies focusing on governmental interventions (e.g., carbon taxes and trading [6–12]), or micro-governance mechanisms (e.g., board diversity and executive compensation [18,20]), this study broadens the literature on corporate carbon emission determinants by revealing a political–institutional pathway unique to China. In doing so, this study examines the internal institutional and cultural mechanisms through which Party organization governance restrains corporate carbon emissions.

From an institutional perspective, it is demonstrated that as SOEs progress toward greater privatization, the effectiveness of Party organization governance in environmental regulation diminishes. This topic remains underexplored in both the environmental management and corporate governance literature. These findings furnish novel evidence that privatization may compromise environmental outcomes, corroborating the findings of Wang et al. [33] and Shen et al. [52], which indicate that increased privatization in SOEs may lead to poorer environmental performance.

From a cultural perspective, this study underscores how Party building into articles of association and the richness of regional red culture reinforce Party organization governance in curbing carbon emissions. Unlike prior studies that examine Party building into articles of association in relation to social donation [42] or the influence of red culture on excess leverage [46] and innovation [53], this work extends the field by demonstrating their positive environmental impacts. Notably, the moderating effect of regional red culture is relatively weak, suggesting that SOEs should prioritize enhancing the quality of Party building into articles of association to achieve greater emission reductions. A possible reason may be that Party building into articles of association emphasizes the statutory role of Party organizations in corporate governance—encompassing decision-making, supervision, and execution—thereby ensuring adherence to environmental policies and low-carbon objectives. By contrast, regional red culture primarily operates via external environmental stimuli, resulting in a more indirect and often less pronounced effect compared to direct governance mechanisms.

Given China's unique political system and the predominance of state ownership, the Chinese Communist Party integrates its norms, core values, and development strategies into corporate governance via mechanisms such as "two-way entry" and "cross-appointments". This governance framework ensures that SOEs implement national low-carbon and green development policies in major decisions, strategic planning, and daily operations while also fostering green technology innovation and low-carbon production through enhanced internal oversight, performance evaluation, and resource allocation. Notably, this framework exhibits clear context-specific effects; its impact may vary substantially across institutional settings, providing valuable perspectives for future cross-national and cross-regional comparative studies.

6. Conclusions

6.1. Research Conclusions

The impact of Party organization governance on the environmental performance of SOEs has garnered academic attention; however, studies specifically examining its relationship with corporate carbon emissions remain limited. Based on the background of Chinese companies, through empirical analysis of panel data for A-share-listed SOEs for six consecutive years, this study assess the effect of Party organization governance on carbon emissions through the mechanisms of "two-way entry" and "cross-appointment". The main findings are as follows: First, Party organization governance in SOEs significantly mitigates corporate carbon emissions. Second, increased privatization attenuates this governance effect. Third, the inhibitory impact of Party organization governance on corporate carbon emissions is strengthened in SOEs characterized by higher-quality Party building into articles of association and in regions with denser networks of patriotic education bases. The findings provide actionable recommendations for energy regulators and corporate managers aiming to embed governance reforms within national energy efficiency strategies.

6.2. Managerial Implications

The findings offer practical guidance for optimizing the modern SOE system with Chinese characteristics, facilitating low-carbon transitions, supporting privatization, and deepening mixed-ownership reforms. Specific suggestions are as follows:

The attachment of importance to the positive environmental role of Party organization governance is imperative. It is essential to strengthen the leadership role of Party organizations in corporate strategy and decision-making, ensuring alignment with national environmental objectives and enabling the rigorous application of low-carbon principles. Furthermore, institutional mechanisms for Party organization participation in governance have been enhanced to establish comprehensive environmental management frameworks, incorporating energy-performance, regular audits, sustainability evaluations, and ecological criteria into executive appraisals. Equally important is the reinforcement of the supervisory role of Party organizations regarding corporate environmental performance. The active monitoring and evaluation of corporate adherence to environmental regulations and sustainability commitments by Party organizations can prompt enterprises to fulfill their social responsibilities, optimize the energy structure, curb carbon footprints, and support broader ecosystem preservation and energy-system decarbonization.

The enhancement of the quality of Party building into articles of association and the richness of patriotic culture in Privatized SOEs is necessary. This study demonstrates that privatization attenuates the influence of Party organization governance on carbon emissions. In privatized SOEs, Party organization governance is constrained by diverging shareholder values and objectives. To mitigate these effects, the incorporation of Party building into articles of association should be strengthened, embedding Party organization governance within operational processes. Embedding the decision-making, supervisory, and execution functions of Party organizations into corporate governance will amplify their capacity to drive carbon reduction. Furthermore, the promotion of patriotic education and traditional cultural elements can guide corporations to foster disciplined, green, and low-carbon values in order to enhance their sense of social responsibility, thereby more effectively curbing energy-sector emissions.

6.3. Research Limitations and Future Directions

Despite these contributions, this study faces certain limitations and avenues for further research.

This study has several limitations: First, the study is heavily reliant on quantitative methods. The absence of qualitative inquiries or case studies limits the study's ability to fully elucidate Party organization governance mechanisms, which might provide richer insight into the role of the CPC. Second, the sample size utilized for empirical analysis is limited. The study utilizes listed SOEs in China from 2016 to 2021 as the research sample, thereby excluding non-listed companies, which results in a limited dataset and potential data omissions or measurement errors. Third, the measurement of the main variable may lack precision. Party organization governance is assessed through two indicators: "two-way entry" and "cross-appointment"; however, this approach does not capture nuances such as the degree of influence or type of involvement, which may vary widely within Party committee-affiliated roles. Finally, the study insufficiently examines the potential limitations associated with strong Party organization involvement in corporate governance, which may entail adverse consequences. Excessive participation by Party organizations in governance may lead to an overconcentration of resources on carbon reduction targets at the expense of innovation investment, thereby undermining firms' technological advancement. Furthermore, excessive involvement may also foster bureaucratic practices, complicating decision-making processes and raising administrative costs; likewise, concentrated authority, especially in the absence of robust oversight, may elevate the risk of corruption.

In view of the above limitations, future research may be conducted in the following areas: First, future studies can focus on longitudinal research. An examination can be conducted to assess the long-term impact of Party organization governance on corporate carbon emissions, thereby illustrating the sustained effects of China's distinctive "Party building + low-carbon" governance model. Second, more extensive exploration can be undertaken in future research. The research scope should be broadened to include other emerging market countries through cross-national comparative studies, thereby testing the generalizability of these findings and providing comparative insights into global state-owned enterprise reform and the green transition, and identify governance configurations that most effectively drive reductions in carbon intensity across diverse institutional and energy-market environments. Third, indicators of Party organization governance can be further refined and expanded. Future studies can use objective measures to explore, such as the scientification and standardization of Party organization behavior in the decision-making processes of major issues, as well as the training and study of Party organization members and cadres, in order to achieve a more comprehensive and multidimensional assessment. Finally, the excessive administrative intervention of Party organizations should be considered. Future research can investigate how low-carbon objectives can be balanced with corporate managerial efficiency under strong Party organization governance while addressing persistent SOEs governance challenges such as corruption, inefficiency, and insider control. Such insights would inform both the theoretical development and practical refinement of SOE governance models within the Chinese context and inform practical refinements to support an efficient, low-carbon energy transition.

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Abbreviations

The following abbreviations are used in this manuscript:

SOEs	State-owned enterprises
CPC	Communist Party of China
SASAC	State-owned Assets Supervision and Administration Commission

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