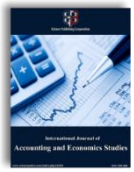
International Journal of Accounting and Economics Studies, 12 (6) (2025) 530-543

International Journal of Accounting and Economics Studies

Website: www.sciencepubco.com/index.php/IJAES
https://doi.org/10.14419/tpra3604
Research paper



The Moderating Role of Internal Control on The Relationship between Carbon Disclosure Quality and Corporate Economic Value: Based on Chinese Listed Companies

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Received: July 27, 2025, Accepted: October 7, 2025, Published: October 14, 2025

Abstract

Sustainable value creation has become an important goal for modern corporations. Among the key drivers, carbon disclosure quality (CDQ) has received growing attention. However, existing studies report mixed results on its impact on corporate economic value (CEV). In addition, little is known about the role of internal control (IC) in this relationship. This study investigates the effect of CDQ on CEV and examines whether IC strengthens this link. It uses panel data from A-share listed companies in China, covering the period from 2010 to 2023. A fixed effects regression model is applied to control for unobserved firm-level heterogeneity. The findings show that higher CDQ is associated with improved CEV. Moreover, an effective IC enhances this positive relationship. These results suggest that internal governance mechanisms can help firms translate carbon disclosure into economic value. Further analysis shows that the effect of CDQ varies across firm types. The positive impact is more evident in non-heavily polluting industries, non-state-owned enterprises, and companies not audited by Big Four accounting firms. This study contributes to the literature on corporate sustainability. It highlights how disclosure quality and internal governance jointly influence firm value under different organizational contexts.

Keywords: *Carbon Disclosure Quality; Corporate Economic Value; Internal Control; Chinese Listed Companies, Fixed Effects Model.*

1. Introduction

Global concerns over climate change and biodiversity loss have intensified, with economic value-creating activities identified as major contributors. (Wu, 2024). These activities cause severe environmental degradation, such as natural disasters and public health threats. (de Almeida Barbosa Franco et al., 2024; Wu, 2024). In response to the traditional emphasis on maximizing shareholder value, Freeman (2010) Offers a critical perspective. He argues that firms should adopt a broader approach—one that considers the interests and benefits of multiple stakeholders, not just shareholders. (Freeman, 2010; Mahajan et al., 2023). Empirical evidence suggests that firms with strong sustainability practices and active stakeholder engagement tend to achieve better long-term performance. (Bai et al., 2023; Onukwulu et al., 2025).

Carbon dioxide (CO_2) is widely recognized as a primary driver of global warming. (Filonchyk et al., 2024). Corporations, as the largest contributors to energy use and emissions, play a pivotal role in addressing climate challenges. (Li et al., 2023; Wright & Nyberg, 2024). High-quality carbon disclosure—defined by accuracy, completeness, and reliability—can enhance transparency and support sustainable development. (Liu & Wu, 2024). Yet, the empirical link between carbon disclosure quality (CDQ) and corporate economic value (CEV) remains inconclusive, with mixed results across studies. (Matthews et al., 2025; Wang et al., 2023a; Wijaya & Handoko, 2025; Zhu et al., 2024).

Inconsistencies partly arise from the lack of a unified standard for measuring CDQ. Without standardized reporting frameworks, credibility and comparability suffer. Greenwashing practices further undermine trust. (Li et al., 2025). Moreover, "greenwashing" practices further undermine stakeholders' trust. (Dagestani et al., 2024; Li et al., 2025). Internal control (IC), which safeguards the accuracy of financial and non-financial disclosures, may enhance the value relevance of CDQ. (Huang et al., 2025; Tao et al., 2023). Yet, its moderating role in the CDQ–CEV relationship remains underexplored.

China offers a compelling empirical setting for this investigation. As the world's largest emitter of CO_2 and the second-largest economy, China's carbon disclosure practices significantly influence global climate governance. (Li et al., 2024; Zhang et al., 2024a). This study addresses two key gaps: the inconsistent findings on CDQ's effect on CEV and the limited understanding of how IC moderates this relationship in the Chinese context.

This study makes three key contributions. First, it extends stakeholder theory by providing evidence from an emerging market context. Second, it offers practical insights into how carbon disclosure enhances economic value for Chinese listed companies. Third, it employs an entropy-weighted evaluation framework to develop a robust, context-specific CDQ index.

The remainder of this paper is structured as follows. Section 2 reviews the relevant literature on CDQ, CEV, and IC, and develops the research hypotheses based on stakeholder theory. Section 3 describes the research design, including sample selection, variable definitions, and the empirical models. Section 4 presents the empirical results, including baseline regression, robustness checks, and heterogeneity analyses. Section 5 discusses the key findings in light of existing literature and theoretical perspectives. Finally, Section 6 concludes the paper by summarising the main contributions, practical implications, and directions for future research.

2. Theoretical Background and Hypotheses Development

2.1. Carbon disclosure quality and corporate economic value

As climate change intensifies, carbon disclosure has become an important mechanism for companies to demonstrate environmental responsibility and respond to growing stakeholder expectations. (Li et al., 2025; Wijaya & Handoko, 2025). The concept of CDQ refers to the accuracy, completeness, consistency, and credibility of a firm's carbon-related disclosures, which play a critical role in shaping stakeholder perceptions and responses. (Ali et al., 2024; Huang et al., 2025).

Existing literature on the relationship between CDQ and CEV has yielded mixed findings. On one hand, some scholars—drawing on shareholder primacy and cost-based views—argue that carbon disclosure imposes substantial compliance costs and administrative burdens, which may weaken firm profitability and shareholder value. (Lu et al., 2021; Siddique et al., 2021; Wijaya & Handoko, 2025). For example, Siddique et al. (2021) Demonstrated that CDQ is negatively associated with return on assets (ROA) and had no significant impact on Tobin's Q (TQ). Lu et al. (2021) Also found that the effect of carbon disclosure on firm performance in China was not uniformly significant across firms, indicating that firm heterogeneity and varying market responses may weaken the financial benefits of disclosure. Recent studies also provided evidence that carbon disclosure exerts a statistically significant negative effect on firm value. (Wijaya & Handoko, 2025).

However, a growing number of studies based on stakeholder theory present a more optimistic view. This theory argues that firms must actively manage relationships with diverse stakeholder groups—including investors, regulators, consumers, and civil society—to sustain long-term legitimacy and performance. (Dagestani et al., 2024; Mahajan et al., 2023; Onukwulu et al., 2025). High-quality carbon disclosure helps reduce information asymmetry, enhances corporate transparency, and builds stakeholder trust, which in turn improves access to capital, strengthens reputation, and promotes sustainable competitive advantage. (Huang et al., 2025; Xu et al., 2025).

Empirical evidence supports these arguments. Xu et al. (2025) Analyzed A-share firms in Shanghai and Shenzhen (2013–2023) and found that enhanced carbon disclosure significantly improves financial performance, mainly by reducing debt costs and increasing institutional ownership. Huang et al. (2025) Also examined firms listed on the Shanghai and Shenzhen stock exchanges between 2013 and 2021, focusing specifically on CDQ. Their empirical findings further support the positive association between disclosure and enterprise value, suggesting that higher-quality carbon reporting can significantly enhance firm valuation.

Taken together, the literature illustrates both the costs and benefits of carbon disclosure, but often remains descriptive in highlighting these competing effects. By engaging stakeholder theory more directly, this study emphasizes that CDQ is not only a financial or compliance issue but also a form of multi-stakeholder accountability. High-quality disclosure assures investors, regulators, and society that corporate practices align with broader environmental goals, thus extending stakeholder theory to the domain of climate governance. (Huang et al., 2025; Li et al., 2025). At the same time, recent research warns that the credibility of CDQ is undermined when firms engage in greenwashing—using symbolic or selective disclosure to create a false impression of responsibility. (Dagestani et al., 2024; Li et al., 2025). This insight highlights the need for governance mechanisms, such as IC, that can safeguard disclosure quality and ensure its positive effect on CEV. (Yan et al., 2024; Zhang et al., 2024b).

Thus, these insights suggest that high-quality carbon disclosure plays a vital role in shaping stakeholder perceptions and enhancing CEV. Accordingly, this study proposes the following hypothesis:

H1: Carbon disclosure quality is positively related to corporate economic value.

2.2. The moderating role of internal control

While CDQ may positively influence corporate value, its effectiveness depends heavily on the credibility and assurance mechanisms that support disclosure practices. One such mechanism is IC, which refers to organizational processes and procedures that ensure the reliability of information, compliance with laws, and efficient operations. (Yan et al., 2024; Zhang et al., 2024b). In the context of carbon disclosure, IC can strengthen the authenticity and integrity of the information reported, thus enhancing stakeholder confidence. (Gao et al., 2025; Zhang et al., 2024b).

The stakeholder theory perspective emphasizes that firms must provide reliable information to meet the evolving needs of multiple stakeholder groups. (Mahajan et al., 2023; Onukwulu et al., 2025). When IC is effective, it acts as an internal governance mechanism that ensures carbon disclosures are not only timely and complete but also consistent with actual corporate behavior. (Yan et al., 2024). This reduces the risk of greenwashing, improves accountability, and increases the decision-usefulness of ESG-related information. (Yan et al., 2024; Zhang et al., 2024b).

Although prior literature has extensively examined IC's influence on financial reporting, its role in non-financial disclosures is increasingly gaining attention. Wu et al. (2025) Found that mandatory disclosure requirements under China's "Dual-Carbon" policy significantly improved ESG performance among listed firms by strengthening IC and curbing managerial short-termism. Kolsi and Al-Hiyari (2024) Demonstrated that among Malaysian listed firms, a higher internal audit budget enhances ESG performance, particularly when audit activities are conducted in-house, highlighting the moderating role of internal audit sourcing in strengthening internal governance.

Despite these developments, few studies have focused specifically on how IC moderates the relationship between CDQ and CEV—especially in China. This omission is critical, as carbon-related information is often voluntary, complex, and non-standardized (Li et al., 2025). Without an effective IC, stakeholders may question the verifiability and strategic relevance of disclosed information. In contrast, effective IC reinforces stakeholder trust and ensures that CDQ translates into tangible economic outcomes such as better stock performance, easier financing, or lower risk premiums. (Meng et al., 2023; Zahid et al., 2023).

Overall, prior studies confirm that IC enhances the reliability of financial information, yet its role in non-financial disclosure remains underexplored. By linking IC with stakeholder theory, this study positions IC as an internal governance mechanism that strengthens multi-stakeholder accountability. Effective IC helps firms move beyond symbolic disclosure and address greenwashing risks, ensuring that reported information reflects substantive corporate actions. (Dagestani et al., 2024; Li et al., 2025). This not only improves stakeholder trust but also advances theoretical understanding by demonstrating how IC enables CDQ to generate tangible CEV within the Chinese policy context.

Based on this reasoning, the following hypothesis is proposed:

H2: Internal control positively and significantly moderates the relationship between carbon disclosure and corporate economic value.

3. Research Design

3.1. Methods

This study adopts a quantitative design with panel data from Chinese listed companies (2010–2023). Given the panel nature of the data, the study begins with a series of model selection tests to identify the appropriate estimation strategy. Specifically, the pooled Ordinary Least Squares (OLS) model is compared with the fixed effects (FE) and random effects (RE) models using the F-test, Breusch–Pagan Lagrange Multiplier (LM) test, and the Hausman specification test. (Mithila & Kengatharan, 2025). The results support the use of an FE model, which accounts for unobserved time-invariant heterogeneity across firms. All statistical analyses are conducted using Stata MP 17.0 (64-bit), with data cleaning and index construction supported by Python 3.12.1 and Microsoft Excel.

3.2. Model specification

Based on the model selection tests described above, the FE model is adopted to control for unobserved, time-invariant firm-specific characteristics that may affect CEV. Two regression models are constructed to test the hypotheses developed in Section 2:

Model (1): Testing the Direct Effect of CDQ on CEV

$$\mathrm{CEV}_{it} = \alpha_i + \alpha_1 \mathrm{CDQ}_{it} + \alpha_2 \mathrm{Controls}_{it} + \alpha_3 \mathrm{FIRM} + \alpha_4 \mathrm{YEAR} + \varepsilon_{it} \quad \text{Model (1)}$$

Model (2): Testing the Moderating Role of IC

$$\mathrm{CEV}_{it} = \alpha_i + \alpha_1 \mathrm{CDQ}_{it} + \alpha_2 \mathrm{IC}_{it} + \alpha_3 (\mathrm{CDQ}_{it} + \mathrm{IC}_{it}) + \alpha_4 \mathrm{Controls}_{it} + \alpha_5 \mathrm{FIRM} + \alpha_6 \mathrm{YEAR} + \varepsilon_{it} \quad \text{Model (2)}$$

Where: CEV_{it} represents the corporate economic value of firm i in year t, CDQ_{it} represents the carbon disclosure quality index, IC_{it}represents internal control dummy variable (1 = effective; 0 = otherwise), $\mathrm{Controls}_{it}$ Represent control variables including firm size, leverage, asset turnover, etc. FIRM represents firm-fixed effects, and YEAR represents year-fixed effects. ε_{it} Represents the error term. α_i Represents unobserved firm-specific effects.

3.3. Sample selection

As the world's second-largest economy and the largest carbon emitter (Li et al., 2024; Zhang et al., 2024a)China plays a pivotal role in global carbon governance. Its stock market is also the second largest globally in terms of total market capitalization. (He & Wei, 2023). Therefore, the carbon disclosure practices of Chinese listed companies not only reflect the national level of carbon management but also exert significant influence on international carbon governance.

China publicly committed to emission reduction targets at the 2009 Copenhagen Climate Summit and subsequently introduced a series of institutional and regulatory measures to meet those targets. (Liu et al., 2022b). In parallel, the Basic Standards for Enterprise Internal Control—jointly issued by the Ministry of Finance and other authorities in 2008—became mandatory for listed companies starting 1 July 2009 (Huang, 2022). Given the typical lag in policy implementation and data availability, this study sets 2010 as the starting year. The endpoint, 2023, is selected to ensure the timeliness and completeness of data.

The initial sample covers all A-share companies listed on the Shanghai and Shenzhen Stock Exchanges from 2010 to 2023. Several screening procedures were applied: (1) financial firms were excluded due to their unique regulatory environment; (2) firms under special treatment (ST/*ST), which are financially distressed or face delisting risks, were removed; (3) observations with missing or inconsistent financial, disclosure, or IC data were excluded.

After these steps, the final dataset consists of 19,288 firm-year observations from 1,428 listed companies over the 14-year period. This unbalanced panel provides a sufficiently large sample to ensure the robustness and generalisability of the empirical analysis.

3.4. Data and variables

This study relies exclusively on secondary data, drawing from several authoritative databases widely recognized in accounting and finance research to ensure reliability and replicability:

Corporate financial and firm characteristics: obtained from the China Stock Market & Accounting Research (CSMAR) database, which is extensively used in prior studies (e.g., Cao et al., 2022; Xu et al., 2023).

IC data: retrieved from the DIB database, which evaluates the effectiveness of IC in Chinese listed companies (Ma et al., 2022; Ong et al., 2024; Wang et al., 2023b).

CDQ data: collected from annual reports, CSR reports, sustainability reports, and ESG disclosures available on Cninfo (http://www.cninfo.com.cn/new/index), the official corporate information disclosure platform supervised by the China Securities Regulatory Commission (CSRC) (Liu & Zhang, 2022; Tang et al., 2021).

3.4.1. Dependent variable

The dependent variable is CEV, measured primarily by TQ, a widely adopted market-based performance indicator. TQ reflects the ratio of the market valuation of a firm to the replacement cost of its assets, capturing investors' expectations of growth and profitability. (Huang et al., 2025; Shah et al., 2025; Wijaya & Handoko, 2025). It is calculated as:

$$TQ = \frac{\text{Market Value of Equity+Total Liabilities}}{\text{Total Assets}} \quad (1)$$

In addition, to ensure robustness, LnMV (natural logarithm of market value) is employed as an alternative measure of CEV in robustness tests (Bahadır et al., 2024; Tang et al., 2022).

3.4.2. Independent variable

The independent variable is CDQ. Following Tang et al. (2021)This study adopts a multi-dimensional evaluation framework including environmental situation cognition, low-carbon target planning, low-carbon promotion and training, and emission reduction incentive mechanisms (see Appendix A). The CDQ evaluation framework has demonstrated strong internal consistency and construct validity, with a Cronbach's alpha of 0.825, KMO of 0.773, and a significant Bartlett's test ($p < 0.001$) (Bartlett, 1950; Kaiser & Rice, 1974).
To objectively construct the CDQ index, the entropy weight method (EWM) is applied. The EWM is a statistical technique used to assign weights to indicators based on the degree of variation in the data. (Shannon, 1948; Yin et al., 2025). In essence, indicators with greater variability contain more information and therefore receive higher weights, while more uniform indicators receive lower weights. (Shannon, 1948; Yin et al., 2025). This approach reduces subjectivity in measurement and has been widely applied in disclosure and sustainability studies. (Xu et al., 2024; Yin et al., 2025). In brief, the method involves (i) normalization of raw data, (ii) entropy calculation for each indicator, (iii) weight determination, and (iv) aggregation into a composite index. The resulting CDQ index ranges from 0 to 1, with higher values representing higher disclosure quality. The specific steps are as follows:
Step 1: Normalization
For each indicator j and firm i in year t, the raw data. x_{ijt} Are normalized:

- Positive indicators (the higher, the better):

$$z_{ijt} = \frac{x_{ijt} - x_{jt}^{min}}{x_{jt}^{max} - x_{jt}^{min}} \quad (2)$$

- Negative indicators (the lower, the better):

$$z_{ijt} = \frac{x_{jt}^{max} - x_{ijt}}{x_{jt}^{max} - x_{jt}^{min}} \quad (3)$$

Step 2: Proportion Calculation
The proportion of firm i's performance in indicator j in year t is calculated as:

$$p_{ijt} = \frac{z_{ijt}}{\sum_{i=1}^{n} z_{ijt}} \quad (4)$$

Step 3: Entropy Value
The entropy of each indicator j in year t is computed by:

$$e_{jt} = -k \sum_{i=1}^{n} p_{ijt} \ln(p_{ijt}), \text{where } k = \frac{1}{\ln(n)} \quad (5)$$

If $p_{ijt} = 0$, define $p_{ijt} \ln(p_{ijt}) = 0$ by convention.
Step 4: Determining Weights
The weight of each indicator is calculated as:

$$w_{jt} = \frac{1 - e_{jt}}{\sum_{j=1}^{m} (1 - e_{jt})} \quad (6)$$

Step 5: Composite CDQ Index
The overall CDQ index for firm i in year t is:

$$CDQ_{it} = \sum_{j=1}^{m} w_{jt} \cdot z_{ijt} \quad (7)$$

This method ensures objectivity and reflects variations in disclosure performance across firms and over time. CDQ_{it} Ranges between 0 and 1, where values closer to 1 indicate a higher quality of corporate disclosure.

3.4.3. Moderator and control variables

The moderator is IC, operationalized as a binary variable from the DIB database: firms are coded as 1 if they are evaluated as having effective IC, and 0 otherwise. (Arianpoor et al., 2023; Boulhaga et al., 2023).
To account for potential firm-level heterogeneity, a set of control variables frequently used in the literature and relevant to firm performance and disclosure behavior is incorporated into the models. Firm size (LnAsset): Natural logarithm of total assets, representing economies of scale and resource availability (Huang et al., 2025; Wu et al., 2025). Leverage (LEV): Ratio of total liabilities to total assets, capturing financial risk and capital structure (Chao et al., 2025; Huang et al., 2025). Total asset turnover (TotalTu): Operating income divided by the

average total assets, reflecting operational efficiency (Huang et al., 2025; Lu et al., 2023). Fixed asset ratio (FixedRa): Ratio of operating income to the average fixed assets, indicating asset intensity (Dai & Sun, 2025; Wu et al., 2025). Sales growth (Growth): Year-on-year growth rate in operating income, representing market expansion (Shao et al., 2025; Wu et al., 2025).
Additionally, Equity concentration (TOP1): Shareholding percentage of the largest shareholder, reflecting ownership structure and potential influence (Huang et al., 2025; Wu et al., 2025). Listing age (Lage): Number of years since IPO, indicating firm maturity (Xu et al., 2023; Zhu et al., 2024). Board size (BS): Total number of directors, serving as a proxy for governance structure (Chao et al., 2025; Huang et al., 2025). CEO duality (Dual): A dummy variable coded as 1 if the CEO also serves as the board chair, and 0 otherwise (Shao et al., 2025; Wu et al., 2025). Audit quality (BIG4): A dummy variable coded as 1 if the firm is audited by one of the Big Four firms (PwC, Deloitte, Ernst & Young, KPMG), and 0 otherwise (Abdalla et al., 2024; Mathath et al., 2025). State-owned enterprises (SOEs): A dummy variable coded as 1 if the firm is a state-owned enterprise, and 0 otherwise (Wu et al., 2025; Xu et al., 2025). Industry type (IND): A dummy variable coded as 1 if the firm operates in a heavily polluting industry, and 0 otherwise (Lu et al., 2023; Sun et al., 2025).
To mitigate the influence of extreme values, all non-categorical variables are winsorized at the 1% and 99% levels. Detailed definitions of all variables are presented in Table 1.

Table 1: Definition of Variables

Variable	Variable Name (Symbol)	Source	Variable Definition
Dependent Variable	Corporate Economic Value (CEV)	CSMAR	(Market Value of Equity + Liabilities)/Total Assets
Independent Variable	Carbon Disclosure Quality (CDQ)	Cninfo	Calculated from Equation (2)～(7)
Moderating Variable	Internal Control (IC)	DIB	1 for Effective Internal Control, 0 for Otherwise.
Control Variables	Firm Size (LnAsset)	CSMAR	Natural Logarithm of Total Assets
	Total Asset Turnover Ratio (TotalTu)	CSMAR	Operating Income/ (Total Assets Closing Balance + Total Assets Opening Balance)/2
	Fixed Asset Ratio (FixedRa)	CSMAR	Operating Income / (Closing Balance of Fixed Assets + Opening Balance of Fixed Assets)/2
	Sales Growth Rate (Growth)	CSMAR	(Current Year Operating Income - Previous Year Operating Income) / Previous Year Operating Income
	Equity Concentration (TOP1)	CSMAR	The Top One Largest Shareholders' Ownership Percentage
	Listing Duration (Lage)	CSMAR	Current Year – IPO Year
	Board Size (BS)	CSMAR	The Total Number of Directors on the Board
	CEO duality (Dual)	CSMAR	1 for the CEO, Also Serves as the Chairman of the Board, 0 for Otherwise
	Audit Quality (BIG4)	CSMAR	1 for the Corporation is Audited by One of the BIG4 (Deloitte, PwC, Ernst & Young, and KPMG), 0 for Otherwise
	State-owned enterprises (SOEs)	CSMAR	1 for State-Owned Enterprises, 0 for Otherwise
	Industry Type (IND)	CSMAR	1 for Heavy Polluting Industry, 0 for Otherwise

Note: All the noncategorical variables are winsorized at the 1% and 99% levels. Source: Own research.

4. Empirical Results

4.1. Descriptive statistics

Table 2 presents the descriptive statistics for all variables included in the analysis. The CEV exhibits a mean of 1.8846 with a standard deviation of 1.1471, and ranges from 0.8097 to 7.2365, suggesting substantial variability in market-based valuations across Chinese listed companies. The mean CDQ score is 0.2149, with a relatively high standard deviation of 0.3519, and a median of only 0.0581, indicating that carbon disclosure remains generally underdeveloped for most companies, although a small number have achieved near-perfect disclosure performance. The mean value of IC is 0.5622, implying that approximately 56% of companies are classified as having effective IC.
Among the control variables, LnAsset has a mean of 22.6472, reflecting the relatively large scale of listed companies in China. The LEV averages 0.4478, with moderate variation across the sample. Operational efficiency, captured by TotalRa and FixedRa, shows a mean of 0.6689 and 8.6805, respectively, with the latter exhibiting high dispersion (SD = 19.7089), indicating varying levels of capital intensity across companies. The average Growth is 0.1463, while the TOP1 averages 34.37%, pointing to relatively high ownership concentration. Companies in the sample have, on average, been listed for 14.08 years (Lage) and maintain a BS of approximately 8.81 directors.
Regarding categorical variables, 20.67% of CEOs also serve as chairpersons of the board (Duality), while 8.22% of companies are audited by BIG4. SOEs account for 51.17% of the sample, and 31.20% operate in IND.
Overall, the statistics highlight considerable heterogeneity across firms in terms of governance, size, industry classification, and disclosure practices. These variations form a robust foundation for the subsequent empirical analyses.

Table 2: Descriptive Statistics Results

Variable	N	Mean	SD	Min	Median	Max
CEV	19288	1.8846	1.1471	0.8097	1.5059	7.2365
CDQ	19288	0.2149	0.3519	0	0.0581	1
IC	19288	0.5622	0.4961	0	1	1
LnAsset	19288	22.6472	1.3487	20.2270	22.4782	26.6094
LEV	19288	0.4478	0.1966	0.0585	0.4517	0.8554
TotalRa	19288	0.6689	0.4738	0.0791	0.5614	2.7772
FixedRa	19288	8.6805	19.7089	0.2794	3.3222	148.7694
Growth	19288	0.1463	0.3364	-0.4949	0.0958	1.9640
TOP1	19288	34.3714	15.2162	8.0871	32.2777	74.8699
Lage	19288	14.0762	7.0880	1	14	29
BS	19288	8.8105	1.7281	5	9	15
Dual	19288	0.2067	0.4049	0	0	1
BIG4	19288	0.0822	0.2747	0	0	1

SOEs	19288	0.5117	0.4999	0	1	1
IND	19288	0.3120	0.4633	0	0	1

Note: Corporate Economic Value (CEV), Carbon Disclosure Quality (CDQ), Internal Control (IC), Natural Logarithm of Total Assets (LnAsset), Debt-to-Asset Ratio (LEV), Total Assets Turnover Ratio (TotalRa), Fixed Asset Turnover Ratio (FixedRa), Sales Growth Rate (Growth), Top One Largest Shareholders' Ownership Percentage (TOP1), Listing Duration (Lage), Board Size (BS), CEO Also Serves as the Chairman of the Board (Dual), Corporations Audited by the Big Four (Deloitte, PwC, Ernst & Young, and KPMG) (BIG4), State-Owned Enterprises (SOEs), Heavily Polluting Industries (IND). Source: Own research.

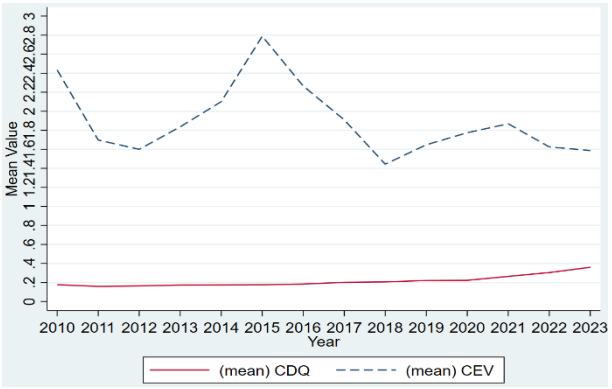

Fig. 1: CDQ and CEV in Chinese Listed Companies (2010–2023).

Note: Corporate Economic Value (CEV), Carbon Disclosure Quality (CDQ), Source: Own research.

Figure 1 illustrates the annual mean values of CDQ and CEV for Chinese listed companies from 2010 to 2023. As shown, CDQ demonstrates a gradual but steady upward trend, particularly after 2018, reflecting the progressive enhancement of disclosure practices in response to regulatory reforms and growing stakeholder scrutiny. In contrast, CEV exhibits greater volatility over the same period, with a notable peak around 2016–2017 and subsequent fluctuations that broadly align with macroeconomic cycles and capital market dynamics. Despite these variations, the overall trajectory of CEV remains positive. The coexistence of a steady rise in CDQ and the more cyclical pattern of CEV suggests that improvements in disclosure quality are structural and persistent, while firm value is simultaneously influenced by broader market and policy conditions. This temporal evidence provides descriptive support for the subsequent regression analysis, which formally tests the positive relationship between CDQ and CEV.

4.2. Correlation analysis

Table 3 reports the Pearson correlation coefficients among the variables. CEV is negatively correlated with CDQ ($\beta = -0.0410$, $p < 0.01$) and LnAsset ($\beta = -0.4059$, $p < 0.01$), suggesting that larger firms or those with more extensive carbon disclosure tend to exhibit lower market-based valuation in the raw data. In contrast, CEV shows a positive and significant correlation with Growth ($\beta = 0.0576$, $p < 0.01$), indicating that dynamic firms tend to be more highly valued by the market.

The correlation between IC and CEV is not statistically significant ($\beta = 0.0089$, $p > 0.10$), indicating no direct linear relationship between these two variables. However, IC is positively associated with TotalRa ($\beta = 0.1734$, $p < 0.01$) and Growth ($\beta = 0.2309$, $p < 0.01$), suggesting that firms with more effective internal control tend to exhibit greater operational efficiency and growth performance.

In addition, CDQ is positively related to LnAsset ($\beta = 0.2107$, $p < 0.01$) and LEV ($\beta = 0.0708$, $p < 0.01$), implying that larger and more leveraged firms are more likely to disclose higher-quality carbon information. CDQ also shows a small negative correlation with FixedRa ($\beta = -0.0177$, $p < 0.05$) and duality ($\beta = -0.0268$, $p < 0.01$), reflecting possible governance effects.

Other variables display statistically significant correlations at various levels, with most coefficients below 0.4 in absolute value. This suggests that multicollinearity is unlikely to bias the subsequent regression results (Gujarati & Porter, 2009). These preliminary findings offer insights into potential relationships and lay the foundation for the multivariate regression analyses.

Table 3: Correlation Analysis Results

Variable	CEV	CDQ	IC	LnAsset	LEV	TotalRa	FixedRa	Growth	TOP1	Lage	BS	Dual	BIG4	SOEs	IND
CEV	1														
CDQ	-0.0410***	1													
IC	0.0089	0.0140*	1												
LnAsset	-0.4059***	0.2107***	0.1030***	1											
LEV	-0.3397***	0.0708***	0.0101	0.5067***	1										
TotalRa	0.0384***	0.0262***	0.1734***	0.0100	0.1480***	1									
FixedRa	-0.0388***	-0.0177**	0.0799***	0.0923***	0.1886***	0.2422***	1								
Growth	0.0576***	0.0014	0.2309***	0.0186***	0.0352***	0.1207***	0.0939***	1							

TOP1	-0.0806***	-0.0063	0.1391***	0.2173***	0.1015***	0.0848***	0.0328***	0.0356***	1						
Lage	-0.1648***	0.1203***	-0.1019***	0.3887***	0.2684***	-0.0045	0.0901***	-0.1149***	0.0167**	1					
BS	-0.1188***	0.0453***	0.0789***	0.2361***	0.1246***	0.0045	-0.0500***	0.0039	0.0571***	0.0551***	1				
Dual	0.0794***	-0.0268***	-0.0248***	-0.1321***	-0.1094***	-0.0277***	-0.0124*	0.0089	-0.1212***	-0.1518***	-0.1740***	1			
BIG4	-0.1095***	0.1762***	0.0872***	0.3741***	0.1219***	0.0263***	0.0080	-0.0149**	0.1650***	0.1140***	0.1062***	-0.0595***	1		
SOEs	-0.1671***	0.0520***	0.0700***	0.3160***	0.2686***	0.0432***	0.0287***	-0.0430***	0.2761***	0.3875***	0.2368***	-0.2738***	0.1417***	1	
IND	-0.0370***	0.0333***	-0.0008	0.0511***	-0.0485***	0.0509***	-0.1814***	-0.0052	0.0531***	0.0004	0.0841***	-0.0353***	0.0001	0.0165**	1

Notes: Corporate Economic Value (CEV), Carbon Disclosure Quality (CDQ), Internal Control (IC), Natural Logarithm of Total Assets (LnAsset), Debt-to-Asset Ratio (LEV), Total Assets Turnover Ratio (TotalRa), Fixed Asset Turnover Ratio (FixedRa), Sales Growth Rate (Growth), Top One Largest Shareholders' Ownership Percentage (TOP1), Listing Duration (Lage), Board Size (BS), CEO Also Serves as the Chairman of the Board (Dual), Corporations Audited by the Big Four (Deloitte, PwC, Ernst & Young, and KPMG) (BIG4), State-Owned Enterprises (SOEs), Heavily Polluting Industries (IND).*, **, *** denote significance at 10%, 5%, and 1% levels, respectively. Source: Own research.

4.3. Baseline regression

Table 4 reports the results of the baseline regressions examining the relationship between CDQ and CEV. Columns (1) and (2) present models without control variables, while Columns (3) and (4) include a full set of firm-level controls. Columns (2) and (4) further control for firm and year FE to account for unobservable heterogeneity.

In Column (1), CDQ is significantly negatively associated with CEV (β = –0.1527***, t = -6.38), suggesting that, in a simple specification, higher disclosure quality is linked to lower firm value. However, once firm and year FE are included (Column 2), this relationship becomes statistically insignificant (β = 0.0022, t = 0.10), indicating that the initial result may be confounded by omitted variables.

In contrast, when control variables are introduced, the coefficient on CDQ becomes positive and significant. In Column (3), the relationship is positive at the 10% level (β = 0.0457*, t = 1.94), and this effect is further strengthened in Column (4) (β = 0.0712***, t = 3.20) after controlling for firm and year FE. These results suggest that the positive impact of CDQ on CEV emerges more clearly when firm characteristics and time-specific effects are taken into account. This finding provides support for H1.

Among the control variables, LnAsset is consistently and significantly negatively associated with CEV, indicating that larger firms tend to have lower market-based valuation ratios. LEV changes sign across models: it is negatively related to CEV in Column (3) but becomes positively significant once FE are controlled in Column (4), implying the importance of accounting for firm heterogeneity.

Operational efficiency indicators, such as TotalRa, show a stable and strong positive impact on CEV across models. FixedRa has a small but significant negative coefficient, while Growth consistently exhibits a positive effect, highlighting its role in enhancing firm value. TOP1 has a negative impact, and Dual is associated with lower CEV. The effects of BIG4, SOEs, and IND vary in magnitude and significance, but are generally consistent with theoretical expectations.

Overall, the results highlight that CDQ has a significant and positive impact on CEV once relevant covariates and unobserved heterogeneity are accounted for. This underscores the necessity of incorporating firm-specific and temporal controls in evaluating the true effect of carbon disclosure.

Table 4: Baseline Regression Results

Variables	(1) CEV	(2) CEV	(3) CEV	(4) CEV
CDQ	-0.1527*** (-6.38)	0.0022 (0.10)	0.0457* (1.94)	0.0712*** (3.20)
LnAsset			-0.3231*** (-28.12)	-0.3889*** (-28.22)
LEV			-0.1352** (-2.43)	0.2305*** (4.19)
TotalRa			0.2194*** (9.34)	0.4092*** (16.57)
FixedRa			-0.0014*** (-2.77)	-0.0015*** (-3.09)
Growth			0.1126*** (6.28)	0.0527*** (3.21)
TOP1			-0.0043*** (-5.75)	-0.0047*** (-5.63)
Lage			0.0004 (0.23)	-0.0296 (-0.64)
BS			-0.0183*** (-3.24)	-0.0014 (-0.26)
Dual			-0.0441** (-2.28)	-0.0416** (-2.32)
BIG4			0.1001** (2.37)	0.0596 (1.34)
SOEs			-0.0709** (-2.44)	-0.0969*** (-2.64)
IND			-0.0596* (-1.96)	-0.0469 (-1.16)
Constant	1.9186*** (83.89)	2.4778*** (112.02)	9.4589*** (39.47)	11.0124*** (24.27)
Firm_FE	NO	YES	NO	YES
Year_FE	NO	YES	NO	YES
Observations	19288	19288	19288	19288

Note: Corporate Economic Value (CEV), Carbon Disclosure Quality (CDQ), Natural Logarithm of Total Assets (LnAsset), Debt-to-Asset Ratio (LEV), Total Assets Turnover Ratio (TotalRa), Fixed Asset Turnover Ratio (FixedRa), Sales Growth Rate (Growth), Top One Largest Shareholders' Ownership Percentage (TOP1), Listing Duration (Lage), Board Size (BS), CEO Also Serves as the Chairman of the Board (Dual), Corporations Audited by the Big Four (Deloitte, PwC, Ernst & Young, and KPMG) (BIG4), State-Owned Enterprises (SOEs), Heavily Polluting Industries (IND). T-statistics in parentheses. *, **, *** denote significance at 10%, 5%, and 1% levels, respectively. Source: Own research.

4.4. Addressing endogeneity

Table 5 reports the results of the two-stage least squares (2SLS) estimation to address potential endogeneity between CDQ and CEV. The natural logarithm of the number of employees (LnEmp), as suggested by Velte et al. (2020), is employed as an instrumental variable for CDQ. Overall, a larger or more engaged workforce is generally associated with higher levels of carbon disclosure.

In the first-stage regression, LnEmp is positively and significantly associated with CDQ (β = 0.0288***, t = 5.35), suggesting that firms with more employees tend to disclose higher quality carbon information. The Kleibergen–Paap LM statistic (KP-LM = 27.960, p < 0.01) rejects the null of under-identification (Liu et al., 2022a). Moreover, the Cragg–Donald Wald F-statistic (35.609) exceeds the conventional threshold of 10, confirming that the instrument is sufficiently strong. (Liu et al., 2022a). The Hansen J test yields a p-value of 0.315, indicating that the null hypothesis of instrument exogeneity cannot be rejected. (Liu et al., 2022a). This supports the validity of the instrument and the overall specification of the model.

In the second-stage regression, the coefficient on CDQ remains positive and statistically significant (β = 1.4195**, t = 2.25), implying that higher carbon disclosure quality enhances firm value after controlling for potential endogeneity. This result is consistent with those of the baseline regressions and provides further empirical support for H1.

Table 5: 2SLS Regression Results

Variable	First Stage CDQ	Second Stage CEV
LnEmp	0.0288*** (5.35)	
CDQ		1.4195** (2.25)
Controls	YES	YES
KP-LM		27.960***
Cragg-Donald Wald F		35.609
Hansen J		0.315
Firm_FE	YES	YES
Year_FE	YES	YES
Observations	19281	19281

Note: Corporate Economic Value (CEV), Carbon Disclosure Quality (CDQ), Natural Logarithm of Employee (LnEmp). Controls include LnAsset, LEV, TotalRa, FixedRa, Growth, TOP1, Lage, BS, Dual, BIG4, SOEs, and IND. T-statistics in parentheses. *, **, *** denote significance at 10%, 5%, and 1% levels, respectively. Source: Own research.

4.5. Robustness tests

Table 6 reports the results of robustness checks conducted to test the stability of the baseline regression findings. Two alternative specifications are applied. Column (1) uses the one-period lag of CDQ (L.CDQ) as the key independent variable to address potential reverse causality. (Zahid et al., 2023). Column (2) replaces TQ with the natural logarithm of market value (LnMV) as an alternative measure of CEV. (Jiang et al., 2021; Tang et al., 2022).

In Column (1), the coefficient on L.CDQ is positive and statistically significant (β = 0.0470**, t = 1.99), suggesting that prior-period CDQ has a positive effect on corporate value. This finding supports the argument that the impact of CDQ is not purely contemporaneous but carries forward over time. In Column (2), the coefficient on CDQ remains positive and strongly significant (β = 0.0434***, t = 5.29) when corporate value is measured by LnMV. This result confirms the robustness of the CDQ–value relationship across different valuation metrics. Together, these findings affirm the reliability of the baseline results. The use of lagged CDQ helps to mitigate endogeneity concerns related to reverse causality, while the substitution of the dependent variable addresses sensitivity to firm value measurement. The consistent results under both specifications, coupled with firm and year FE, further strengthen the conclusion that higher carbon disclosure quality is positively associated with corporate economic value. These results provide additional support for H1.

Table 6: Robustness Test Results

Variables	(1) CEV (TQ)	(2) CEV (LnMV)
L.CDQ	0.0470** (1.99)	
CDQ		0.0434*** (5.29)
Controls	YES	YES
Constant	9.8854*** (20.05)	4.6299*** (27.68)
Firm_FE	YES	YES
Year_FE	YES	YES
Observations	17584	19288

Note: Corporate Economic Value (CEV), Tobin's Q (TQ), Natural Logarithm of Corporate Market Value (LnMV), Carbon Disclosure Quality with a One-Period Lag (L.CDQ), Carbon Disclosure Quality (CDQ), Controls include LnAsset, LEV, TotalRa, FixedRa, Growth, TOP1, Lage, BS, Dual, BIG4, SOEs, IND. T-statistics in parentheses. *, **, *** denote significance at 10%, 5%, and 1% levels, respectively. Source: Own research.

4.6. The moderating role of internal control

Table 7 presents the regression results assessing whether IC moderates the relationship between CDQ and CEV. Two models are estimated: Model (1) uses TQ as the dependent variable, while Model (2) replaces it with the LnMV.

In both models, IC is positively and significantly associated with corporate economic value. Specifically, the coefficient of IC is 0.0542*** (t = 4.01) in Model (1) and 0.0272*** (t = 5.47) in Model (2), suggesting that firms with more effective IC tend to achieve higher CEV. The coefficient of CDQ is positive in both models but only statistically significant in Model (2), where CDQ positively influences firm value measured by LnMV (β = 0.0231**, t = 2.20).

Crucially, the interaction term between CDQ and IC is positive and statistically significant in both specifications, indicating a moderating effect. In Model (1), CDQ×IC = 0.0674** (t = 2.19), and in Model (2), CDQ×IC = 0.0339*** (t = 2.99). These results confirm that IC strengthens the positive effect of CDQ on CEV, thereby supporting H2.

This moderating effect highlights the important governance role of IC in facilitating the translation of transparent carbon disclosure into enhanced corporate value. Firms with effective IC are better positioned to ensure the credibility, consistency, and effectiveness of their

disclosure practices, which in turn increases stakeholder trust and improves value creation outcomes. The inclusion of firm and year FE in both models controls for unobserved heterogeneity and time-specific shocks, further reinforcing the robustness of these findings.

Table 7: The Moderating Role of IC Tests

Variables	(1) CEV (TQ)	(2) CEV (LnMV)
CDQ	0.0309 (1.08)	0.0231** (2.20)
IC	0.0542*** (4.01)	0.0272*** (5.47)
CDQ×IC	0.0674** (2.19)	0.0339*** (2.99)
Controls	YES	YES
Constant	11.0884*** (24.45)	4.6681*** (27.95)
Firm_FE	YES	YES
Year_FE	YES	YES
Observations	19288	19288

Note: Corporate Economic Value (CEV), Tobin's Q (TQ), Natural Logarithm of Corporate Market Value (LnMV), Carbon Disclosure Quality (CDQ), Internal Control (IC), Interaction of Carbon Disclosure Quality and Internal Control (CDQ×IC). Controls include LnAsset, LEV, TotalRa, FixedRa, Growth, TOP1, Lage, BS, Dual, BIG4, SOEs, and IND. T-statistics in parentheses. *, **, *** denote significance at 10%, 5%, and 1% levels, respectively. Source: Own research.

4.7. Further analysis

To further verify the robustness and applicability of the baseline findings, this section conducts heterogeneity tests from three perspectives: industry category, firm ownership type, and external audit quality. These subgroup analyses aim to assess whether the relationship between CDQ and CEV varies across different firm characteristics.

4.7.1. Industry heterogeneity test

Given that heavily polluting industries are subject to stricter environmental scrutiny and regulation in China (Nguyen et al., 2021)It is necessary to assess whether the CDQ–CEV relationship differs between industry types. Following the classification criteria of the China Securities Regulatory Commission (CSRC) and the Ministry of Environmental Protection (MEP), firms in 16 industries—such as coal mining, oil and gas extraction, chemicals, and smelting—are identified as heavily polluting industries. (Feng & Bao, 2024).
As shown in Table 8, the regression results indicate that in IND, the coefficient of CDQ is positive but statistically insignificant (β = 0.0338, t = 0.85). By contrast, in non-IND, CDQ has a positive and statistically significant association with CEV (β = 0.0892***, t = 3.33). These findings suggest that the effect of CDQ on CEV is more pronounced among non-IND firms.

4.7.2. Firm type heterogeneity test

Firm ownership structure may influence disclosure incentives and stakeholder responses. This section divides the sample into SOEs and non-SOEs to explore whether the CDQ–CEV relationship differs by ownership type.
As shown in Table 8, the coefficient for CDQ among SOEs is positive but not statistically significant (β = 0.0192, t = 0.69). However, for non-SOEs, CDQ has a strong and significant positive effect on CEV (β = 0.1453***, t = 4.17). This result implies that non-SOEs derive more economic benefits from carbon disclosure activities than their state-owned counterparts.

4.7.3. Audit quality heterogeneity test

Audit quality may affect the credibility and informativeness of sustainability disclosures. This section separates firms based on whether they are audited by one of the Big Four accounting firms (Deloitte, PwC, Ernst & Young, and KPMG) to examine whether external audit quality influences the CDQ–CEV relationship.
The results in Table 8 show that for BIG4, CDQ is negatively associated with CEV (β = –0.1328***, t = –3.10), while for non-BIG4, CDQ shows a significantly positive effect (β = 0.1034***, t = 4.21). These results demonstrate that the impact of CDQ on CEV differs across audit quality levels.

Table 8: Heterogeneity Test Results

Variables	IND CEV	Non-IND CEV	SOEs CEV	Non-SOEs CEV	BIG4 CEV	Non-BIG4 CEV
CDQ	0.0338 (0.85)	0.0892*** (3.33)	0.0192 (0.69)	0.1453*** (4.17)	-0.1328*** (-3.10)	0.1034*** (4.21)
Controls	YES	YES	YES	YES	YES	YES
Constant	10.1577*** (9.98)	11.3919*** (27.68)	10.1216*** (16.17)	12.4582*** (18.21)	3.8540*** (2.61)	11.5497*** (23.97)
Firm_FE	YES	YES	YES	YES	YES	YES
Year_FE	YES	YES	YES	YES	YES	YES
Observations	6018	13270	9870	9418	1586	17702

Note: Corporate Economic Value (CEV), Carbon Disclosure Quality (CDQ), Internal Control (IC), Natural Logarithm of Total Assets (LnAsset). Controls include LnAsset, LEV, TotalRa, FixedRa, Growth, TOP1, Lage, BS, Dual, BIG4, SOEs, and IND. T-statistics in parentheses. *, **, *** denote significance at 10%, 5%, and 1% levels, respectively. Source: Own research.

5. Discussions

Amid rising concerns about climate change and corporate environmental responsibility, the role of carbon disclosure in enhancing corporate value has attracted substantial scholarly interest. However, the empirical findings remain mixed, particularly in emerging markets where institutional arrangements and governance structures differ from those in developed countries. Drawing on stakeholder theory, this study examines how CDQ affects CEV and further investigates the moderating effect of IC within the context of Chinese listed firms.

5.1. Impact of carbon disclosure quality on corporate economic value

The baseline regression results show a significant positive association between CDQ and CEV (β = 0.0712***, t = 3.20), indicating that higher quality carbon disclosure improves corporate valuation. This finding is robust to model adjustments, including the use of lagged CDQ (β = 0.0470**, t = 1.99) and an alternative dependent variable (LnMV), where CDQ also shows a strong positive effect (β = 0.0434***, t = 5.29). These results are consistent with the stakeholder theory proposition that transparent and credible information disclosure reduces information asymmetry, enhances legitimacy, and strengthens trust among key stakeholders (Freeman, 2010; Mahajan et al., 2023).

Compared to earlier studies, such as Xu et al. (2025) and Huang et al. (2025), which reported a similar positive link between carbon disclosure and firm value in various contexts, this study adds empirical support from China, a transitional economy with increasing environmental regulatory pressure. It affirms that stakeholders—including investors, regulators, and the public—recognize and reward firms that voluntarily disclose high-quality carbon information, even in environments with less mature sustainability frameworks. (Huang et al., 2025; Xu et al., 2025).

5.2. The moderating role of internal control

This study further identifies IC as a significant moderator of the CDQ–CEV relationship. The interaction term (CDQ × IC) is positively associated with both TQ (β = 0.0674**, t = 2.19) and LnMV (β = 0.0339***, t = 2.99), suggesting that effective IC enhances the value relevance of carbon disclosure practices. These findings align with the stakeholder theory perspective that strong internal governance facilitates the implementation of credible disclosure practices and ensures that sustainability information is embedded into strategic decisions. (Zhang et al., 2024b).

This insight expands upon the literature by introducing IC as a contingency factor. While previous research has largely treated CDQ as a direct driver of CEV, this study emphasizes the enabling function of internal processes, thus offering a more nuanced explanation. Firms with effective IC are better equipped to align sustainability initiatives with operational performance, thereby improving stakeholder evaluations and market perceptions. (Meng et al., 2023; Zahid et al., 2023).

5.3. Heterogeneity across industry, ownership, and audit quality

The heterogeneity analyses reveal that the positive impact of CDQ on firm value is more pronounced in non-IND (β = 0.0892***, t = 3.33) and in non-SOEs (β = 0.1453***, t = 4.17). These results support the notion that stakeholder expectations differ across institutional and industrial contexts. For firms operating in less environmentally intensive sectors or with more market-oriented governance structures, carbon disclosure is likely to signal proactive risk management and innovation orientation—attributes highly valued by investors and other stakeholders.(e,g., Alsaifi et al., 2020; Hardiyansah et al., 2021; Jiang et al., 2021; Zhu et al., 2024).

Moreover, this study finds that the effect of CDQ is significantly positive in non-BIG4 (β = 0.1034***, t = 4.21), but negative in BIG4 (β = –0.1328***, t = -3.10). This challenges the conventional belief that higher audit quality uniformly enhances the credibility of disclosure. One possible explanation is that Big Four accounting firms apply stricter standards, leading to more conservative reporting or limiting the perceived incremental value of voluntary carbon disclosure. Alternatively, stakeholders may interpret carbon disclosures differently depending on audit contexts, highlighting the complex dynamics between third-party assurance and voluntary reporting.

These nuanced findings complement and, to some extent, challenge prior studies. For instance, while Kolsi and Al-Hiyari (2024) demonstrated that a higher internal audit budget enhances ESG performance, particularly when audit activities are conducted in-house. The study's findings suggest that in China, stakeholder perception may be shaped more by perceived authenticity and initiative of disclosure rather than auditor identity alone.

The heterogeneity analysis reveals that the positive association between CDQ and CEV is more pronounced in non-SOEs and non-IND. This finding can be understood through the lens of stakeholder theory. Non-SOEs are more exposed to market discipline and investor scrutiny, with weaker political connections and fewer implicit guarantees from the state. Consequently, they face stronger incentives to improve the credibility of their carbon disclosure to attract capital, enhance reputation, and secure stakeholder trust. Similarly, firms in non-IND are less constrained by regulatory compliance costs, enabling them to treat carbon disclosure as a strategic tool to strengthen competitiveness and legitimacy rather than a mere compliance burden. These dynamics are consistent with prior evidence suggesting that stakeholder pressure and market expectations exert differentiated impacts across firm types. (Wang et al., 2023a).

The results further show that the CDQ–CEV relationship is stronger for firms audited by non-Big4. This can be interpreted as evidence that high-quality disclosure provides an important substitute for external assurance where audit credibility may be perceived as weaker. For such firms, enhancing the transparency and quality of carbon disclosure becomes a critical mechanism to reduce information asymmetry and to secure stakeholder confidence in the absence of strong reputational support from top-tier auditors.

In addition, the issue of greenwashing warrants attention. While carbon disclosure is expected to reduce information asymmetry, the risk of symbolic disclosure—where firms exaggerate or misrepresent their environmental commitments—can undermine CDQ's credibility. (Dagestani et al., 2024; Li et al., 2025). In this regard, IC plays a crucial role. Effective IC mechanisms strengthen the reliability of disclosed information by ensuring compliance, monitoring reporting processes, and reducing managerial discretion in sustainability communication. (Zhang et al., 2024b). Thus, IC mitigates the risks of greenwashing and enhances the substantive value of CDQ for stakeholders, consistent with governance-oriented interpretations of stakeholder theory. (Li et al., 2025; Xu et al., 2023).

The findings also need to be interpreted in the specific context of China's regulatory and policy framework. Since 2020, China has officially committed to achieving carbon peaking by 2030 and carbon neutrality by 2060—the so-called "dual-carbon goals" (Liu et al., 2023; Wu, 2024). These commitments have been embedded into the 14th Five-Year Plan (2021–2025), which explicitly emphasizes green development, energy transition, and stricter disclosure requirements for listed companies. (Chao et al., 2025). Against this backdrop, the positive impact of CDQ on CEV and the strengthening role of IC reflect how firms are not only responding to investor demands but also aligning with national policy priorities. Moreover, the CSRC has progressively advanced mandatory environmental disclosure requirements, particularly after 2018, which has accelerated improvements in CDQ. (Downie et al., 2023a, 2023b). This institutional environment provides both regulatory pressure and market incentives, explaining the upward trend in disclosure quality observed in our sample period.

6. Conclusions and Recommendations

This study investigates the relationship between CDQ and CEV, with particular attention to the moderating role of IC and the heterogeneity across industries, ownership types, and audit quality. Based on panel data from Chinese listed companies (2010–2023) and grounded in stakeholder theory, the results reveal that high-quality carbon disclosure positively affects corporate value, as measured by TQ and LnMV. The inclusion of IC significantly strengthens this relationship, confirming the importance of internal governance in translating sustainability practices into economic outcomes. Further analyses suggest that the effect of CDQ is more pronounced among non-IND, non-SOEs, and non-BIG4, underscoring the importance of contextual factors in shaping disclosure effectiveness (see Appendix B).

This study makes several notable contributions. Theoretically, it extends stakeholder theory by demonstrating the value relevance of CDQ and the governance-enhancing role of IC. Practically, the findings offer insights for managers, investors, and policymakers regarding the strategic importance of disclosure transparency and governance alignment. Methodologically, the study enhances the robustness of empirical inquiry through the use of FE, instrumental variables, and multiple value proxies.

From a policy perspective, the results underscore the importance of enhancing CDQ and IC in supporting China's national carbon neutrality strategy. As regulators move towards full-scale implementation of mandatory ESG disclosure rules, firms with more effective IC will be better positioned to ensure compliance, credibility, and long-term value creation. This is consistent with the objectives of the 14th Five-Year Plan and the dual-carbon goals, highlighting the role of disclosure quality and governance in facilitating China's transition to a low-carbon economy.

In particular, the findings are consistent with recent regulatory developments led by the CSRC, which is moving towards mandatory environmental disclosure requirements. By aligning disclosure practices with the CSRC mandates, firms can both ensure compliance and unlock CEV. The evidence also supports the strategic role of carbon disclosure in advancing China's dual-carbon goals, demonstrating that regulatory alignment and internal governance are mutually reinforcing in promoting sustainable growth.

From a managerial perspective, effective IC is essential for preventing symbolic or selective reporting that may constitute greenwashing. Firms are encouraged to integrate carbon-related metrics into their internal audit and control processes, establish board-level oversight of climate-related reporting, and ensure that sustainability data is subject to the same level of assurance as financial information. In addition, emerging digital tools provide new opportunities to enhance disclosure credibility. AI-assisted verification can detect inconsistencies or exaggerations in corporate sustainability reports, while blockchain technologies can improve the traceability and auditability of emissions data. By combining effective IC with digital innovation, firms can build stakeholder trust and enhance the value relevance of their carbon disclosure.

However, certain limitations should be acknowledged. The reliance on publicly available data may not fully capture qualitative dimensions of carbon management; the China-specific context may limit the generalisability of the findings; and although endogeneity has been addressed through 2SLS and robustness checks, causal interpretations remain cautious.

Future research could be extended in several directions. First, longitudinal studies are needed to capture the long-term effects of internal control on the value relevance of carbon disclosure, beyond the short- to medium-term horizon analyzed here. Second, cross-country comparative analyses could examine whether the CDQ–CEV relationship and the moderating role of IC vary across institutional environments, particularly between emerging and developed markets. Third, future studies may focus on China-specific challenges, such as the enforcement of disclosure regulations and the consistency of implementation across provinces and industries. In addition, further exploration of mediating mechanisms—such as corporate reputation, stakeholder engagement, or risk perception—could provide deeper insights into how CDQ creates value. Finally, the impact of emerging themes, including net-zero strategies, AI-assisted disclosure verification, and digital platforms for carbon reporting, represents a promising direction for advancing the literature on sustainable value creation.

Acknowledgments

We are grateful to Wu Zhiming for his help with data collection.

Declaration of Conflicting Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding Statement

No funding was received to assist with the preparation of this manuscript.

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Appendix A

Carbon Disclosure Quality Evaluation Indicators and Criteria

Symbol	indicators	Relevant interpretation	Evaluation method and score basis
I1	Environmental situation cognition	Enterprises' understanding of the opportunities and challenges brought by climate change	1 point for the opportunity and challenge of the company facing the environmental situation; 0 for otherwise
I2	Low-carbon target planning	Low-carbon target planning	1 point is stated for the target plan; 0 for otherwise
I3	Low-carbon promotion and training	Promote low-carbon and environmental protection, conduct low-carbon education or low-carbon technology training for employees	1 point for the disclosure of training and publicity; 0 for otherwise
I4	Emission reduction incentive mechanism	Whether to adopt incentives for emission reduction	1 point for taking the incentive mechanism for emission reduction; 0 for otherwise
I5	Energy consumption	Energy consumption data	2 points for qualitative and quantitative combination; 1 point for qualitative description; 0 for otherwise
I6	Greenhouse gas emission	Greenhouse gas emissions data	2 points for qualitative and quantitative combination; 1 point for qualitative description; 0 for otherwise
I7	Action in energy conservation and emission reduction	Description of the adopted low carbon actions or emission reduction measures	2 points for qualitative and quantitative combination; 1 point for qualitative description; 0 for otherwise

Symbol	indicators	Relevant interpretation	Evaluation method and score basis
I8	Investment in energy conservation and emission reduction	Invested capital	2 points for qualitative and quantitative combination; 1 point for qualitative description; 0 for otherwise
I9	Low-carbon technology development	Research and development in low-carbon technologies, subjects and projects	2 points for qualitative and quantitative combination; 1 point for qualitative description; 0 for otherwise
I10	Development and utilization of new energy	Development and utilization of clean and renewable energy	2 points for qualitative and quantitative combination; 1 point for qualitative description; 0 for otherwise
I11	Improve resource utilization	Description of improving resource utilization	2 points for qualitative and quantitative combination; 1 point for qualitative description; 0 for otherwise
I12	Environmental protection department	Whether a specialized department of environmental protection is set up, or one department has the function of supervising the environment	1 point for the establishment of a special environmental protection department or a department with environmental regulatory functions; 0 for otherwise
I13	Energy conservation effect	Energy conservation effect achieved after implementing measures	2 points for qualitative and quantitative combination; 1 point for qualitative description; 0 for otherwise
I14	Emission reduction effect	Emission reduction effect achieved after implementing measures	2 points for qualitative and quantitative combination; 1 point for qualitative description; 0 for otherwise
I15	Environmental protection certification	Whether environmental certificates are obtained, e.g., ISO14001	1 point for obtaining environmental protection certification, e.g., ISO14001; 0 for otherwise
I16	Honor rewards	Whether to win the award of energy conservation, emission reduction and environmental protection	1 point for obtaining energy conservation, emission reduction and environmental protection rewards; 0 for otherwise

Source: Tang et al. (2021).

Appendix B

Summary of Regression Results

Model	Dependent Variable	Independent Variable	Moderator	Main Findings
(1) Baseline regression	CEV (TQ)	CDQ	None	CDQ positively and significantly improves CEV
(2) Moderation model	CEV (TQ)	CDQ)	IC	IC strengthens the positive CDQ–CEV relationship
(3) Robustness test	CEV (LnMV)	CDQ	None	Results remain consistent with baseline
(4) Heterogeneity tests	CEV (TQ)	CDQ	None	Stronger effects for non-SOEs, non-heavy-polluting firms, and non-Big Four audited firms

Source: Own Research.