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Statistical Analysis to Measure the Relation between Carbon Emission Disclosure and Firm Value in Saudi Listed Firms

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Abstract: This study examines whether carbon emissions disclosure is associated with firm value in Saudi listed nonfinancial firms. Using a panel of 120 firms over 2023–2025, we construct an unweight carbon disclosure index from content analysis of annual reports, sustainability reports, and standalone ESG disclosures. Firm value is measured using Tobin's Q and market value, and the association is tested using panel regressions with controls for firm size, leverage, sales growth, firm age, profitability, and board size. Estimation and robustness checks are implemented in Stata 17. The results indicate that higher carbon disclosure is linked to higher market valuation in the Saudi market during the sample period. By providing recent evidence from Saudi Arabia, the study extends carbon-disclosure valuation research to a setting where sustainability reporting guidance has strengthened, and it offers implications for firms and market institutions seeking to improve the clarity and comparability of carbon disclosures.

Keywords: Carbon Emission Disclosure - Firm Value.

1. Introduction

Carbon emissions (GHG) disclosure has increasingly been treated as an accounting disclosure decision because it converts a firm's emissions footprint into quantified and comparable information that can be incorporated into valuation, contracting, and monitoring(Foundation, 2023b; IFRS, 2023a). Reporting practice has also moved toward more structured measurement disclosure, with greater emphasis on clear organizational boundaries, scope classification, and consistent estimation methods that improve comparability across firms and over time(CDP, 2023a, 2023b). In parallel, developments in assurance practice have strengthened expectations that emissions disclosures are supported by stronger evidence and assurance readiness, particularly for complex items such as scope 3 emissions, which can affect how users evaluate reliability and completeness(Young, 2026).

Despite these institutional developments, the valuation relevance of emissions disclosure remains an open empirical issue in many emerging and energy intensive markets. The central research problem addressed in this study is whether carbon emissions disclosure is associated with firm value in Saudi listed nonfinancial firms. This problem matters because disclosure is an information channel that can affect how investors evaluate firms, especially when emissions information becomes more comparable, structured, and usable in market assessment. At the same time, the economic implications of disclosure are not automatic. Valuation effects are more likely when disclosure reduces uncertainty and improves interpretability of reported information rather than when reporting remains generic or difficult to verify (Steindl et al., 2024; Tan et al., 2025).

This problem is also important because disclosure is conceptually distinct from carbon performance. Disclosure reflects what firms report and how complete and informative the reporting is, whereas performance reflects actual emissions outcomes and efficiency(Perdichizzi et al., 2024; Sun et al., 2022). Even when the analysis focuses on disclosure, making this distinction is important because it specifies that the study examines the capital market relevance of reporting quality and transparency, rather than changes in firms' actual emissions levels. It also supports a careful interpretation of the results, especially in settings where reporting practices can improve more quickly than emissions performance or operational adjustment(Hágen & Ahmed, 2024; Perdichizzi et al., 2024; Sun et al., 2022).

A second element of the research problem concerns the channels through which emissions disclosure may relate to firm value. Emissions disclosure may be value relevant if it reduces uncertainty about measurement practices and reported exposures, thereby strengthening the firm's information environment and supporting valuation decisions(Steindl et al., 2024). When disclosure increases transparency, it can improve investors' ability to compare firms, evaluate reporting reliability, and incorporate emissions related information into pricing and monitoring decisions. In this sense, disclosure can matter for valuation even when the primary effect operates through information quality and investor assessment rather than immediate operational

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change(Steindl et al., 2024; Xu et al., 2024).

Credibility further sharpens the valuation question. Markets may discount emissions disclosure if it is perceived as incomplete, selective, or primarily used to manage external pressure rather than to communicate decision useful information(Khan et al., 2023; Liu et al., 2023). Recent evidence also documents that selective environmental disclosure and related greenwash behavior can be shaped by managerial incentives and organizational governance structures, implying that disclosure quality and completeness cannot be assumed even when firms increase the volume of reporting(Chi & Cheng, 2026). Evolving assurance requirements and guidance for emissions disclosure likewise highlight that the reliability of reported emissions information is increasingly treated as a practical reporting issue, not merely a voluntary communication choice(Luo & Pan, 2025; Young, 2026). Together, these insights support examining whether disclosure is associated with valuation outcomes in a way that is consistent with information usefulness and credibility, rather than assuming that more disclosure automatically leads to a valuation premium.

The Saudi capital market provides a timely setting to investigate these issues. Saudi listed nonfinancial firms operate in an economy with meaningful variation in emissions related activities across industries, and market level initiatives and regulatory guidance have increasingly emphasized transparency and disclosure development(Exchange, 2021; Group, 2024; KPMG, 2024). At the firm level, evidence from Saudi listed firms suggests that governance quality, including board effectiveness, is associated with greenhouse gas disclosure quality, supporting the feasibility of measuring disclosure variation and linking reporting practices to identifiable organizational mechanisms(Ebnaoof, 2026). However, while governance oriented evidence supports the existence of measurable disclosure outcomes in Saudi Arabia, the valuation relevance of emissions disclosure remains insufficiently established in this context. This gap limits managers' ability to evaluate whether investments in emissions reporting translate into valuation benefits, limits investors' ability to interpret emissions information consistently, and limits policymakers' ability to assess the economic consequences of expanding disclosure guidance in the market.

This study is important for both accounting research and capital market practice. From a research perspective, it contributes by testing whether emissions disclosure is value relevant in the Saudi setting, adding evidence to the literature on nonfinancial disclosure and market valuation. It also speaks to recent debates about whether markets reward disclosure when it is credible and decision useful, versus discounting disclosure when it appears selective or symbolic(Chi & Cheng, 2026; Liu et al., 2023). From a practical perspective, the study provides evidence that is relevant for investors who need to evaluate the usefulness of emissions disclosures when assessing firm value, and for managers who must decide what type of emissions information, measurement detail, and supporting documentation are most relevant for market users. It also offers implications for regulators and market institutions assessing the potential economic impact of initiatives aimed at improving transparency and disclosure quality(Exchange, 2021; Group, 2024) .

In line with the above, the objective of this study is to examine whether carbon emissions disclosure is positively associated with firm value in Saudi listed nonfinancial firms, consistent with the view that transparent and decision useful reporting can strengthen the information environment and support market valuation (Hussain et al., 2024; Steindl et al., 2024; Xu et al., 2024). The remainder of the study is organized as follows. First, the theoretical framework is presented. Next, the research methodology is described, followed by the regression results estimated using Stata 17. Finally, the study concludes with a discussion of the findings and the practical contribution.

2. Theoretical Study

In capital markets, carbon emissions disclosure matters for firm value insofar as it improves the transparency of climate related exposures that investor's price. In particular, **(**Cohen et al., 2023**)** show that investors linked to the CDP setting increasingly demand emissions related information as part of valuation and portfolio allocation decisions, especially when climate related risks are perceived as financially material. As a result, when emissions disclosure is available, comparable, and accessible, it becomes more likely that such information is incorporated into market prices rather than remaining peripheral to financial analysis. This pricing effect is further supported by evidence that institutional investors value and actively demand climate risk disclosures, and that such demand can shape firms' disclosure behavior(Ilhan et al., 2023; Krueger et al., 2020) . This argument is particularly relevant in emerging capital markets such as Saudi Arabia, where empirical evidence documents meaningful variation in sustainability and environmental disclosure practices and their governance drivers(Aladwey & Alsudays, 2024; Ebnaoof, 2026; Qasem et al., 2022) .

Evidence from disclosure platforms widely used by institutional investors, such as CDP, further reinforces this valuation channel. Specifically, (Tomar, 2023) demonstrates that standardized greenhouse gas disclosure can generate benchmarking and monitoring effects, which strengthens the informational role of emissions data for market participants. When firms report emissions information in a structured and consistent manner, investors are better able to evaluate environmental exposure and reporting discipline. Consequently, disclosure can affect perceived firm risk and, in turn, firm value, not because it immediately alters operational outcomes, but because it shapes beliefs about transparency and responsiveness to external scrutiny, consistent

with the institutional investor evidence in(Ilhan et al., 2023). Accordingly, the monitoring and benchmarking role of standardized disclosure provides a valuation channel by shaping perceived transparency and risk, even if operational outcomes do not change immediately **.**Similar mechanisms are increasingly plausible in the Saudi capital market, where market and regulatory actors have promoted stronger ESG transparency through guidance and governance reforms (W. I. Almubarak et al., 2023)

A related stream of literature focuses on information risk and cost of capital as central mechanisms linking disclosure to firm value. Prior accounting research indicates that higher quality voluntary disclosure, including CSR disclosure, can reduce information risk and is associated with a lower cost of equity capital(Dhaliwal et al., 2011) . Building on this logic,(Bonetti et al., 2024) provide direct evidence that when environmental disclosure becomes more relevant to investors following an exogenous uncertainty shock (Fukushima), disclosing firms experience a smaller increase in the cost of capital than non-disclosing firms. From a valuation perspective, a lower discount rate translates into higher firm value even when expected cash flows remain unchanged. Therefore, the expected valuation effect operates through the discount rate component of firm value, meaning that disclosure can be priced even when expected cash flows remain stable. In addition, more recent evidence highlights that carbon related information can reduce information asymmetry when disclosures include decision useful detail, which is consistent with valuation effects operating through the information environment(Steindl et al., 2024) .

The usefulness of emissions disclosure for valuation purposes, however, depends critically on its structure and specificity. As argued by(Steindl et al., 2024) ,textual disclosure that explains the measurement basis, scope boundaries, and estimation choices underlying reported carbon information can improve the interpretability and comparability of numerical emissions data. By making underlying reporting choices more transparent, such narrative detail helps investors assess the consistency of reported figures across firms and over time and, consequently, reduces information asymmetry. This implies that structure and methodological clarity are not merely reporting features, but conditions that determine whether emissions information is usable in valuation analysis. When boundaries and measurement choices are clear, investors can compare firms and assess exposure more confidently, which supports price incorporation. This information usefulness perspective is consistent with the decision usefulness objective embedded in the IFRS Foundation's ISSB standards, including IFRS S2 Climate-related Disclosures issued in June 2023 (Exchange, 2021; Group, 2024).

Moreover, the valuation relevance of carbon emissions disclosure tends to be stronger under conditions of heightened uncertainty. When investors face increased ambiguity regarding environmental regulation, energy transition risks, or climate related exposures, disclosure can serve as a stabilizing signal by reducing information asymmetry. Consistent with this channel, **(**Bonetti et al., 2024**)** show that following Fukushima, environmental disclosure is associated with a smaller increase in firms' cost of capital, which is consistent with disclosure functioning as a risk mitigating signal when uncertainty rises. This insight is particularly relevant for the Saudi market, which is undergoing regulatory and economic transitions linked to sustainability initiatives and energy diversification, alongside increased emphasis on ESG transparency.

An important distinction in this literature is between carbon emissions disclosure and carbon performance. While performance reflects underlying emissions outcomes, disclosure captures the transparency and completeness of reported information. As shown by(Matsumura et al., 2014) **,** markets can respond to carbon disclosure in ways that affect firm valuation. More recent evidence also demonstrates that voluntary carbon disclosure and emissions can have distinct valuation implications(Sun et al., 2022) , while other studies emphasize the direct negative valuation association of emissions levels in market settings(Perdichizzi et al., 2024). In Saudi Arabia, research documents that disclosure quality varies with governance and oversight attributes, supporting the feasibility of measuring disclosure variation rather than treating it as purely a performance proxy(Ebnaoof, 2026). However, the extent to which disclosure affects firm value depends on whether investors view the content as credible, complete, and decision useful.

Credibility and completeness further condition the valuation impact of emissions disclosure. Prior research warns that selective disclosure and decoupling can reduce the decision usefulness of sustainability reporting, which limits its ability to reduce information risk and therefore weakens potential valuation effects(Michelon et al., 2015; Roszkowska-Menkes et al., 2024). Accordingly, valuation effects are more plausible when emissions disclosure is perceived as informative and reliable, rather than primarily symbolic or incomplete, because credible disclosure improves investors' ability to assess long term exposure and preparedness. Evidence from Saudi listed firms also suggests that governance and audit related characteristics are associated with ESG disclosure quality, which is consistent with credibility being shaped by oversight mechanisms (W. Almubarak et al., 2023; Fayad et al., 2024).

Recent research also highlights the role of assurance and verification in strengthening the valuation relevance of emissions disclosure. (Datt et al., 2025) provide international evidence that voluntary carbon assurance is associated with a lower cost of equity capital, which supports the interpretation that assurance enhances investor confidence in the reliability of emissions information and, consequently, strengthens the disclosure valuation channel. This argument is consistent with broader evidence showing that assurance and related reporting practices may be adopted strategically and that credibility concerns shape how sustainability disclosures are interpreted(Michelon et al., 2015). In valuation terms, assurance strengthens the disclosure channel

by increasing the likelihood that emissions information is treated as reliable input in risk pricing.

Forward looking disclosure elements, such as emissions reduction targets and transition commitments, provide additional channels through which emissions disclosure can affect firm value. **(**Roszkowska-Menkes et al., 2024**)** find valuation differences associated with emissions reduction target disclosure, which indicates that markets can price credible forward looking climate commitments in addition to current metrics. Complementary evidence from institutional investor–focused studies indicates that climate risks and related forward-looking disclosures influence investor risk assessment, valuation judgments, and engagement activities, reinforcing the role of forward-looking climate information in equity valuation processes(Ilhan et al., 2023; Krueger et al., 2020). These insights are increasingly relevant in the Saudi context, as firms align disclosure practices with long-term sustainability strategies and as regulatory and market guidance encourages more standardized and decision useful ESG reporting.

In the Saudi context, the institutional environment has evolved toward stronger sustainability disclosure capacity and greater market level transparency. Initiatives associated with the Saudi Exchange ESG Disclosure Guidelines and Saudi Tadawul Group sustainability reporting increase the likelihood that investors encounter and use emissions related information in firm valuation(Exchange, 2021; Group, 2024) . Moreover, professional and regulatory commentary notes that although ESG reporting remains largely voluntary in Saudi Arabia, listed companies increasingly follow the Saudi Exchange guidance in anticipation of future regulation and harmonization trends(KPMG, 2024).Academic evidence confirms that Saudi governance reforms and oversight mechanisms are part of the evolving disclosure ecosystem in the Saudi capital market(W. I. Almubarak et al., 2023)

At the firm level, emerging Saudi evidence indicates that governance quality and board effectiveness are associated with higher quality greenhouse gas disclosure. For example, **(**Ebnaoof, 2026**)** provides Saudi evidence linking board effectiveness attributes to GHG disclosure variation, while related Saudi work shows that institutional ownership is positively associated with ESG reporting in Saudi listed firms(Qasem et al., 2022). Accordingly, this variation provides a foundation for examining whether differences in emissions disclosure are reflected in firm value as disclosure expectations continue to expand.

Taken together, prior research supports the expectation of a positive association between carbon emissions disclosure and firm value through well specified valuation mechanisms. Evidence from capital markets shows that investor demand makes emissions information more likely to be processed and reflected in pricing and valuation decisions(Cohen et al., 2023; Ilhan et al., 2023), consistent with broader evidence that institutional investors treat climate risk information as a financially relevant input in portfolio decisions(Krueger et al., 2020) . In addition, disclosure theory implies that more informative emissions reporting can reduce information risk and, therefore, the required return, which increases firm value through a lower discount rate(Bonetti et al., 2024; Steindl et al., 2024) .Importantly, the valuation effect depends on whether users perceive disclosed emissions information as reliable and decision useful. Evidence on disclosure quality and third party assurance indicates that credibility and verification strengthen the pricing relevance of sustainability information by improving confidence in reported emissions data(Bugshan et al., 2024; Datt et al., 2025) . These mechanisms are particularly applicable in Saudi Arabia, where market level guidance and governance reforms have expanded the reporting infrastructure and encouraged more structured ESG disclosure, including emissions related information(W. I. Almubarak et al., 2023). In Saudi Arabia, the combination of expanding disclosure guidance and firm level variation in reporting practices supports testing whether these mechanisms translate into higher firm value. Accordingly, this study proposes the following hypothesis:

H_1: *Carbon emissions disclosure is positively associated with firm value in Saudi listed nonfinancial firms.*

3. Research design

3.1 Sample construction

This study examines the association between carbon emissions (GHG) disclosure and firm value among Saudi listed nonfinancial firms using a balanced panel of 360 firm year observations (120 firms × 3 years) *over the period* 2023 to 2025**.** The sampling frame covers all nonfinancial firms listed on the Saudi Exchange, while banks and insurance companies are excluded because their regulatory setting and reporting structure differ in ways that can distort comparisons with nonfinancial firms. Data on emissions related disclosure are collected from firms' annual reports and sustainability reports, and these disclosures are matched with market and accounting information obtained from publicly available sources, including Saudi Exchange disclosures and the Mubasher database, to compute firm value and the study control variables. To maintain consistent measurement across the panel, firm year observations are included only when the dependent variable, the disclosure measure, and the core controls can be constructed from publicly available information. In addition, only firms that remain listed throughout the study period and report using a consistent fiscal year-end are included to ensure comparability over time. These criteria produce a balanced panel with complete observations, enabling a consistent examination of the relationship between carbon emissions disclosure and firm value.

3.2 Variables measurements

Carbon emissions disclosure is the independent variable in this study and is measured using an unweighted carbon emissions disclosure index (CED) ranging from 0 to 10, constructed through content analysis of the firm's annual report, sustainability report, and any standalone ESG disclosure for the fiscal year; specifically, the index relies on a 10-item checklist, where each item is scored 1 if the disclosure item is reported and 0 otherwise, and the firm's total CED score equals the total number of disclosed items (0–10), consistent with recent checklist-based content-analysis scoring of carbon disclosure(HAPSARI & HARDIYANTI, 2024; Susilawati et al., 2025; Wahyuningrum et al., 2024). Firm value is the dependent variable and is measured primarily by Tobin's Q (TQ), captured as a market-based valuation proxy by combining the market value of equity (computed from the year-end share price and shares outstanding) with the book value of liabilities, then scaling by total assets, in line with recent firm-value research using Tobin's Q and similar control structures(Metwally et al., 2025; Vaihekoski & Yahya, 2025). As an additional proxy, firm value is also measured using MV, defined as the natural logarithm of the firm's market value of equity (market capitalization) at fiscal year-end, to reduce skewness and the influence of extreme values(Altarawneh et al., 2025). The model controls for firm-specific characteristics, including firm size (ln total assets), leverage (total liabilities/total assets), sales growth (annual percentage change in net sales), firm age (ln(1 + years since listing)), earnings per share (net income attributable to ordinary shareholders divided by weighted-average shares), and board size (number of directors).

3.3 Empirical Models

To examine the association between carbon emissions disclosure and firm value in Saudi listed nonfinancial firms, this study estimates the following baseline panel regression model. The model controls for firm specific characteristics that may jointly influence disclosure and valuation, including firm size, leverage, sales growth, firm age, earnings per share, and board size.

H_1: Carbon emissions disclosure is positively associated with firm value in Saudi listed nonfinancial firms.

Model (1) Baseline model:

$$\textbf{Tobin's Q} = \theta_0 + \theta_1 \text{CED}_{it} + \theta_2 \text{SIZE}_{it} + \theta_3 \text{LEV}_{it} + \theta_4 \text{GROWTH}_{it} + \theta_5 \text{AGE}_{it} + \theta_6 \text{EPS}_{it} + \theta_7 \text{BSIZE}_{it} + + \varepsilon_{,it} \quad (1)$$

Model (2) Robustness model using an alternative firm value proxy (if you use Market value):

$$\textbf{MV}_{it} = \theta_0 + \theta_1 \text{CED}_{it} + \theta_2 \text{SIZE}_{it} + \theta_3 \text{LEV}_{it} + \theta_4 \text{GROWTH}_{it} + \theta_5 \text{AGE}_{it} + \theta_6 \text{EPS}_{it} + \theta_7 \text{BSIZE}_{it} + + \varepsilon_{,it} \quad (2)$$

Where:

- *Tobin's Q*: Firm value of firm i in year t (main proxy, Tobin's Q).
- MV_{it}: Alternative firm value proxy of firm i in year t (MV = natural logarithm of the firm's market value of equity / market capitalization at fiscal year-end), used for robustness.
- CED_{it}: Carbon emissions disclosure of firm i in year t (index variable from 0 to 10), measured as the total score on a 10-item carbon disclosure checklist (higher scores indicate more extensive disclosure).
- $SIZE_{it}$: Firm size, measured as the natural logarithm of total assets for firm i in year t.
- LEV_{it}: Financial leverage, measured as total liabilities divided by total assets for firm i in year t.
- $GROWTH_{it}$: Sales growth, measured as the annual percentage change in net sales for firm i in year t.
- AGE_{it}: Firm age, measured as the natural logarithm of one plus the number of years since listing for firm i in year t.
- EPS_{it}: Earnings per share for firm i in year t.
- $BSIZE_{it}$: Board size, measured as the total number of board directors for firm i in year t.
- ε,it : Error term

4. Results and Discussion

4.1. Descriptive statistics & Correlation analysis

Table (1) reports descriptive statistics for 360 firm-year observations. The mean market value (MV) is 6.806 with a standard deviation of 0.514, whereas Tobin's Q records an average of 1.836 (0.389). Carbon disclosure (CD) shows a mean score of 5.0 on a 0–10 scale, with a standard deviation of 2.92, and the values span the entire index range. Firm size averages 21.939 (1.229). Leverage has a mean of 0.553 (0.281). Sales growth extends from −1.72 to 1.993. Firm age remains relatively stable, with an average of 3.18. Earnings per share (EPS) exhibit substantial dispersion and include negative observations. Finally, board size

averages around eight members, with values ranging between five and twelve.

Table 1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
MV	360	6.806	.514	5.511	8.325
TobinsQ	360	1.836	.389	.756	2.832
CD	360	5	2.92	0	10
size	360	21.939	1.229	18.669	25.244
lev	360	.553	.281	-.244	1.501
SG	360	.318	.662	-1.72	1.993
age	360	3.18	.394	1.974	4.301
EPS	360	1.518	2.423	-6.561	8.879
Boardsize	360	7.967	1.597	5	12

Figure (1) shows how Tobin's Q is distributed across the sample. In general, most observations fall between about 1.3 and 2.3, and the highest concentration is around the middle of this range, which means that Tobin's Q is above one for most firms. In addition, the values are spread out enough to reflect clear differences in firm value across companies. At the same time, observations at the lower and upper tails are limited, indicating that the distribution is not dominated by extreme values. The figure therefore shows a relatively stable pattern with variation across the sample, supporting the use of Tobin's Q in the regression analysis.

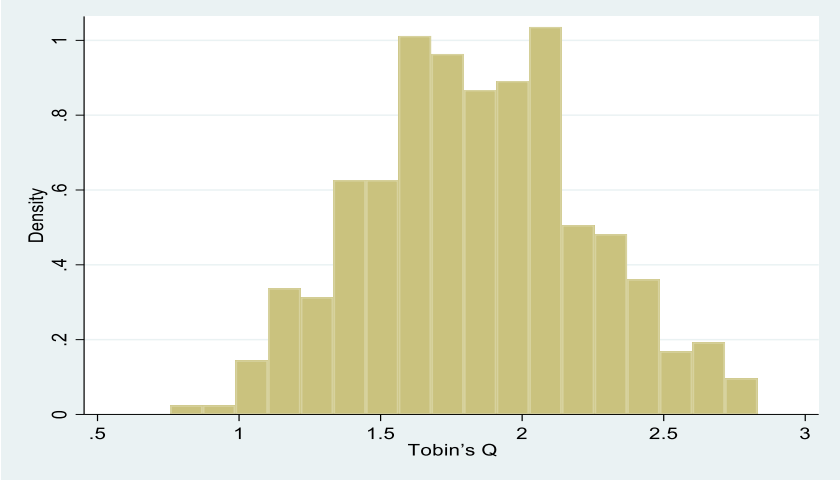

Fig. 1: Distribution of Tobin's Q (Histogram)

Figure (2) presents the distribution of market value (MV) for the sample firms. Values are mainly concentrated in the mid-range, approximately between 6.3 and 7.4. Observations also appear on both sides of this range, though in smaller numbers. As a result, the distribution is not concentrated around a few extreme values and shows variation across firms that can be used in the subsequent correlation and regression analysis.

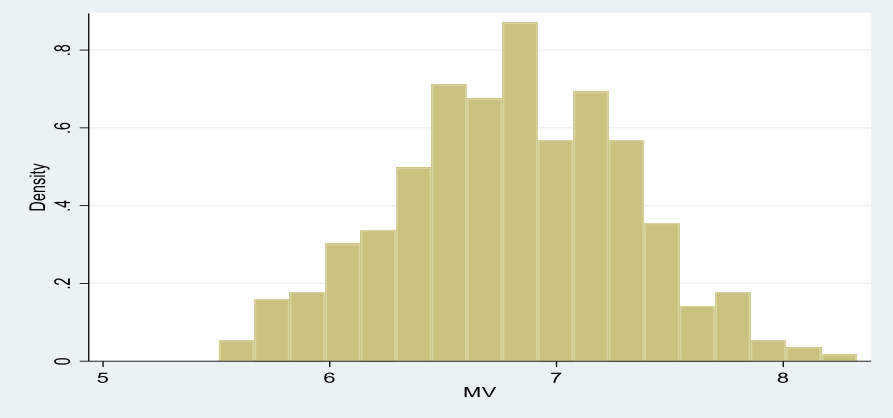

Fig. 2: Histogram of MV

Table (2) shows that firm value measures are positively related to carbon disclosure and firm size. In particular, MV is strongly correlated with CD (0.737, $p < 0.001$) and size (0.776, $p < 0.001$), and Tobin's Q is also strongly correlated with CD (0.757, $p < 0.001$) and size (0.658, $p < 0.001$), which is consistent with higher disclosure and larger firms being associated with higher market valuation. Leverage has no meaningful correlation with MV or Tobin's Q (both $p > 0.10$), while sales growth is positively related to both valuation measures (0.134 and 0.173, $p \leq 0.011$). Carbon disclosure is positively associated with sales growth, EPS, and board size (0.237 to 0.253, all $p < 0.001$), and negatively associated with leverage (−0.121, $p = 0.022$). Age shows weak correlations with most variables. Finally, some correlations are relatively high, especially between CD and size (0.772) and between MV and size (0.776).

Table 2: Pairwise correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) MV	1.000								
(2) Tobins Q	0.517	1.000							
	(0.000)								
(3) CD	0.737	0.757	1.000						
	(0.000)	(0.000)							
(4) size	0.776	0.658	0.772	1.000					
	(0.000)	(0.000)	(0.000)						
(5) LEV	0.039	0.043	-0.121	0.141	1.000				
	(0.463)	(0.415)	(0.022)	(0.008)					
(6) SG	0.134	0.173	0.237	0.133	0.112	1.000			
	(0.011)	(0.001)	(0.000)	(0.011)	(0.034)				
(7) AGE	0.037	0.087	0.047	0.071	0.148	0.170	1.000		
	(0.489)	(0.098)	(0.373)	(0.177)	(0.005)	(0.001)			
(8) EPS	0.077	0.116	0.253	0.072	0.172	0.090	0.107	1.000	
	(0.146)	(0.028)	(0.000)	(0.173)	(0.001)	(0.089)	(0.042)		
(9) Board Size	0.117	0.126	0.253	0.149	0.100	0.116	0.068	0.126	1.000
	(0.027)	(0.017)	(0.000)	(0.005)	(0.058)	(0.028)	(0.201)	(0.016)	

Figure (3) shows a clear positive relationship between market value (MV) and Tobin's Q. In general, firms with higher MV tend to have higher Tobin's Q, which indicates that the two valuation measures move in the same direction in this sample. At the same time, the points are spread around the upward pattern, meaning that firms with similar MV can still have different Tobin's Q values, so other firm factors also matter for valuation. Overall, the figure provides simple visual evidence that MV and Tobin's Q are consistent measures of firm value and that the sample includes noticeable variation across firms.

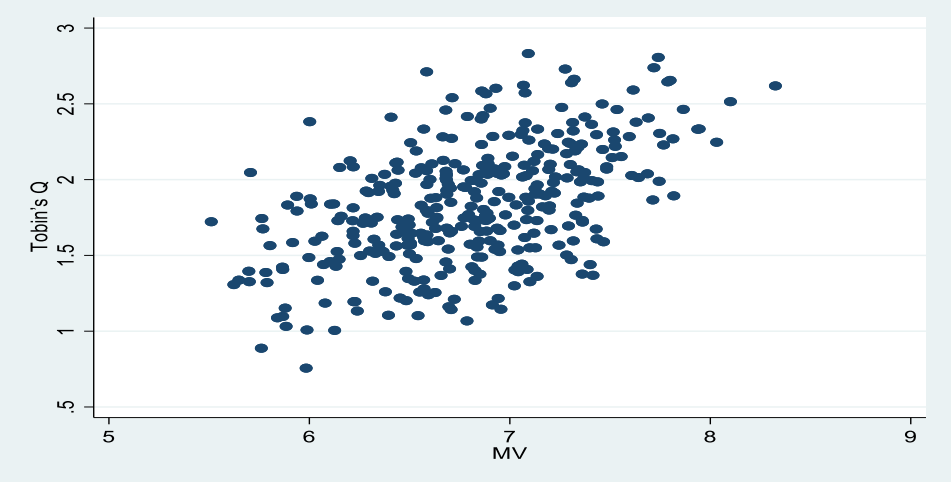

Fig. 3: Scatter Plot of Market Value (MV) and Tobin's Q

Figure (4) plots carbon disclosure (CD) against Tobin's Q. Higher values of Tobin's Q are more frequently observed at higher disclosure levels, although the relationship is not uniform across firms. For a given level of disclosure, Tobin's Q varies noticeably, indicating that differences in valuation remain even among firms with similar disclosure scores.

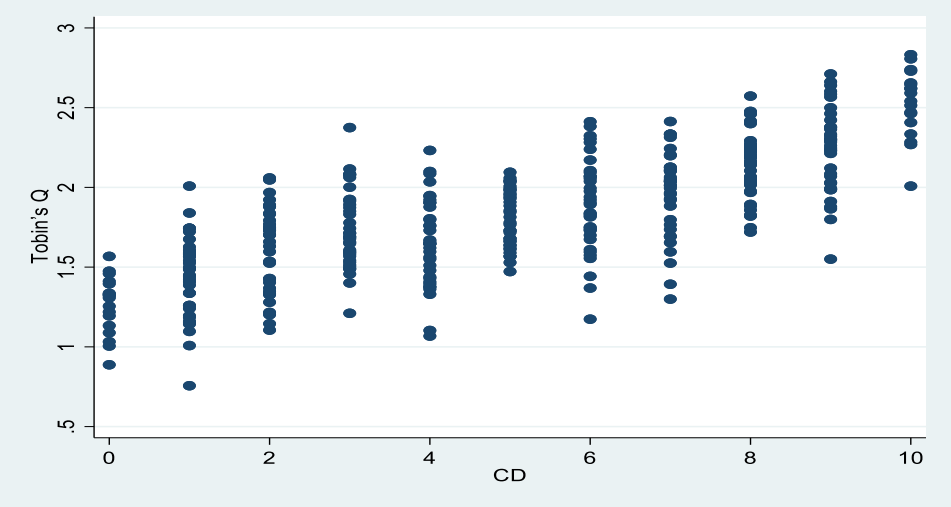

Fig. 4: Scatter Plot: Carbon Disclosure (CD) and. Tobin's Q

Figure (5) shows a clear positive relationship between carbon disclosure (CD) and market value (MV). Firms with higher disclosure levels generally exhibit higher MV, which is consistent with the idea that more transparent emissions reporting is associated with higher market valuation. At the same time, the spread of points within each disclosure level indicates that firms with the same disclosure score can still differ in market value, meaning that disclosure is not the only driver of valuation.

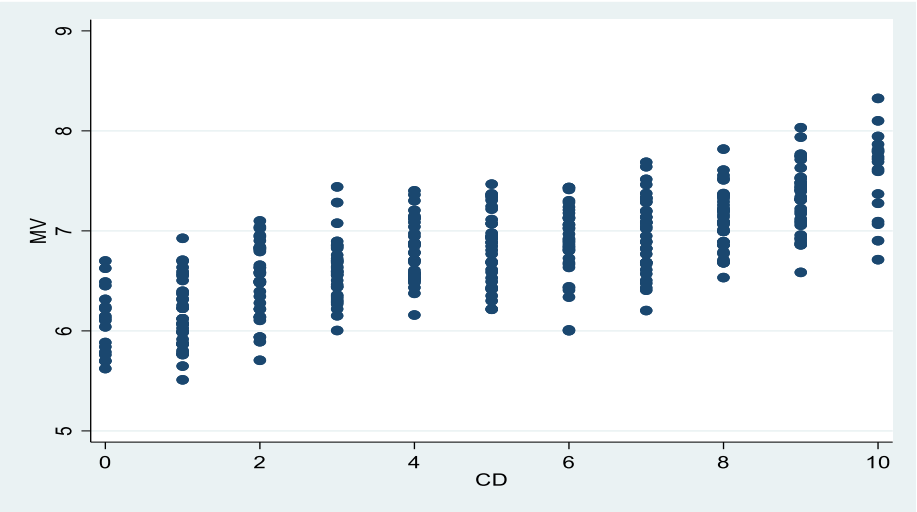

Fig. 5: Scatter Plot of Carbon Disclosure (CD) and Market Value (MV)

4.2 Regression results

Table (3) reports the linear regression results using Tobin's Q as the dependent variable. Carbon disclosure (CD) enters the model with a positive and statistically significant coefficient (0.106, $p < 0.001$). Leverage is also positive and significant (0.216, $p < 0.001$). In contrast, earnings per share is negatively associated with Tobin's Q (−0.017, $p = 0.004$). Board size shows a small negative coefficient that is statistically significant at conventional levels (−0.020, $p = 0.017$). Firm size, sales growth, and firm age are not statistically significant ($p > 0.10$). The model is jointly significant based on the F-test ($p < 0.001$), with an R-squared of 0.613.

Table 3: Regression Results of Carbon Disclosure on Firm Value (Tobin's Q as Dependent Variable)

TobinsQ	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
CD	.106	.009	12.16	0	.089	.123	***
size	.014	.019	0.72	.474	-.024	.051	
lev	.216	.054	3.97	0	.109	.323	***
SG	-.016	.021	-0.75	.451	-.057	.025	
age	.045	.034	1.33	.184	-.021	.111	

EPS	-.017	.006	-2.88	.004	-.029	-.005	***
Boardsize	-.02	.009	-2.40	.017	-.037	-.004	**
Constant	.938	.396	2.37	.018	.16	1.717	**
Mean dependent var	1.836		SD dependent var	0.389			
R-squared	0.613		Number of obs	360			
F-test	79.669		Prob > F	0.000			
Akaike crit. (AIC)	15.343		Bayesian crit. (BIC)	46.432			
*** $p<.01$, ** $p<.05$, * $p<.1$							

Figure (6) shows the structural equation model, which reports a positive and statistically significant path coefficient from carbon emissions disclosure to firm value measured by Tobin's Q ($\beta = 0.106$, $p < 0.001$). Firm size ($\beta = 0.194$, $p < 0.001$) and leverage ($\beta = 0.216$, $p < 0.001$) also show positive and significant associations with firm value. Sales growth is not statistically significant. Earnings per share is negatively associated with Tobin's Q ($\beta = -0.017$, $p < 0.01$), and board size shows a negative and statistically significant coefficient ($\beta = -0.020$, $p < 0.05$).

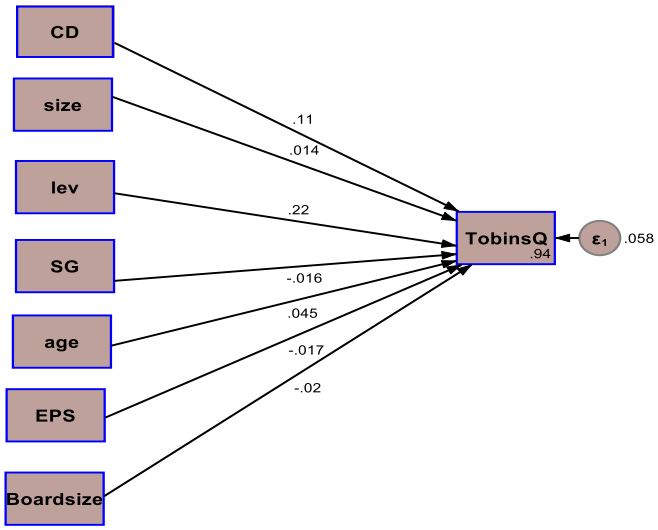

Fig. 6: Structural Equation Model Results for the Relationship between CED and Firm Value (Tobin's Q)

Table (4) presents the linear regression model with market value (MV) as the dependent variable. The coefficient on carbon disclosure (CD) is positive and statistically significant (0.073, $p < 0.001$), providing evidence of a positive association between carbon disclosure and firm value after controlling for firm-specific characteristics. This result is consistent with the study hypothesis predicting a positive relationship between carbon disclosure and firm value. Firm size also shows a positive and highly significant coefficient (0.194, $p < 0.001$). Leverage, sales growth, and firm age are not statistically significant in this model ($p > 0.10$). Earnings per share has a negative and marginally significant coefficient (−0.013, $p = 0.085$), while board size is negative but not statistically significant ($p = 0.115$). The model is jointly significant based on the F-test ($p < 0.001$), with an R-squared of 0.655.

Table 4: Regression Results of Carbon Disclosure on Firm Value (Market Value as Dependent)

MV	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
CD	.073	.011	6.77	0	.052	.095	***
size	.194	.024	8.14	0	.147	.24	***
lev	.079	.068	1.17	.245	-.054	.212	
SG	-.014	.026	-0.55	.58	-.065	.037	
age	-.012	.042	-0.29	.769	-.095	.07	
EPS	-.013	.007	-1.73	.085	-.027	.002	*
Boardsize	-.017	.011	-1.58	.115	-.038	.004	
Constant	2.346	.493	4.76	0	1.377	3.316	***
Mean dependent var	6.806		SD dependent var	0.514			
R-squared	0.655		Number of obs	360			

F-test	95.677	Prob > F	0.000
Akaike crit. (AIC)	173.362	Bayesian crit. (BIC)	204.451
*** p<.01, ** p<.05, * p<.1			

Figure (7) reports the structural equation model estimated with market value (MV) as the measure of firm value. The path coefficient from carbon emissions disclosure to MV is positive and statistically significant ($\beta = 0.073$, $p < 0.001$). Firm size shows a positive and significant coefficient ($\beta = 0.194$, $p < 0.001$). Leverage is also positive and significant ($\beta = 0.079$, $p < 0.01$). Sales growth and firm age are not statistically significant. Earnings per share has a negative and significant coefficient ($\beta = -0.013$, $p < 0.05$). Board size is negative and statistically significant ($\beta = -0.017$, $p < 0.05$).

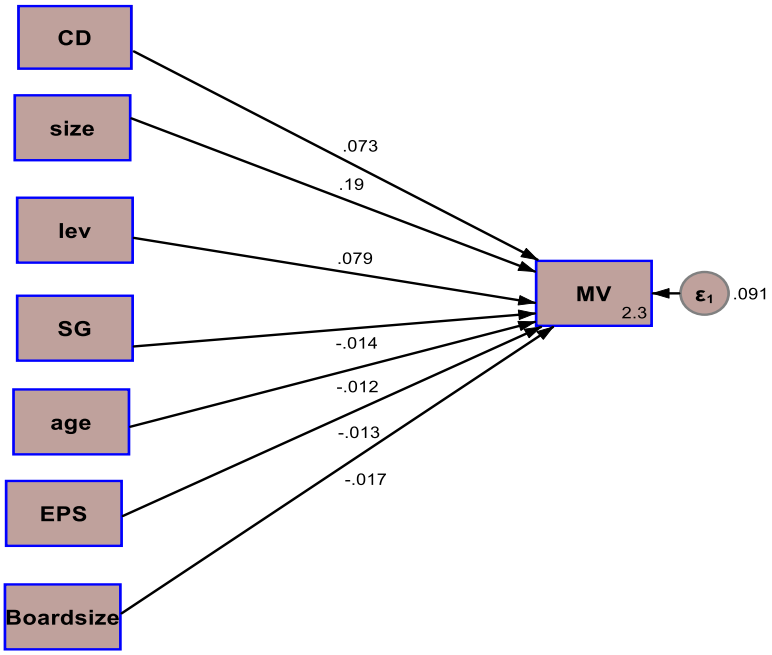

Fig. 7: Structural Equation Model of the Effect of Carbon Emissions Disclosure on Firm Value (MV)

Table (5) reports variance inflation factor (VIF) statistics for the regression models. All VIF values fall below commonly applied thresholds. The highest values are observed for carbon disclosure (3.885) and firm size (3.306). The remaining variables show VIF values close to one. The mean VIF equals 1.877. These statistics indicate that multicollinearity does not affect the estimated coefficients.

Table 5: Variance inflation factor

	VIF	1/VIF
CD	3.885	.257
size	3.306	.303
lev	1.401	.714
EPS	1.245	.804
SG	1.134	.882
Board size	1.111	.9
age	1.057	.946
Mean VIF	1.877	.

4.3 Robustness Analysis: Generalized Linear Models (GLM)

Table (6) reports generalized linear model estimates as a robustness test using Tobin's Q as the dependent variable. The coefficient on carbon disclosure (CD) remains positive and statistically significant (0.106, $p < 0.001$), in line with the OLS regression results. Leverage also shows a positive and significant coefficient (0.216, $p < 0.001$). Firm size, sales growth, and firm age are not statistically significant, consistent with the earlier regression findings. Earnings per share is negative and significant (−0.017, $p = 0.003$), and board size also enters with a negative and significant coefficient (−0.020, $p = 0.018$). The model is jointly significant (Prob > $chi^2 = 0.000$).

Table 6: Generalized Linear Model Results of Carbon Disclosure on Firm Value (Tobin's Q)

TobinsQ	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
CD	.106	.009	12.44	0	.089	.123	***
size	.014	.019	0.73	.468	-.023	.051	
lev	.216	.05	4.34	0	.118	.314	***
SG	-.016	.02	-0.78	.436	-.055	.024	
age	.045	.034	1.34	.182	-.021	.11	
EPS	-.017	.006	-2.98	.003	-.028	-.006	***
Boardsize	-.02	.009	-2.36	.018	-.037	-.003	**
Constant	.938	.388	2.42	.016	.178	1.699	**
Mean dependent var	1.836		SD dependent var	0.389			
Number of obs	360		Chi-square	595.529			
Prob > chi2	0.000		Akaike crit. (AIC)	15.343			
*** $p<.01$, ** $p<.05$, * $p<.1$							

Table (7) reports generalized linear model estimates using market value (MV) as the dependent variable as a robustness check. Carbon disclosure (CD) shows a positive and statistically significant coefficient (0.073, $p < 0.001$), providing clear evidence of a positive relationship between carbon disclosure and firm value after controlling for firm characteristics. This result supports the study hypothesis predicting a positive association between carbon disclosure and firm value. Firm size also enters the model with a positive and statistically significant coefficient (0.194, $p < 0.001$). Leverage, sales growth, and firm age are not statistically significant ($p > 0.10$). Earnings per share has a negative and marginally significant coefficient (-0.013, $p = 0.088$), and board size is negative and marginally significant (-0.017, $p = 0.093$). The model is jointly significant (Prob > $chi^2 = 0.000$).

Table 7: Generalized Linear Model Results of Carbon Disclosure on Firm Value (Market Value)

MV	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
CD	.073	.011	6.90	0	.053	.094	***
size	.194	.022	8.68	0	.15	.237	***
lev	.079	.064	1.23	.218	-.047	.205	
SG	-.014	.028	-0.52	.606	-.069	.04	
age	-.012	.043	-0.29	.774	-.096	.072	
EPS	-.013	.007	-1.71	.088	-.027	.002	*
Boardsize	-.017	.01	-1.68	.093	-.036	.003	*
Constant	2.346	.48	4.88	0	1.405	3.288	***
Mean dependent var	6.806		SD dependent var	0.514			
Number of obs	360		Chi-square	696.722			
Prob > chi2	0.000		Akaike crit. (AIC)	173.362			
*** $p<.01$, ** $p<.05$, * $p<.1$							

5. Conclusions & Scientific Contribution

The objective of this study is to test whether carbon emissions disclosure is associated with firm value in Saudi listed nonfinancial firms. The results indicate a positive association between emissions disclosure and firm value, which means that firms providing more carbon-related disclosure tend to have higher market valuation. This conclusion is in line with evidence that markets can price carbon-related reporting because it provides investors with information they use in valuation decisions, including how they assess exposure to climate-related risks and how they evaluate reporting quality (Matsumura et al., 2014; Matthews et al., 2025).

This association remains after controlling for standard firm characteristics and governance attributes, which indicates that disclosure contributes information beyond what investors infer from firm fundamentals alone. A clear interpretation is that disclosure helps investors compare firms on climate-related issues using company-reported information, which makes valuation judgments more grounded in observable disclosures rather than assumptions. Recent evidence shows similar valuation links when firms disclose carbon information in ways that investors can use, including studies reporting that carbon information disclosure can increase firm value and that this effect can be stronger when firms have related capabilities such as green innovation(Liu et al., 2025; Zhu et al., 2025). In addition, the study's focus on disclosure rather than emissions outcomes is consistent with research emphasizing that markets can react to what firms disclose separately from the level of

emissions itself (Matsumura et al., 2014; Matthews et al., 2025).

The Saudi setting also supports the contribution of the study because there is published market guidance that encourages listed firms to disclose ESG information and helps standardize what firms report. The Saudi Exchange ESG Disclosure Guidelines provide a formal reference point for companies on what to disclose and how to present ESG information, which can increase consistency across firms and make disclosures easier for investors to use(Exchange, 2021). Saudi Tadawul Group has also documented sustainability-related activities and initiatives at the market level, which increases the visibility of sustainability information and supports investor use of such information in market assessment(Group, 2024). Academic evidence from Saudi listed firms further shows that sustainability and governance practices are linked to market valuation measures, which is consistent with the idea that nonfinancial reporting and related practices can have valuation implications in this market(Alofaysan et al., 2024; Hussain et al., 2024).

Also, current study adds Saudi-specific evidence on the relation between carbon emissions disclosure and firm value in an important market that has received less attention than advanced markets in carbon disclosure valuation research. It also strengthens the literature by treating carbon emissions disclosure as a reporting decision that can be measured and tested as an input to valuation, rather than treating it as a substitute for carbon performance(Matsumura et al., 2014). In addition, the study supports recent work showing that the credibility of sustainability information matters for market outcomes: evidence on carbon assurance indicates that verification is associated with capital market benefits consistent with higher confidence in reported emissions information(Datt et al., 2025). From a practical perspective, the results inform investors that carbon disclosure can be used alongside financial information when assessing firm value, guide managers toward improving the completeness and structure of emissions reporting, and provide regulators and market institutions with evidence that strengthening disclosure guidance can have market consequences(W. I. Almubarak et al., 2023; Exchange, 2021).

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