Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

When Governance Talks Back: Board Composition as a Boundary Condition of the ESG–Firm Value in Saudi Arabia

KHALID ALSAKEB

kmhossyan@kku.edu.sa

King Khalid University

Article

Keywords: ESG disclosure, firm value, Tobin's Q, Saudi Arabia, Tadawul, board gender diversity, board size, board expertise, corporate governance, quantile regression, system GMM

Posted Date: September 1st, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10284233/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License. Read Full License

Additional Declarations: No competing interests reported.

Abstract

This paper asks whether three attributes of the boardroom, namely gender diversity, member expertise, and overall size, condition how corporate ESG disclosure translates into firm value among non-financial companies on the Saudi Stock Exchange (Tadawul). Firm value is captured through Tobin's Q. The setting is Saudi Arabia's Vision 2030 sustainability push and the ESG reporting rules the Capital Market Authority put in place during 2021–2022. Working with an unbalanced panel of 413 firm-year observations spanning the 2018–2024 period across a wide range of GICS-classified industries, the paper triangulates three estimators, namely fixed-effects panel regression, quantile regression spanning the conditional distribution of firm value, and a dynamic two-step system GMM model, to capture both average tendencies and distribution-wide patterns while guarding against endogeneity and value persistence. The evidence points to a firm-value penalty from ESG disclosure overall, one that clusters at the lower and upper ends of the value distribution rather than spreading evenly across it. Board gender diversity comes out positive under every estimator, yet its interaction with ESG disclosure turns negative chiefly among the highest-value firms, suggesting the two act as substitutes rather than reinforcing one another. Board size lifts the ESG–value relationship for top-performing firms in the fixed-effects and upper-quantile results, while board expertise carries a negative direct link to firm value and only narrowly, and performance-dependently, moderates the ESG effect. A wide set of specification checks, namely variance inflation factors, the White and Cameron–Trevedi heteroskedasticity tests, the Wooldridge test for autocorrelation, and the Breusch–Pagan LM and Hausman tests, back up the validity of the models reported. Taken together, the findings suggest board composition conditions, rather than uniformly reinforces, the value relevance of ESG disclosure, carrying implications for the Capital Market Authority, Tadawul boards, and investors navigating the Vision 2030 reform period.

1. Introduction

National economic policy in Saudi Arabia now revolves substantially around the Vision 2030 program's push for sustainable, diversified growth, and the Saudi Stock Exchange (Tadawul) has translated that ambition into practice through its 2021 ESG disclosure guidelines and the Capital Market Authority's 2022 follow-up ESG framework. The logic behind these reforms is simple enough: getting listed companies to publish environmental, social, and governance information ought to narrow information asymmetry, build investor confidence, and eventually show up in higher market valuations. Whether that logic actually plays out for Tadawul-listed firms, though, remains an open question. Using Bloomberg ESG data, Firmansyah et al. (2023) find that ESG disclosure pulls Tobin's Q down significantly, while Hussain et al. (2024), studying the top 100 non-financial Tadawul firms, report the opposite, a significant positive link between a composite ESG index and firm performance, Tobin's Q included. These contradictory findings, drawn from the very same national market, suggest the ESG–value relationship in Saudi Arabia is not one-size-fits-all but instead turns on governance characteristics that earlier single-method studies have not fully teased apart.

A parallel and expanding stream of Saudi governance research treats board composition as a central boundary condition for this relationship. Musa et al. (2025) show that board diversity, independence, size, and expertise jointly influence ESG disclosure behavior among Tadawul firms; Babiker et al. (2025) find that female board representation meaningfully affects ESG disclosure among Saudi companies in heavily polluting sectors; Almulhim and Metwally (2025) demonstrate that gender diversity and the presence of a sustainability committee shape the ESG–performance link in the Saudi setting; and Alomair and Al Naim (2025) show, in a related governance-and-value-relevance context, that board and audit committee chairman characteristics significantly affect how accounting information is priced by the Saudi market. Even so, most of this literature isolates a single governance moderator, relies on one estimation technique, and stops short of testing whether the ESG–value relationship holds steady across the entire conditional distribution of firm value rather than only at its conditional mean.

The present study is designed to close these gaps. It jointly examines three board-level moderators, namely gender diversity, member expertise, and board size, of the ESG disclosure–firm value relationship among Tadawul-listed non-financial firms, using a triangulated estimation approach that pairs fixed-effects panel regression with quantile regression and dynamic system GMM. This combination makes it possible to assess, in a single study: (i) the average direct effect of ESG disclosure on firm value in the Saudi market; (ii) whether this effect, and the way it is moderated by board attributes, differs systematically

between low-, median-, and high-value firms; and (iii) whether the relationship holds once dynamic endogeneity and firm-specific persistence in valuation are taken into account, issues that matter directly to the Capital Market Authority and Tadawul as the Kingdom's ESG disclosure regime continues to evolve under Vision 2030.

The remainder of the paper proceeds as follows. Section 2 sets out the theoretical background and develops four hypotheses drawn from the international and Saudi-specific ESG literatures. Section 3 details the sample, variable measurement, and empirical models. Section 4 reports the empirical findings, covering descriptive statistics, correlation and diagnostic tests, and the three sets of regression estimates. Section 5 interprets these findings against the theoretical framework and the prior Saudi and international evidence. Section 6 closes with the theoretical and practical implications for Saudi regulators and boards, the study's limitations, and directions for future research.

2. Literature Review and Hypothesis Development

2.1 Theoretical Framework

Several complementary theoretical perspectives motivate this study. Stakeholder theory (Freeman, 1984) holds that firms disclosing ESG information signal a wider commitment to employees, communities, regulators, and the environment, which in turn builds legitimacy and supports long-run value creation (a rationale Tadawul itself invokes in presenting its ESG guidelines as a mechanism for attracting domestic and international capital under Vision 2030. Agency theory (Jensen & Meckling, 1976) cautions that, absent effective board oversight, ESG disclosure can become a vehicle for managerial self-promotion rather than a substantive performance signal, making the value relevance of disclosure conditional on the quality of internal governance, a concern also raised by Umar et al. (2024) in their examination of governance mechanisms and ESG disclosure in Saudi Arabia. Signaling theory (Spence, 1973) treats ESG disclosure as a costly signal aimed at narrowing the information gap between managers and outside investors, particularly relevant to a market such as Tadawul where ESG reporting has traditionally been voluntary. Resource dependence theory (Pfeffer & Salancik, 1978) together with upper echelons theory (Hambrick & Mason, 1984) suggest that board composition) the range of perspectives represented, the substantive expertise of directors, and overall board size (shapes the strategic decisions Saudi firms make about sustainability investment and disclosure quality. Finally, critical mass theory (Kanter, 1977) proposes that the influence of female board representation on strategic outcomes, including sustainability-linked value creation, depends on women reaching a sufficient share of the board to shape its dynamics rather than occupying token positions) a consideration of particular relevance in Saudi Arabia, where female board representation has historically been low but is increasing under the Kingdom's Vision 2030 gender-inclusion targets.

2.2 ESG Disclosure and Firm Value

The direct link between ESG disclosure and firm value has attracted considerable attention in the Saudi context, with results that diverge substantially. Using an unbalanced panel of 26 Saudi-listed firms from 2010 to 2020, Firmansyah et al. (2023) find that overall ESG disclosure, together with its social and governance sub-components, significantly lowers Tobin's Q. Hussain et al. (2024), by contrast, apply a principal-component ESG index to the top 100 non-financial Tadawul firms over 2017–2022 and report a significant positive association between ESG disclosure and Tobin's Q, ROA, and ROE across fixed-effects, random-effects, and GMM specifications. Hamdouni (2025) similarly finds a positive ESG–value relationship among heavy-polluting Saudi industries using a two-step system GMM estimator. Beyond the Saudi setting, a broader systematic review by Bani-Khaled et al. (2025) concludes that the ESG–firm value relationship documented across the international literature is genuinely mixed and highly sensitive to context, measurement choice, and estimation technique, echoing the divergence found within Saudi Arabia itself. Methodologically related evidence reinforces the case for a distribution-sensitive approach: Veeravel et al. (2024), using a method-of-moments quantile regression on Indian listed firms, find that ESG disclosure raises Tobin's Q at higher quantiles while depressing accounting profitability, and Yadav and Asongu (2025) similarly apply a wavelet-enhanced quantile regression to Indian firms and show that the ESG–value relationship is conditional on both the quantile of firm value and the firm's financial distress status. Agarwala et al. (2024), disaggregating ESG into its constituent pillars for Indian firms, further show that the environmental, social, and governance components can carry opposite signs even when the composite

ESG score shows a single average effect, while Biju et al. (2025) find that the direct ESG–performance link in an emerging-market setting is often statistically insignificant once market-level and firm-level controls are properly specified, and Lusy et al. (2025) report a significant positive ESG–Tobin's Q relationship alongside a negative effect of audit committee size in an emerging-market governance-ESG-value model. Because this divergence occurs within a single national market, plausibly reflecting differences in sample composition, ESG measurement, and study period, the direct ESG–value relationship is tested here as a non-directional hypothesis:

H1. There is a significant relationship between the level of sustainability (ESG) disclosure and firm value.

2.3 Role of Board Gender Diversity

Board gender diversity has drawn growing attention as both a determinant and a moderator of ESG-related outcomes in Saudi Arabia. Babiker et al. (2025) find that female board representation in heavily polluting Saudi industries significantly influences the extent of ESG disclosure, while Almulhim and Metwally (2025) show that gender diversity, together with the presence of a sustainability committee, moderates the relationship between ESG disclosure and firm performance among Saudi-listed companies. Musa et al. (2025) likewise identify gender diversity as one of several board attributes, alongside independence, size, and expertise, that jointly shape ESG commitment on Tadawul. At the international level, Alkhawaja et al. (2023) provide cross-country evidence that gender-diverse boards significantly increase ESG disclosure regardless of the stakeholder regime in place, a pattern consistent with critical mass theory (Kanter, 1977) and resource dependence theory (Pfeffer & Salancik, 1978): female directors are thought to bring broader risk perspectives and a stronger stakeholder orientation that should shape how ESG disclosure translates into firm value. More recent evidence reinforces this picture and adds important nuance. Alodat and Hao (2025), studying European non-financial firms, find that board gender diversity strengthens the link between ESG disclosure and accounting-based performance, while Wasiuzzaman and Abdul Wahab (2025), using a 37-country energy-sector panel, show that the positive association between gender-diverse boards and ESG disclosure is itself amplified in countries with stronger accountability and governance institutions, a boundary condition that may apply with particular force in a reforming market such as Saudi Arabia. Liu and Ren (2025), examining Chinese listed firms, similarly report that female directors raise ESG disclosure quality through a governance spillover channel, and Lepore et al. (2025) extend this logic to circular-economy disclosure among European firms, finding that gender-diverse boards disclose more extensively particularly when ESG controversies are salient. Most directly relevant to the present study's methodology, Luh and Asare (2026) apply quantile regression to the gender diversity–sustainability disclosure relationship and find that the strength of the association varies markedly across the conditional distribution of disclosure, echoing the distributional heterogeneity this study documents for the ESG–value relationship itself. This distributional sensitivity was anticipated by Conyon and He (2017), whose quantile-regression analysis of large listed firms found that the relationship between boardroom gender diversity and firm performance itself differs across the conditional performance distribution rather than holding uniformly at the mean, a methodological precedent this study extends to the ESG–value relationship in a single-country Saudi setting.

H2. The relationship between the level of sustainability disclosure and firm value differs according to the proportion of women's representation on the board of directors.

2.4 Role of Board Members' Expertise

Upper echelons theory (Hambrick & Mason, 1984) implies that directors' substantive expertise, whether financial, industry-specific, or sustainability-related, determines the board's capacity to evaluate and challenge management's ESG strategy. Musa et al. (2025) identify board expertise as a significant driver of ESG disclosure among Tadawul firms, alongside board size, independence, and gender diversity, while Basali (2025) shows that governance mechanisms more broadly condition the ESG disclosure behavior of Saudi firms following the 2021 guideline reforms. Velte (2024), studying European firms, similarly finds that sustainability-specific board expertise, captured through directors' relevant professional backgrounds, is a significant driver of environmental performance, reinforcing the idea that board expertise operates as a distinct governance channel from gender diversity or board size alone. Boards with greater relevant expertise may therefore be better equipped to convert sustainability initiatives into credible, value-relevant disclosure, yet they may equally apply more stringent scrutiny that alters how the market prices ESG-related investment depending on firm performance:

H3. The relationship between the level of sustainability disclosure and firm value differs according to the level of expertise of board members.

2.5 Role of Board Size

Board size occupies a long-standing but ambiguous position in the governance literature: larger boards can offer greater monitoring capacity and a wider pool of expertise, yet may also be prone to coordination problems, slower decision-making, and free-riding among directors. Musa et al. (2025) find that board size significantly shapes ESG disclosure practices among Saudi-listed firms, and Umar et al. (2024) show that broader governance mechanisms, including board structure, are closely tied to the quality and consequences of ESG disclosure in the Saudi market. Regionally, Awad et al. (2023) analyze 354 non-financial GCC firms and find that board size is positively associated with firm value alongside gender diversity, while Abu Khalaf (2024) shows that board characteristics, including size, significantly predict the adoption of sustainable reporting practices among GCC-listed companies (evidence directly relevant to interpreting the Saudi board-size effects reported below. At a broader cross-country level, Omenihu and Nwafor (2025), using a dynamic system GMM approach across 1,604 firms in 41 developed and emerging economies, find that the positive association between board size and firm performance weakens systematically as national governance quality rises, suggesting that board size operates as a substitute rather than a complement for external governance quality) a pattern conceptually parallel to the substitution this study finds between board attributes and ESG disclosure. Tawiah et al. (2024), studying African firms, likewise find that board composition, including the presence of directors with strong local and environmental grounding, shapes environmental outcomes in ways that are not reducible to board size alone, reinforcing the idea that the value of a governance attribute such as board size is contingent on the broader composition of the board. This suggests that the value relevance of ESG disclosure is unlikely to be constant across Tadawul-listed firms of differing board size, particularly among firms occupying different positions in the performance distribution:

H4. The relationship between the level of sustainability disclosure and firm value differs according to board size.

Figure 1 summarizes the conceptual model tested in this study: ESG disclosure (independent variable) is linked to firm value (dependent variable), with the relationship moderated by board gender diversity, board expertise, and board size (H2–H4), and with firm size, financial leverage, profitability (ROA, ROE), and an accounting profitability indicator entered as controls.

3. Materials and Methods

3.1 Sample and Data Sources

All data underlying this study were hand-collected from publicly available sources: firm financial statement items (Tobin's Q components, firm size, leverage, ROA, ROE, and profitability), ESG disclosure scores, and board composition variables (board size, gender diversity, and board members' expertise) were compiled from the audited annual reports and corporate governance reports published by sample firms on the Saudi Stock Exchange (Tadawul) website and in Capital Market Authority (CMA) filings, cross-checked against each firm's investor relations disclosures for the 2018–2024 period. No proprietary or subscription-based databases were used. The evidence base is an unbalanced panel spanning 413 firm-year observations on non-financial companies listed on the Saudi Stock Exchange (Tadawul) over the period 2018–2024, sorted under the Global Industry Classification Standard (GICS) into 26 industry groups, Chemicals, Construction Materials, Food Products, Real Estate, Metals & Mining, and Oil, Gas & Consumable Fuels among them (Table 1 gives the complete sectoral breakdown). That Chemicals, Construction Materials, and Metals & Mining carry extra weight in the sample is not an artifact of sampling; it broadly tracks the shape of the Saudi equity market itself, still tilted toward materials and energy even as Vision 2030 pushes economic diversification. This sectoral mix lets the model pick up cross-industry variation in sustainability disclosure and governance arrangements within one institutionally coherent national market, and the panel structure underpins the fixed-effects, quantile, and dynamic GMM estimators used to net out unobserved firm heterogeneity and dynamic persistence in firm value.

3.2 Variable Definitions and Measurement

Firm value, the dependent variable, is captured through Tobin's Q (*ltobinq*), computed by dividing the market value of a firm's assets by their book value. The independent variable, the intensity of sustainability disclosure, is proxied by an ESG score (*esgscore*). Three attributes of board composition serve as moderators: board gender diversity (*BGND*), calculated as the share of seats held by women; board members' expertise (*boardskill*), coded as a binary flag for whether the board includes members with relevant skills or experience; and board size (*Boardsize*), the headcount of directors. Firm size (*FSIZE*), financial leverage (*LEV_w5*), return on assets (*ROA*), return on equity (*ROE_w*), and an accounting profitability indicator (*Profit*) enter the models as controls.

3.3 Empirical Model Specification

Three estimation strategies work together here. The starting point is a panel fixed-effects model, adopted once two diagnostic checks, the Breusch–Pagan Lagrangian Multiplier test and the Hausman specification test, point to fixed effects as superior to both pooled OLS and random effects. Building on this, quantile regression (Koenker & Bassett, 1978) traces the ESG–value relationship, and how board attributes moderate it, at the 10th, 25th, 50th, 75th, and 90th points of the conditional distribution of *ltobinq*; this lets low-, median-, and high-value Saudi firms reveal patterns a single conditional-mean estimate would blur together. Finally, a dynamic two-step system GMM model (Arellano & Bond, 1991; Blundell & Bond, 1998) folds in the lagged dependent variable (*L.ltobinq*) as a regressor to confront dynamic endogeneity and the tendency of firm value to persist year over year, an approach mirroring what Hamdouni (2025) and Hussain et al. (2024) have done elsewhere in Saudi ESG–performance research. The same interaction terms, namely ESG × Boardsize, ESG × boardskill, and ESG × BGND, recur across all three approaches to probe H2–H4, while the direct coefficient on *esgscore* speaks to H1. Model adequacy rests on variance inflation factor (VIF) checks for multicollinearity, White's test alongside the Cameron–Trevedi decomposition for heteroskedasticity, the Wooldridge test for first-order panel autocorrelation, and residual normality plots.

4. Results

This section presents the descriptive statistics, correlation analysis, diagnostic tests, and the three sets of regression results, namely fixed-effects, quantile regression, and system GMM, used to test H1–H4.

4.1 Sectoral Composition of the Sample

Table 1 shows how the 413 firm-year observations are distributed across the 26 GICS industry groups represented in the sample. Chemicals is the largest sector, with 70 observations (16.95% of the sample; 18.64% cumulative), followed by Construction Materials with 42 observations (10.17%; 30.51% cumulative). Food Products, Metals & Mining, and Real Estate Management & Development each contribute 28 observations (6.78% each), while Consumer Staples Distribution & Retail, Health Care Providers & Services, and Oil, Gas & Consumable Fuels each account for 21 observations (5.08% each). At the other end of the distribution, ten sectors, including Electric Utilities, Diversified Telecommunication Services, Building Products, and Commercial Services & Supplies, contribute just 7 observations apiece (1.69% each).

Table 1

Distribution of Sample Firms by GICS Industry

GICS Industry Name	Freq.	Percent	Cum.
Building Products	7	1.69	1.69
Chemicals	70	16.95	18.64
Commercial Services & Supplies	7	1.69	20.34
Construction Materials	42	10.17	30.51
Consumer Staples Distribution & Retail	21	5.08	35.59
Containers & Packaging	7	1.69	37.29
Diversified Telecommunication Services	7	1.69	38.98
Electric Utilities	7	1.69	40.68
Electrical Equipment	7	1.69	42.37
Energy Equipment & Services	14	3.39	45.76
Food Products	28	6.78	52.54
Gas Utilities	7	1.69	54.24
Health Care Providers & Services	21	5.08	59.32
Hotels, Restaurants & Leisure	14	3.39	62.71
Household Durables	7	1.69	64.41
IT Services	14	3.39	67.80
Independent Power and Renewable Electricity Producers	7	1.69	69.49
Media	7	1.69	71.19
Metals & Mining	28	6.78	77.97
Oil, Gas & Consumable Fuels	21	5.08	83.05
Paper & Forest Products	7	1.69	84.75
Real Estate Management & Development	28	6.78	91.53
Specialty Retail	14	3.39	94.92
Transportation Infrastructure	7	1.69	96.61
Wireless Telecommunication Services	14	3.39	100.00
Total	**413**	**100.00**	

Taken together, Chemicals, Construction Materials, and Metals & Mining account for 33.9% of all observations, a concentration that reflects the structural weight of materials- and energy-intensive industries on the Saudi Stock Exchange, a feature also noted by Hussain et al. (2024) in their analysis of the top 100 non-financial Tadawul firms and by Musa et al. (2025) in their study of board characteristics and ESG commitment among Saudi companies. This sectoral profile is relevant for interpreting the results that follow, since capital-intensive, heavy-polluting industries face materially different ESG disclosure incentives and regulatory scrutiny than services- or utilities-oriented sectors, a distinction that also motivated the sector-specific analysis of female board representation and ESG disclosure by Babiker et al. (2025) in Saudi heavy-polluting industries. The Chemicals- and Materials-heavy weighting of the present sample should therefore be kept in mind when comparing the magnitude of the ESG–value coefficients reported in Tables 8–13 with prior Saudi studies built on broader or differently weighted samples.

4.2 Descriptive Statistics

Table 2 reports descriptive statistics for the dependent, independent, and control variables. Firm value (*ltobinq*) averages 0.845 (SD = 0.734; range − 0.489 to 3.645), indicating that, on average, the market value of assets in the sample falls below their book value: consistent with the historically modest market premia observed among Tadawul-listed industrial firms before ESG-linked reforms gained momentum under Vision 2030. The ESG score (*esgscore*) averages 30.46 (SD = 14.85; range 0.85 to 82.05), reflecting substantial dispersion in disclosure intensity across firms and years, consistent with the still-maturing and largely voluntary character of ESG reporting on Tadawul noted by Umar et al. (2024) and Basali (2025).

Regarding board characteristics, average board size (*Boardsize*) is 9.15 directors (SD = 1.73; range 1–25), close to the eight-to-eleven-member range typically documented for Gulf Cooperation Council boards, while average board gender diversity (*BGND*) is only 5.93% (SD = 5.22; range 0–18.18%). This low average female representation echoes Babiker et al. (2025), who similarly document limited but rising female board presence among Saudi-listed firms, and underscores the policy relevance of testing the BGND moderation under H2 in a market where female board representation still lags well behind international norms. Firm size (*FSIZE*) averages 10.35 (SD = 0.68), financial leverage (*LEV_w5*) averages 0.284 (SD = 0.70), and profitability, measured by ROA and ROE_w, averages 8.1% (SD = 5.8%) and 14.7% (SD = 11.5%), respectively, figures broadly in line with those reported for non-financial Tadawul-listed firms by Hussain et al. (2024).

Table 2
Descriptive Statistics for Study Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
ltobinq	413	.845	.734	− .489	3.645
esgscore	413	30.462	14.849	.852	82.053
Boardsize	413	9.15	1.731	1	25
BGND	413	5.933	5.218	0	18.182
FSIZE	413	10.352	.68	9.016	12.397
LEV_w5	413	.284	.7	.001	2.958
ROA	413	.081	.058	− .141	.428
ROE_w	413	.147	.115	− .039	.415

Table 3 cross-tabulates board expertise (*boardskill*) against the accounting profitability indicator (*Profit*). Of the 212 firm-year observations without a formally recognized board skill (*boardskill* = 0), 189 (89.2%) reported positive accounting profit and 23 (10.8%) did not. Of the 201 observations with board skill present (*boardskill* = 1), 186 (92.5%) reported positive profit and 15 (7.5%) did not. Across the full sample, 375 of 413 observations (90.8%) were profitable. Although the gap in profitability rates between the two groups is modest (89.2% versus 92.5%), its direction is consistent with the idea that boards possessing relevant expertise are somewhat more likely to be associated with accounting profitability, even though, as Sections 4.5 and 4.6 show, this same expertise variable is negatively related to market-based firm value once ESG disclosure and other controls are accounted for. This tension between accounting profitability and market valuation is examined further in Section 5.3.

Table 3
Cross-Tabulation of Board Skill and Accounting Profitability

boardskill	Profit = 0	Profit = 1	Total
0	23	189	212
1	15	186	201
Total	**38**	**375**	**413**

4.3 Correlation Analysis

Table 4 presents the pairwise correlation matrix for the study variables. Firm value (*ltobinq*) is not significantly correlated with the ESG score itself (r = − 0.032, n.s.): an early sign, later confirmed by the multivariate results in Tables 8–13, that the direct ESG–value relationship in this sample is not a simple linear association at the bivariate level but instead depends on model specification and a firm's position within the value distribution, consistent with the divergent bivariate-to-multivariate patterns noted by Firmansyah et al. (2023) for Saudi-listed firms. Board gender diversity (*BGND*), by contrast, is positively and significantly correlated with firm value (r = 0.270, p < 0.01), giving initial bivariate support for H2 and foreshadowing the robust positive coefficient on BGND documented across the fixed-effects, quantile, and GMM models reported later; this is directionally consistent with Babiker et al. (2025) and Almulhim and Metwally (2025), both of whom link female board representation to more favorable ESG-related firm outcomes in Saudi Arabia.

Board expertise (*boardskill*) is negatively and significantly correlated with firm value (r = − 0.221, p < 0.01) and positively correlated with the ESG score (r = 0.130, p < 0.01), suggesting that firms with more expert boards disclose more but are not, on a simple bivariate basis, more highly valued by the market (a pattern that foreshadows the negative direct *boardskill* coefficients reported in Tables 8–11. *BGND* and *boardskill* are themselves strongly negatively correlated (r = − 0.634, p < 0.01), indicating that, within this sample, boards with greater female representation tend to include fewer members formally classified as possessing specialized expertise, a structural feature worth bearing in mind when interpreting the separate H2 and H3 moderation effects. Among the control variables, ROA is positively correlated with firm value (r = 0.348, p < 0.01) while ROE_w is negatively correlated (r = − 0.212, p < 0.01), and firm size is positively correlated with ESG disclosure (r = 0.305, p < 0.01), consistent with the well-established tendency of larger firms to disclose more extensively, as also reported by Hussain et al. (2024) and Basali (2025) for the Saudi market. The largest absolute off-diagonal coefficient across the full matrix is 0.634 (BGND–boardskill), comfortably below the 0.80–0.90 threshold conventionally used to flag problematic multicollinearity) an initial reassurance formally confirmed by the variance inflation factor analysis in Section 4.4.

Table 4
Pairwise Correlation Matrix

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
(1) ltobinq	1.000									
(2) esgscore	-0.032	1.000								
(3) Boardsize	-0.024	0.088*	1.000							
(4) boardskill	-0.221***	0.130***	0.064	1.000						
(5) BGND	0.270***	0.112**	-0.027	-0.634***	1.000					
(6) FSIZE	-0.030	0.305***	0.062	0.038	0.015	1.000				
(7) LEV_w5	0.051	-0.167***	-0.068	-0.105**	0.037	-0.475***	1.000			
(8) ROA	0.348***	-0.038	-0.054	0.016	0.031	-0.130***	0.078	1.000		
(9) ROE_w	-0.212***	-0.104**	0.026	0.142***	-0.150***	0.135***	-0.068	-0.069	1.000	
(10) Profit	-0.097**	-0.022	0.037	0.059	-0.056	-0.009	0.070	-0.018	0.492***	1.000

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

4.4 Diagnostic Testing

Multicollinearity. Given the moderate correlations surfaced in Table 4, Table 5 checks whether they distort the regression estimates by reporting variance inflation factors (VIF) for each independent variable. Every VIF sits comfortably under the conventional ceiling of 5, and below the stricter ceiling of 10 as well, spanning 1.017 for Boardsize up to 1.836 for boardskill, with a mean of 1.384. Fittingly, the two variables carrying the strongest correlation in Table 4, boardskill and BGND, also post the two highest VIF readings (1.836 and 1.801), though still nowhere near a level of concern. Multicollinearity is thus not distorting the coefficients or standard errors that follow, and the H2 and H3 moderation effects can be read as independent of one another.

Table 5
Variance Inflation Factors

Variable	VIF	1/VIF
boardskill	1.836	.545
BGND	1.801	.555
FSIZE	1.443	.693
ROE_w	1.432	.698
Profit	1.348	.742
LEV_w5	1.318	.759
esgscore	1.237	.808
ROA	1.027	.973
Boardsize	1.017	.983
Mean VIF	**1.384**	

Residual normality. Figures 2–4 present graphical diagnostics for the residual distribution underlying the fixed-effects specification: a histogram overlaid with the theoretical normal density (Fig. 2), a kernel density estimate against the normal benchmark (Fig. 3), and a normal Q–Q plot against theoretical quantiles (Fig. 4). In all three figures, the residuals track the fitted normal curve or the 45-degree reference line closely, with only minor departures in the extreme tails, a pattern typical of firm-level financial panel data that supports the validity of the significance tests reported in Tables 8–13.

Heteroskedasticity. White's general test returns a chi-square of 24.73 on 26 degrees of freedom ($p = 0.5343$), well above the 0.05 cutoff, leaving the null of homoskedasticity intact. Table 6 breaks this down further via the Cameron–Trevedi decomposition of the information matrix (IM) test, splitting the overall statistic into heteroskedasticity, skewness, and kurtosis pieces. None comes close to significance: heteroskedasticity ($\chi^2 = 24.73$, df = 26, $p = 0.5343$) echoes the White's test finding, skewness ($\chi^2 = 9.91$, df = 6, $p = 0.1284$) shows no meaningful asymmetry, and kurtosis ($\chi^2 = 2.51$, df = 1, $p = 0.1132$) shows no excess peakedness. The combined test ($\chi^2 = 37.15$, df = 33, $p = 0.2835$) again fails to reject the null. The fixed-effects model can accordingly be regarded as free of heteroskedasticity, with no need for a robust correction to its reported standard errors.

Table 6
Cameron–Trevedi Decomposition of the Information Matrix (IM) Test

Source	chi2	df	p
Heteroskedasticity	24.73	26	0.5343
Skewness	9.91	6	0.1284
Kurtosis	2.51	1	0.1132
Total	**37.15**	**33**	**0.2835**

Autocorrelation and model selection. The Wooldridge test for first-order autocorrelation returns an F-statistic of 5.747 (F(1, 58); p = 0.1198), which falls short of conventional significance, so the null of no first-order autocorrelation stands, and the panel residuals show no systematic serial pattern. Turning to model choice, the Breusch–Pagan Lagrangian Multiplier test for random effects decisively rejects pooled OLS in favor of a panel-structured alternative (χ^2bar(01) = 795.57, p < 0.001), confirming that unobserved firm-level heterogeneity is at work in this sample and that pooled OLS would misspecify the relationship.

Table 7 turns to the Hausman specification test, used here to arbitrate between random-effects and fixed-effects estimators. The result (χ^2 = 29.894, p < 0.001) firmly rejects the null that random effects would be consistent, meaning firm-specific effects correlate with the regressors and that fixed effects (reported in Table 8) is the preferred choice. This two-step sequence, Breusch–Pagan followed by Hausman, follows the same model-selection logic Hussain et al. (2024) applied in their multi-estimator study of Saudi-listed firms, and it justifies anchoring H1–H4 testing in fixed effects rather than pooled OLS or random effects.

Table 7
Hausman Specification Test

Chi-square test value	**Coef.**
	29.894
P-value	0.000

4.5 Fixed-Effects Panel Regression Results

Table 8 presents the fixed-effects estimates for the direct effect of ESG disclosure on firm value (Model 1) and the three moderation models (Models 2–4). In Model 1, the direct coefficient on *esgscore* is negative and highly significant (β = −0.004, p < 0.01): holding firm size, leverage, profitability, and firm-fixed effects constant, a one-unit increase in the ESG score is associated with a 0.004 decrease in log Tobin's Q. This finding supports H1 and aligns directly with Firmansyah et al. (2023), who similarly report that ESG disclosure significantly reduces Tobin's Q among Saudi-listed firms, while diverging from the positive relationship documented by Hussain et al. (2024) and Hamdouni (2025) for other Saudi samples, a divergence discussed further in Section 5.1.

In Model 2, which adds the Boardsize × ESG interaction, the direct ESG coefficient loses significance (β = 0.002, n.s.), board size itself is positive and significant (β = 0.021, p < 0.05), and the interaction term ESG_BOARDSIZE is negative and significant (β = −0.001, p < 0.1). This pattern supports H4: larger Saudi boards are independently associated with higher firm value, but larger boards blunt the incremental value of ESG disclosure, consistent with the classical governance concern, and with Musa et al. (2025), who find that board size significantly shapes ESG disclosure outcomes among Tadawul firms, that larger boards may face coordination costs that limit their capacity to convert sustainability disclosure into market value.

In Model 3, which adds the boardskill × ESG interaction, board expertise carries a negative and highly significant direct coefficient (β = −0.175, p < 0.01), while the interaction term ESG_BOARDSKILL is negative but not significant (β = −0.001, n.s.). This gives partial support to H3: board expertise matters for firm value primarily through a direct rather than an ESG-moderating channel, a more nuanced pattern than the uniformly positive role that Musa et al. (2025) assign to board expertise in shaping ESG disclosure intensity, suggesting that expertise may raise disclosure quality (as Musa et al. document) while simultaneously depressing near-term market valuation (as found here), a distinction discussed in Section 5.3.

In Model 4, board gender diversity (BGND) carries a positive and highly significant direct coefficient (β = 0.023, p < 0.01) and the ESG_BGND interaction is negative and significant (β = −0.0004, p < 0.05), supporting H2 and echoing the positive role of female board representation documented by Babiker et al. (2025) and Almulhim and Metwally (2025) in the Saudi context, and by Alkhawaja et al. (2023) internationally. Across all four models, firm size (FSIZE) and the accounting profitability indicator (Profit) are consistently positive and significant (p < 0.01), while ROA is negative and significant (p < 0.01 or p < 0.05) in every specification, an initially counterintuitive result that the quantile regression evidence in Section 4.6 helps clarify, showing that

the ROA–value relationship is in fact strongly positive across most of the conditional distribution and only appears negative once averaged across the full sample in the fixed-effects specification. In terms of model fit, Model 3 (boardskill moderation) explains the largest share of variance ($R^2 = 0.337$), followed by Model 4 (BGND moderation, $R^2 = 0.222$), Model 2 (Boardsize moderation, $R^2 = 0.156$), and Model 1 (direct effect only, $R^2 = 0.144$), with all four F-statistics significant at $p < 0.001$.

Table 8
Fixed-Effects Panel Regression: Direct and Moderating Effects of ESG Disclosure on Firm Value

VARIABLES	**(1) Direct effect**	**(2) Moderating (Boardsize)**	**(3) Moderating (boardskill)**	**(4) Moderating (BGND)**
esgscore	-0.004*** (0.0011)	0.002 (0.0034)	-0.004** (0.0020)	-0.005*** (0.0012)
Boardsize		0.021** (0.0099)		
ESG_BOARDSIZE		-0.001* (0.0003)		
boardskill			-0.175*** (0.0602)	
ESG_BOARDSKILL			-0.001 (0.0021)	
BGND				0.023*** (0.0051)
ESG_BGND				-0.0004** (0.0001)
FSIZE	0.136*** (0.0280)	0.140*** (0.0279)	0.088*** (0.0252)	0.131*** (0.0269)
LEV_w5	0.031 (0.0252)	0.034 (0.0251)	-0.018 (0.0227)	0.013 (0.0243)
ROA	-0.627*** (0.2239)	-0.595*** (0.2238)	-0.535*** (0.1978)	-0.579*** (0.2144)
ROE_w	-0.308** (0.1208)	-0.306** (0.1204)	-0.127 (0.1090)	-0.214* (0.1168)
Profit	0.111*** (0.0397)	0.115*** (0.0396)	0.101*** (0.0352)	0.118*** (0.0380)
Constant	-0.444 (0.2963)	-0.691** (0.3156)	0.138 (0.2700)	-0.474* (0.2857)
Observations	413	413	413	413
R-squared	0.144	0.156	0.337	0.222
Number of id	59	59	59	59
F-Stat	9.764	7.988	22.00	12.34
Prob > F	5.99e-10	6.86e-10	0.000	0.000

Note: Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4.6 Quantile Regression Results

To check whether the fixed-effects results in Table 8 conceal heterogeneity across the conditional distribution of firm value, Table 9 reports quantile regression estimates of the direct ESG–value relationship at the 10th, 25th, 50th, 75th, and 90th percentiles of *ltobinq*. The ESG coefficient is negative and significant at the 10th quantile ($\beta = -0.004$, $p < 0.05$) and more strongly so at the 90th quantile ($\beta = -0.014$, $p < 0.05$), but is statistically indistinguishable from zero at the 25th, 50th, and 75th quantiles. This U-shaped pattern of significance, a penalty at both tails but not in the middle of the distribution, refines H1 well beyond what the average fixed-effects coefficient in Table 8 could show, and offers a possible explanation for the conflicting average-effect findings of Firmansyah et al. (2023) and Hussain et al. (2024): differences in sample composition across studies may simply place more or fewer firms at the tails where the ESG penalty concentrates. Return on assets (ROA) is positive and highly significant from the 25th through the 90th quantile (coefficients ranging from 2.502 to 5.226, all $p < 0.1$ or

better), confirming that the negative ROA coefficient observed in the fixed-effects model in Table 8 reflects conditional-mean averaging rather than a genuine negative relationship; the true relationship is strongly positive across most of the distribution. Return on equity (ROE_w) is negative and significant from the median upward (β ranging from − 1.332 to − 2.139, $p < 0.01$), indicating that the negative ROE effect concentrates among median-to-high-value firms.

Table 9
Quantile Regression: Direct Effect of ESG Disclosure on Firm Value

VARIABLES	**Q10**	**Q25**	**Q50**	**Q75**	**Q90**
esgscore	-0.004** (-2.422)	-0.000 (-0.016)	0.000 (0.097)	-0.002 (-0.538)	-0.014** (-2.524)
FSIZE	0.138** (2.507)	-0.029 (-0.496)	0.018 (0.219)	0.144 (1.538)	0.257* (1.950)
LEV_w5	0.033 (0.750)	-0.003 (-0.052)	0.025 (0.336)	0.117 (1.344)	-0.015 (-0.119)
ROA	-0.615 (-1.164)	4.691*** (8.004)	5.226*** (6.541)	4.272*** (4.620)	2.502* (1.917)
ROE_w	-0.195 (-0.916)	-0.049 (-0.142)	-1.332*** (-2.816)	-2.139*** (-3.908)	-2.107*** (-2.728)
Profit	0.053 (0.760)	0.022 (0.164)	-0.002 (-0.011)	-0.118 (-0.556)	0.242 (0.806)
Constant		0.249 (0.401)	0.342 (0.405)	-0.118 (-0.121)	-0.562 (-0.407)
Observations	413	413	413	413	413
Pseudo R2	.	0.114	0.120	0.102	0.077
Note: t-values in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1.					

Table 10 extends the quantile analysis to test the moderating role of board size (H4). The ESG_BOARDSIZE interaction is negative and significant only at the 75th and 90th quantiles (β = −0.003 and − 0.007, respectively, both $p < 0.1$ or better), while board size itself becomes positive and highly significant only at the 90th quantile (β = 0.292, $p < 0.01$). This indicates that the attenuating effect of board size on the ESG–value relationship identified in the fixed-effects Model 2 (Table 8) is not a uniform, sample-wide phenomenon but is instead concentrated among the highest-value Saudi firms, precisely the firms where, per resource dependence theory (Pfeffer & Salancik, 1978), boards are most likely to have expanded to accommodate a wider range of expertise and stakeholder representation, potentially at the cost of decision-making speed.

Table 10

Quantile Regression: Moderating Effect of Board Size on the ESG–Firm Value Relationship

VARIABLES	Q10	Q25	Q50	Q75	Q90
esgscore	-0.001 (-0.225)	0.007 (0.659)	0.006 (0.390)	0.024 (1.535)	0.055*** (2.671)
Boardsize	0.021 (1.154)	0.025 (0.782)	-0.007 (-0.150)	0.059 (1.219)	0.292*** (4.673)
ESG_BOARDSIZE	-0.000 (-0.497)	-0.001 (-0.689)	-0.001 (-0.391)	-0.003* (-1.824)	-0.007*** (-3.477)
FSIZE	0.140** (2.034)	-0.030 (-0.521)	0.024 (0.296)	0.154* (1.726)	0.284** (2.450)
LEV_w5	0.033 (0.608)	-0.010 (-0.179)	0.020 (0.260)	0.121 (1.468)	0.133 (1.242)
ROA	-0.583 (-0.879)	4.683*** (8.159)	5.071*** (6.254)	3.886*** (4.431)	2.342** (2.057)
ROE_w	-0.211 (-0.795)	-0.232 (-0.681)	-1.408*** (-2.933)	-2.110*** (-4.062)	-2.218*** (-3.290)
Profit	0.054 (0.625)	0.082 (0.619)	-0.006 (-0.031)	-0.079 (-0.391)	0.204 (0.777)
Constant		0.000 (0.000)	0.371 (0.375)	-0.758 (-0.708)	-3.553** (-2.556)
Observations	413	413	413	413	413
Pseudo R2	.	0.115	0.125	0.107	0.097

Note: t-values in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1.

Table 11 tests the moderating role of board expertise (H3) across quantiles. The direct *boardskill* coefficient is negative and significant at the 10th quantile (β = −0.222, p < 0.1) and again at the 90th quantile (β = −0.864, p < 0.05), but is not significant across the middle of the distribution, while the ESG_BOARDSKILL interaction is negative and significant only at the median (β = −0.021, p < 0.05). This pattern indicates that board expertise depresses firm value specifically among the weakest- and strongest-performing Saudi firms, while narrowing the incremental value of ESG disclosure only among firms clustered near the median, a considerably more performance-contingent pattern than the broadly positive role that Musa et al. (2025) attribute to board expertise in shaping the quantity of ESG disclosure. One plausible reading, developed further in Section 5.3, is that expert boards apply more rigorous internal review to both weak performers and strong performers, since expertise may expose additional risks among weak performers and increase scrutiny of already-elevated valuations among strong performers, while their moderating influence on the ESG–value link itself is confined to firms nearer the middle of the performance spectrum.

Table 11

Quantile Regression: Moderating Effect of Board Expertise on the ESG–Firm Value Relationship

VARIABLES	Q10	Q25	Q50	Q75	Q90
esgscore	-0.005 (-1.212)	0.009 (1.427)	0.020** (2.181)	-0.004 (-0.428)	-0.020* (-1.806)
boardskill	-0.222* (-1.767)	0.038 (0.188)	0.402 (1.315)	-0.425 (-1.333)	-0.864** (-2.418)
ESG_BOARDSKILL	0.001 (0.121)	-0.008 (-1.201)	-0.021** (-2.160)	0.002 (0.183)	0.016 (1.366)
FSIZE	0.084* (1.666)	-0.130** (-2.287)	0.049 (0.570)	0.118 (1.303)	0.182* (1.794)
LEV_w5	-0.001 (-0.012)	-0.061 (-1.159)	0.061 (0.757)	0.039 (0.462)	0.002 (0.024)
ROA	-0.664 (-1.374)	3.951*** (7.054)	4.932*** (5.760)	4.500*** (5.031)	2.835*** (2.832)
ROE_w	-0.010 (-0.054)	-0.020 (-0.059)	-1.310** (-2.558)	-1.257** (-2.351)	-1.859*** (-3.105)
Profit	0.064 (1.006)	0.045 (0.346)	0.065 (0.329)	-0.211 (-1.024)	-0.052 (-0.224)
Constant		1.182* (1.905)	-0.500 (-0.527)	0.342 (0.345)	0.678 (0.611)
Observations	413	413	413	413	413
Pseudo R2	.	0.128	0.137	0.129	0.112

Note: t-values in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1.

Table 12 tests the moderating role of board gender diversity (H2) across quantiles. BGND is positive and significant at every quantile examined, with the coefficient rising monotonically from 0.024 at the 10th quantile to 0.110 at the 90th quantile (all $p < 0.1$ or better), confirming that gender diversity is not only a robust average predictor of firm value (Table 8) but that its positive association strengthens systematically as firm value rises. The ESG_BGND interaction, by contrast, is negative and significant only at the 10th quantile ($\beta = -0.0002$, $p < 0.1$) and the 90th quantile ($\beta = -0.002$, $p < 0.01$), with an effect roughly ten times larger in magnitude at the top of the distribution than at the bottom. This confirms that the substitution pattern between gender diversity and ESG disclosure identified in the fixed-effects Table 8 is overwhelmingly concentrated among the highest-value Saudi firms, where gender-diverse boards appear to secure firm value through channels other than incremental ESG disclosure, a finding that refines the positive, largely undifferentiated role assigned to gender diversity by Almulhim and Metwally (2025) and by the international evidence of Alkhawaja et al. (2023).

Table 12

Quantile Regression: Moderating Effect of Board Gender Diversity on the ESG–Firm Value Relationship

VARIABLES	Q10	Q25	Q50	Q75	Q90
esgscore	-0.004** (-2.230)	0.000 (0.057)	0.001 (0.140)	-0.002 (-0.498)	-0.002 (-0.471)
BGND	0.024*** (3.099)	0.025* (1.914)	0.049** (2.295)	0.067*** (3.127)	0.110*** (5.713)
ESG_BGND	-0.0002* (-1.664)	0.000 (0.017)	-0.001 (-1.070)	-0.001 (-1.499)	-0.002*** (-3.519)
FSIZE	0.139** (2.481)	-0.132** (-2.468)	0.062 (0.720)	0.139 (1.593)	0.116 (1.484)
LEV_w5	0.023 (0.523)	-0.066 (-1.330)	0.084 (1.055)	0.054 (0.669)	0.081 (1.128)
ROA	-0.557 (-1.017)	3.787*** (7.219)	4.791*** (5.682)	4.947*** (5.782)	3.314*** (4.327)
ROE_w	-0.158 (-0.727)	-0.031 (-0.099)	-1.019** (-2.027)	-1.338*** (-2.622)	-1.956*** (-4.284)
Profit	0.084 (1.269)	0.062 (0.512)	-0.023 (-0.119)	-0.190 (-0.963)	-0.152 (-0.863)
Constant		1.212*** (2.150)	-0.278 (-0.307)	-0.399 (-0.433)	0.387 (0.470)
Observations	413	413	413	413	413
Pseudo R2	.	0.140	0.139	0.135	0.145

Note: t-values in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1.

4.7 Dynamic System GMM Results

Table 13 reports the two-step system GMM estimates, which address dynamic endogeneity and the persistence of firm value over time by including the lagged dependent variable (*L.ltobinq*) as a regressor, an approach that parallels the GMM strategies used by Hussain et al. (2024) and Hamdouni (2025) in the Saudi ESG literature. The lagged Tobin's Q coefficient is positive and highly significant across all four models (ranging from 0.282 to 0.441, all $p < 0.01$), confirming substantial persistence in firm value from one year to the next and validating the dynamic specification. The direct ESG coefficient remains negative and significant in Model 1 ($\beta = -0.004$, $p < 0.01$) and Model 4 ($\beta = -0.003$, $p < 0.05$), reproducing the negative direct effect found in the fixed-effects Table 8 and the quantile results in Table 9, and confirming that H1 is not an artifact of static-model endogeneity.

Board gender diversity (BGND) again emerges as positive and highly significant ($\beta = 0.016$, $p < 0.01$), with a negative and significant interaction with ESG disclosure ($\beta = -0.0002$, $p < 0.05$), fully corroborating the pattern found in Tables 8 and 12 under a dynamic specification that explicitly controls for endogeneity, among the strongest available forms of robustness evidence for H2. Board size is positive and significant ($\beta = 0.015$, $p < 0.01$) with a negative and significant ESG interaction ($\beta = -0.0002$, $p < 0.01$), reproducing the Table 8 and Table 10 pattern and confirming H4 under the dynamic specification, while board expertise (boardskill) is negative but not significant in the dynamic model ($\beta = -0.087$, n.s.), a modest attenuation relative to the strongly significant static fixed-effects estimate in Table 8, consistent with part of the negative boardskill effect reflecting short-run adjustment dynamics rather than a purely structural relationship. Profitability (Profit) is positive and highly significant in every model ($p < 0.01$), and firm size and leverage are weakly positive. Critically, the Arellano–Bond AR(2) test fails to reject the null of no second-order serial correlation in every specification (p-values ranging from 0.152 to 0.485), while the AR(1) test detects first-order correlation as expected by construction of the GMM difference estimator, confirming that the instruments are valid and the moment conditions are correctly specified across all four models.

Table 13
Dynamic Two-Step System GMM Regression Results

VARIABLES	(1) Direct effect	(2) Moderating (Boardsize)	(3) Moderating (boardskill)	(4) Moderating (BGND)
L.ltobinq	0.428*** (0.0469)	0.441*** (0.0453)	0.282*** (0.0357)	0.352*** (0.0428)
esgscore	-0.004*** (0.0012)	0.001 (0.0017)	-0.002 (0.0020)	-0.003** (0.0013)
Boardsize		0.015*** (0.0034)		
ESG_BOARDSIZE		-0.0002*** (0.0001)		
boardskill			-0.087 (0.0651)	
ESG_BOARDSKILL			-0.001 (0.0022)	
BGND				0.016*** (0.0039)
ESG_BGND				-0.0002** (0.0001)
FSIZE	0.041* (0.0243)	0.044* (0.0253)	0.038* (0.0205)	0.033 (0.0220)
LEV_w5	0.026* (0.0144)	0.030** (0.0149)	0.009 (0.0101)	0.014 (0.0117)
ROA	0.033 (0.1004)	0.012 (0.0987)	-0.049 (0.0803)	-0.038 (0.0845)
ROE_w	-0.170** (0.0759)	-0.155** (0.0738)	-0.047 (0.0658)	-0.035 (0.0675)
Profit	0.061*** (0.0158)	0.059*** (0.0161)	0.062*** (0.0146)	0.051*** (0.0146)
Constant	0.063 (0.2441)	-0.151 (0.2507)	0.176 (0.2105)	0.137 (0.2243)
Wald chi2	160.54	188.54	169.36	143.06
Prob>chi2	0.000	0.000	0.000	0.000
AR(1) p-value	0.000	0.000	0.03	0.01
AR(2) p-value	0.226	0.152	0.377	0.485
No. of groups	59	59	59	59
No. of instruments	23	25	25	25

5. Discussion

The results offer partial support for all four hypotheses while revealing substantial heterogeneity across the conditional distribution of firm value that a single conditional-mean model would have concealed, helping to reconcile the conflicting Saudi evidence noted in the introduction.

5.1 The Direct Effect of ESG Disclosure on Firm Value (H1)

Consistent with H1, sustainability disclosure is significantly related to firm value across the fixed-effects (Table 8), quantile (Table 9), and system GMM (Table 13) specifications, but the relationship runs predominantly negative rather than positive. This result aligns directly with Firmansyah et al. (2023), who report that ESG disclosure significantly reduces Tobin's Q among Saudi-listed firms, and contrasts with the positive relationship reported by Hussain et al. (2024) and Hamdouni (2025) for other Saudi samples and time periods. Read alongside the quantile results in Table 9, where the negative ESG coefficient concentrates at the 10th and 90th quantiles but is statistically indistinguishable from zero between the 25th and 75th

quantiles, this divergence suggests that the Saudi ESG–value relationship is highly sensitive to a firm's position within the value distribution and to how mature its ESG reporting practices are during the early years of Tadawul's voluntary, and subsequently CMA-guided, disclosure regime. This fits the agency-theoretic concern (Jensen & Meckling, 1976) that, absent sufficiently strong board oversight, ESG disclosure can impose compliance and reporting costs, particularly salient in a market where mandatory ESG reporting is still relatively recent, that are not immediately offset by market re-rating.

5.2 The Moderating Role of Board Gender Diversity (H2)

Board gender diversity (BGND) emerges as a robust, independent, and positive predictor of firm value in the correlation analysis (Table 4), the fixed-effects model (Table 8), the quantile regressions (Table 12), and the dynamic GMM specification (Table 13) alike (an unusually consistent result across estimators. This aligns closely with Babiker et al. (2025) and Almulhim and Metwally (2025), who document that female board representation and gender diversity shape ESG-related outcomes among Saudi-listed firms, and with the global evidence of Alkhawaja et al. (2023), Alodat and Hao (2025), and Wasiuzzaman and Abdul Wahab (2025), consistent with critical mass theory (Kanter, 1977) and resource dependence theory (Pfeffer & Salancik, 1978): female directors appear to bring a distinct risk orientation and stakeholder sensitivity that independently strengthens market valuation, regardless of the sustainability disclosure channel) an encouraging signal given the still relatively low female board representation (averaging 5.93% in Table 2) across the Saudi market. However, the interaction between ESG disclosure and gender diversity is negative and significant primarily at the 90th quantile in Table 12 ($\beta = -0.002$, $p < 0.01$, roughly ten times the magnitude of the 10th-quantile coefficient), indicating a substitutive rather than complementary relationship concentrated among high-value firms: in these firms, greater gender diversity appears to reduce the marginal contribution of ESG disclosure to firm value, possibly because gender-diverse boards in these firms already secure strong valuations through other governance channels, leaving less incremental value for disclosure-based signaling. This nuance qualifies the largely undifferentiated positive role attributed to gender diversity by Almulhim and Metwally (2025) and points to a genuine boundary condition worth testing in future Saudi research. It also resonates with Luh and Asare (2026), whose quantile-regression evidence shows that the gender diversity–disclosure relationship itself is not constant across the distribution, reinforcing the broader methodological argument of this paper that conditional-mean estimates can conceal economically important tail behavior.

5.3 The Moderating Role of Board Expertise (H3)

Board members' expertise (boardskill) shows a negative direct association with firm value in both the fixed-effects (Table 8, $\beta = -0.175$, $p < 0.01$) and quantile (Table 11) specifications, significant at the 10th and 90th quantiles but not in the middle of the distribution, while its interaction with ESG disclosure is small and significant only around the median (Table 11, $\beta = -0.021$, $p < 0.05$) and not significant at all in the dynamic GMM model (Table 13). This nuance qualifies the more uniformly positive role attributed to board expertise by Musa et al. (2025) in explaining ESG disclosure intensity among Tadawul firms, and stands somewhat apart from Velte (2024), who finds that sustainability-specific board expertise mainly benefits environmental performance rather than depressing it among European firms, a contrast that may reflect the difference between a still-developing, largely voluntary disclosure regime such as Tadawul's and the more mature, mandatory European sustainability reporting environment. Expertise may enhance the quantity and quality of ESG disclosure itself while simultaneously depressing near-term market value if boards with greater substantive expertise impose more rigorous internal standards on sustainability spending. The bivariate correlation in Table 4, a strong negative association between boardskill and firm value ($r = -0.221$, $p < 0.01$), combined with the cross-tabulation in Table 3, which shows only a modest profitability gap between boards with and without recognized expertise (92.5% versus 89.2% profitable), together suggest that the Saudi market may initially discount the near-term costs of more rigorous board-level scrutiny of ESG initiatives before any credibility premium materializes in accounting profitability or market value.

5.4 The Moderating Role of Board Size (H4)

Board size interacts positively and significantly with firm value in the fixed-effects model (Table 8, $\beta = 0.021$, $p < 0.05$) and shows an increasingly positive direct association with value specifically at the 90th quantile in Table 10 ($\beta = 0.292$, $p < 0.01$), while its interaction with ESG disclosure turns negative and significant at the 75th and 90th quantiles (Table 10) and in the dynamic GMM model (Table 13, $\beta = -0.0002$, $p < 0.01$). This pattern is consistent with Musa et al. (2025), who find that board

size significantly shapes ESG disclosure practices among Saudi firms, with Umar et al. (2024), who link board structure to the broader quality of Saudi corporate governance and ESG outcomes, and with the GCC-specific evidence of Awad et al. (2023), who likewise report a positive direct association between board size and firm value. It also parallels the cross-country GMM evidence of Omenihu and Nwafor (2025), who find that the positive board size–performance relationship weakens as external governance quality strengthens (a substitution logic that mirrors the present study's finding that board size substitutes for, rather than reinforces, the incremental value of ESG disclosure among high-value Saudi firms. It supports the classical governance concern that larger boards, while offering greater monitoring capacity and expertise diversity (consistent with resource dependence theory; Pfeffer & Salancik, 1978), may also experience slower decision-making and diffusion of responsibility that weakens the incremental value of sustainability disclosure once a Saudi firm has already achieved high market valuation) precisely the pattern isolated in the upper-quantile results of Table 10.

5.5 Robustness and Model Consistency

The diagnostic picture as a whole (a mean VIF of 1.384, comfortably under conventional ceilings [Table 5]; homoskedasticity holding up under both White's and the Cameron–Trevedi tests [Table 6]; no first-order autocorrelation per the Wooldridge test; and the Hausman test's clear preference for fixed effects [Table 7]) gives confidence in the panel regression estimates of Table 8. The dynamic GMM results in Table 13 add a further layer of assurance: controlling for the lagged dependent variable, they pass the Arellano–Bond AR(2) test in every specification (p-values from 0.152 to 0.485, no sign of second-order serial correlation), and they reproduce the fixed-effects and quantile-regression story. The negative direct ESG effect, the robust positive role of board gender diversity, and the performance-contingent moderation from board size and expertise all hold up once dynamic endogeneity is addressed, which strengthens confidence in the H1–H4 conclusions summarized in Table 14.

Table 14
Summary of Hypothesis Testing Results

Hypothesis	Statement	Result
H1	There is a significant relationship between the level of sustainability (ESG) disclosure and firm value.	Supported
H2	The relationship between the level of sustainability disclosure and firm value differs according to the proportion of women's representation on the board of directors.	Strongly supported
H3	The relationship between the level of sustainability disclosure and firm value differs according to the level of expertise of board members.	Partially supported
H4	The relationship between the level of sustainability disclosure and firm value differs according to board size.	Partially supported
Note: Results are based on the triangulated evidence from the fixed-effects, quantile regression, and dynamic system GMM specifications reported in Tables 8\u201313.		

6. Conclusions

This study examined the relationship between ESG disclosure and firm value among Tadawul-listed firms, along with the moderating roles of board gender diversity, board expertise, and board size, using an unbalanced panel of 413 firm-year observations covering the 2018–2024 period and a triangulated estimation strategy combining fixed-effects regression, quantile regression, and dynamic system GMM. The results support H1: ESG disclosure is significantly, and predominantly negatively, related to firm value, with the effect concentrated at the tails of the value distribution, consistent with Firmansyah et al. (2023) but at odds with the positive relationship documented by Hussain et al. (2024) and Hamdouni (2025), a divergence that appears attributable to differences in sample period, ESG measurement, and firm positioning within the value distribution. H2 is strongly supported: board gender diversity is a robust, independent, positive determinant of firm value, and it significantly moderates the ESG–value relationship, especially among high-value firms, where the two appear to act as substitutes rather than complements. H3 receives partial support: board expertise is negatively related to firm value directly, and its interaction with ESG disclosure is limited and concentrated around the median. H4 is also partially supported: board size positively

moderates firm value at high quantiles under the fixed-effects specification, but its interaction with ESG disclosure turns negative among high-value firms.

Practically, the findings are directly relevant to the Capital Market Authority, Tadawul, and Saudi-listed firms as they continue to implement the Kingdom's ESG disclosure guidelines under Vision 2030. For boards and firms, the results imply that investment in board gender diversity is likely to generate consistent value benefits independent of the disclosure strategy pursued, while increases in board size or member expertise should be accompanied by careful attention to their interaction with existing ESG initiatives, particularly for firms that already occupy the upper end of the market valuation distribution. For investors and analysts operating in the Saudi market, the results caution against assuming a uniform positive market reward for ESG disclosure and instead point to the importance of jointly assessing disclosure intensity and board composition when valuing sustainability-oriented Tadawul-listed firms. For the Capital Market Authority and Tadawul, the findings support disclosure frameworks paired with governance quality requirements, such as minimum female board representation and defined expertise criteria, rather than disclosure quantity requirements alone.

6.4 Limitations and Future Research

This study is subject to several limitations that suggest avenues for future research. First, although the sample is sectorally diverse within the Saudi market, it is limited to 413 firm-year observations over the 2018–2024 period; replication with a larger sample of Tadawul-listed firms, a longer time span, or a cross-country GCC panel, would help establish the external validity of the results. Second, the ESG score used here is a composite measure; disaggregating the analysis into environmental, social, and governance sub-pillars could reveal whether the negative direct effect documented here is driven by a specific dimension of disclosure, since the constituent pillars have been shown elsewhere to carry opposite signs even when the composite score shows a single average effect. Third, while the study addresses dynamic endogeneity through system GMM, future work could explore mediating mechanisms, such as cost of capital, analyst coverage, or foreign investor participation, through which board characteristics translate ESG disclosure into firm value in the Saudi context.

Declarations

Ethical Approval

This article does not contain any studies with human participants performed by any of the authors.

Informed Consent

This article does not contain any studies with human participants performed by any of the authors.

Author Contribution

K.A. conceived and designed the study, collected and analyzed the data, performed the statistical modeling, interpreted the results, and wrote and revised the manuscript.

Acknowledgement

The authors extend their appreciation to the Deanship of Research and Graduate Studies at King Khalid University for funding this work through Large Group Project under grant number (RGP2/721/46)

Data Availability Statement

The dataset generated and analyzed during the current study, comprising 413 firm-year observations on non-financial companies listed on the Saudi Stock Exchange (Tadawul) over 2018–2024, was hand-collected by the author from publicly available sources: audited annual reports, corporate governance reports, and investor relations disclosures published by sample firms on the Tadawul website, together with Capital Market Authority (CMA) filings. No proprietary or subscription-based databases were used. The compiled dataset, the variable coding scheme, and the statistical code (Stata do-files) used to produce the descriptive statistics, diagnostic tests, and fixed-effects, quantile regression, and system GMM estimates reported in this manuscript are provided as a supplementary file accompanying this submission and will additionally be deposited in a public repository (e.g., Mendeley Data or OSF), with the access link to be provided, prior to publication.

References

1. Abu Khalaf B (2024) Impact of board characteristics on the adoption of sustainable reporting practices. Cogent Bus Manage 11(1):2391563. https://doi.org/10.1080/23311975.2024.2391563
2. Agarwala N, Jana S, Sahu TN (2024) ESG disclosures and corporate performance: A non-linear and disaggregated approach. J Clean Prod 437:140517. https://doi.org/10.1016/j.jclepro.2023.140517
3. Alkhawaja A, Hu F, Johl S, Nadarajah S (2023) Board gender diversity, quotas, and ESG disclosure: Global evidence. Int Rev Financial Anal 90:102823. https://doi.org/10.1016/j.irfa.2023.102823
4. Alodat AY, Hao Y (2025) Environmental, social and governance (ESG) disclosure and firm performance: Moderating role of board gender diversity and sustainability committee. Sustain Dev 33(1):636–651. https://doi.org/10.1002/sd.3126
5. Alomair A, Al Naim AS (2025) The influence of board, CEO, and audit committee chairman busyness on the value relevance of accounting information in Saudi listed firms. PLoS ONE 20(1):e0315886. https://doi.org/10.1371/journal.pone.0315886
6. Almulhim A, Metwally ABM (2025) ESG disclosure and firm performance: Do gender diversity and sustainability committee matter? Cogent Business Management 12(1):2545610
7. Arellano M, Bond S (1991) Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. Rev Econ Stud 58(2):277–297
8. Awad AB, Khalaf A, B., Afzal A (2023) The power of board size and gender diversity on the value of companies listed on emerging markets. Corporate Law Governance Review 5(2):128–139
9. Babiker I, Bakhit M, Bilal AOA, Abubakr AAM, Abdelraheem AAE (2025) The effect of female representation on boards on environmental, social, and governance disclosure: Empirical evidence from Saudi highly polluting industries. Sustainability 17(6):2751
10. Basali M (2025) Impact of financial performance and corporate governance on ESG disclosure: Evidence from Saudi Arabia. Sustainability 17(18):8473
11. Bani-Khaled S, Azevedo G, Oliveira J (2025) Environmental, social, and governance (ESG) factors and firm value: A systematic literature review of theories and empirical evidence. AMS Rev 15(1):228–260
12. Biju AVN, Geetha S, Prasad S, Sasidharan A, Jayachandran A (2025) ESG-firm performance nexus: Evidence from an emerging economy. Bus Strategy Environ 34(3):3469–3496. https://doi.org/10.1002/bse.4152
13. Blundell R, Bond S (1998) Initial conditions and moment restrictions in dynamic panel data models. J Econ 87(1):115–143
14. Conyon MJ, He L (2017) Firm performance and boardroom gender diversity: A quantile regression approach. J Bus Res 79:198–211. https://doi.org/10.1016/j.jbusres.2017.06.013
15. Firmansyah EA, Umar UH, Jibril RS (2023) Investigating the effect of ESG disclosure on firm performance: The case of Saudi Arabian listed firms. Cogent Economics Finance 11(2):2287923. https://doi.org/10.1080/23322039.2023.2287923
16. Freeman RE (1984) Strategic Management: A Stakeholder Approach. Pitman
17. Hambrick DC, Mason PA (1984) Upper echelons: The organization as a reflection of its top managers. Acad Manage Rev 9(2):193–206

18. Hamdouni A (2025) The impact of ESG disclosure on corporate performance: Empirical evidence from Saudi Arabia's listed heavy-polluting companies. Int J Innovative Res Sci Stud 8(3):1164–1174. https://doi.org/10.53894/ijirss.v8i3.6766
19. Hussain MA, Alsayegh MF, Boshnak HA (2024) The impact of environmental, social, and governance disclosure on the performance of Saudi Arabian companies: Evidence from the top 100 non-financial companies listed on Tadawul. Sustainability 16(17):7660. https://doi.org/10.3390/su16177660
20. Jensen MC, Meckling WH (1976) Theory of the firm: Managerial behavior, agency costs and ownership structure. J Financ Econ 3(4):305–360
21. Kanter RM (1977) Men and Women of the Corporation. Basic Books
22. Koenker R, Bassett G (1978) Regression quantiles. Econometrica 46(1):33–50
23. Lepore L, Nastari R, Pisano S, Pozzoli M (2025) Board gender diversity, ESG controversies and circular economy disclosure: An analysis on European listed companies. Corp Governance: Int J Bus Soc 25(8):156–176. https://doi.org/10.1108/CG-07-2024-0354
24. Liu W, Ren T (2025) Board gender diversity and ESG disclosure: The spillover effect of governance. *Asian Review of Accounting*, ahead-of-print. https://doi.org/10.1108/ARA-05-2024-0165
25. Luh PK, Asare N (2026) Gender diversity on corporate boards and sustainability disclosures: A quantile regression approach. Corp Governance: Int J Bus Soc 26(5):1079–1098. https://doi.org/10.1108/CG-08-2024-0417
26. Lusy, Ginting R, Hermanto YB (2025) ESG, corporate governance, and firm value in emerging markets. Jurnal Ilmiah Manajemen Kesatuan 13(6):5833–5846
27. Musa AMH, Alqubaysi R, Alqahtani HA (2025) The effect of board characteristics on ESG commitment in Saudi Arabia: How diversity, independence, size, and expertise shape corporate sustainability practices. Sustainability 17(12):5552. https://doi.org/10.3390/su17125552
28. Omenihu CM, Nwafor C (2025) Board structure and firm performance: The moderating role of national governance quality. Administrative Sci 15(8):314. https://doi.org/10.3390/admsci15080314
29. Pfeffer J, Salancik GR (1978) The External Control of Organizations: A Resource Dependence Perspective. Harper & Row
30. Spence M (1973) Job market signaling. Quart J Econ 87(3):355–374
31. Tawiah V, Matemane R, Oyewo B, Lemma TT (2024) Saving the environment with indigenous directors: Evidence from Africa. Bus Strategy Environ 33(3):2445–2461. https://doi.org/10.1002/bse.3603
32. Umar UH, Firmansyah EA, Danlami MR, Al-Faryan MAS (2024) Revisiting the relationship between corporate governance mechanisms and ESG disclosures in Saudi Arabia. J Acc Organizational Change 20:724–747
33. Veeravel V, Sadharma EKS, Kamaiah B (2024) Do ESG disclosures lead to superior firm performance? A method of moments panel quantile regression approach. Corp Soc Responsib Environ Manag 31(1):741–754. https://doi.org/10.1002/csr.2598
34. Velte P (2024) Sustainable board governance and environmental performance: European evidence. Bus Strategy Environ 33(4):3397–3421. https://doi.org/10.1002/bse.3654
35. Wasiuzzaman S, Abdul Wahab EA (2025) Board gender diversity and environmental, social and governance (ESG) disclosure: Assessing the moderating role of country-level accountability and governance. Pac Acc Rev 37(3):420–454. https://doi.org/10.1108/PAR-09-2024-0216
36. Yadav A, Asongu SA (2025) The role of ESG performance in moderating the impact of financial distress on company value: Evidence of wavelet-enhanced quantile regression with Indian companies. Bus Strategy Environ 34(3):2782–2798. https://doi.org/10.1002/bse.4118

Figures

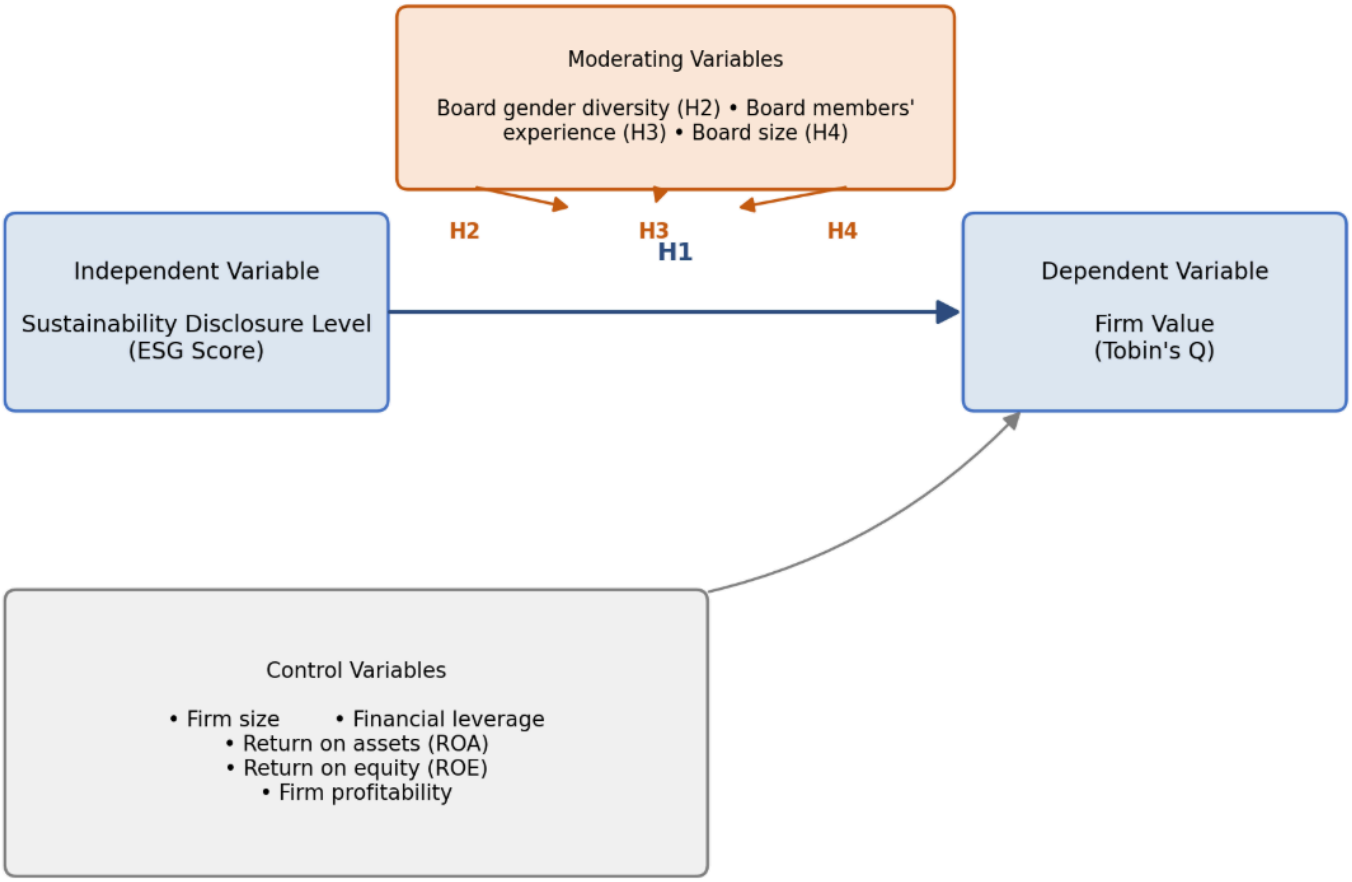


Figure 1

Conceptual Research Model.

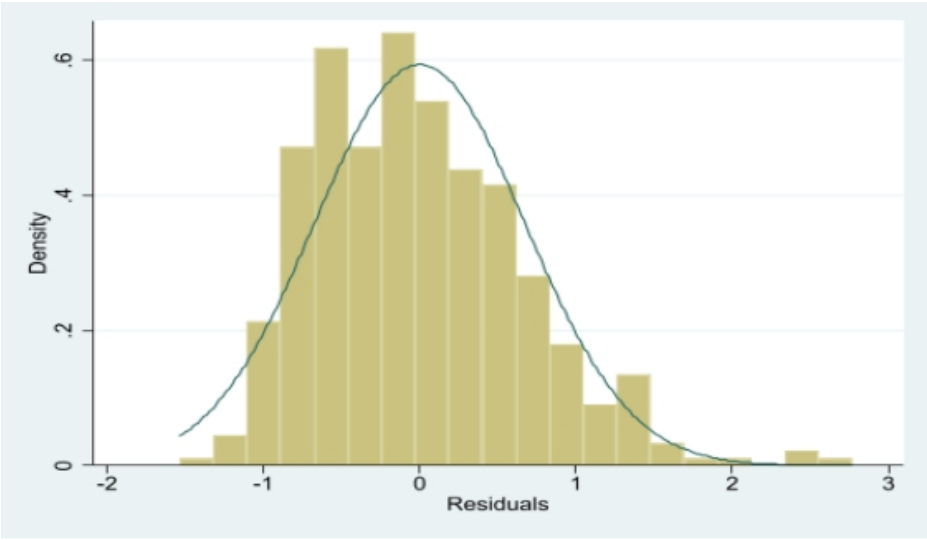


Figure 2

Histogram of Regression Residuals with Superimposed Normal Density.

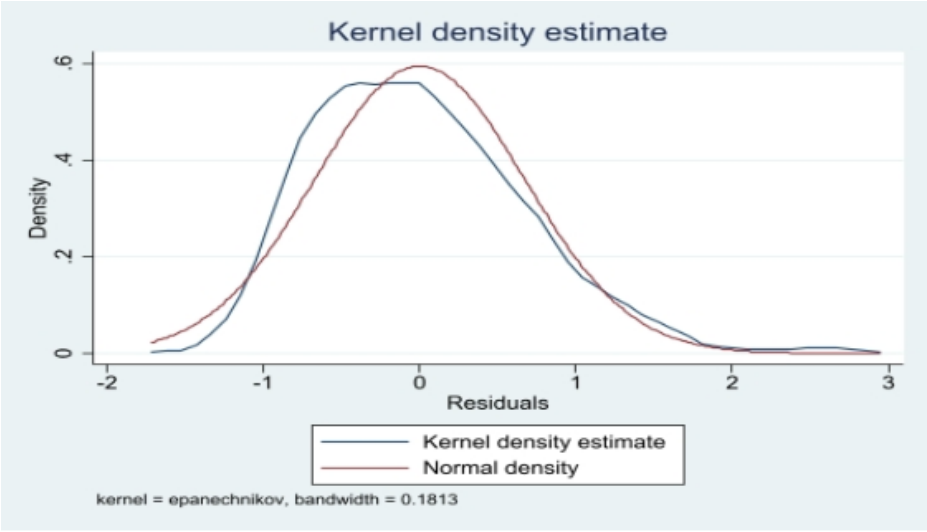


Figure 3

Kernel Density Plot of Regression Residuals.

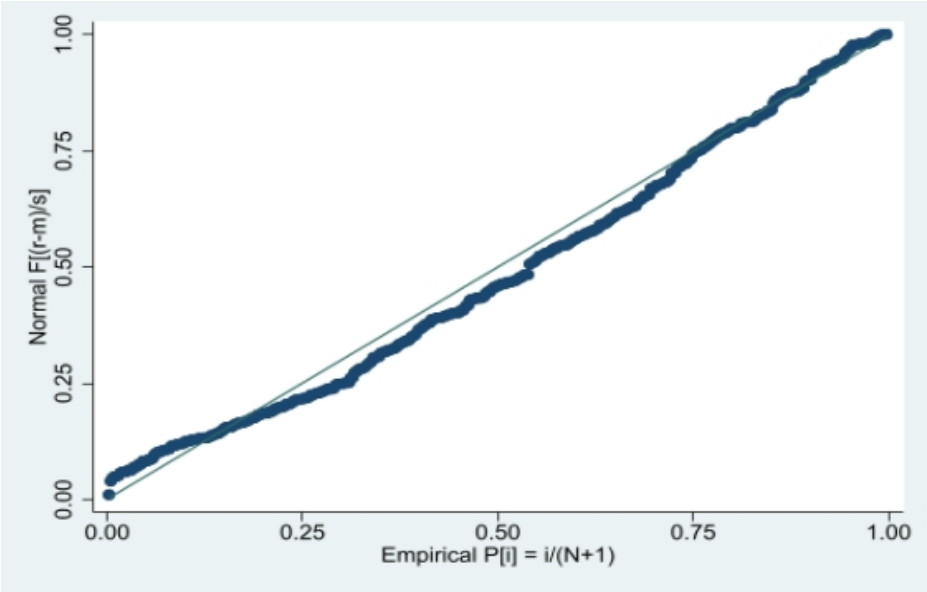


Figure 4

Normal (Q–Q) Plot of Regression Residuals.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- finaldata.xlsx