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The Nonlinear Value Relevance of ESG: Dynamic Panel Evidence from Asian Firms

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Abstract

This study examines the nonlinear relationship between environmental, social, and governance (ESG) performance and market capitalization, addressing the inconclusive evidence on the value relevance of ESG. Drawing on stakeholder theory, signaling theory, and the resource-based view, the analysis employs an unbalanced panel of 15,029 firm-year observations from non-financial listed firms across selected Asian economies during 2010–2024. Using a dynamic panel estimator, the results provide formal evidence of a U-shaped relationship between ESG performance and market capitalization. The squared ESG coefficient is positive and statistically significant, while the marginal association is significantly negative at the lower bound of the observed ESG range and significantly positive at the upper bound. The estimated turning point of approximately 33.94 lies within the observed range. The findings remain robust to an alternative instrument lag structure and to ESG performance lagged by one and two years. This study demonstrates that a constant linear specification may conceal substantially different valuation associations across ESG levels. The findings highlight the importance of ESG maturity, suggesting that ESG becomes more positively associated with market capitalization as firms develop more advanced and credible ESG practices.

JEL classification numbers: G14, G30, M14, Q56.
Keywords: ESG performance, Market capitalization, U-shaped relationship, System GMM, Firm value, Asian markets.

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1. Introduction

Capital markets may not value every incremental improvement in ESG performance equally. At low ESG levels, implementation costs and uncertainty about the credibility of sustainability initiatives may dominate their perceived benefits. At higher levels, more consistent ESG performance may convey stronger information about organizational quality, stakeholder management, and long-term risk. This possibility challenges the constant marginal effect assumed in conventional ESG valuation models.

Prior studies provide mixed evidence regarding the ESG–firm-value relationship. A substantial body of research suggests that ESG performance can enhance firm value by reducing information asymmetry, strengthening stakeholder relationships, improving risk management, and attracting long-term investors (Alareeni and Hamdan, 2020; Friede et al., 2015; Xie et al., 2019). Other studies, however, show that the valuation implications of ESG may differ between ESG strengths and concerns and may depend on disclosure quality, institutional settings, measurement choices, and empirical methods (Fatemi et al., 2018; Gillan et al., 2021). These inconsistent findings may reflect differences in institutional environments, ESG measures, valuation outcomes, and empirical specifications.

One possible explanation is that the relationship between ESG and firm value is nonlinear. Most conventional models assume that each incremental improvement in ESG performance produces a constant change in firm value. This assumption may be overly restrictive because ESG initiatives often require substantial investment in environmental management, stakeholder engagement, internal controls, and disclosure systems before their benefits become credible and visible to investors. At relatively low ESG levels, implementation costs and investor uncertainty may outweigh the observable benefits. As ESG practices become more substantive and strategically embedded, however, ESG performance may provide a more credible signal of organizational quality, stakeholder-management capability, and long-term resilience. Its marginal valuation effect may therefore become increasingly favorable.

Prior research provides support for this nonlinear perspective. Barnett and Salomon (2006) argue that the financial benefits of corporate social performance depend on firms' capacity to convert stakeholder relationships into economic value. Nollet et al. (2016) show that linear specifications may not adequately represent the relationship between corporate social performance and financial outcomes, while Trumpp and Guenther (2017) report U-shaped associations between dimensions of environmental and financial performance. More recently, Bagh et al. (2024) document nonlinear ESG–sustainable-growth dynamics among US and Chinese firms. Although these studies do not necessarily identify an identical functional form, they indicate that the financial consequences of sustainability performance may vary across ESG levels and institutional settings.

This issue is particularly relevant in Asian capital markets. Listed firms across the region operate under heterogeneous reporting standards, investor-protection regimes, market-development conditions, and sustainability institutions. These differences may influence both the credibility of ESG information and the extent to which investors incorporate it into market valuation. Nevertheless, relatively limited evidence examines whether the ESG–market-value relationship follows a U-shaped pattern across Asian markets while accounting for valuation persistence and potential endogeneity.

This study addresses this gap by examining the nonlinear association between ESG performance and market capitalization among non-financial listed firms in selected Asian economies from 2010 to 2024. Market capitalization captures investors' aggregate assessment of firms' future cash flows, growth prospects, and risk. Because firm valuation may persist over time, the analysis employs a dynamic panel framework estimated using two-step System GMM (Arellano and Bover, 1995; Blundell and Bond, 1998).

Using 15,029 firm-year observations, the results provide formal evidence of a U-shaped relationship between ESG performance and market capitalization. The coefficient on the squared ESG term is positive and statistically significant, and the estimated turning point of approximately 33.94 ESG points lies within the observed ESG range. In addition, the marginal association is significantly negative at the lower bound and significantly positive at the upper bound, supporting the presence of a U-shaped relationship rather than merely a positive quadratic coefficient. The result remains stable under an alternative instrument structure and when ESG performance is lagged by one and two years, indicating that the nonlinear association is not confined to the contemporaneous period.

This study makes three contributions. First, it extends the ESG value-relevance literature by showing that a single linear coefficient may conceal substantially different valuation associations across the ESG distribution. Second, it provides evidence of a turning-point mechanism: ESG is negatively associated with market capitalization at extremely low ESG levels, but its marginal association becomes positive as ESG performance increases. Third, the study provides dynamic panel evidence from a large cross-market sample of Asian firms, showing that the nonlinear association remains evident after accounting for the persistence of firm valuation.

The remainder of the paper is organized as follows. Section 2 reviews the relevant literature and develops the hypothesis. Section 3 describes the data, variables, empirical specification, and estimation method. Section 4 presents empirical results and robustness analyses. Section 5 discusses the findings and their implications. Section 6 concludes.

2. Literature Review and Hypothesis Development

2.1 ESG Performance and Capital-Market Valuation

Whether capital markets reward stronger environmental, social, and governance (ESG) performance remains an unresolved empirical question. From a value-creation perspective, ESG practices may improve firms' relationships with key stakeholders, strengthen risk-management systems, and increase the transparency of non-financial information. These benefits can reduce uncertainty regarding firms' long-term prospects and influence how investors assess future cash flows and risk. ESG performance may therefore be reflected in market capitalization when investors consider sustainability practices relevant to organizational quality and long-term competitiveness.

Much of the existing evidence supports a favorable association between sustainability performance and financial outcomes. Friede et al. (2015), synthesizing findings from more than 2,000 empirical studies, report that approximately 90% identify a non-negative relationship between ESG factors and corporate financial performance. Xie et al. (2019) find that ESG activities can generate financial benefits by improving corporate efficiency. Evidence from US firms also indicates that ESG disclosure is related to both accounting- and market-based performance, although the magnitude and direction of the results differ across individual ESG dimensions (Alareeni and Hamdan, 2020).

Nevertheless, stronger ESG performance does not necessarily translate immediately or uniformly into higher market value. Developing environmental systems, employee-related programs, governance controls, and sustainability-reporting capabilities require financial resources and managerial attention. These expenditures may be recognized before their strategic benefits become observable. Moreover, investors may discount ESG information when reporting is inconsistent or when sustainability activities appear symbolic rather than operationally embedded. Fatemi et al. (2018) demonstrate that ESG strengths and concerns can have different valuation implications, while Gillan et al. (2021) emphasize that the financial consequences of ESG depend on institutional settings, governance arrangements, measurement choices, and empirical methods.

These competing mechanisms help explain why prior studies report mixed findings. A positive average coefficient assumes that an incremental improvement in ESG has the same valuation implication for firms with weak, moderate, and advanced ESG practices. Such an assumption may overlook differences in the costs, credibility, and organizational maturity associated with different ESG levels. Market capitalization may respond weakly or negatively when ESG activities remain limited and fragmented but more favorably when they become sufficiently consistent to convey economically relevant information.

This issue is especially important in a cross-market Asian sample. Firms across Asian economies face heterogeneous sustainability-reporting requirements, investor-protection systems, market-development conditions, and enforcement mechanisms. These institutional differences can affect the credibility of ESG information and investors' ability to incorporate it into firm valuation. Consequently, the ESG–market-capitalization relationship may differ not only across institutional environments but also across the level of ESG performance achieved by individual firms.

2.2 The U-Shaped Relationship Between ESG and Market Capitalization

A nonlinear perspective provides a plausible explanation for the inconsistent valuation effects documented in previous research. At relatively low ESG levels, firms may incur the initial costs of sustainability programs without establishing the systems and organizational capabilities required to generate measurable benefits. Investors may also be unable to distinguish substantive ESG improvements from isolated disclosure or compliance activities. Under these conditions, an increase in ESG performance may be associated with additional costs and uncertainty rather than an immediate improvement in market valuation.

The balance between costs and benefits may change as ESG performance advances. More developed ESG practices can reflect established environmental controls, systematic stakeholder engagement, stronger internal oversight, and more credible disclosure. When these elements become integrated into corporate decision-making, ESG may provide investors with more reliable information about firms' capacity to manage long-term environmental, regulatory, and reputational risks. Accordingly, the marginal association between ESG and market capitalization may become progressively more favorable at higher ESG levels.

Stakeholder theory helps explain this change in valuation. Firms depend on relationships with employees, customers, suppliers, regulators, communities, and investors to maintain access to resources and sustain their operations (Freeman, 1984). Limited ESG engagement may be insufficient to generate stakeholder cooperation or reduce stakeholder-related conflict. By contrast, sustained ESG practices can improve trust, legitimacy, and organizational stability. Barnett and Salomon (2006) argue that the financial returns to corporate social performance depend on firms' ability to develop stakeholder influence capacity. This reasoning implies that stakeholder-related benefits may emerge only after sustainability practices attain sufficient depth and consistency.

Signaling theory provides a complementary capital-market explanation. Investors cannot directly observe all dimensions of managerial quality, organizational resilience, or long-term risk management. ESG performance may reduce this information gap by communicating firms' commitment to responsible and forward-looking management (Spence, 1973). However, weak ESG performance may offer little informational value because limited or fragmented initiatives are relatively easy to imitate and may reflect symbolic compliance. Stronger and more consistent ESG performance can constitute a more credible signal because it generally requires sustained investment, internal coordination, and organizational commitment. The valuation content of ESG may therefore increase as the signal becomes more difficult to reproduce through superficial actions.

The resource-based view further suggests that ESG creates value when sustainability practices develop into firm-specific capabilities (Barney, 1991). Environmental management systems, stakeholder-engagement processes, governance oversight, and sustainability-reporting routines require accumulated experience and organizational knowledge. At an early stage, these investments may primarily represent additional costs. Once they become embedded and mutually reinforcing, however, they may support risk management, operational adaptation, and long-term competitiveness. This development provides a theoretical basis for a relationship that initially declines but subsequently becomes positive.

Prior empirical findings are consistent with the broader possibility of such nonlinear effects. Barnett and Salomon (2006) document a curvilinear relationship between corporate social performance and financial performance. Nollet et al. (2016) show that nonlinear specifications can provide a more appropriate representation of the association between corporate social performance and financial outcomes than conventional linear models. Focusing on environmental performance, Trumpp and Guenther (2017) identify U-shaped relationships in which initial environmental improvements impose costs, whereas stronger performance is associated with more favorable financial outcomes.

More recent evidence also indicates that ESG effects vary across performance levels. Bagh et al. (2024) document nonlinear ESG–firm-value dynamics among firms in the United States and China. Their findings support the relevance of nonlinear modelling but should not be interpreted as establishing a universally identical functional form. The estimated shape may depend on the selected valuation measure, ESG indicator, institutional context, sample composition, and econometric specification. The present study therefore evaluates the U-shaped relationship directly rather than inferring it solely from the statistical significance of a squared ESG term.

Taken together, the theoretical mechanisms and empirical evidence suggest two distinct valuation regions. At relatively low ESG levels, implementation costs and uncertainty regarding the credibility of ESG activities may dominate their perceived benefits, resulting in a negative marginal association with market capitalization. As ESG practices become more advanced and organizationally embedded, stakeholder, signaling, and capability-related benefits may become sufficiently strong to reverse this association. The proposed hypothesis is therefore:

Hypothesis 1: *ESG performance has a U-shaped relationship with market capitalization: its marginal association with market capitalization is negative at relatively low ESG levels and becomes positive as ESG performance increases.*

3. Methodology

3.1 Data and Sample

Firm-level ESG scores, market capitalization, and financial statement data were obtained from Refinitiv Worldscope. Monetary firm-level measures used in level form were standardized to millions of US dollars using the corresponding fiscal-year-end exchange rates, where applicable. After excluding financial firms, observations with missing data for the required variables, and firms with insufficient consecutive observations for the dynamic panel specification, the final sample comprises 15,029 firm-year observations across 10 Asian economies.

Table 1: Sample distribution

Market	Emerging Markets	Advanced Markets	Total
China	5,117	0	5,117
Hong Kong	0	2,267	2,267
India	1,505	0	1,505
Indonesia	213	0	213
Korea, Republic (South Korea)	0	1,486	1,486
Malaysia	1,802	0	1,802
Singapore	0	533	533
Taiwan	0	1,264	1,264
Thailand	665	0	665
Philippines	177	0	177
Total	*9,479*	*5,550*	*15,029*

Notes: Market classification is based on MAR, where MAR = 1 denotes advanced markets and MAR = 0 denotes emerging markets. The table reports observations included in the main U-shape System GMM estimation sample.

3.2 Variable Definitions

The dependent variable is market capitalization (*MCA*), measured as the fiscal-year-end market value of a firm's outstanding common shares in millions of US dollars. Market capitalization represents the closing share price multiplied by the number of common shares outstanding. This market-based measure captures investors' aggregate assessment of a firm's expected future cash flows, growth prospects, and risk exposure. To account for the persistence of firm valuation over time, the model includes one-period lagged market capitalization, $MCA_{i,t-1}$, to capture dynamic adjustment.

The principal explanatory variable is the firm-level ESG score. To estimate the nonlinear specification and reduce nonessential multicollinearity between the linear and quadratic terms, *ESG* is mean-centered as follows:

$$C\_ESG_{it} = ESG_{it} - \overline{ESG}$$

where $\overline{ESG}$ denotes the mean ESG score of the sample used to construct the centered variable. The quadratic term is subsequently constructed as:

$$C\_ESG^2{}_{it} = (C\_ESG_{it})^2$$

Mean-centering does not alter the estimated curvature, fitted values, or overall model fit. It reduces the nonessential correlation between the linear and quadratic ESG terms and facilitates coefficient interpretation.

The models include firm-level and institutional controls. IFRS reporting status (*IFRS*) is included to capture differences in financial reporting environments and disclosure transparency. Market classification (*MAR*) is included as a dummy variable to distinguish advanced markets from emerging markets. Leverage (*LEV*) is measured as a firm's debt-related financing position, while capital intensity (*CAP*) captures the extent to which firms rely on capital assets. Firm growth (*GRO*) controls growth opportunities, and firm size (*SIZ*) is included as a winsorized measure of firm scale. Continuous variables are winsorized at the 1st and 99th percentiles to limit the influence of extreme observations. Year dummies control for common macroeconomic and market shocks, while TRBC industry dummies account for systematic differences across industries.

3.3 Empirical Specification

The baseline linear model is specified as:

$$MCA_{it} = \alpha + \rho MCA_{i,t-1} + \beta_1 C\_ESG_{it} + \gamma X_{it} + \lambda_t + \delta_j + \varepsilon_{it}$$

where (MCA_{it}) is market capitalization, ($MCA_{i,t-1}$) is lagged market capitalization, (C_ESG_{it}) is the centered ESG variable, (X_{it}) is the vector of control variables, (λ_t) denotes year effects, and (δ_j) denotes industry effects. The main nonlinear model is specified as:

$$MCA_{it} = \alpha + \rho MCA_{i,t-1} + \beta_1 C\_ESG_{it} + \beta_2 C\_ESG^2_{it} + \gamma X_{it} + \lambda_t + \delta_j + \varepsilon_{it}$$

Because ESG is mean-centered, its conditional marginal association with market capitalization is:

$$\frac{\partial MCA_{it}}{\partial ESG_{it}} = \beta_1 + 2\beta_2 C\_ESG_{it}$$

The turning point on the original ESG scale is calculated as:

$$ESG^* = \overline{ESG} - \frac{\beta_1}{2\beta_2}$$

A positive and significant β_2 is suggestive of convexity but is insufficient by itself to confirm a U-shaped relationship. Formal confirmation additionally requires the turning point to lie within the observed ESG range and the marginal effects at the lower and upper bounds to be significantly negative and positive, respectively (Lind and Mehlum, 2010).

3.4 Estimation Method

The models are estimated using two-step System GMM with Windmeijer-corrected robust standard errors (Arellano and Bover, 1995; Blundell and Bond, 1998; Windmeijer, 2005). This estimator is appropriate for dynamic specifications because the model includes lagged market capitalization. Lagged market capitalization and leverage are treated as endogenous, whereas ESG, its squared term, and the remaining control variables are treated as exogenous. The instrument set is restricted to avoid excessive instrument proliferation. Model validity is assessed using the Arellano–Bond AR (2) test and the Hansen test of overidentifying restrictions.

4. Empirical Results

4.1 Descriptive Statistics and Correlation Analysis

Table 2: Descriptive statistics based on the main estimation sample

Variable	N	Mean	SD	Min	P25	Median	P75
MCA	15,029	123.566	181.110	3.008	25.763	58.799	141.574
ESG	15,029	44.984	19.615	0.188	29.530	44.817	59.811
C_ESG	15,029	0.318	19.615	-44.479	-15.137	0.151	15.145
C_ESG^2	15,029	384.837	421.911	0.000	58.078	229.275	578.258
IFRS	15,029	0.375	0.484	0.000	0.000	0.000	1.000
MAR	15,029	0.369	0.483	0.000	0.000	0.000	1.000
LEV	15,029	0.247	0.182	0.000	0.092	0.228	0.368
CAP	15,029	0.041	0.044	0.000	0.008	0.028	0.059
GRO	15,029	0.097	0.326	-0.576	-0.054	0.054	0.186
SIZ	15,029	22.320	1.865	16.144	21.193	22.309	23.535

Notes: MCA denotes winsorized market capitalization. ESG was centered using the mean of the sample available when the centered variable was constructed. Table 2 is based on the more restricted main estimation sample; therefore, the mean of C_ESG is not exactly zero. C_ESG² is the squared mean-centered ESG term. IFRS is a dummy variable equal to 1 for firms reporting under IFRS and 0 otherwise. MAR is a dummy variable equal to 1 for firms in advanced markets and 0 for firms in emerging markets. LEV represents leverage. CAP represents capital intensity. GRO represents firm growth. SIZ is the winsorized measure of firm size.

Table 2 presents descriptive statistics for the 15,029 firm-year observations used in the main System GMM estimation. Using a common estimation sample ensures consistency across the descriptive analysis, correlation matrix, and baseline regressions. Market capitalization (MCA) also displays substantial dispersion, supporting the use of a dynamic specification that accounts for persistent differences in firm valuation. ESG has a mean of 44.984 and a median of 44.817, with values ranging from 0.188 to 92.847. The centered ESG squared variable has a mean of 384.837. The wide ESG range provides a suitable setting for testing whether ESG has a nonlinear relationship with market capitalization.

Table 3: Correlation matrix based on the main estimation sample

	MCA	*C_ESG*	*C_ESG*^{2}	*IFRS*	*MAR*	*LEV*	*CAP*	*GRO*	*SIZ*
MCA	1								
C_ESG	-0.088***	1							
C_ESG^2	0.020*	0.078***	1						
IFRS	-0.126***	0.154***	0.143***	1					
MAR	-0.187***	0.160***	0.124***	0.519***	1				
LEV	-0.288***	0.029***	-0.036***	-0.066***	-0.020*	1			
CAP	0.191***	-0.006	0.026**	-0.001	-0.015	0.076***	1		
GRO	0.135***	-0.046***	-0.001	-0.046***	-0.015	-0.015	0.066***	1	
SIZ	-0.397***	0.328***	0.075***	-0.104***	0.217***	0.185***	-0.146***	-0.016*	1

Notes: MCA denotes winsorized market capitalization; C_ESG is the mean-centered ESG score; C_ESG² is the squared mean-centered ESG term; IFRS is a dummy variable equal to 1 for firms reporting under IFRS and 0 otherwise; MAR is a dummy variable equal to 1 for firms in advanced markets and 0 for firms in emerging markets; LEV represents leverage; CAP represents capital intensity; GRO represents firm growth; and SIZ is the winsorized measure of firm size. *, ** and *** indicate significance at the 5%, 1% and 0.1% levels, respectively.

Table 3 reports pairwise correlations. Market capitalization is negatively correlated with centered ESG but positively correlated with its squared term. This pattern is only preliminary and cannot establish a U-shaped relationship because bivariate correlations do not account for valuation persistence, observed covariates, unobserved firm heterogeneity, or endogeneity. The correlation between C_ESG and C_ESG^2 is 0.078, indicating that mean-centering limits mechanical collinearity between the linear and quadratic terms. Formal evaluation of Hypothesis 1, therefore, relies on the multivariate estimates and the boundary-slope test reported below.

4.2 Regression Results

4.2.1 Baseline Linear ESG Model

Table 4: Dynamic Panel Estimates of the ESG–Market Capitalization Association

Variables	Model 1 Linear ESG	Model 2 Nonlinear ESG	Model 3 Robust lag 4–5
L.MCA	0.7127 (13.92)***	0.7145 (13.97)***	0.9327 (11.69)***
C_ESG	0.2351 (3.26)***	0.2272 (3.19)***	0.0775 (1.00)
C_ESG^2	—	0.0106 (3.96)***	0.0087 (3.67)***
IFRS	-17.3073 (-4.38)***	-18.4646 (-4.65)***	-3.8716 (-0.68)
MAR	-5.8484 (-2.44)**	-5.8122 (-2.47)**	-1.1124 (-0.46)
LEV	-62.0093 (-2.40)**	-62.5656 (-2.42)**	29.4639 (0.77)
CAP	-42.7503 (-1.04)	-43.2786 (-1.05)	-197.5276 (-3.12)***
GRO	-3.9179 (-0.83)	-4.0469 (-0.86)	-15.4008 (-2.58)***
SIZ	-11.6107 (-6.11)***	-11.8103 (-6.17)***	-5.6715 (-2.09)**
N	15,029	15,029	15,029
Number of groups	2,870	2,870	2,870
Number of instruments	38	39	39
AR (2) p-value	0.606	0.600	0.417
Hansen p-value	0.745	0.721	0.832
Sargan p-value	0.397	0.397	0.295
p-value: ESG squared		0.000	0.000
Turning point of ESG		33.9402	40.2285

Notes: MCA denotes winsorized market capitalization; ESG is the original environmental, social, and governance score; C_ESG is the mean-centered ESG score; C_ESG^2 is the squared mean-centered ESG term; IFRS is a dummy variable equal to 1 for firms reporting under IFRS and 0 otherwise; MAR is a dummy variable equal to 1 for firms in advanced markets and 0 for firms in emerging markets; LEV represents leverage; CAP represents capital intensity; GRO represents firm growth; and SIZ is the winsorized measure of firm size. t-statistics are reported in parentheses. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively. All models include year and TRBC industry effects.

Model (1) presents the baseline linear ESG specification (Table 4). The coefficient on C_ESG is positive and statistically significant at the 1% level ($\beta = 0.2351$, $t = 3.26$), indicating that higher ESG performance is associated with greater market capitalization after controlling valuation persistence, financial characteristics, market classification, year effects, and industry effects. This estimate provides a useful benchmark, but it imposes a constant marginal association and therefore does not test Hypothesis 1.

The coefficient on lagged market capitalization (L.MCA) is positive and highly significant ($\beta = 0.7127$, $t = 13.92$), demonstrating substantial persistence in firm valuation and supporting the use of a dynamic panel specification. Among the control variables, IFRS reporting status, market classification, leverage, and firm size have negative and statistically significant

coefficients. By contrast, the coefficients on capital intensity and firm growth are not statistically significant in Model (1). These control-variable estimates are conditional associations and are not central to the hypothesis test.
The specification diagnostics are satisfactory. The AR (2) test does not reject the null of no second-order serial correlation ($p = 0.606$), and the Hansen test does not reject the joint validity of the instruments ($p = 0.745$). The Sargan statistic is also insignificant ($p = 0.397$), although inference should primarily emphasize the Hansen statistic because the reported estimation uses robust two-step standard errors. These diagnostics support the adequacy of the instrument set; they do not, by themselves, establish the substantive ESG relationship.

4.2.2 Baseline Nonlinear ESG Model

Model (2) introduces the squared centered ESG term. The coefficient on C_ESG^2 is positive and statistically significant ($\beta = 0.0106$, $t = 3.96$), showing that the marginal association between ESG and market capitalization becomes more positive as ESG performance increases. The coefficient on C_ESG is also positive and significant ($\beta = 0.2272$, $t = 3.19$). Because ESG is mean-centered, this linear coefficient represents the estimated slope at the centering value rather than at an ESG score of zero. It should therefore not be interpreted as contradicting a negative slope at the lower end of the observed ESG range.
A positive quadratic coefficient alone is insufficient to demonstrate a U-shaped relationship. The implied turning point is 33.9402 on the original ESG scale, which lies within the observed range of 0.1876–92.8473. The formal boundary-slope results in Table 6 provide decisive evidence: the estimated slope is negative and significant at the minimum ESG value (−0.7149) and positive and significant at the maximum value (1.2477). The linear and quadratic terms are also jointly significant ($p = 0.000$). Together, these results satisfy the formal conditions for a U-shaped relationship (Lind and Mehlum, 2010). Hypothesis 1 is therefore supported.
The remaining estimates are broadly consistent with Model (1). Lagged market capitalization remains positive and highly significant, while IFRS reporting status, advanced-market classification, leverage, and firm size are negatively associated with market capitalization. Capital intensity and firm growth remain statistically insignificant. The nonlinear specification passes the main diagnostic checks: AR (2) $p = 0.600$ and Hansen $p = 0.721$. Accordingly, neither second-order serial correlation nor invalid overidentifying restrictions are detected at conventional significance levels.

4.2.3 Robustness: Alternative Instrument-Lag Structure

Model (3) evaluates the sensitivity of the main nonlinear result to the choice of GMM-style instruments (Table 4). In this specification, lags 4–5 of market capitalization and leverage are used as instruments, replacing the lag 2–3 structure adopted in Model (2). Despite this modification, the squared ESG term retains its positive sign and statistical significance, indicating that the estimated nonlinear association is not dependent on the original lag selection. The post-estimation tests also provide no indication that the alternative instrument structure compromises model validity. In particular, the insignificant AR (2) statistic shows no evidence of second-order serial correlation, while the high Hansen p-value suggests that the instrument-validity condition continues to be satisfied. The central nonlinear finding therefore remains stable under a more distant set of instrument lags.
Nevertheless, the estimated coefficient on lagged market capitalization increases under this specification, implying greater valuation persistence than in the main model. Given this change in the dynamic coefficient, Model (2), which uses lags 2–3, is retained as the preferred specification. Model (3) serves as a sensitivity analysis confirming that the nonlinear ESG result is robust to a reasonable alternative treatment of the instrument lag structure.

4.2.4 Temporal Robustness: Nonlinear Effects of Lagged ESG

Models (4) and (5) shift the analysis from contemporaneous ESG performance to its one- and two-year lagged values (Table 5). This approach assesses whether ESG continues to be associated with market valuation beyond the period in which the underlying performance is observed.

Table 5: Dynamic GMM Estimates of the Nonlinear Association Using Lagged ESG

Variables	Model 4 Lag1 ESG	Model 5 Lag2 ESG
L.MCA	0.7120 (14.27)***	0.6754 (12.83)***
L.C_ESG	0.1921 (2.97)***	—
L.C_ESG²	0.0082 (3.43)***	—
L2.C_ESG	—	0.2614 (4.02)***
L2.C_ESG²	—	0.0082 (3.24)***
IFRS	-14.6235 (-4.15)***	-11.2559 (-3.52)***
MAR	-9.0877 (-3.89)***	-12.4745 (-4.39)***
LEV	-79.0482 (-3.04)***	-53.5904 (-2.17)**
CAP	-66.6755 (-1.67)*	-47.8672 (-1.17)
GRO	-1.5228 (-0.33)	0.9309 (0.23)
SIZ	-10.2432 (-5.31)***	-9.8472 (-5.21)***
N	13,829	11,794
Number of groups	2,790	2,634
Number of instruments	39	39
AR(2) p-value	0.704	0.488
Hansen p-value	0.892	0.785
Sargan p-value	0.358	0.172
p-value: ESG squared	0.001	0.001
Turning point of ESG	32.2850	27.2426

Notes: MCA denotes winsorized market capitalization; ESG is the original environmental, social, and governance score; C_ESG is the mean-centered ESG score; C_ESG² is the squared mean-centered ESG term; IFRS is a dummy variable equal to 1 for firms reporting under IFRS and 0 otherwise; MAR is a dummy variable equal to 1 for firms in advanced markets and 0 for firms in emerging markets; LEV represents leverage; CAP represents capital intensity; GRO represents firm growth; and SIZ is the winsorized measure of firm size. t-statistics are reported in parentheses. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively. All models include year and TRBC industry effects.

The one-year lag specification in Model (4) provides strong evidence of temporal persistence. Both L.C_ESG ($\beta = 0.1921$, $t = 2.97$) and L.C_ESG² ($\beta = 0.0082$, $t = 3.43$) are positive and statistically significant at the 1% level. The implied turning point is 32.2850 on the original ESG scale. Thus, the nonlinear valuation pattern remains observable when ESG performance precedes market capitalization by one year.

Extending the lag to two years produces a consistent pattern. In Model (5), L2.C_ESG has a positive and significant coefficient ($\beta = 0.2614$, $t = 4.02$), and its squared term is likewise positive and significant ($\beta = 0.0082$, $t = 3.24$). The corresponding turning point is 27.2426 on the original ESG scale. The preservation of the signs and significance of both ESG terms across the two lag structures demonstrates that the main nonlinear result is not confined to the contemporaneous specification.

The remaining estimates are broadly consistent across Models (4) and (5). L.MCA continues to exhibit a positive and highly significant coefficient, reflecting substantial persistence in firm valuation. IFRS reporting status, market classification, leverage, and firm size are negatively and significantly associated with market capitalization in both models. Capital intensity is only weakly significant in the one-year lag specification, whereas firm growth shows no statistically significant association in either model.

Model validity is supported by post-estimation diagnostics. The AR (2) p-values of 0.704 and 0.488 indicate no evidence of second-order serial correlation in Models (4) and (5), respectively. Instrument validity is also supported by the Hansen p-values of 0.892 and 0.785 (Roodman, 2009) and the corresponding Sargan p-values of 0.358 and 0.172. Although introducing additional lags reduces the usable sample from 13,829 observations in Model (4) to 11,794 in Model (5), the nonlinear ESG terms remain statistically significant. The number of instruments ranges from 38 to 39 across the reported specifications and remains substantially below the corresponding number of firms, which ranges from 2,634 to 2,870. The instrument matrix collapses, and the lag ranges are restricted to limit instrument proliferation. Although the Hansen p-values are relatively high in some specifications, the small instrument counts relative to the number of firms substantially reduces concerns that the Hansen test is weakened by excessive instruments.

Taken together, these results suggest that the estimated nonlinear association persists over time rather than being absorbed entirely in the current period. The persistence of the nonlinear pattern for up to two years is consistent with ESG performance functioning as a longer-term strategic and intangible resource whose market implications may materialize gradually.

4.2.5 Formal Confirmation of the U-shaped Relationship

Table 6: Formal U-Shape Test for the ESG–Market Capitalization Relationship

Test/statistic	Estimate	Test statistic	p-value	Result
ESG²	0.0106	3.96	0.000	Positive, convex
Joint test of ESG and ESG²	—	12.30	0.000	Significant
Estimated turning point	33.9402	—	—	Interior
Observed ESG range	0.1876–92.8473	—	—	TP within range
Slope at minimum ESG	−0.7149***	−2.92	0.004	Negative
Slope at maximum ESG	1.2477***	4.61	0.000	Positive
Slope at ESG p25	−0.0934	-0.89	0.374	Insignificant
Slope at ESG median	0.2304***	3.23	0.001	Positive
Slope at ESG p75	0.5480***	4.95	0.000	Positive
Overall U-shape test	**Supported**	—	—	**U-shape confirmed**

Notes: The test is based on the main nonlinear System GMM specification. The turning point is reported on the original ESG scale. Evidence of a U-shaped relationship requires a significantly negative slope at the lower bound, a significantly positive slope at the upper bound, and a turning point within the observed ESG range. All three conditions are satisfied. The reported slope p-values are two-sided. p25, median, and p75 denote the corresponding percentiles of the ESG distribution. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table 6 provides formal evidence supporting the U-shaped relationship proposed in Hypothesis 1. The coefficient on the quadratic ESG term is positive and statistically significant (β=0.0106, t=3.96, p=0.000), indicating that the estimated relationship is convex. The linear and quadratic ESG terms are also jointly significant (test statistic =12.30, p=0.000).

More importantly, the boundary-slope conditions are satisfied. The marginal slope at the minimum observed ESG value is negative and statistically significant (−0.7149, t=−2.92, p=0.004), whereas the slope at the maximum ESG value is positive and statistically significant (1.2477, t=4.61, p=0.000). The estimated turning point is 33.9402 and lies within the observed ESG range of 0.1876–92.8473. Taken together, the positive quadratic coefficient, the oppositely signed significant boundary slopes, and the interior turning point support the presence of a U-shaped ESG–market capitalization relationship.

The percentile-specific slopes further show how the marginal association changes across the ESG distribution. At the 25th percentile, the slope is negative but statistically insignificant (−0.0934, t=−0.89, p=0.374). At the median, it becomes positive and significant (0.2304, t=3.23, p=0.001), and it increases further at the 75th percentile (0.5480, t=4.95, p=0.000). These results indicate a gradual change in the marginal association rather than an immediate statistically significant effect directly above the turning point. Accordingly, 33.9402 should be interpreted as the estimated minimum of the fitted quadratic relationship, rather than as a universal ESG threshold or target.

5. Discussion

The principal finding is that the association between ESG performance and market capitalization is U-shaped. This conclusion rests on the full formal test rather than on the squared term alone: the turning point lies inside the observed ESG range, and the estimated marginal association changes from significantly negative at the lower bound to significantly positive at the upper bound (Lind and Mehlum, 2010). The result supports Hypothesis 1 and shows why a single linear coefficient can obscure materially different valuation patterns across firms with low and high ESG performance.

The downward-sloping portion of the curve indicates that ESG improvements made from an extremely weak starting position may not receive an immediate valuation premium. Early initiatives can require expenditures on environmental controls, employee programs, governance systems, data collection, and disclosure before their benefits become observable. When these activities are fragmented or mainly compliance-oriented, investors may remain uncertain about their strategic substance. Importantly, the insignificant slope at the 25th percentile shows that the negative association identified at the minimum should not be generalized to all firms below the turning point. The evidence instead suggests a transition from a significantly negative association at the extreme lower bound to a statistically indistinguishable association around the lower quartile.

Beyond the turning point, the marginal association becomes positive and strengthens across the ESG distribution. The positive slopes at the median and the 75th percentile are consistent with the view that more developed ESG practices convey greater economic relevance. At these levels, environmental management, stakeholder engagement, governance oversight, and disclosure may be more coherent and embedded in organizational routines. Investors may consequently view ESG as more informative about long-term risk management, organizational quality, and resilience. The turning point of 33.94 is an estimated feature of this sample and model, however, and should not be treated as a universal ESG target or a structural threshold applicable to every firm or market.

Stakeholder theory helps explain this changing association. Firms depend on employees, customers, suppliers, regulators, communities, and investors for resources and legitimacy (Freeman, 1984). Limited ESG engagement may be insufficient to generate trust or reduce stakeholder conflict. As ESG practices become more consistent, firms may develop the stakeholder influence capacity needed to translate social and environmental engagement into economic benefits (Barnett and Salomon, 2006). The upward-sloping segment is therefore consistent with stakeholder benefits becoming more visible after ESG practices acquire greater depth and continuity.

Signaling theory offers a complementary capital-market explanation. ESG information can reduce uncertainty about managerial quality, risk-management capacity, and long-term strategic orientation (Connelly et al., 2011; Spence, 1973). Weak or isolated ESG actions are relatively easy to imitate and may be interpreted as symbolic compliance. Sustained ESG performance generally requires greater investment and internal coordination, making the signal more credible. This interpretation is consistent with the progressively larger positive slope observed from the median to the upper quartile.

The resource-based view further suggests that ESG becomes value-relevant when it develops into an organizational capability rather than remaining a reporting exercise (Barney, 1991). Environmental systems, stakeholder processes, oversight governance, and sustainability disclosure require accumulated knowledge and coordination. At an early stage, these investments may mainly represent costs. Once embedded and mutually reinforcing, they can support adaptation, risk control, and long-term competitiveness. The U-shaped pattern is therefore compatible with a shift from a cost-dominant stage to a capability- and credibility-dominant stage.

The findings align with research showing that sustainability–performance relationships may be nonlinear (Barnett and Salomon, 2006; Nollet et al., 2016; Trumpp and Guenther, 2017). They also complement more recent evidence that ESG effects vary across performance levels and empirical contexts (Bagh et al., 2024; Pu, 2023). The present study adds to this literature by examining market capitalization in a dynamic, cross-market Asian panel and by formally evaluating the boundary slopes. Because the direction and shape reported in earlier studies differ across outcomes and samples, the current result should be interpreted as context-specific evidence rather than as proof of a universal ESG curve.

The lagged specifications add a temporal robustness dimension. Positive nonlinear curvature remains significant when ESG is lagged by one and two years, suggesting that the association is not limited to contemporaneous ESG performance. This pattern is compatible with the gradual development of stakeholder trust, disclosure credibility, and organizational capabilities. Nevertheless, the lagged results do not identify a fixed causal transmission period, and formal U-shape tests would be required before claiming that each lagged model independently satisfies all U-shape conditions.

Overall, the evidence helps reconcile mixed findings in the ESG–firm-value literature. Linear models summarize the relationship with one average coefficient, whereas the present results distinguish an adverse association at the extreme lower bound, a statistically neutral region around the lower quartile, and increasingly positive associations at moderate and high ESG levels. The central implication is not that ESG automatically increases market value, but that its valuation relevance depends on the level, consistency, and credibility of firms' ESG performance.

6. Conclusion

This study shows that the association between ESG performance and market capitalization cannot be represented adequately by a constant linear coefficient. Using 15,029 firm-year observations from non-financial listed firms in selected Asian economies during 2010–2024 and a two-step System GMM framework, the analysis identifies a U-shaped relationship. The estimated turning point is 33.9402 on the original ESG scale and lies within the observed data range. More importantly, the marginal association is significantly negative at the lower bound and significantly positive at the upper bound. These results formally support Hypothesis 1.

The marginal-slope estimates illustrate how the association changes across selected points of the ESG distribution. At the extreme lower end of ESG performance, additional ESG engagement is negatively associated with market capitalization. Around the lower quartile, the estimated slope is no longer statistically different from zero. At the median and upper quartile, the association is positive and becomes progressively stronger. This pattern is consistent with initial implementation costs and weak signal credibility giving way to stakeholder, signaling, and capability-related benefits as ESG practices become more developed and organizationally embedded.

The study contributes in three ways. First, it demonstrates that a linear average can conceal changes in both the direction and magnitude of ESG value relevance. Second, it validates the U-shaped pattern through an interior turning point and significant slopes of opposite signs at the observed boundaries, rather than inferring the shape solely from a positive quadratic coefficient. Third, the persistence of positive nonlinear curvature under an alternative instrument structure and with one- and two-year lagged ESG measures shows that the main pattern is not confined to a single instrument choice or to contemporaneous ESG performance. The results also have practical implications. Managers should not assume that isolated ESG initiatives will generate an immediate valuation premium. Market recognition is more likely when ESG practices are coherent, credible, and integrated with governance, risk management, stakeholder relations, and long-term strategy. Investors should assess not only changes in ESG scores but also the organizational substance underlying those changes. The estimated turning point should remain a sample-specific statistical result rather than a universal managerial benchmark.

Several limitations qualify the conclusions. ESG scores may differ because of rating methodologies, disclosure availability, and measurement practices. System GMM addresses valuation persistence, time-invariant heterogeneity, and specified forms of endogeneity, but it does not establish definitive causality. Market capitalization is also only one valuation outcome. Future studies could examine Tobin's Q, market-to-book ratios, stock returns, or cost of capital; test whether the curve differs across industries and institutional settings; and formally compare turning points across market classifications, reporting regimes, and periods of economic stress.

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