

Impact of Environmental, Social, and Governance Scores on Stock Market Valuation: Panel Data Analysis of S&P 500 Firms

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ABSTRACT

Environmental, Social, and Governance (ESG) disclosure is increasingly becoming a mandatory component of the corporate governance framework. This study explores the relationship between ESG scores and stock market valuation using panel data of 333 S&P 500 firms. Data has been collected for the year 2015-2023 which are recorded annually. Market capitalisation is the dependent variable, analysed using fixed-effects panel regression with Driscoll-Kraay and two-way clustered standard errors. The overall ESG Score and its three sub-scores (Environmental, Social, and Governance) are estimated separately. The results show that the overall ESG Score is not reliably related to market valuation once year-to-year market-wide trends are accounted for, suggesting that its apparent relationship with valuation largely reflects the fact that both ESG scores and stock valuations rose together over the sample period, rather than a genuine firm-level effect. When the three pillars are examined separately, a more informative pattern appears: the Environmental score is associated with lower market valuation and the Social score with higher market valuation, a pattern that holds under two different measures of firm value. The Governance score is positively related to market capitalisation but not to Tobin's Q, suggesting this result may partly reflect firm size rather than governance quality on its own. These findings suggest that combining ESG performance into a single composite score can conceal differences between its underlying components, with implications for how ESG data is reported and used in investment decisions.

Keywords: ESG performance; stock market valuation; S&P 500; panel data; Driscoll-Kraay estimator; sustainability.

INTRODUCTION

ESG (Environmental, Social, Governance) is now a fundamental factor in risk and management in today's financial world. This information about ESG is used by modern financial markets to forecast the health of a company and driven by shifts in public opinion, companies are now encouraged to reveal and enhance their ESG compliance. The ESG ratings are constructed based on evaluation by independent rating

providers which includes popular organisations like S&P 500 Capital IQ Pro, Morgan Stanley Capital International etc. Similar to credit rating scores, the ESG ratings can influence investment behavior of both retail and institutional investors. As a result, companies are investing in the necessary business verticals to improve their sustainability performance. Given the nature of the changing landscape of ESG governance framework, the returns on these investments are still uncertain. This is especially evident in the S&P 500 index, where the “short-term” demands of stock performance and “long-term” requirements for ESG improvements can be incongruent with each other.

Today, large financial institutions are treating sustainability as a major concern, directing trillions of dollars into sustainability funds and integrating ESG score tracking into the stock-buying and selling process. As of the end of December 2025, the total value of sustainable funds under management (FUM) globally reached a new high of USD 4.13 trillion (Morgan Stanley Institute for Sustainable Investing, 2026). Earlier ESG was seen as a small segment of corporate responsibility, and was limited to ethical assessments of businesses. Increasingly, it is turning into a cornerstone of financial risk management, investor confidence, and company’s evaluation. Figure 1 shows that the percentage of S&P 500 companies reporting on sustainability has increased dramatically since 2011, when less than 20% of companies published sustainability reports, to almost 99% in 2024 (Governance & Accountability Institute, 2025). The positive ESG-valuation relationship is based on stakeholder theory and signaling theory, both of which suggest that sustainability efforts mitigate regulatory risk, enhance efficiency, and decrease the cost of capital for companies.

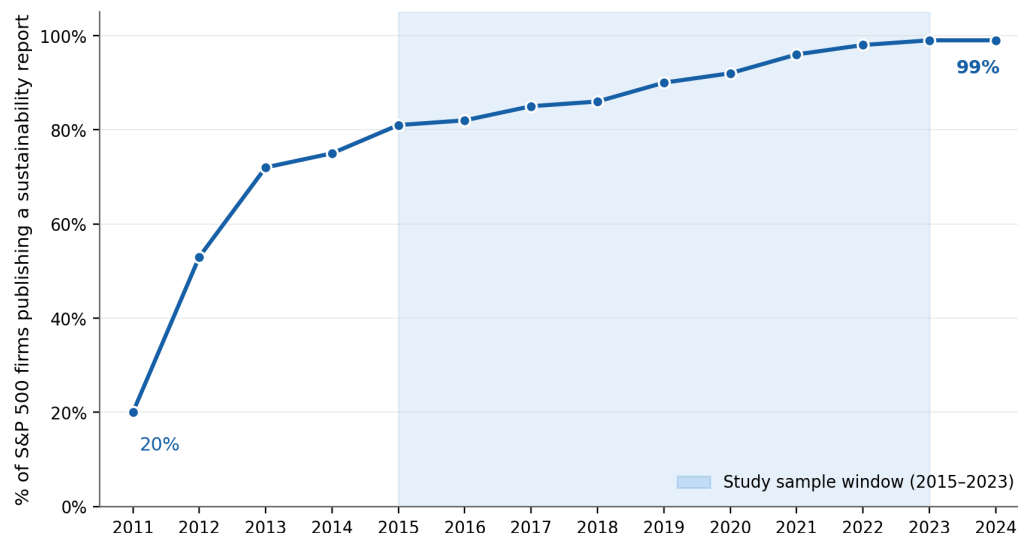


Figure 1. Growth in sustainability reporting among S&P 500 companies, 2011–2024. The shaded region marks the 2015–2023 sample window of this study.

Source: Governance & Accountability Institute annual reviews of S&P 500 sustainability reporting.

This study aims to answer the question of whether ESG performance is captured in market valuation by

analyzing a panel of 333 S&P 500 constituent firms over 2015–2023, a time period that includes the rapid development of the ESG ratings system, the COVID-19 shock, and the early stages of the regulatory rollback. The central research question is:

How does the overall ESG score of companies in the S&P 500 index, as well as the individual ESG dimensions (E, S, G), affect the stock market performance of these companies?

The theoretical case for a positive ESG–valuation relationship rests on Stakeholder Theory. This concept was introduced by Freeman (1984) and it suggests that the long-term viability of a business is not just about meeting the needs of shareholders but also about addressing the needs of other stakeholders, such as employees, customers, suppliers, communities, regulators, and the natural environment. Stakeholder theory holds that firms that proactively consider the legitimate needs of these stakeholders can earn trust, legitimacy, and reputation that will result in long-term financial success. This theoretical view was presented in contrast to Friedman’s (1970) idea of shareholder primacy which suggests that the sole purpose of a firm is to maximise shareholder value. Borrowing from Freeman’s (1984) idea of long term viability of business, one can argue that ESG performance can be seen as a structured operationalisation of the theory: the environmental pillar is the firm’s relationship with the natural environment; the social pillar is the firm’s relationship with employees and communities; and the governance pillar is the firm’s relationship with shareholders and regulators. As per stakeholder theory, firms with stronger ESG performance should therefore enjoy lower regulatory and reputational risk, more loyal customers and employees, easier access to capital, and a stronger long-term valuation premium, predictions that motivate the hypotheses tested in this study.

As a result of growing regulatory requirements for ESG reporting, the debate is gaining new urgency in the contemporary policy environment. The decade of growing sustainability requirements has brought a significant shift in regulation in recent years. In March 2024, the U.S. Securities and Exchange Commission (SEC) adopted rules requiring companies to disclose climate-related information. The U.S. Securities and Exchange Commission (SEC) proposed in May 2026 to revoke the March 2024 climate-related disclosure rules in their entirety. The Omnibus I Directive was adopted by the Council of the European Union on 24 February 2026, further restricting the scope of the Corporate Sustainability Reporting Directive (CSRD) by introducing higher thresholds (i.e. firms with over 1,000 employees and an annual net turnover of more than €450 million) and excluding a significant proportion of entities covered by the initial CSRD mandates. Investor sentiment has followed these trends: US-domiciled sustainable funds saw their 12th consecutive quarter of net outflows in Q3 2025, which may be partly due to the growing anti-ESG political backlash (Morningstar Sustainalytics, 2025). The cooling has more recently spread to Europe, as shown in Figure 2.

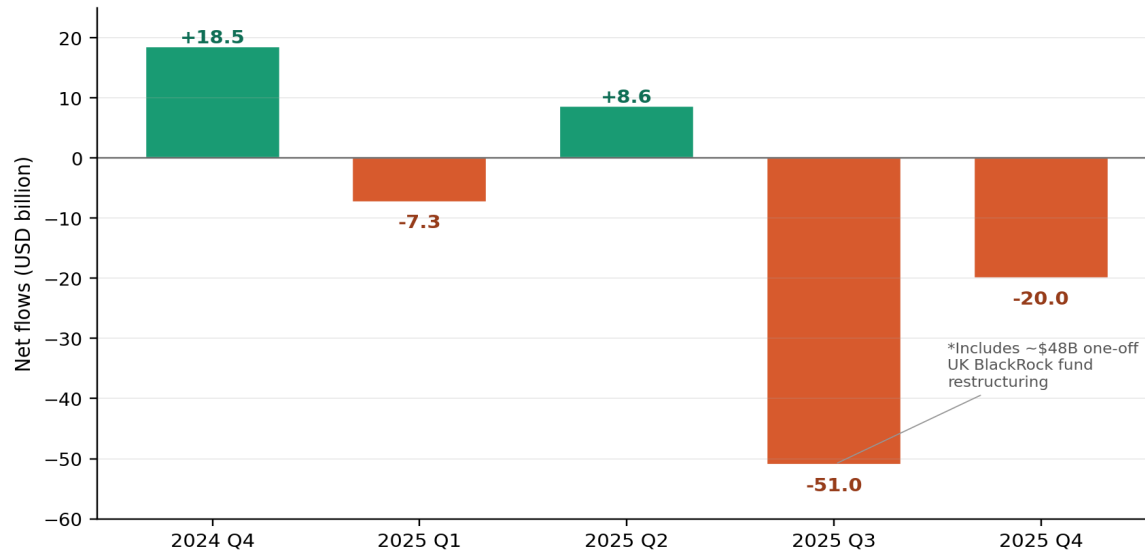


Figure 2. Net flows into European-domiciled sustainable funds by quarter, 2024 Q4 – 2025 Q4 (USD billion). The 2025 Q3 figure is influenced by a one-off reallocation of approximately USD 48 billion of UK BlackRock pooled funds into bespoke mandates.

Source: Morningstar Sustainalytics, Global Sustainable Fund Flows quarterly reports (2025–2026).

Table 1.1 summarises the divergent regulatory trajectories across the two major jurisdictions as of June 2026. While the United States moves toward rescission and the European Union toward simplification, the regulatory consensus that drove the first wave of ESG mainstreaming is therefore fragmenting precisely at the moment when investor capital embedded in sustainable strategies has reached its all-time peak. Whether markets themselves, independently of mandate, price ESG performance is therefore not only an academic question but a live test of whether ESG investing rests on economic foundations or on regulatory scaffolding now being dismantled.

Table 1.1 Comparative ESG disclosure regimes as of June 2026.

Dimension	United States	European Union
Primary framework	SEC Climate-Related Disclosure Rules (adopted March 2024)	Corporate Sustainability Reporting Directive (CSRD), as amended by Omnibus I
Current status (June 2026)	Proposed for full rescission by the SEC (May 2026); rule has remained unenforced since 2024 stay.	Omnibus I Directive adopted 24 February 2026; scope significantly narrowed and timelines delayed

Scope of application	US-listed public companies (if reinstated); large accelerated, accelerated, and other filers	Firms with >1,000 employees and >€450m annual net turnover (post-Omnibus thresholds).
Disclosure orientation	Climate-focused: GHG emissions, climate-related risks, severe weather losses.	Comprehensive ESG: double materiality across environmental, social, and governance topics (ESRS).
Direction of travel	Regulatory retreat under the current administration; state-level mandates (e.g. California) continue.	Simplification and scope reduction to ease compliance burden and boost competitiveness.

Source: Compiled by the author from U.S. Securities and Exchange Commission (2024, 2026), Council of the European Union (2026).

Three hypotheses are tested in this study:

- H1:** ESG scores are significantly related to stock market performance, grounded in stakeholder theory.
- H2:** The higher the ESG score, the greater the market valuation, since high ESG ratings signal corporate strength and a reduced possibility of administrative fines in the future.
- H3:** When the environmental, social, and governance dimensions are separately analysed, they have differentiated impacts on market valuation.

One of the well known problems in the literature is the joint determination of market valuation, fundamentals of the firm and ESG scores, and the fact that panel data do not satisfy the standard OLS assumptions. A Hausman test is used to test for the preference of a fixed-effects specification over a random-effects specification. The diagnostic tests are used to show serial correlation in the residuals (Wooldridge test, $p < 0.05$), heteroscedasticity (Breusch–Pagan test, $p < 0.05$), and cross-sectional dependence (Pesaran CD test, $p \approx 0.00$). Conventional standard errors are biased if any of these conditions are violated, and all three are present, so the model is estimated using the standard errors of Driscoll and Kraay (1998) which provide consistent inference under any of these conditions of arbitrary form. It is precisely because of these robustness properties that this estimator has become the workhorse in panel applications in finance.

The paper has three contributions. First, it offers updated evidence on the ESG–valuation connection for the 333 S&P 500 companies, utilizing an estimator suitable to the documented properties of the data.

Second, it reveals that there is significant heterogeneity in the ways in which the stock market responds back to Environmental, Social, and Governance dimensions, and that the ESG effect as a whole is not a single effect but a combination of three. Thirdly, the results provide an empirical benchmark for the ongoing policy discussion regarding the market value of mandatory ESG disclosure regimes, at a time when the regimes are themselves being reconsidered.

The paper is organised as follows. Section 2 summarizes the existing theoretical and empirical perspectives on the relationship between ESG performance and firm value. Section 3 explains the data, variables, panel data structure and econometric methodology that is adopted in the study. The empirical results, the results from the diagnostic tests, the separated results for combined ESG effect and pillar wise effect and robustness check of the model with Tobin's Q is presented in section 4. Section 5 discussed the results in relation to the previous literature and the current regulatory situation.. Section 6 discusses the policy implications of the findings and directions for future research.

2. LITERATURE REVIEW

Academic interest in stock valuations and its relationship with ESG has increased in both developed and emerging markets. Deng and Cheng (2019) find a positive correlation between the ESG indices using the analysis of stock market performance in A-share listed companies in China, with heterogeneous effects observed in different ownership structures in different industry sectors. More specifically, they discovered that the impact of ESG ratings is stronger for non-state-owned enterprises than for state-owned enterprises, as a result of the different pressures faced by the markets and the flexibility of governance. The study also reveals that the ESG effect is more pronounced in manufacturing sector companies as compared to service companies, highlighting the strategic relevance of ESG for the industrial sector. Competitive and market conditions also play an important role in the success of ESG initiatives in creating value for the firm. Jung and Yoo (2023), demonstrate that at the global level, ESG performance and market capitalisation have a U-shaped relationship, implying that early investments in ESG may not yield linear returns in the short term, while higher ESG maturity over the long term drives market value. The authors also demonstrate that market competition is a negative moderator: the positive effect of ESG activities on firm performance is weaker in more competitive markets, where the costs of implementing ESG practices are less likely to be offset by the resulting benefits.

Alareeni and Hamdan (2020) have also looked at the disaggregated effect of ESG metrics on the S&P 500 companies in the USA. The overall ESG disclosure has a positive effect on the performance of the firm, but the individual components have mixed effects. According to their panel regression analysis, there is a negative association between disclosure of environmental and social responsibility, Return on Assets (ROA) and Return on Equity (ROE); there is a positive association between disclosure of corporate governance and Return on Assets (ROA) and Tobin's Q. This suggests that, from a short-term profitability perspective, structural governance may be more important to investors in the US market than environmental and social indicators..

The quality of ESG reporting also has an impact on immediate market responses. Pandey et al. (2024) discuss the ESG assurance requirement, which is a third-party verification requirement for ESG metrics. They conclude that this requirement led to a negative return of about -1.20% in the period after the announcement, which they view as evidence that investors view stricter reporting requirements as an indicator of increased reporting costs or the revelation of previously unobserved risks. However, firms with stronger pre-existing ESG ratings, particularly in governance, were able to mitigate these adverse responses, confirming that a strong ESG foundation can serve as a buffer against regulatory shocks.

Wang (2025) also investigates the value-generating mechanisms of ESG, he believes ESG performance helps create value for the firm by reducing the risks faced by the company and improving production efficiency. Better ESG practices enhance investor confidence and promote long-term sustainability through greater access to financing and lower cost of capital. This view highlights the benefits of the operational practice of ESG and its future development opportunities, not just the disclosure.

Geographic and economic context is one of the main factors that influences the effectiveness of ESG. Kevser et al. (2023) investigated the G7 countries and concluded that only in the German stock market, the ESG scores were statistically significant. This finding indicates that the German market is especially developed in terms of the application of CSR in management and reporting. No significant results in other G7 countries during the study period suggests that the impact of ESG is not consistent across all countries and is highly dependent on the culture of management and the priorities of local investors in those countries. Gul and Altuntaş (2024) analyzed 347 companies between 2010 and 2022 and concluded that an increase in ESG ratings is associated with an increase in stock prices, primarily driven by the environmental and social ratings. Unlike other studies, governance ratings were not significantly correlated with stock returns in their specific sample, indicating that investors in their sample were more interested in the social and environmental impact of companies than their internal governance.

Asymmetric market responses to ESG news are also documented in the literature. Capelle-Blancard and Petit (2019) show that negative ESG events result in readily identifiable drops in market value, but positive events do not have a noticeable impact. This suggests that the stock market is more attuned to ESG risks than ESG rewards – and that high ESG performance is a standard expectation and not a competitive advantage that commands a premium. On this asymmetry, Orpizewski et al. (2024) extracted and analysed the sentiment of news using BERT models and validated the asymmetric market reaction. They discovered that positive ESG news generates an average abnormal return of just 0.31% , while negative ESG news generates a significantly larger negative abnormal return of -0.75% . The study reveals that the market's reaction to the new information is influenced by the attitude towards ESG reporting and the past ESG performance of the company, and negative information has always been more influential in investor decision-making. Similar trends are noted in European banking by Lupu and Criste (2024). Their study reveals that investment reactions are directly proportional to the changes in ESG values: positive changes in ESG values are linked to positive changes in the market, while negative changes in ESG values are linked to negative changes in the market. The findings highlight the importance of transparency in ESG as one of the key elements of stability and investor trust in the financial services sector.

Last but not least, Pasupuleti et al. (2024) identified that companies in sectors with higher pollution levels saw positive market performance in the post-COVID-19 era when their ESG scores improved. This implies that investing in ESG may be a sign of better risk management and financial stability for companies that have a high environmental footprint. In some instances, the green measures in their study did not have a significant moderating effect, but during times of global economic uncertainty, ESG performance was an important determinant of financial health. Taken together, the existing literature suggests that the relationship between ESG performance and firm value is positive on aggregate but heterogeneous across pillars, regions, ownership structures, and market conditions. The present study contributes to this debate by providing updated panel evidence from the S&P 500 over 2015–2023, using an estimator robust to the documented panel data violations.

3. METHODOLOGY

3.1 Data Pre-Processing and Sample

The empirical analysis evaluates the impact of ESG ratings on the stock market performance of firms listed in the S&P 500 index. The sample consists of 333 S&P 500 constituent firms observed annually over the period 2015–2023 i.e. for 9 years, yielding an unbalanced panel of 2997 firm-year observations. Firm-level financial and accounting data are obtained from S&P 500 Capital IQ Pro and ESG scores (overall score and the three pillar sub-scores) are drawn from ESG ratings providers. The 2015–2023 window is chosen because it spans the rapid maturation of ESG ratings infrastructure, the COVID-19 macroeconomic shock, and the early phases of the contemporary regulatory rollback.

Capital IQ financial and market data is available for all 503 S&P 500 constituents which was used for the financial data of the firms; ESG ratings coverage from the provider identified was available only for 333 firms. By comparison, the provider identified only covers 333 constituents in terms of ESG ratings coverage. The sample size is limited by the number of observations that have both financial and ESG data, not just financial data, as in this case it is the ESG data that has a more limited number of observations. All fields were natively denominated in thousands of US dollars, except for three fields (net income, net cash flow and total revenue) which are natively denominated in millions of US dollars. These inconsistencies were due to reporting conventions that the data vendor had adopted, and were taken care of in the analysis process when these fields were used together in ratio construction.

3.2. Variable Construction

The following ratios are derived from the Capital IQ's underlying data fields that were obtained directly through the vendors.

- Firm Size is calculated as the natural logarithm of total assets

Firm Size = "Log" of Total Assets

- Debt Level is the natural logarithm of the ratio of total liabilities to total assets:

$$\text{Debt Level} = \log \text{ of } (\text{Total Liabilities} / \text{Total Assets})$$

- The Asset Tangibility is the natural logarithm of the ratio of fixed assets to total assets
- Cash Ratio is the ratio of cash to total assets: The Cash Ratio indicates the proportion of cash to total assets on a company's balance sheet. It shows how well a firm is able to meet its short-term obligations with its liquid assets, which is a common metric for liquidity, rather than on its cash flow, defined as the net flow of cash into and out of a firm during a specific period. The variable is not logarithmically transformed as all the values are between 0 and 1.
- Firm Age is defined as the natural log of the number of years after a firm has been in operation plus one: If the corporate structure of a firm has been formed from a spin-off or a legal re-establishment, the year of establishment represents the date of the spin-off or re-establishment and not the historical date the firm was established.

$$\text{Firm Age} = \log_{10}(\text{Current year} - \text{Year of establishment} + 1)$$

- The return on assets, return on equity and asset turnover are vendor computed and are not “reconstructed” from other variables in the panel. In particular, the panel does not report a ROE that is calculated in-house as a ratio of net income to shareholders' equity.
- Asset turnover reflects Capital IQ's own proprietary calculation rather than a locally-derived ratio of income or revenue to assets.

A set of firm-level financial control variables is included to isolate the ESG effect, comprising Firm Size, Debt Level, Asset Tangibility, Cash Ratio, and Firm Age as defined above, together with Return on Assets, Return on Equity, and Asset Turnover as vendor-computed profitability and efficiency measures, and the natural logarithms of Net Income, Total Revenue, Net Cash Flow, and Total Debt as additional scale and performance controls. Net Income and Net Cash Flow, which can take negative values, are transformed using an inverse hyperbolic sine-type transformation, $\text{sign}(x) \cdot \ln(1+|x|)$, rather than a conventional logarithm. This transformation compresses very large positive and negative values the same way a logarithm normally would, but unlike a normal logarithm, it still works when a company has a loss (a negative number) or exactly zero net income.

Total assets, total liabilities, fixed assets, and cash holdings are not entered as separate controls in addition to Firm Size, Debt Level, Asset Tangibility, and Cash Ratio, since each of the latter four is constructed directly from one or more of the former and their joint inclusion would be mechanically overlapping. The price-to-earnings ratio and price-to-book ratio are retained in the underlying dataset but are excluded from the regression specifications, as both are constructed using market price and therefore embed the

dependent variable.

3.3 Descriptive Statistics

Table 3.1 presents the descriptive statistics for the dependent variable, the ESG measures, and the firm-level financial controls used in the analysis, over the 2015–2023. The mean ESG Score is 3.89 (on a scale of 0–9.7) with a standard deviation of 1.40, indicating moderate variation across the 333 firms. Governance has the highest mean (7.09) and the lowest dispersion (SD = 0.84), consistent with the comparatively uniform governance practices expected among large US-listed firms, while the Environmental and Social sub-scores display substantially greater variation. The dependent variable, Market Capitalisation, ranges from USD 357 million to USD 1.92 trillion with a mean of approximately USD 54.9 billion, reflecting formal heterogeneity within the data set chosen for analysis. Observation counts vary across variables reflecting the differential completeness of ESG pillar coverage and, for a small number of balance-sheet items, ordinary reporting gaps; no variable falls below 76 percent of the theoretical maximum of 2,997 firm-year observations (333 firms × 9 years).

Table 3.1. Descriptive statistics for the variables, 2015–2023.

Variable	Obs	Mean	Std. Dev.	Min	Max
ESG Score	2,726	3.891	1.401	0.650	8.560
Environmental Score	2,283	3.365	1.913	0.003	9.570
Social Score	2,679	3.176	2.014	0.145	9.702
Governance Score	2,726	7.087	0.843	2.504	9.056
Market Cap (USD m)	2,951	54,924.88	110,843.80	356.72	1,921,855

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ROA	2,973	0.059	0.072	-0.194	0.306
ROE	2,973	0.168	0.676	-3.044	3.740
Firm Size (ln assets)	2,973	10.201	1.471	6.807	14.466
Firm Age (ln)	2,969	3.935	0.838	0.693	5.481
Debt Level (ln)	2,973	-0.453	0.384	-1.904	0.272
Asset Tangibility (ln)	2,917	-2.174	1.516	-5.976	-0.054
Cash Ratio	2,623	0.109	0.134	0.001	0.628
Asset Turnover	2,814	0.604	0.494	0.045	2.443
Total Assets (USD m)	2,973	96,856.11	295,940.40	50.44	3,875,393
Total Liabilities (USD m)	2,973	78,502.29	267,404.90	4.75	3,547,515
Total Debt (USD m)	2,973	23,766.33	71,749.48	0.00	1,069,803
Fixed Assets (USD m)	2,917	10,855.04	24,276.65	1.38	276,690
Cash Holdings (USD m)	2,623	4,799.74	16,086.07	0.27	261,036

Net Income (USD m)	2,985	2,499.18	5,822.98	−22,440	76,033
Net Cash Flow (USD m)	2,983	474.31	11,203.98	−173,600	263,978
Total Revenue (USD m)	2,985	23,305.35	42,980.99	18.08	574,785

Source: Author's calculation on STATA. Continuous control variables (ROA, ROE, Firm Size, Debt Level, Asset Tangibility, Cash Ratio, Asset Turnover) were winsorised at the 1st and 99th percentiles prior to estimation; values reported here are post-winsorisation. Debt Level ($\ln$) = $\ln(\text{Total Liabilities} / \text{Total Assets})$; Asset Tangibility ($\ln$) = $\ln(\text{Fixed Assets} / \text{Total Assets})$; see Section 3.2 for full variable definitions.

3.4 Panel Data

Panel data combine cross-sectional and time-series dimensions, observing the same set of firms across a defined sequence of time periods. This structure allows firm-specific heterogeneity to be controlled for directly, and is appropriate here because it permits unobserved, time-invariant factors that vary across companies such as corporate culture or management style to be separated from the relationships of interest. The sample construction, firm count, and panel balance are described in full in section 3.1; this study employs the resulting panel of 333 firms observed over 2015–2023.

The basic linear panel data model is represented as:

$$Y_{it} = \alpha + \beta X_{it} + \mu_i + \varepsilon_{it}$$

where Y_{it} is the dependent variable (the natural logarithm of market capitalisation, or Tobin's Q in the robustness specification as discussed in later section 4.5) for firm i at time t ; X_{it} is the vector of independent and control variables for firm i at time t ; μ_i is the unobservable, time-invariant firm-specific effect; and ε_{it} is the idiosyncratic error term.

3.5 Fixed Effects Model and Hausman Test

The Fixed Effects (FE) model is used to control for unobserved heterogeneity that is constant over time, allowing firm-specific effects to be correlated with the independent variables without biasing the coefficients of interest. To determine whether a fixed-effects or random-effects (RE) specification is appropriate, a Hausman test is conducted for each model reported in Section 4. The null hypothesis is that the random-effects estimator is the more efficient specification; where the resulting p-value is below 0.05, eventually the null is rejected and fixed effects is used, on the grounds that firm-specific effects are correlated with the regressors and the RE approach would therefore be inconsistent.

3.6 Empirical Model Specification

The composite ESG Score and its three constituent pillars are not entered into the same regression, since the composite is constructed as an industry-specific weighted function of the three pillars rather than an independent measure (Section 3.2), and doing so would render the resulting coefficients uninterpretable. The relationship between ESG performance and market valuation is instead estimated using two panel regression equations:

$$\ln(\text{MarketCap}_{it}) = \alpha + \beta_1 \text{ESGScore}_{it} + \gamma'X_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (1a)$$

$$\ln(\text{MarketCap}_{it}) = \alpha + \beta_1 \text{EnvironmentScore}_{it} + \beta_2 \text{SocialScore}_{it} + \beta_3 \text{GovernanceScore}_{it} + \gamma'X_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (1b)$$

where X_{it} is the vector of twelve firm-level controls described in Section 3.2 (Firm Size, Debt Level, Asset Tangibility, Cash Ratio, Firm Age, ROA, ROE, Asset Turnover, and the natural logarithms of Net Income, Total Revenue, Net Cash Flow, and Total Debt); μ_i is a firm fixed effect; and δ_t is a year fixed effect, included in the specifications so noted in Section 4. Equation (1a) is used to estimate the aggregate ESG Score, and equation (1b) to estimate the three pillars jointly with the aggregate omitted; each pillar is additionally estimated on its own, replacing the three-pillar term in (1b) with a single pillar score. The subscript i indexes the firm and t indexes the time period throughout.

3.7 Diagnostic Tests

A series of diagnostic tests is performed on the specification in equation (1b) to identify violations of the standard panel data assumptions. The Hausman test confirms that a fixed-effects specification is preferred over random effects for every model reported in Section 4 ($p < 0.001$ throughout). Three further violations emerge from the diagnostic process. The Wooldridge test for autocorrelation yields $F(1, 259) = 112.68$ ($p < 0.001$), rejecting the null of no first-order autocorrelation and confirming serial correlation in the residuals. The Breusch–Pagan/Cook-Weisberg test, computed against the fitted values of the dependent variable with one degree of freedom, yields $\chi^2(1) = 30.11$ ($p < 0.001$), confirming heteroscedasticity; this is distinct from the Breusch–Pagan Lagrange multiplier test used to compare random effects against pooled OLS, and the degrees of freedom are reported explicitly here because the test's interpretation depends on them. Finally, the Pesaran CD test, computed on the residuals of the fixed-effects model, yields $CD = -0.118$ ($p < 0.001$), confirming cross-sectional dependence and indicating that shocks to one firm's residual are correlated with shocks to other firms in the panel.

Table 3.2. Diagnostic tests for panel data assumptions

Test	Statistic (p-value)	Conclusion
Hausman test (FE vs RE)	$p < 0.001$ (all specifications)	Fixed effects preferred
Wooldridge test for autocorrelation	$F(1, 259) = 112.68$ ($p < 0.001$)	Serial correlation present

Breusch–Pagan/Cook-Weisberg test for heteroskedasticity (fitted values of ln Market Cap, 1 d.f.)	$\chi^2(1) = 30.11$ ($p < 0.001$)	Heteroscedasticity present
Pesaran CD test for cross-sectional dependence (model residuals)	$CD = -0.118$ ($p < 0.001$)	Cross-sectional dependence present

Source: Author's calculation on STATA. All statistics are computed on the corrected specification in equation (1b); see Section 4.1 for the corresponding regression.

3.8 Driscoll–Kraay Estimation

To obtain consistent inference in the simultaneous presence of serial correlation, heteroscedasticity, and cross-sectional dependence, the model is estimated using the Driscoll and Kraay (1998) non-parametric covariance matrix estimator, with a maximum kernel bandwidth of two lags. The Driscoll–Kraay method averages across the cross-section before computing the variance, producing standard errors robust to general forms of all three violations simultaneously, and has become a standard choice in panel applications in finance for this reason.

The Driscoll–Kraay estimator's asymptotic properties rely on a reasonably long time dimension, and the present panel spans nine annual periods (2015–2023), which is short relative to the estimator's ideal use case. For this reason, two-way clustered standard errors, by firm and year, are reported alongside Driscoll–Kraay throughout Section 4 as a robustness comparison, consistent with the more common benchmark in finance panels of this kind; where the two approaches disagree, both are reported and the disagreement is discussed explicitly rather than resolved by selecting one specification.

4. EMPIRICAL FINDINGS

4.1 Individual Pillar and Aggregate Models

Models are estimated following equations (1a) and (1b) of Section 3.6, using the twelve-control specification described in Section 3.2 and the Driscoll–Kraay and two-way clustered standard errors motivated by the diagnostic evidence in Section 3.7 and Table 3.2. Table 4.1 reports each pillar and the aggregate ESG Score estimated individually, alongside a Hausman test comparing fixed-effects (FE) and random-effects (RE) specifications for each. In every case the Hausman test rejects the null hypothesis that the random-effects estimator is consistent ($p < 0.001$ throughout), so fixed effects is adopted as the preferred specification for all subsequent models. Estimated alone, without year fixed effects and without competing against the other pillars in the same specification, all four measures i.e. environment, social, governance, and the aggregate ESG score are positive and statistically significant.

Table 4.1. Individual pillar and aggregate models.

Pillar (alone)	FE	RE	Hausman test
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Environment	0.0239*** (0.0063)	0.0308*** (0.0058)	$\chi^2(13)=130.29$, $p<0.001 \rightarrow$ FE
Social	0.0384*** (0.0054)	0.0388*** (0.0051)	$\chi^2(13)=158.80$, $p<0.001 \rightarrow$ FE
Governance	0.0377* (0.0177)	0.0433* (0.0167)	$\chi^2(13)=170.18$, $p<0.001 \rightarrow$ FE
ESG (aggregate)	0.0651*** (0.0084)	0.0715*** (0.0075)	$\chi^2(13)=141.72$, $p<0.001 \rightarrow$ FE

*Note: Firm fixed effects included in both FE and RE columns; RE columns additionally model firm effects as random draws. Standard errors in parentheses. * $p<0.05$, ** $p<0.01$, *** $p<0.001$. The Hausman test uses the sigmamore option to obtain a well-defined test statistic. $N=1,933$ (Environment), 2,181 (Social), 2,226 (Governance and aggregate ESG).*

4.2 Aggregate ESG Score: Sensitivity to Year Fixed Effects

Table 4.2 presents the aggregate ESG Score model without year fixed effects, with year fixed effects under Driscoll-Kraay standard errors, and with year fixed effects under two-way clustering by firm and year. Without year fixed effects, the ESG Score coefficient is 0.0651 and highly significant ($p=0.002$), similar in magnitude to the 0.069 coefficient reported in the original manuscript. Once year fixed effects are added, the coefficient falls to 0.0106 and is not statistically distinguishable from zero under either standard error specification ($p=0.424$ under Driscoll-Kraay; $p=0.545$ under two-way clustering), a decline of approximately 84 percent. Over the sample period, both ESG scores and S&P 500 market capitalisations rose considerably; the year indicators (not tabulated here for brevity) are jointly large and highly significant, peaking in 2020 and 2021. This pattern indicates that the positive aggregate ESG-valuation relationship reported in the original manuscript reflects, to a substantial degree, a shared time trend in both series rather than a stable, within-firm relationship between ESG performance and valuation, and does not survive this check.

Table 4.2. Aggregate ESG Score, with and without year fixed effects.

Variable	(1) No Year FE(DK)	(2) Year FE(DK)	(3) Year FE(2-way cluster)
ESG Score	0.0651*** (0.0150)	0.0106 (0.0126)	0.0106 (0.0168)
Firm Size	0.7295*** (0.0946)	0.6124*** (0.0747)	0.6124*** (0.1089)
Debt Level	0.0237 (0.0395)	-0.0500 (0.0234)	-0.0500 (0.1122)
Asset Tangibility	0.0802** (0.0199)	0.0524* (0.0158)	0.0524 (0.0334)

Cash Ratio	0.5295* (0.2182)	0.4110 (0.1900)	0.4110 (0.2939)
Firm Age	0.1729* (0.0606)	-0.0616 (0.0406)	-0.0616 (0.1340)
ROA	1.5257*** (0.2092)	1.5021*** (0.1547)	1.5021*** (0.2783)
ROE	0.0302** (0.0081)	0.0201* (0.0082)	0.0201 (0.0133)
Asset Turnover	0.0064 (0.0383)	-0.0049 (0.0545)	-0.0049 (0.1033)
ln(Net Income)	0.0060*** (0.0009)	0.0059** (0.0013)	0.0059 (0.0027)
ln(Total Revenue)	0.0677 (0.0648)	0.1319* (0.0418)	0.1319 (0.0703)
ln(Net Cash Flow)	-0.0015 (0.0015)	-0.0026 (0.0012)	-0.0026 (0.0016)
ln(Total Debt)	-0.0767* (0.0240)	-0.0696** (0.0201)	-0.0696 (0.0465)
Year fixed effects	No	Yes	Yes
Observations	2,226	2,226	2,226
Firms	285	285	285

*Note: Columns (1) and (2) use Driscoll-Kraay standard errors (maximum lag 2); column (3) uses STATA with two-way clustering by firm and year. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (columns 1–2 only; significance stars omitted in column 3, in which no coefficient of interest is significant).*

4.3 Disaggregated Pillars: Joint Model and Formal Test of Pillar Equality

Table 4.3 reports the three pillars estimated jointly, with the aggregate ESG Score omitted, corresponding to the alternative specification. Without year fixed effects, Environment is not statistically significant ($p=0.213$) while Social and Governance are both positive and significant. Once year fixed effects are added, the pattern changes materially: Environment becomes significantly negative (-0.0159 , $p=0.041$), while Social (0.0131 , $p=0.011$) and Governance (0.0323 , $p=0.047$) remain positive and significant under Driscoll-Kraay standard errors.

A formal Wald test of the equality of the three pillar coefficients (H3) is reported at the foot of the table. Under Driscoll-Kraay standard errors, the null hypothesis that the three pillars have equal effects is rejected ($F(2,8)=5.65$, $p=0.030$), providing formal support for pillar heterogeneity. Under two-way clustered standard errors by firm and year a more conservative benchmark, and one better suited to a panel with a comparatively short time dimension none of the three pillar coefficients remains individually significant, and the Wald test no longer rejects the null of equality ($F(2,8)=2.12$, $p=0.182$). The point estimates are identical between columns (2) and (3); only the standard errors differ. Given this sensitivity

to the choice of standard error, the finding of pillar heterogeneity in this specification is reported as suggestive rather than conclusive.

Table 4.3. Three ESG pillars estimated jointly, aggregate omitted.

Variable	(1) No Year FE(DK)	(2) Year FE(DK)	(3) Year FE(2-way cluster)
Environment Score	0.0082 (0.0060)	-0.0159* (0.0065)	-0.0159 (0.0113)
Social Score	0.0312*** (0.0049)	0.0131* (0.0040)	0.0131 (0.0077)
Governance Score	0.0430* (0.0131)	0.0323* (0.0138)	0.0323 (0.0231)
Firm Size	0.8143*** (0.0656)	0.6987*** (0.0498)	0.6987*** (0.0945)
Debt Level	-0.0641* (0.0230)	-0.1338** (0.0373)	-0.1338 (0.1192)
Asset Tangibility	0.0601* (0.0201)	0.0365 (0.0202)	0.0365 (0.0312)
Cash Ratio	0.4422* (0.1711)	0.3701* (0.1480)	0.3701 (0.2829)
Firm Age	0.0319 (0.0605)	-0.1934* (0.0690)	-0.1934 (0.1495)
ROA	1.3140** (0.2424)	1.2803*** (0.1802)	1.2803*** (0.2084)
ROE	0.0240* (0.0083)	0.0122 (0.0083)	0.0122 (0.0102)
Asset Turnover	0.2068** (0.0403)	0.1997** (0.0525)	0.1997 (0.1055)
ln(Net Income)	0.0050** (0.0012)	0.0049* (0.0019)	0.0049 (0.0027)
ln(Total Revenue)	-0.0067 (0.0409)	0.0537* (0.0218)	0.0537 (0.0539)
ln(Net Cash Flow)	-0.0011 (0.0014)	-0.0020 (0.0010)	-0.0020 (0.0013)
ln(Total Debt)	-0.1156*** (0.0121)	-0.1095*** (0.0122)	-0.1095*** (0.0280)
Year fixed effects	No	Yes	Yes
Observations	1,910	1,910	1,903
Firms	279	279	272
Wald test: Env = Soc = Gov	—	F(2,8)=5.65, p=0.030	F(2,8)=2.12, p=0.182

Note: Column (3) uses two-way clustering by firm and year; standard errors are adjusted for a non-positive-semi-definite variance-covariance matrix using the Cameron, Gelbach and Miller

correction. Seven singleton observations are dropped in column (3). * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (columns 1–2 only).

4.4 Robustness: Tobin's Q as an Alternative Dependent Variable

Market capitalization is a valuation level rather than a performance measure, and Tobin's Q is the more standard outcome variable in the comparison literature. Table 4.4 re-estimates the joint pillar model using Tobin's Q, calculated as (Market Capitalisation + Total Liabilities) / Total Assets, in place of log market capitalisation. The Wald test of pillar equality is considerably stronger under this alternative dependent variable ($F(2,8)=13.17$, $p=0.003$) than under log market capitalisation. Social remains positive and significant (0.0161, $p=0.028$), consistent with its result in Table 4.3. The environment is significantly negative and larger in magnitude (-0.0563 , $p=0.001$) than under log market capitalisation. Governance, by contrast, is not statistically significant under Tobin's Q (-0.0373 , $p=0.342$), in contrast to its significant positive coefficient under log market capitalisation. Since Tobin's Q already normalises firm value by asset base, this divergence is consistent with the possibility that Governance's apparent association with market capitalisation reflects its correlation with firm scale rather than a valuation effect specific to governance quality.

Table 4.4. Three ESG pillars, Tobin's Q as a dependent variable.

Variable	Tobin's Q (Year FE, Driscoll-Kraay)
Environment Score	-0.0563*** (0.0105)
Social Score	0.0161* (0.0060)
Governance Score	-0.0373 (0.0369)
Firm Size	-0.1053 (0.0914)
Debt Level	0.9709*** (0.1595)
Asset Tangibility	0.1544*** (0.0326)
Cash Ratio	1.1124 (0.6796)
Firm Age	-0.4937** (0.1119)
ROA	1.6991*** (0.2025)
ROE	0.0233 (0.0367)
Asset Turnover	0.6726*** (0.1036)
ln(Net Income)	0.0007 (0.0041)
ln(Total Revenue)	0.1471* (0.0496)
ln(Net Cash Flow)	-0.0087* (0.0030)
ln(Total Debt)	-0.3494*** (0.0672)
Year fixed effects	Yes
Observations	1,910

Firms	279
Wald test: Env = Soc = Gov	F(2,8)=13.17, p=0.003

*Note: Driscoll-Kraay standard errors (maximum lag 2) in parentheses, year fixed effects included. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Tobin's Q is calculated as (Market Capitalisation + Total Liabilities) / Total Assets and is not winsorised.*

4.5 Interpretation of Results

Taken together, the three hypotheses receive a more qualified pattern of support than in the original specification. H1, that ESG performance is significantly related to stock market valuation, is not supported at the level of the aggregate ESG Score once year fixed effects are included, but is supported at the pillar level: the Social and Governance pillars are positively associated with valuation under log market capitalisation, and the Social pillar remains positively associated with valuation under Tobin's Q as well. H2, that greater ESG performance is associated with greater market valuation, is not supported uniformly across pillars: the Environmental pillar is negatively, not positively, associated with valuation once the shared time trend is controlled for, a result that holds under both dependent variables used in this study. H3, that the three pillars have differentiated effects on valuation, is supported by a formal Wald test under Driscoll-Kraay standard errors and under Tobin's Q , but the same test does not reject the null of pillar equality under two-way clustered standard errors.

Two results are robust across both the year-fixed-effects check and the choice of dependent variable, and are given the greatest weight in the discussion that follows. First, the aggregate ESG-valuation relationship is substantially attributable to a shared upward trend in ESG scores and equity valuations over 2015–2023, rather than to a stable within-firm relationship. Second, the Environmental and Social pillars behave consistently in sign negative and positive, respectively whether valuation is measured as log market capitalisation or as Tobin's Q , while the Governance pillar's positive association with market capitalisation does not extend to Tobin's Q , and should accordingly be interpreted with caution.

5. DISCUSSION OF RESULTS

5.1 The Aggregate ESG Effect

The results of this analysis are broadly consistent with Wang (2025), who argues that ESG performance reduces firm risk and enhances operational efficiency, with the global relationship reported in Jung and Yoo (2023), and with the meta-analytic conclusion of Friede et al. (2015) that the ESG–performance relationship is positive on average across more than 2,000 studies. The results in Table 4.2 show that in this particular sample, a positive and significant aggregate coefficient is substantially attenuated and loses statistical significance once year fixed effects are included (0.0106, $p=0.424$). Because ESG reporting coverage and S&P 500 valuations both rose markedly over 2015–2023, a specification without year controls is at risk of attributing common time-series movement in the two series to the ESG variable; this

is precisely the pattern observed here. This does not establish that ESG performance is unrelated to valuation in general, only that the aggregate, composite-level relationship in this sample is not distinguishable from a shared trend once that trend is properly controlled for.

5.2 The Disaggregated Pillars

Once the composite score is set aside and the three pillars are estimated jointly, a different and more informative pattern emerges. The Social pillar is positively associated with valuation under both dependent variables used in this study, a result consistent with the stakeholder-theory prediction that stronger relationships with employees, customers, and suppliers are rewarded by the market (Freeman, 1984). The Environmental pillar is negatively associated with valuation once year effects are controlled for, and this result is consistent in sign under both log market capitalisation and Tobin's Q. This is a genuine empirical finding and it warrants a cautious interpretation rather than a causal one. A negative coefficient on an environmental rating is consistent with several explanations that the present data cannot distinguish between: environmental leadership may be concentrated among firms in capital- and emissions-intensive sectors that carry other valuation discounts for reasons unrelated to their environmental performance; environmental disclosure and compliance costs may be capitalised by the market as a near-term drag even where they reduce long-run risk; or, per the industry-specific weighting documented in Section 3.2, the Environmental sub-score may proxy different underlying content across sectors in ways that a single pooled coefficient cannot capture. Distinguishing between these explanations would require sector-specific interaction terms, which the present specification does not include (see Section 6).

The Governance pillar is positively associated with valuation under log market capitalisation but not under Tobin's Q. Since Tobin's Q already normalises firm value by asset base, this divergence is consistent with the possibility that Governance's apparent valuation premium under market capitalisation is partly attributable to its correlation with firm size. Larger, more mature firms tend to exhibit both stronger governance practices and larger market capitalisations rather than to a valuation effect specific to governance quality. This finding should be read as a caution against over-interpreting the market-capitalisation result for Governance rather than as evidence that governance quality is unpriced for this given sample.

5.3 Relation to the Literature

The study's finding of a positive Governance coefficient under market capitalisation is directionally consistent with Alareeni and Hamdan (2020) positive governance result, while the Environmental result reported here (significantly negative) is not addressed by their insignificant finding for that pillar. This comparison in any case requires a caveat that applies throughout this section: Alareeni and Hamdan (2020) use return on assets, return on equity, and Tobin's Q as dependent variables rather than market capitalisation, so agreement or disagreement between the two sets of results is not a like-for-like comparison. The present study's own Tobin's Q specification (Table 4.4) offers a partial bridge to this literature and, notably, finds Governance insignificant under that dependent variable closer to Alareeni and Hamdan's original result for the other two pillars than the market-capitalisation specification is.

Capelle-Blancard and Petit (2019) and Orpiszewski et al. (2024) concerns differential reactions to ESG news events, not the sign of a coefficient on the level of an ESG rating within this study we find a positive Social coefficient which is broadly consistent with this literature. Further the social pillar result is directionally consistent with Gul and Altuntaş (2024), who report that environmental and social ratings are positively associated with stock returns in a sample of developed and emerging markets, with governance not significantly related to returns. The present study's Environmental result is not consistent with theirs, a divergence that may reflect differences in sample composition, time period, dependent variable (returns rather than a valuation level), or the well-documented divergence in methodology across ESG rating providers. On this point, Berg, Kölbel, and Rigobon (2022) show that ESG ratings from different providers correlate only moderately with one another (average pairwise correlations of 38 to 71 percent across six major providers), with measurement differences in how the same underlying concept is scored contributing the largest share of the divergence. Because the present study relies on a single ESG data provider its results should be understood as specific to that provider's methodology. Kevser et al. (2023), who find a significant ESG–valuation relationship only in the German market among G7 economies, and the present study's US-only sample are not directly comparable on institutional grounds, though both point to the same broader conclusion: the relationship between ESG ratings and firm value is not homogeneous across markets, sectors, or, as shown here, across the individual dimensions of ESG itself.

A scope limitation concerns the dependent variable used in this study is that market capitalisation is a valuation level, while the research question, and most of the cited comparison literature (Capelle-Blancard and Petit, 2019; Orpiszewski et al., 2024; Gul and Altuntaş, 2024), concerns stock market returns or abnormal returns. A coefficient on a market-capitalisation level and a finding about return responses are not measuring the same thing, and the comparisons drawn in this section should be read with that difference in mind. The Tobin's Q specification in Table 4.4 partially addresses the level-versus-performance distinction, though Tobin's Q remains a valuation ratio rather than a realised-return measure, and a returns-based specification is a direction for future research work.

6. CONCLUSION

This study set out to test whether equity markets price environmental, social, and governance performance in the valuation of S&P 500 firms, and whether the three pillars are priced alike. Formally testing the equality of the three pillar coefficients, as hypothesis H3 requires, yields a result that depends on the choice of standard error: pillar heterogeneity is supported under Driscoll-Kraay standard errors and, more strongly, when Tobin's Q is used as the dependent variable, but is not supported under two-way clustering by firm and year. Environmental pillar is associated with lower firm valuation and the Social pillar with higher firm valuation once year effects are controlled for, a pattern that holds under both log market capitalisation and Tobin's Q; the Governance pillar's positive association with market capitalisation does not extend to Tobin's Q, and is accordingly the least robust of the three pillar results.

Two policy-relevant observations follow from this analysis: first, because the ESG composite score is constructed as an industry-specific weighted average of its three pillars rather than an equally-weighted or transparent function of them, a composite score can obscure materially different, and in this study's results opposite-signed, relationships between individual ESG dimensions and firm value. Disclosure and reporting standards built around a single composite figure are therefore likely to be less decision-useful than standards that report the three pillars, or their material sub-components, separately.

Future research can focus on sector interaction terms that would allow a direct test of whether the negative Environmental result, and the broader pattern of pillar heterogeneity, is concentrated in particular industries, as the industry-specific pillar-weighting evidence suggests it may be. Extending the panel with post-2023 data would allow a direct test of whether the pillar-level relationships identified here persist through the 2025–2026 regulatory rollback discussed in above and lies outside the current sample window. Finally, a returns-based specification, using monthly or annual stock returns rather than a valuation level, would allow more direct comparisons possible.

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