

Effect Of ESG Scores On Firm Performance – A Study On Two Capital Intensive Industries In India

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ABSTRACT

This paper examines the effect of Environmental, Social, and Governance (ESG) scores on firm performance in two capital-intensive industries in India: metals and mining, and chemicals. Using acquisition announcements of NSE 500 firms from 2010 to 2020, the analysis integrates accounting-based measures—Return on Equity (ROE), Return on Assets (ROA), and Return on Capital Employed (ROCE)—with value-based indicators including Economic Value Added (EVA), Market Value Added (MVA), Cumulative Abnormal Returns (CAR), and Tobin's Q. Paired sample t-tests, regression models, and Holm–Bonferroni corrections are applied to ensure robust results. Findings indicate that metals and mining firms achieve stronger environmental and governance improvements, which correspond to moderate financial gains and significant increases in EVA and MVA. The chemical sector, in contrast, shows weaker ESG progress with limited profitability impact. Disaggregated analysis reveals that aggregate ESG scores do not reliably predict outcomes. The environmental pillar is critical for metals and mining, while the social pillar dominates in chemicals, though its effect on profitability is adverse. Governance signals remain mixed but show some emerging relevance. Event-study results demonstrate that markets react mainly before or around announcements, with significant CARs clustering in trailing windows. Overall, ESG's financial relevance is industry-specific and pillar-driven, underscoring the importance of materiality-focused ESG strategies for managers and a nuanced evaluation framework for investors.

Key words: ESG, firm performance, Mergers and acquisitions, event study, Capital-Intensive Industries

1 INTRODUCTION

In recent years, the incorporation of Environmental, Social, and Governance (ESG) considerations into corporate decision-making has moved from being a peripheral concern to a mainstream expectation. Firms are now assessed not only on their ability to deliver financial results but also on how responsibly they manage environmental impacts, social relationships, and governance practices (khan, Busch, & Bassen, 2015; Khan, Serafeim, & Yoon, 2016). In India, this trend has been accelerated by regulatory changes such as the Securities and Exchange Board of India's (SEBI) Business Responsibility and Sustainability Report (BRSR), which requires the top 1000 listed firms to disclose ESG-related practices. For capital-intensive sectors—where environmental externalities are significant and governance challenges complex—ESG performance has become a critical component of long-term competitiveness.

The relationship between ESG practices and financial outcomes has been debated widely. On one hand, a growing body of work argues that investments in ESG enhance operational efficiency, reduce business risk, and improve stakeholder relations, thereby strengthening traditional profitability indicators such as Return on Equity (ROE), Return on Capital Employed (ROCE), and Return on Assets (ROA) (Eccles, Ioannou, & Serafeim, 2014; Velte, 2017). On the other, more recent contributions stress that accounting ratios capture only part of the story, and that value-based measures such as Economic Value Added (EVA) and Market Value Added (MVA) provide a better assessment of whether ESG integration creates wealth for shareholders (Stewart, 1991; Sharma & Kumar, 2010). This distinction is particularly relevant in industries where projects require large capital commitments and their payoffs unfold gradually.

ESG performance also matters in financial markets, not just in operations. Investors frequently react to sustainability disclosures and strategic decisions through stock price movements. The literature on mergers and acquisitions (M&A) shows that acquisition announcements are especially informative events, as they signal managerial intent and often coincide with commitments related to financing, restructuring, or ESG practices (Deng, Kang, & Low, 2013; Krüger, 2015). Since markets respond immediately to new information, cumulative abnormal returns (CAR) around such announcements provide a window into short-term investor sentiment,

while changes in Tobin's Q can reveal whether ESG improvements are associated with longer-term valuation effects (Lins, Servaes, & Tamayo, 2017).

Building on this context, the present study examines the role of ESG in shaping firm performance within two capital-intensive industries in India, using acquisition announcements as the event reference point. The analysis proceeds along two dimensions. First, it considers financial performance by comparing pre- and post-announcement metrics, covering both traditional indicators (ROE, ROCE, ROA) and modern measures (EVA, MVA). Second, it investigates market outcomes by assessing the impact of ESG scores on CAR during acquisition announcements, as well as the relationship between changes in ESG performance and changes in Tobin's Q. In combining accounting measures, value-based indicators, and market reactions, this paper aims to provide a more comprehensive view of ESG-performance linkages in the Indian setting.

By situating the analysis in an emerging economy, the study also extends the existing ESG literature, which remains dominated by evidence from developed markets. Differences in institutional frameworks, regulatory enforcement, and investor expectations mean that ESG outcomes in India cannot be assumed to mirror those elsewhere (Aggarwal & Singh, 2019). The findings therefore carry practical relevance for managers seeking to justify sustainability investments, for investors evaluating acquisition strategies, and for policymakers interested in strengthening the role of ESG in capital-intensive sectors.

Based on the premise above it is essential to test the following research questions.

To check ESG-Performance Linkage,

RQ1: Does a change in ESG scores following acquisition announcements significantly influence the financial performance of firms in capital-intensive industries in India?

To check market valuation Impact,

RQ2: How do pre- and post-acquisition changes in ESG scores affect firms' market valuation in these industries?

This research is premised on the capital-intensive sectors of India, where mergers and acquisitions represent strategic shifts that can reshape both financial performance and sustainability priorities. By concentrating on acquisition announcements rather than only completed deals, the study narrows its focus to a moment that is most likely to influence investor perception and firm-level ESG strategies. The sample is drawn from NSE 500 acquiring firms between 2010 and 2020, allowing for an industry-specific and time-bound evaluation while still capturing meaningful variations across firms and sectors.

The study aims to explore whether changes in ESG scores following acquisition announcements carry measurable consequences for firm performance and market valuation. In doing so, it assesses how sustainability practices are interpreted by both internal stakeholders, reflected in financial outcomes, and external stakeholders, reflected in market reactions. The broader objective is to clarify whether ESG improvements in resource-intensive industries translate into tangible value creation, or whether such changes remain more symbolic in the short run.

2 LITERATURE REVIEW

2.1 Theoretical Foundations

Corporate sustainability draws on established theoretical frameworks that explain why firms integrate non-financial factors into strategy. Stakeholder theory (Freeman, 1984) emphasizes that firms operate within networks of stakeholders whose expectations shape corporate outcomes. Alignment with these groups can reduce reputational risks and enhance legitimacy (Donaldson & Preston, 1995; Awan et al., 2021). Carroll's CSR pyramid (Carroll, 1979) outlines layered obligations—economic, legal, ethical, and philanthropic—that influence how corporations are evaluated by society. Elkington's Triple Bottom Line (1998) further broadens corporate performance to include social and environmental dimensions. These frameworks converge to suggest that ESG practices are not peripheral but central to long-term competitiveness, especially in industries with high externalities.

2.2 ESG and Its Dimensions

The concept of ESG has evolved as a structured framework to evaluate firms' sustainability practices. Rating agencies now quantify ESG performance to aid investors and policymakers (Alareeni & Hamdan, 2020). The environmental pillar focuses on resource efficiency, pollution control, and climate resilience, particularly critical for sectors such as metals and mining and chemicals, where emissions, waste, and hazardous by-products are major concerns (Hilson, 2012; Kolk & Pinkse, 2008). The social pillar emphasizes workplace safety, diversity,

and community relations (Turban & Greening, 1997; Jenkins & Yakovleva, 2006). For example, mining firms often face pressure from local communities affected by displacement or pollution (Kapelus, 2002). The governance dimension encompasses transparency, shareholder rights, and board accountability, which are essential to control agency risks in large capital projects (Fama & Jensen, 1983; Klapper & Love, 2004).

Evidence on ESG's effectiveness is mixed. Some studies find that ESG strength improves operational efficiency and investor confidence (Derwall et al., 2005; Gillan et al., 2021), while others document neutral or negative effects, particularly when sustainability investments raise short-term costs (Brammer et al., 2006; Nollet et al., 2016). The divergence underscores the importance of context, with heavy industries facing sharper trade-offs than service sectors (Friede et al., 2015).

2.3 Measures of Financial Performance

Accounting-based performance measures are frequently used in sustainability research. Return on Assets (ROA) captures resource-use efficiency, Return on Equity (ROE) measures shareholder returns, and Return on Capital Employed (ROCE) evaluates effectiveness of capital deployment (Waters, 2011). Other metrics such as Economic Value Added (EVA) and Earnings per Share (EPS) extend analysis to value creation for investors (Lee et al., 2009).

Empirical evidence is divided. Positive links have been found between ESG factors and financial efficiency (Peiris & Evans, 2010; Zhao et al., 2018; Dalal & Thaker, 2019), often explained by reduced financing costs and improved stakeholder trust (Lo & Sheu, 2007). Yet, other work suggests sustainability expenditures may suppress profitability in the short term, particularly in capital-intensive industries where compliance and transformation costs are high (Elsayed & Paton, 2005; Mittal et al., 2008). Meta-analyses conclude that while long-term gains are possible, short-term results often remain neutral (Orlitzky et al., 2003).

2.4 Market-Based Valuation: Cumulative Abnormal Returns (CAR)

Event studies use Cumulative Abnormal Returns (CAR) to capture how markets react to firm-specific events. CAR compares realized returns with expected returns over a defined event window (MacKinlay, 1997). Positive CAR indicates favorable market response, while negative CAR reflects investor concerns.

Research suggests ESG moderates CAR outcomes around mergers and acquisitions. Firms with strong ESG reputations often experience positive CAR because investors anticipate lower integration risks and improved stakeholder acceptance (Servaes & Tamayo, 2013; Aktas et al., 2011). By contrast, firms with weak ESG credentials may suffer negative CAR due to perceived liabilities (Cai et al., 2016). This is especially relevant in metals and chemicals, where acquisitions can amplify environmental and governance risks, making markets particularly sensitive to ESG signals (Kemp et al., 2012).

2.5 Market-Based Valuation: Tobin's Q

Beyond short-term event reactions, Tobin's Q offers a long-term valuation measure by comparing the market value of assets to their replacement cost (Tobin, 1969). A higher ratio suggests that markets reward intangible factors such as innovation, brand value, or credible ESG commitments.

Several studies document positive associations between ESG and Tobin's Q (Lo & Sheu, 2007; Filbeck et al., 2009; Velte, 2017), suggesting that sustainability enhances growth prospects. However, neutral or negative effects are also reported, particularly in contexts where ESG initiatives are perceived as excessive relative to returns (Nollet et al., 2016; Garcia & Orsato, 2020). In capital-intensive industries, Tobin's Q provides a critical lens: investors may reward long-term environmental investments that reduce regulatory risks, but penalize firms that incur heavy compliance costs without visible benefits.

2.6 ESG in Capital-Intensive Industries: Metals and Chemicals

The metals and mining and chemical sectors are uniquely positioned for ESG analysis because they combine high capital intensity with significant environmental and social externalities. These industries require massive fixed investments, operate under strict regulations, and often confront societal resistance (Hilson, 2012; Jenkins & Yakovleva, 2006). Environmental risks include greenhouse gas emissions, water contamination, and hazardous waste (Cairncross, 1994). Social risks involve occupational safety, labor disputes, and community displacement (Kapelus, 2002). Governance, meanwhile, ensures transparency and accountability in projects that involve long lead times and substantial financial commitments (Bauer et al., 2010).

Scholars argue that ESG engagement in such industries secures a "social license to operate" and facilitates access to green financing (Gunningham et al., 2004; Humphreys, 2000). Yet, the ESG paradox persists: while strong ESG performance may enhance reputation and reduce risk in the long run, the upfront costs of compliance

often depress profitability in the short run (Elsayed & Paton, 2005; Mittal et al., 2008). Empirical work thus emphasizes the need to combine both accounting-based measures (ROA, ROE, ROCE) and market-based indicators (CAR, Tobin's Q) to capture the multifaceted effects of ESG practices in these industries.

2.7 Synthesis and Research Gap

While ESG is widely studied, findings remain mixed and are often cross-industry or focused on developed markets. Capital-intensive sectors such as metals and chemicals, with high environmental and social risks, remain underexplored in the Indian context. Moreover, most studies emphasize either accounting-based or market-based measures, without integrating both perspectives.

3 Objectives of the Study

To test whether changes in ESG scores around acquisition announcements are associated with changes in financial performance (ROA, ROE, ROCE) in capital-intensive industries.

To evaluate how pre- and post-acquisition changes in ESG scores affect market valuation, measured through Cumulative Abnormal Returns (CAR) and Tobin's Q, in the metals and chemicals sectors.

The flow of analysis is as follows: first, paired t-tests are conducted to examine changes in ESG scores (overall and E, S, G pillars) and financial ratios (ROE, ROA, ROCE) before and after acquisition announcements. Next, regressions are used to test whether changes in ESG scores explain changes in financial ratios. Finally, the impact of ESG changes on market valuation is evaluated through regressions with CAR and Tobin's Q. Based on this sequence, the following hypotheses are formulated.

4 Hypothesis

To test whether there are significant changes in ESG scores (overall and E, S, G pillars) and in financial performance measures, including traditional indicators (ROE, ROA, ROCE) and modern value-based metrics (EVA, MVA), following acquisition announcements,

Hypotheses (paired t-tests)

H0-1: The mean change in the acquirer's overall ESG score is zero.

H0-2: The mean change in Environmental (E), Social (S), and Governance (G) scores is zero.

H0-3: The mean change in ROE is zero.

H0-4: The mean change in ROA is zero.

H0-5: The mean change in ROCE is zero.

H0-6: The mean change in EVA is zero.

H0-7: The mean change in MVA is zero.

Test: Paired sample t-test (pre vs. post), with Cohen's d as effect size.

To evaluate whether changes in ESG scores are associated with changes in financial ratios,

Hypotheses (accounting-based regression)

H1: Δ ESG has no significant effect on Δ ROE.

H2: Δ ESG has no significant effect on Δ ROA.

H3: Δ ESG has no significant effect on Δ ROCE.

(Δ E, Δ S, Δ G \rightarrow Δ financial ratios)

Test: OLS regression of Δ Financial Ratio on Δ ESG.

To examine whether changes in ESG scores explain market reactions and long-term valuation,

Hypotheses (market value-based regression)

H4: Δ ESG has no significant effect on CAR around acquisition announcements.

H5: Δ ESG has no significant effect on Tobin's Q.

Test: OLS regression of CAR and Tobin's Q on Δ ESG.

5 DATA AND METHODOLOGY

5.1 Study sample

Acquisition events are treated as sample units, with announcement dates as event triggers. From 620 acquisitions by NIFTY 500 firms (2010–2020), 209 acquiring companies were identified. For focused analysis, the study considers two capital-intensive sectors: metals and mining (27 units) and chemicals (16 units).

5.2 Study variable

The study examines both market-based and accounting-based outcomes around acquisition announcements. Market performance is captured through cumulative abnormal returns (CAR) and Tobin's Q, while accounting performance is assessed using ROA, ROE, and ROCE. The key explanatory constructs are ESG scores and their three pillars (E, S, G), since the impact of one dimension may offset another (Margolis & Walsh, 2003; Brammer et al., 2006; Buallay et al., 2020). To reduce omitted variable bias, firm-level controls are introduced following prior research (Dkhili, 2024; Zumente & Bistrova, 2021): for accounting-based regressions (ROA, ROE, ROCE) we use the natural logarithm of book value (LnBV), debt ratio, and asset turnover (AT), whereas for value-based regressions (CAR, Tobin's Q) we use LnBV, debt ratio, and ROA. Any variable expressed with the delta sign (Δ) denotes its pre- to post-acquisition change, e.g., ΔE refers to the percentage change in environmental score based on the announcement date.

5.3 Period of Study

The study covers January 2010 to December 2020, providing a decade-long window for pre- and post-acquisition analysis. This period was chosen as ESG reporting in India became more structured and reliable, while also avoiding distortions from the COVID-19 era.

5.4 Methodology

A paired sample t -test is applied to examine differences in pre- and post-acquisition values of ESG scores (overall and E, S, G pillars) and financial performance measures (ROE, ROA, ROCE, EVA, MVA). This test is appropriate because each firm serves as its own control, allowing within-firm changes to be captured directly.

The test statistic is given by:

$$t = (\bar{d}) / (sd / \sqrt{n})$$

To complement statistical significance, Cohen's d is reported as an effect size for paired designs.

$$d = \bar{d} / sd$$

This provides an indication of the magnitude of change, with benchmarks of 0.2 (small), 0.5 (medium), and 0.8 (large) effects (Cohen, 1988). Reporting both p -values and effect sizes ensures that results reflect not only whether changes are statistically significant but also whether they are practically meaningful.

For both the above methods,

\bar{d} = mean differences between paired observations

sd = standard deviation of the differences

n = number of pairs

Thereafter event study is conducted where the abnormal return (AR) and cumulative abnormal return (CAR) are estimated using the market model proposed by Sharpe (1963) represented as follows:

$$AR_{it} = R_{it} - (\alpha_1 + \beta_1 R_{mt})$$

$$CAR(t1, t2) = \sum_{t=t1}^{t2} AR_t$$

Where,

AR_{it} = Abnormal return.

R_{it} = Observed return.

R_{mt} = Market return.

(i and t represents security and time respectively)

Event windows from day -40 to +40 around the acquisition announcement were used to compute cumulative abnormal returns (CAR). A total of 24 windows were considered, grouped into trailing (pre-event), forward (post-event), overall (spanning both sides), and trailing excluding event-day windows, enabling a comprehensive assessment of anticipatory, immediate, and adjustment effects.

For the Accounting based regression, the models are as follows:

$$\Delta ROE_{it} = \beta_0 + \beta_1 \Delta ESG_{it} + \beta_2 \Delta \ln BV_{it} + \beta_3 \Delta Debt\ ratio_{it} + \beta_4 \Delta AT_{it} + e_{it}$$

$$\Delta ROCE_{it} = \beta_0 + \beta_1 \Delta ESG_{it} + \beta_2 \Delta \ln BV_{it} + \beta_3 \Delta Debt\ ratio_{it} + \beta_4 \Delta AT_{it} + e_{it}$$

$$\Delta ROA_{it} = \beta_0 + \beta_1 \Delta ESG_{it} + \beta_2 \Delta \ln BV_{it} + \beta_3 \Delta Debt\ ratio_{it} + \beta_4 \Delta AT_{it} + e_{it}$$

$$\Delta EVA_{it} = \beta_0 + \beta_1 \Delta ESG_{it} + \beta_2 \Delta \ln BV_{it} + \beta_3 \Delta Debt\ ratio_{it} + \beta_4 \Delta AT_{it} + e_{it}$$

$$\Delta EVA_{it} = \beta_0 + \beta_1 \Delta ESG_{it} + \beta_2 \Delta \ln BV_{it} + \beta_3 \Delta Debt\ ratio_{it} + \beta_4 \Delta AT_{it} + e_{it}$$

The same is repeated for ΔE , ΔS and ΔG .

For market value-based regression,

$$CAR_{it} = \beta_0 + \beta_1 ESG_{i,t-1} + \beta_2 \ln BV_{i,t-1} + \beta_3 Debt\ ratio_{i,t-1} + \beta_4 ROA_{i,t-1} + e_{it}$$

The same is repeated for E, S and G for 24 event windows.

$$\Delta \text{Tobin's } Q_{it} = \beta_0 + \beta_1 \Delta \text{ESG}_{it} + \beta_2 \Delta \text{LnBV}_{it} + \beta_3 \Delta \text{Debt Ratio}_{it} + \beta_4 \Delta \text{ROA}_{it} + e_{it}$$

The same is repeated for ΔE , ΔS and ΔG .

5.5 Error Corrections

Each of the four variables—ESG, E, S, and G—is tested separately for its effect on CAR and Tobin’s Q, yielding multiple models for each period. To control family-wise error, the Holm–Bonferroni method is applied, as it is less conservative than the standard Bonferroni approach and reduces the risk of Type II errors (Armstrong, 2014; Eichstaedt et al., 2013). The adjusted significance levels for the four tests are: rank 1 = 0.0125, rank 2 = 0.0167, rank 3 = 0.025, and rank 4 = 0.05.

5.6 Winsorization

Tobin’s Q is sensitive to outliers arising from market anomalies or accounting distortions, which can skew results and lead to misleading inferences. To address this, the study applies winsorization at the 1st and 99th percentiles, replacing extreme values with their respective cutoff points (L. Brown & Caylor, 2006). This reduces variance distortion, improves normality, and enhances robustness. Although residual normality tests were not performed, the combined use of winsorized values and change variables mitigates bias from outliers, unobserved heterogeneity, and potential endogeneity, strengthening the reliability of the estimations.

6 Analysis

As seen in Table 1, the Metals and Mining sector demonstrates stronger ESG-related improvements compared to the Chemical industry. While both industries record large overall ESG gains, Metals and Mining shows significant environmental and governance improvements, with effect sizes in the medium–large to large range, whereas the Chemical industry records only small changes in environment and moderate gains in social and governance aspects.

In terms of traditional financial metrics, Metals and Mining reflects moderate improvements in ROE and slight gains in ROCE and ROA, though not statistically significant. In contrast, the Chemical industry shows negligible to small gains in these metrics, with minimal change in ROE and relatively weak ROCE and ROA growth.

Modern metrics further highlight the divergence. Metals and Mining records moderate gains in EVA and MVA, both statistically significant, underscoring value creation post-acquisition. The Chemical industry, however, displays negligible changes in EVA and MVA, indicating limited value addition in modern financial performance measures.

Table 1 Comparative ESG and Financial Changes of Metals and Mining vis-à-vis Chemical Industry

Category	Metric	Metals and Mining			Chemical		
		Paired test	Effect Size (Cohen’s d)	Interpretation	Paired test	Effect Size (Cohen’s d)	Interpretation
ESG	ESG	0.001***	0.889 (Large)	Substantial ESG gain	0.019**	0.870 (Large)	Meaningful ESG gain
	E	0.022**	0.694 (Medium–Large)	Environmental gain	0.875	0.246 (Small)	Slight improvement in E
	S	0.031**	0.381 (Small–Medium)	Social improvement	0.002***	0.719 (Medium–Large)	Moderate improvement
	G	0.000***	1.009 (Large)	Strong governance gain	0.137	0.496 (Medium)	Moderate governance gain

Traditional	ROE	0.109	0.591 (Medium)	Moderate ROE gain	0.513	-0.069 (Negligible)	Minimal ROE change
	ROCE	0.109	0.379 (Small-Medium)	Slight ROCE gain	0.533	0.218 (Small)	Weak ROCE gain
	ROA	0.215	0.375 (Small-Medium)	Slight ROA gain	0.335	0.314 (Small)	Small ROA gain
Modern	EVA	0.043**	0.472 (Small-Medium)	Moderate EVA gain	0.654	0.072 (Negligible)	Minimal EVA change
	MVA	0.029**	0.477 (Small-Medium)	Moderate MVA gain	0.549	0.059 (Negligible)	Minimal MVA change

Curated by the authors. *** = .01 sig. **=.05 sig. *=.10 sig.

Table 2 presents the effect of changes in ESG scores and their components (E, S, and G) on traditional (ROE, ROCE, ROA) and modern (EVA, MVA) performance measures for Metals and Mining and the Chemical industry. The coefficients (β) indicate the direction and magnitude of the effect, while significance is determined by the p-values.

For the overall ESG score, none of the associations with financial performance metrics are statistically significant in either industry, suggesting that aggregate ESG changes do not directly translate into improvements in profitability or value-based outcomes. When looking at the environmental (E) dimension, the results are also insignificant across all metrics, reflecting little standalone influence of environmental initiatives on financial performance.

The social (S) dimension stands out with consistent significance in the Chemical industry. Negative coefficients for ROE, ROCE, and ROA indicate that higher social scores are associated with declines in these profitability measures, pointing to possible short-term trade-offs between social investments and firm-level returns. For Metals and Mining, social scores positively affect ROE and ROA, though significance is marginal, suggesting a more favorable alignment between social initiatives and financial performance compared to the Chemical sector.

The governance (G) dimension shows weak to moderate effects, with some near-significant results in the Chemical industry—for instance, ROE ($p = 0.055$) and ROCE ($p = 0.088$). These results suggest that improvements in governance may exert a more direct influence on financial outcomes in chemicals, though the evidence is not statistically conclusive. It is also important to note that the strict Holm-Bonferroni correction was applied to control for family-wise error rates, which raises the significance threshold and may explain why these borderline values did not cross the conventional 5% level. For Metals and Mining, governance changes are generally insignificant, with coefficients even turning negative for ROE and ROA.

Overall, the table suggests that disaggregating ESG into its components provides deeper insights: while aggregate ESG scores show no significant financial impact, the social pillar in Chemicals exerts significant but adverse effects, and governance shows emerging importance in profitability measures. Metals and Mining, meanwhile, exhibits more positive but statistically weaker effects of social factors.

Table 2 Impact of ESG Score Changes on Financial Performance

Industry	ROE		ROCE		ROA		EVA		MVA	
	Metals and Mining	Chemical	Metals and Mining	Chemical	Metals and Mining	Chemical	Metals and Mining	Chemical	Metals and Mining	Chemical
β	2.138	0.233	-1.932	0.526	16.584	0.627	1.568	9.755	11.033	11.747

ESG	p value	0.819	0.799	0.84	0.539	0.419	0.564	0.876	0.2	0.302	0.166
	β	-3.216	-0.006	-2.116	0.001	-0.247	0	2.966	0.184	4.002	0.209
E	p value	0.475	0.743	0.648	0.935	0.981	0.97	0.541	0.244	0.446	0.166
	β	3.17	0.131** *	0.276	0.128***	8.517	0.156***	0.847	-0.716	2.476	-0.803
S	p value	0.137	0.001	0.904	0	0.066	0.001	0.724	0.12	0.333	0.121
	β	12.928	1.776	0.637	1.536	-7.981	1.837	-3.702	2.838	5.279	2.336
G	p value	0.346	0.055	0.964	0.088	0.797	0.113	0.805	0.761	0.341	0.824
	β										

Curated by the authors. *** = .01 sig. **=.05 sig. *=.10 sig.

Table 3: Effect of ESG metrics on CAR

		Effect of overall ESG score on CAR				Effect of environmental score on CAR				Effect of social score on CAR				Effect of governance score on CAR			
		Metals and Mining		Chemicals		Metals and Mining		Chemicals		Metals and Mining		Chemicals		Metals and Mining		Chemicals	
Period	Event window	Coeff.	P value	Coeff.	P value	Coeff.	P value	Coeff.	P value	Coeff.	P value	Coeff.	P value	Coeff.	P value	Coeff.	P value
Trailing	(-40, 0)	-0.0092	0.029	0.011**	0.014	-0.007*	0.001	0.005	0.012	-0.002	0.009	0.008**	0.005	0.011	0.038	0.011*	0.008
	(-30, 0)	-0.0118	0.014	0.007**	0.008	-0.009**	0.002	0.002	0.031	-0.004	0.030	0.006***	0.009	0.013	0.026	0.008*	0.007
	(-20, 0)	-0.012*	0.004	0.007***	0.008	-0.008***	0.004	0.003	0.014	-0.002	0.039	0.006***	0.003	0.016*	0.007	0.007*	0.007
	(-10, 0)	-0.0073	0.012	0.005**	0.008	-0.005**	0.007	0	0.063	-0.004	0.040	0.004***	0.004	0.011	0.011	0.003	0.024
	(-5, 0)	-0.005*	0.009	0.002	0.016	-0.004**	0.007	0.002	0.016	-0.001	0.056	0.002**	0.008	0.007	0.016	0.002	0.032

	(-2,0)	0.00232	0.002	0.00226	0.0022*	0.002097	0.00201	0.00201	0.00201	0.00201	0.00201	0.00201	0.00203	0.00203	0.00203	0.00203	0.00203
Forward	(0,2)	0.00938	0.002	0.00345	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0,5)	0.00637	0.002	0.00436	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0,10)	0.00018	0.003	0.00381	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0,20)	0.00049	0.002	0.00591	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0,30)	0.0009*	0.003	0.00407	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0,40)	0.0009*	0.006	0.00193	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Total	(-40,+40)	0.0016*	0.007**	0.00022	0.0001**	0.00014	0.00009*	0.00006	0.00005	0.00003	0.00002	0.00001	0.00001	0.00001	0.00001	0.00001
	(-30,+30)	0.0018*	0.007**	0.00028	0.0002***	0.00009	0.00004	0.00004	0.00004	0.00004	0.00004	0.00004	0.00004	0.00004	0.00004	0.00004	0.00004
	(-20,+20)	0.0014*	0.009*	0.0007	0.0009***	0.00008	0.00004	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
	(-10,+10)	0.0006	0.007*	0.00063	0.0004*	0.00006	0.00003	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
	(-5,+5)	0.00054	0.003	0.00195	0.0003**	0.00005	0.00002	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
	(-2,+2)	0.00015	0.003	0.00103	0.0001	0.00004	0.00002*	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001

Trailing event date)	-40	-	0.011**	-	-	-	0.005	-	-	-	0.007**	-	0.008	-	0.012*	-
		0.007	0.0362	0.014	0.006	0.0103	0.001	0.014	0.002	0.073	0.001	0.007	0.011	0.047	0.012*	0.0058
	-30	-	0.007**	-	-	-	0.002	-	-	-	0.005***	-	0.011	-	0.008*	-
		0.001	0.0177	0.003	0.007**	0.003	0.003	0.0389	0.004	0.028	0.008	0.009	0.011	0.033	0.008*	0.0044
	-20	-	0.007**	-	-	-	0.002	-	-	-	0.005***	-	0.014*	-	0.007*	-
		0.001*	0.0052	0.001	0.007***	0.006	0.002	0.0203	0.002	0.0378	0.005	0.014*	0.0089	0.007*	0.0048	0.0048
-10	-	0.004**	-	-	-	0.002	-	-	-	0.003***	-	0.008	-	0.004	-	
	0.005	0.0149	0.0028	0.004**	0.0046	0.0027	0.005	0.025	0.001	0.0318	0.007	0.008	0.0142	0.004	0.0164	
-5	-	0.001	-	-	-	0	-	0	-	0.001*	-	0.008	-	0.002	-	
	0.004*	0.007	0.0278	0.003**	0.0015	0	0.0974	0.0055	0.0088	0.001*	0.005	0.008	0.0142	0.002	0.0172	
-2	-	0.001	-	0	-	0.001	-	0	-	0.001	-	0	-	0.001	-	
	0.001	0.0414	0.031	0	0.0408	0.001	0.0421	0.0055	0.0088	0.001	0.028	0	0.086	0.001	0.0698	

Curated by the authors. *** = .01 sig. ** = .05 sig. * = .10 sig.

Table 3 presents the effect of ESG metrics on CAR. Significant CARs cluster in pre-announcement (trailing) windows (-30,0; -20,0; -10,0; -5,0), while forward windows are largely null after Holm-Bonferroni correction. This timing indicates that investors update valuations before or around the announcement as information diffuses through ratings, media, lenders, and supply-chain channels; the formal notice mostly confirms prior beliefs. The lack of durable post-event reactions aligns with rapid information incorporation. ESG materiality is both pillar- and industry-specific. In chemicals, the social pillar—process safety, workforce health, community relations, product stewardship—drives the robust effects, and the aggregate ESG metric also survives correction. In metals and mining, the environmental pillar dominates, consistent with permitting risk, remediation liabilities, and land or water use. Governance signals are intermittent and non-systematic, suggesting governance quality may be priced continuously via lender oversight and board processes rather than discretely at an M&A event.

Where results persist after correction, coefficients are predominantly positive, implying that financially material ESG improvements are read as risk reduction or value creation through lower expected capital costs, fewer disruption risks, and stronger social licence to operate. Multiple overlapping windows and pillars necessitate Holm-Bonferroni control; retained findings are therefore conservative. Caveats remain: event-study CARs are associational, not causal; short-horizon signals should be triangulated with accounting (ROE, ROCE, ROA), value-based (EVA, MVA), and valuation (Tobin's Q) evidence. Generalization is most appropriate for heavy, capital-intensive settings with similar materiality profiles.

Table 4 Effect of ESG on firm value across industries

Regressand	D	ESG	E	S	G
Tobin's q					
	Coeff.	0.359	0.531***	0.144	-0.89
Metals and Mining	p-value	0.829	(<0.0001)	0.677	0.62

Chemicals	Coeff.	0.483	-0.124	0.018	1.124
	P-value	0.491	0.19	0.902	0.155

Curated by the authors. *** = .01 sig. ** = .05 sig. * = .10 sig.

Framed explicitly as a change-on-change specification, the evidence indicates that valuation responds only when the environmental pillar improves—and this effect is confined to the metals and mining industry as seen in table 4. The mechanism is consistent with reduced expected remediation costs, permitting risk, and long-horizon environmental exposures being priced by investors. The absence of effects for aggregate Δ ESG, social, and governance—or for any pillar in chemicals—suggests these changes are either already reflected in prices, diffuse over longer horizons, or too small around the event to move Δ Tobin's Q in this sample.

7 Investor Takeaway

For investors, the findings stress the importance of looking beyond aggregate ESG ratings and adopting a pillar-specific, industry-sensitive lens. In Metals and Mining, improvements in the environmental pillar signal reduced remediation and permitting risks, translating into tangible valuation gains and lower long-term capital costs. In contrast, Chemical firms' social initiatives may create near-term profitability pressures despite their relevance for regulatory compliance and reputation management. Governance signals remain mixed, but emerging evidence suggests they may gradually shape profitability, especially in Chemicals. Investors seeking value in capital-intensive industries should therefore focus on material ESG dimensions most relevant to sectoral risk exposures rather than treating ESG as a uniform construct. This approach can enhance portfolio screening, improve risk-adjusted returns, and align investments with sustainability-driven value creation.

8 CONCLUSION AND KEY INSIGHTS

The study highlights distinct industry-level differences in how ESG improvements influence financial outcomes. In Metals and Mining, stronger environmental and governance gains coincide with moderate profitability improvements and significant post-acquisition value creation through EVA and MVA. By contrast, the Chemical industry records smaller ESG advances, limited financial impact, and in some cases negative links between social scores and profitability.

Breaking ESG into components shows that aggregate changes mask material differences. The environmental pillar drives investor revaluations in Metals and Mining, while the social pillar in Chemicals exerts adverse short-term effects on returns, reflecting trade-offs between community and workforce investments and profitability. Governance signals remain weaker but show emerging relevance in Chemicals. Event-study evidence further suggests that valuation responses occur around announcements as markets price in ESG information early.

Overall, ESG's financial relevance is pillar-specific and industry-contingent. Metals and Mining benefits most from environmental advances, while Chemicals faces complex social trade-offs. For investors, this underlines the need to look past aggregate ESG scores and focus on material dimensions most aligned with sectoral risks and opportunities.

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