



Research Article

From ESG Strength to Reputational Risk: Evidence from Environmental Penalties in S&P 500 Firms

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Abstract

Environmental sanctions can generate financial consequences that extend well beyond the direct monetary cost of regulatory penalties, particularly when they conflict with firms' established sustainability reputations. This study investigates how financial markets respond to environmental penalties and whether prior ESG performance shapes the magnitude of this response. Using a comprehensive sample of environmental violations involving S&P 500 companies over the 2000-2024 period, we combine a market-model event-study framework with parametric and non-parametric tests and regression analysis of cumulative abnormal returns. The results show that environmental penalties are followed by negative abnormal stock returns, with the adverse market response becoming more pronounced and persistent over longer event windows. More importantly, the relationship between ESG performance and market reactions changes substantially after the Paris Agreement. From 2016 onward, firms characterized by stronger ESG profiles experience more negative stock-market reactions when environmental sanctions occur. Rather than providing reputational protection, high ESG credentials may therefore increase firms' exposure to market losses when observed environmental behavior conflicts with previous sustainability signals. We interpret this pattern as a "hypocrisy penalty", whereby investors react more strongly to misconduct when it represents a breach of expectations created by a firm's sustainability profile. The findings suggest that the financial implications of environmental misconduct increasingly depend not only on the violation itself but also on the consistency between corporate sustainability commitments and actual behavior. Overall, the study highlights the growing relevance of ESG credibility and perceived authenticity for investor assessment and capital-market valuation.

Keywords

Environmental Penalties, ESG Performance, Reputational Market Risk, Financial Markets, Market Reactions, Financial Econometrics

1. Introduction

Environmental violations are defined as a company's failure to comply with environmental regulations set by governmental authorities [1]. These violations represent a significant risk to both corporate performance [2] and investor trust [3]. Beyond the financial penalties imposed by regulatory author-

ities, such violations can lead to reputational damage, increasing perceived risk among stakeholders [4], and a negative impact on firms' market value [5]. Environmental penalties serve a dual function: on the one hand, they act as a deterrent, discouraging firms from engaging in environmentally harmful behaviors; on the other hand, they serve as a punitive measure,

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imposing direct financial costs and reputational consequences. This study provides a detailed analysis of the role of environmental penalties, exploring both their potential deterrent or punitive effects on firms' stock performance.

While the literature on the financial consequences of environmental violations has grown substantially in recent years [6], the majority of studies focus on emerging markets, particularly China. For example, [5] find that Chinese firms suffer significant stock price declines following penalties, with smaller firms and those penalized more severely being most affected. [7] show that CSR practices can shield firms from reputational harm, while [6] confirm the buffering role of CSR in mitigating firm value losses. However, many of these studies focus on limited timeframes - for example, 2015 - 2020 [5, 6] or 2010 - 2013 [8] - and do not fully account for the global regulatory and market shifts that followed the 2015 Paris Agreement. To address these gaps, our study shifts the focus to the United States, a developed market that remains not completely covered in this specific context. This choice is motivated by the need to assess whether dynamics observed in emerging markets also apply to mature financial systems. In the USA context, [9] replicate [10] in the U. S. setting and find that legal penalties have a more pronounced effect on stock prices than reputational damage. [11] further investigate how ESG-related news influences short- and long-term returns, using advanced techniques such as rolling portfolios and overlapping returns. However, even within U.S.-based research, environmental violation data are often drawn from media coverage or self-reported disclosures, which may be biased or incomplete. Although several recent studies in China have started to incorporate regulator-verified environmental penalties as indicators of environmental misconduct [12, 13], evidence from developed markets remains limited. Existing work in the U. S. focuses largely on operational and regulatory outcomes rather than financial-market reactions [14]. In contrast, our study leverages Violation Tracker¹, a government-sourced and systematically maintained database of corporate misconduct, which allows for a more objective and comprehensive identification of environmental sanctions, thereby strengthening the reliability and validity of our empirical analysis.

Despite growing interest, three important gaps persist in the literature. First, evidence from developed markets using regulator-verified environmental penalties remains scarce. Most studies rely on media reports or self-disclosures, which produce selection bias and fail to capture the full scope of environmental misconduct. Studies such as [12] and [13] highlight the potential of using penalties as objective measures of corporate misconduct, but this approach has rarely been applied in the U. S. context. Second, the question of how ESG performance interacts with negative events is not completely resolved. Some studies suggest that ESG strengths accumulate reputational capital that dampens market reactions to adverse shocks

[15-17], while others show that ESG commitments can backfire when firms behave inconsistently with their sustainability claims [7, 18] provide evidence that long-term CSR can buffer market penalties in China, but the protective effect may vanish under repeated or severe violations. Third, few studies explicitly examine whether markets interpret sustainability failures as hypocrisy - particularly in the context of large, publicly traded firms with strong ESG reputations. Research on greenwashing and hypocrisy [19, 20] acknowledges stakeholder skepticism, but empirical evidence linking these perceptions to market penalties remains limited. [7, 12, 13], suggest that penalties can serve as signals of ESG-performance misalignment, yet almost no study has systematically examined their impact on stock prices for high-ESG firms in developed markets for a long time-period.

Following [21], who analyzed reputational costs among Chinese firms, the main goal of this study is to quantify a component of reputational cost - measured as loss in stock value - of poor environmental performance among companies listed on the S&P 500 index. Specifically, we investigate (1) whether environmental sanctions negatively impact firm value; (2) whether prior ESG performance mitigates or amplifies reputational damage following environmental sanctions; (3) whether a strong corporate ESG profile, when followed by an environmental penalty, is perceived as hypocritical, thereby worsening external perception and exacerbating stock value losses. These research questions are examined through an integrated financial-econometric framework combining market-model event-study estimation, parametric and non-parametric inference, and regression-based modeling of cumulative abnormal returns.

This third research question is examined from a temporal perspective through an additional comparison between pre- and post-Paris Agreement periods. The Paris Agreement - considered a pivotal event in global climate governance - has played a key role in pushing policymakers toward stricter environmental policies [22], in response to the United Nations' call for urgent sustainability transformation [23], and in increasing stakeholders' environmental awareness and expectations [24]. Consistent with this view, [25] identify the Paris Agreement as a relevant turning point in investors' expectations, showing that negative market reactions to climate-policy announcements became more widespread after the Agreement came into force. We provide new insights into how the post-Paris regulatory landscape has influenced market expectations and reactions to ESG inconsistencies. In particular, we build on studies such as [26], who show that ESG can mitigate stock price volatility following negative events through enhanced reputational capital; [27], who highlights the stabilizing role of brand strength during crises; and [28], who demonstrate how robust environmental governance reduces the likelihood of market crashes - especially under weak external oversight.

¹ <https://violationtracker.goodjobsfirst.org/>

The core contribution of this study lies in introducing and empirically validating the concept of the “hypocrisy penalty”, which we define as the intensified negative market reaction to environmental penalties when the sanctioned firm has a strong prior ESG profile. We argue that when companies project a highly sustainable image but subsequently engage in environmentally harmful behavior, investors perceive a discrepancy between communicated commitments and actual practices. This perceived inconsistency functions as a breach of trust, triggering stronger reputational losses compared to firms with weaker ESG credentials. In this sense, ESG performance does not always serve as reputational insurance; instead, it can magnify the financial consequences of misconduct by raising stakeholder expectations. We further show that this “hypocrisy penalty” becomes significantly stronger in the post-Paris Agreement period. The heightened regulatory pressure, increased scrutiny from stakeholders, and the institutionalization of ESG reporting amplify investor sensitivity to inconsistencies between sustainability claims and environmental performance. By comparing pre- and post-2016 market reactions, we demonstrate that the evolving climate policy landscape contributes to greater intolerance for ESG-behavior mismatches. We assess whether this global shift has contributed to a stronger “hypocrisy effect”, where sustainability failures by high-ESG firms are met with greater investor disappointment and more severe market penalties, as captured by cumulative abnormal returns (CARs).

Our study contributes to environmental finance and ESG literature by integrating a reputation-based perspective linked to market volatility, using robust, government-sourced data on environmental penalties and providing new insights on how the post-Paris regulatory landscape has influenced market expectations and reactions to ESG inconsistencies. From a financial-econometric perspective, the study combines market-model event-study estimation with conventional cross-sectional inference and non-parametric sign- and rank-based procedures. This integrated framework makes it possible to examine both the average magnitude and the distributional structure of investors’ reactions, distinguishing a broadly diffused market response from an aggregate effect driven by more pronounced losses among a subset of sanctioned firms. The subsequent regression analysis further investigates the firm-level and institutional factors explaining the cross-sectional heterogeneity in cumulative abnormal returns. By conceptualizing and measuring the “hypocrisy penalty”, we contribute to ongoing conversations on reputational capital, signaling, and stakeholder expectations, suggesting that authenticity may represent an increasingly financially material dimension of corporate sustainability performance.

The research is structured as follows. Section 2 reviews the literature on environmental violations, ESG scores, and market reactions to sustainability, and outlines the theoretical frameworks that inform our hypotheses. Section 3 presents the data and the methodology. Section 4 discusses the empirical results, while Section 5 reports the robustness tests. Finally,

Section 6 provides the final remarks, highlighting the implications of our results for investors, policymakers, and corporate decision-makers.

2. Literature Review

2.1. Theoretical Framework

Environmental penalties serve as a critical tool for promoting regulatory compliance and encouraging more responsible corporate behaviour, signalling non-compliance while influencing investors’ risk perception, with direct implications for market value [29]. Their impact extends beyond the direct financial costs of fines, affecting corporate reputation [30], stakeholder trust [5], and, consequently, long-term competitiveness. Environmental violations can create a vicious cycle of uncertainty, leading to negative effects on stock value. [31] highlight that environmental penalties may incentivize greenwashing practices, particularly among firms with weak internal controls, high competition, or significant environmental impact. Such companies may adopt superficial sustainability strategies rather than implementing structural changes, aiming to minimize the costs of true sustainability commitments while attempting to mitigate the negative effects of penalties.

To understand how financial markets react to environmental penalties, this study draws on three theoretical frameworks: signalling theory, stakeholder theory, and institutional theory. These perspectives help explain why and how environmental penalties impact corporate financial performance, investor perception, and firm behaviour.

According to signalling theory [32], in situations of information asymmetry, firms send signals to the market to reduce uncertainty and influence investment decisions [33]. Environmental penalties act as negative signals, leading investors to perceive them as indicators of poor environmental management. This increased risk perception reduces confidence in a firm’s future performance, contributing to stock price declines [15, 34]. Investors anticipate potential future penalties, legal costs, and reputational damage, which exacerbate negative stock reactions. However, firms with strong ESG commitments can attenuate these negative effects [30], reassuring investors about their ability to effectively manage environmental challenges [6]. In this context, environmental transparency plays a crucial role in mitigating such effects. Firms that proactively disclose environmental information - both positive and negative - are perceived as more reliable by stakeholders [1]. Moreover, early disclosure of environmental violations can mitigate the loss of investor trust, as a company that openly communicates its challenges may be perceived as more responsible compared to one whose involvement emerges through third-party sources [35, 36].

From a stakeholder theory perspective [37], companies that fail to meet environmental standards risk damaging relationships with key stakeholders, negatively impacting their financial performance [38]. Environmental penalties generate three

major risks: reputational damage, increased regulatory scrutiny, and a higher risk of divestment by institutional investors [2, 5]. However, firms with strong ESG strategies can mitigate these effects by protecting their reputation and reducing stock price volatility [7]. Sustainable business practices reassure investors and help firms maintain legitimacy in the eyes of the public and regulatory authorities, ultimately reducing the risk of future penalties [39].

Institutional theory [40] highlights that firms align with regulatory and social pressures to ensure long-term survival. As sustainability standards evolve, firms face greater market penalties for non-compliance. Those that fail to adapt to changing environmental expectations experience stronger financial consequences, whereas those with strong ESG performance signal compliance, mitigating the adverse effects of environmental penalties.

2.2. Reputation, Perceived Risk and Market Reaction

The stock market reaction of a company reflects how the financial market reacts to external events that may influence risk perception and investor behaviour [41]. Significant events - whether positive or negative - alter expectations regarding the company's future performance, leading to variations in stock returns. In this context, event study methodology serves as a fundamental tool for analysing the impact of specific events on stock market performance [42-44]. Since abnormal returns around corporate events may depart from normality and may be affected by skewness, extreme observations and event-induced changes in volatility, the event-study literature has also developed non-parametric inferential procedures based on signs and ranks. These methods provide distribution-free evidence that complements conventional cross-sectional tests and allows researchers to assess whether event-related effects reflect a broad distributional shift or are driven by a limited number of extreme observations [45-47]. When a relevant event occurs, investors adjust their expectations regarding the company's future profitability, causing variations in stock prices. However, several studies suggest that the market reaction is more pronounced for negative events than for positive ones. [48] finds that negative ESG news triggers a stronger unfavourable market reaction, with a particularly pronounced impact on events related to environmental issues. In contrast, positive ESG news does not generate an equally significant effect and, in some cases, may even result in a slightly negative reaction, especially if perceived as a signal of agency problems.

According to perceived risk theory, investors tend to overestimate uncertainty following negative events, amplifying risk perception and significantly influencing market dynamics [49]. Instead, a strong ESG commitment can serve as a risk mitigation mechanism. [50] demonstrate that during the 2008 financial crisis, firms with high CSR commitment recorded superior stock performance compared to those with weaker sustainability commitment. This effect is attributed to the social capital accumulated by responsible companies, which act

as a protective factor during periods of uncertainty. Investor risk perception is influenced not only by a firm's financial performance but also by its reputation and ESG management strategies. [51], for example, highlight that a strong environmental reputation can improve market performance. However, it is essential that a company's environmental actions are perceived as genuine. When a company with a high ESG reputation becomes involved in a negative ESG event, the market may react more severely, viewing the event as an attempt at deception and damaging the company's reputation. Companies with a strong ESG reputation are more vulnerable to negative impacts on their market valuation in the event of a reputational crisis, especially if the event in question is perceived as being in contrast to their stated values. A particularly critical case is greenwashing, where companies exaggerate their sustainability commitments without implementing meaningful changes, ultimately damaging their credibility. When companies are exposed for misleading environmental claims, the market reacts severely, generating negative CARs and reducing investor trust [52]. The market tends to interpret greenwashing as a signal of poor managerial transparency, amplifying reputational and financial damage.

[53] further refine this perspective by examining how firms' financial structures interact with ESG reputational risk. They show that when companies with excess cash holdings face negative assessments related to ESG issues, investors interpret the combination as a red flag, indicating weak governance or a lack of managerial discipline. However, the study also finds that firms that engage in active payout policies can partially offset this perception, as such actions signal financial transparency and stakeholder alignment. Moreover, [54] argue that while CSR reputational capital may act as a cushion in the short term, it can transform into a moral liability in the long term. When high CSR firms fail to meet elevated stakeholder expectations, they may face harsher market reactions, as the breach of trust generates greater disillusionment. This supports the idea that ESG reputation must be constantly reinforced through authentic behavior. Supporting this dynamic, [21] provide empirical evidence from China demonstrating that environmental violations lead to significant and persistent declines in stock value, particularly when the company lacks a credible track record of voluntary ESG commitment. In such cases, investors interpret regulatory action not merely as a fine, but as a signal of systemic irresponsibility. [13] similarly highlight that environmental penalties act as a particularly strong deterrent in this context, as firms penalized for environmental violations face the dual risk of financial penalties and heightened investor scepticism. This dynamic is expected to be even more pronounced in the post-Paris Agreement period, where stricter regulations and increasing stakeholder scrutiny make investors less tolerant of ESG inconsistencies. Based on these insights, we propose the following hypothesis:

H1. Environmental penalties generate negative CARs.

2.3. ESG Performance and Environmental Penalties as Mitigation and Punishment Signals

ESG scores represent a key and reliable measure for evaluating a firm's sustainability performance and financial risk by identifying companies with responsible management practices [55, 56]. Several studies confirm that companies with high ESG scores tend to have better risk management and superior financial performance. For example, [57] demonstrate that companies with a strong ESG commitment exhibit lower financial risk because ESG practices help predict and mitigate operational, regulatory, and reputational risks. Similarly, previous evidence suggests that ESG scores are positively associated with financial performance and investment outcomes [57, 58]. In fact, from an institutional theory perspective, regulatory and social pressures push firms to adhere to higher ESG standards to maintain their legitimacy and meet stakeholder expectations. Consequently, companies with high ESG scores are perceived as more solid and trustworthy, reducing the likelihood of excessive market reactions to negative events. [59] analyse the impact of ESG scores on firms listed in the S&P 500, confirming that companies with higher ESG ratings achieve better financial performance and exhibit greater resilience during economic crises. Also, [60] emphasize that ESG scores play a crucial role in determining market reactions to new information, influencing investor response and stock price fluctuations. Their study demonstrates that firms with high ESG scores tend to exhibit more positive stock reactions following favourable news, suggesting that a strong ESG rating serves as a signal of quality and strong corporate governance. This suggests that ESG performance is not only an ethical consideration, but a strategic advantage that enhances financial stability and reduces stock return volatility. These findings reinforce the concept that a high ESG score signals a strong commitment to sustainability, protecting firms from the negative impacts of environmental penalties and ESG controversies.

However, the literature does not provide unanimous evidence regarding the relation between ESG scores and financial performance [56, 59, 61]. The effectiveness of ESG scores depends on the regulatory and cultural context in which firms operate, as well as the industry sector [61]. For example, [56] examine the relationship between ESG scores, financial performance, and corporate governance in Nordic firms, finding that ESG scores are positively correlated with financial performance. Their study suggests that a strong ESG commitment enhances corporate profitability and long-term sustainability. Another key finding of their research highlights the role of corporate governance, emphasizing that gender diversity on corporate boards improves firm performance. [62], studying a sample of 569 Indian listed companies from 2010 to 2022, find a positive relationship between ESG scores and both internal and external financial performance. Their results indicate that each ESG dimension plays a distinct role, with the

environmental practices contributing most to internal profitability, while social factors have the strongest effect on market valuation. Moreover, governance quality remains crucial for investor confidence, reinforcing the importance of transparent and effective corporate leadership. Also, [63], focusing only on ESG overall, find a positive relation between ESG disclosure and financial performance. Using a sample of S&P 500 firms from 2009 to 2015, they show that ESG performance has a stronger effect on Tobin's Q for larger firms, while positively affecting both Tobin's Q and ROA among smaller firms. Despite the generally positive results associated with ESG scores, the impact of negative ESG issues also varies depending on market structure and industry sector. As [53] show, companies involved in ESG scandals tend to suffer a more severe penalty in terms of stock value, especially if their ESG reputation was high before the scandal. Investors, in fact, interpret the inconsistency between the company's declared sustainable image and a negative event as a signal of poor managerial reliability.

Based on this review, we examine how environmental penalties, which act as a negative signal for the market, influence perceived risk and market reaction. On the one hand, a high ESG score is generally seen as an indicator of corporate reliability; on the other hand, when a company with a strong ESG performance receives an environmental penalty, the market may perceive this action as a breach of trust. The discrepancy between a firm's sustainable image and its actual behaviour may trigger harsher market reactions, particularly in the post-Paris Agreement period, where investor scrutiny and regulatory pressure have intensified. In this evolving landscape, ESG strategies serve not only as value-creating mechanisms but also as risk mitigation tools. However, as previous studies suggest, it remains unclear whether ESG scores are still sufficient to protect firms from severe stock price declines following environmental penalties, or whether the market has become increasingly critical and punitive toward firms that fail to align with their sustainability claims. Taken together, these arguments suggest that, particularly in the post-Paris period, stronger prior ESG credentials may increase rather than mitigate reputational exposure when an environmental penalty conflicts with the expectations created by a firm's sustainability profile. We therefore formulate an overarching hypothesis and examine this mechanism across different dimensions of ESG performance:

H2. In the post-Paris period, stronger pre-violation ESG standing is associated with more negative cumulative abnormal returns following environmental penalties.

H2a. In the post-Paris period, higher pre-violation overall ESG Scores are associated with more negative CARs following environmental penalties.

H2b. In the post-Paris period, higher pre-violation Environmental Scores are associated with more negative CARs following environmental penalties.

H2c. In the post-Paris period, higher pre-violation ESG Controversies Scores are associated with more negative CARs

following environmental penalties.

Corporate governance plays an essential role in advancing sustainable business conduct, especially regarding corporate environmental performance. As highlighted by [64], governance structures are instrumental in shaping a company's capacity to handle environmental risks and adhere to regulatory demands. The presence of robust governance - reflected in measures such as the Governance Score - is linked to improved transparency and a stronger commitment to ESG principles [65, 66]. In this context, strong governance practices and effective board supervision are viewed as key to meeting stakeholder expectations and reinforcing the trustworthiness of non-financial reporting [67]. Recent evidence also shows that dedicated sustainability governance mechanisms shape corporate responses to ESG controversies. [68] find that the presence of a sustainability committee or a chief sustainability officer increases the likelihood that firms involved in ESG controversies seek external assurance, thereby reinforcing reporting credibility and supporting legitimacy restoration. Good governance practices contribute to a firm's ability to set and maintain long-term sustainability goals, fostering corporate decisions that integrate financial, environmental, and social considerations. According to [69], such governance features not only meet regulatory expectations but also address the concerns of investors, who increasingly seek to avoid assets with high ESG risks and prefer companies committed to sustainability. A high Governance Score is perceived as a signal of corporate responsibility and transparency, which in turn enhances firm reputation, lowers the cost of capital, and strengthens market confidence [67, 70]. The board of directors plays a strategic role in connecting the firm to its external environment [71], thereby shaping strategies that embed environmental and social accountability into the corporate agenda. Our analysis builds on this perspective by considering governance quality as a distinct source of market expectations. Firms characterized by stronger governance are expected to exhibit more effective monitoring, regulatory compliance, and environmental risk oversight. Consequently, when such firms are subject to environmental penalties, the event may represent not only an environmental failure but also a breakdown in the monitoring and oversight mechanisms expected from well-governed firms. This inconsistency may therefore intensify the negative market reaction. Accordingly, we formulate the following dimension-specific hypothesis:

H2d. In the post-Paris period, higher pre-violation Governance Scores are associated with more negative CARs following environmental penalties.

Taken together, H2a–H2d distinguish the different channels through which prior ESG standing may shape market reactions to environmental penalties. Overall ESG performance captures the firm's broader sustainability reputation, the Environmental Score reflects expectations specifically related to environmental conduct, the ESG Controversies Score captures

the firm's prior controversy-related profile, while the Governance Score reflects expectations regarding monitoring, oversight, and compliance. The post-Paris period provides a particularly relevant setting in which to examine these mechanisms, given the increasing regulatory pressure and stakeholder attention to the consistency between corporate sustainability commitments and actual conduct.

3. Data and Methodology

To test the proposed hypotheses, the analysis proceeds in two main steps. First, using the event study methodology, we assess how the stock market reacts to the environmental penalties received by a firm. This approach allows us to capture abnormal returns associated with the negative event. In the second step, we apply regression models to investigate whether a firm's ESG performance moderates the market reaction to a negative sustainability-related event. Specifically, we examine whether higher ESG scores can mitigate the potential negative impact observed in the event study, providing insights into the role of sustainability as a reputational buffer. The event-study stage combines conventional cross-sectional inference with generalized sign and rank-based non-parametric tests. This additional evidence allows us to determine whether the estimated market reaction reflects an increase in the frequency of negative outcomes, a downward shift in the abnormal-return distribution, or relatively pronounced losses concentrated among a subset of sanction events.

3.1. Dataset Description

This study is based on a dataset of environmental violations committed by firms listed in the S&P 500 between 2000 and 2024. The dataset was compiled using Violation Tracker, a publicly accessible database that documents corporate misconduct in the United States. We focused exclusively on environmental penalties and collected firm level data on the number of violations, monetary fines, dates, and types of infractions. The final dataset includes 4,578 violations committed by firms across 11 industry sectors, as classified by Yahoo Finance. Since not all firms are observed in every year, the dataset is unbalanced in its time coverage, which allows us to capture variation across firms and over time.

To explore whether global climate policy, particularly the 2016 Paris Agreement, has influenced corporate environmental behaviour, we split the sample into pre-Paris (2000–2015) and post-Paris (2016–2024) periods. This classification is useful to evaluate potential shifts in regulatory compliance and industry practices in response to increased international pressure for sustainability.

Summary statistics on the distribution of environmental penalties by sector, as well as their breakdown before and after the Paris Agreement, are reported in Table 1 and Table 2 below.

Table 1. *Distribution of environmental penalties by sector.*

Sectors	N° Firms by Sector	N° Penalties by Sector
Basic Materials	22	834
Communication Services	23	29
Consumer Cyclical	57	163
Consumer Defensive	38	271
Energy	23	2228
Financial Services	67	50
Healthcare	67	111
Industrials	70	442
Real Estate	31	46
Technology	76	80
Utilities	30	324

This table reports the classification of firms by industry sector, along with the number of firms and the total environmental penalties recorded for each sector.

Table 2. *Number of environmental penalties by sector pre (2000-2015) and post (2016-2024) Paris Agreement.*

Sectors	N° Penalties pre - Paris	N° Penalties post - Paris
Basic Materials	578	256
Communication Services	20	9
Consumer Cyclical	113	50
Consumer Defensive	191	80
Energy	1617	611
Financial Services	33	17
Healthcare	79	32
Industrials	292	150
Real Estate	35	11
Technology	59	21
Utilities	225	99

This table reports the number of environmental penalties per sector, distinguishing between the pre-Paris Agreement (2000-2015) and post-Paris Agreement (2016-2024) periods.

3.2. First-Phase Analysis: Event-Study Approach and Non-Parametric Inference

To assess the stock-market reaction to environmental penalties, we employ an event-study methodology based on the Market Model. For each firm-event observation, expected daily returns are estimated through the following specification:

$$R_{i,t} = \alpha_i + \beta_i R_{m,t} + \varepsilon_{i,t} \quad (1)$$

where $R_{i,t}$ is the return of firm i on trading day t , $R_{m,t}$ is the corresponding market return, α_i is the firm-specific intercept, β_i measures the sensitivity of the firm's return to market movements, and $\varepsilon_{i,t}$ is the error term. The parameters α_i and β_i are estimated separately for each firm-event observation by

ordinary least squares over a fixed pre-event estimation period.

The event date is defined as day zero. Event windows are constructed by directly applying the relevant trading-day offsets to the penalty date. Thus, positive offsets identify trading days following the environmental penalty, while negative offsets identify trading days preceding it. Symmetric windows capture the market response around the event date, post-event windows isolate the subsequent adjustment, and pre-event windows make it possible to examine whether abnormal price movements were already present before the formal sanction.

To prevent contamination between the estimation period and the event window, the estimation period ends immediately before the beginning of the event window whenever the latter includes pre-event days. For event windows beginning on or after day zero, the estimation period ends on the trading day immediately preceding the penalty. Observations are retained only when complete return information is available throughout both the estimation period and the relevant event window. Abnormal returns are calculated as the difference between the observed firm return and the return predicted by the Market Model:

$$R_{i,t} = R_{i,t} - (\hat{\alpha}_i + \hat{\beta}_i R_{m,t}) \quad (2)$$

where $AR_{i,t}$ denotes the abnormal return of firm i on trading day t , while $\hat{\alpha}_i$ and $\hat{\beta}_i$ are the parameters estimated during the corresponding estimation period. A negative abnormal return indicates that the firm underperformed relative to the return predicted by general market movements. For each event window (τ_1, τ_2) , cumulative abnormal returns are obtained by summing daily abnormal returns:

$$CAR_i(\tau_1, \tau_2) = \sum_{t=\tau_1}^{\tau_2} AR_{i,t} \quad (3)$$

where τ_1 and τ_2 respectively identify the first and last trading days included in the event window. The resulting CAR_i measures the total firm-specific abnormal stock-price response accumulated over the selected interval. The cumulative average abnormal return is then calculated across all valid firm-event observations:

$$CAAR(\tau_1, \tau_2) = \frac{1}{N_{\tau_1, \tau_2}} \sum_{i=1}^{N_{\tau_1, \tau_2}} CAR_i(\tau_1, \tau_2) \quad (4)$$

where N_{τ_1, τ_2} is the number of valid firm-event observations available for the relevant event window. The CAAR therefore measures the average cumulative market reaction associated with environmental penalties. The unit of analysis is the unique firm-date event. When a firm receives more than one environmental penalty on the same date, the sanctions are consolidated into a single event-study observation because they correspond to the same stock-return window. This procedure prevents the same market reaction from being counted more than once. The number of observations may vary slightly across windows because the longest intervals require a more

extensive return history before and after the penalty date. The statistical significance of the CAAR is initially assessed through the conventional cross-sectional statistic:

$$t_{CAAR} = \frac{CAAR(\tau_1, \tau_2)}{s_{CAR}(\tau_1, \tau_2) / \sqrt{N_{\tau_1, \tau_2}}} \quad (5)$$

where $s_{CAR}(\tau_1, \tau_2)$ is the cross-sectional standard deviation of the event-specific cumulative abnormal returns. The statistic tests the null hypothesis that the average cumulative abnormal return is equal to zero. Conventional cross-sectional inference may, however, be sensitive to non-normality, skewness, extreme observations and event-induced changes in return volatility. These issues are particularly relevant in the present setting because the market implications of environmental penalties may vary considerably according to their severity, visibility and reputational consequences. We therefore complement the parametric test with two non-parametric procedures: the generalized sign test proposed by [46] and the rank-based test introduced by [45]. The generalized sign test evaluates whether negative cumulative abnormal returns occur more frequently during the event window than would normally be expected based on the return distribution observed during the estimation period. Unlike the conventional sign test, the generalized procedure does not impose an equal probability of positive and negative abnormal returns. Instead, the expected probability of a negative observation is estimated directly from the estimation-period abnormal returns. Let $\hat{p}^-$ denote the expected probability of observing a negative abnormal return:

$$\hat{p}^- = \frac{\sum_{i=1}^N \sum_{t \in E_i} I(AR_{i,t} < 0)}{\sum_{i=1}^N T_i} \quad (6)$$

where E_i denotes the estimation period associated with event i , T_i is the number of observations included in that estimation period, and I is an indicator function equal to one when the condition inside the brackets is satisfied and zero otherwise. The numerator counts all negative abnormal returns observed during the estimation periods, while the denominator represents the total number of estimation-period abnormal returns.

The number of negative cumulative abnormal returns in a given event window is defined as:

$$N_{CAR}^- = \sum_{i=1}^N I[CAR_i(\tau_1, \tau_2) < 0] \quad (7)$$

The generalized sign statistic is then calculated as:

$$Z_{GS} = \frac{N_{CAR}^- - N\hat{p}^-}{\sqrt{N\hat{p}^-(1-\hat{p}^-)}} \quad (8)$$

The numerator measures the difference between the observed number of negative CARs and the number expected under the null hypothesis. The denominator standardizes this difference using the variance of a binomial distribution with

probability $\hat{p}^-$.

Because H1 predicts a negative market reaction, the generalized sign test is conducted as a one-sided test. The null and alternative hypotheses are:

$$\begin{aligned} H_0: P[CAR_i(\tau_1, \tau_2) < 0] &= \hat{p}^- \\ H_1: P[CAR_i(\tau_1, \tau_2) < 0] &> \hat{p}^- \end{aligned} \quad (9)$$

A positive and statistically significant value of Z_{GS} indicates that negative CARs occur more frequently during the event window than would normally be expected. In addition to the asymptotic statistic, the corresponding exact one-sided binomial probability is calculated using $\hat{p}^-$ as the null probability.

The Corrado rank test provides a complementary form of non-parametric inference based on the relative position of abnormal returns within their historical distributions. For each firm-event observation, abnormal returns from the estimation period and the event window are pooled and ranked jointly. This procedure reduces the influence of extreme observations because it replaces the original return values with their positions in the combined distribution.

Let $K_{i,t}$ denote the rank assigned to abnormal return $AR_{i,t}$, and let L_i denote the total number of abnormal returns included in the ranking procedure for event i . The normalized rank is calculated as:

$$U_{i,t} = \frac{K_{i,t}}{L_i + 1} \quad (10)$$

The normalization places the ranks on a common scale across firm-event observations. Under the null hypothesis of no abnormal market response, the expected normalized rank is equal to one half. The centred cross-sectional average rank on trading day (t) is defined as:

$$\bar{U}_t^c = \frac{1}{N_t} \sum_{i=1}^{N_t} U_{i,t} - \frac{1}{2} \quad (11)$$

where N_t is the number of valid events available on day (t).

A negative value indicates that abnormal returns on that day tend to occupy positions below the centre of their historical distributions. The variance of the rank statistic is estimated using the centred average ranks observed during the estimation period:

$$S_U^2 = \frac{1}{T_E} \sum_{t \in E} (\bar{U}_t^c)^2 \quad (12)$$

where T_E is the number of trading days included in the estimation period. This variance provides the benchmark against which the event-window rank displacement is evaluated.

For a multi-day event window containing L_τ trading days, the cumulative rank statistic is calculated as:

$$Z_{RANK} = \frac{\sum_{t=\tau_1}^{\tau_2} \bar{U}_t^c}{\sqrt{L_\tau S_U^2}} \quad (13)$$

The numerator accumulates the centred cross-sectional ranks over the entire event window. The denominator standardizes this cumulative displacement according to the length of the event window and the rank variance estimated during the estimation period. A negative and statistically significant rank statistic indicates that event-window abnormal returns occupy systematically lower positions than those observed during the estimation periods. Unlike the generalized sign test, which only considers whether the cumulative return is positive or negative, the rank test also uses information about the relative position of each abnormal return while remaining less sensitive than conventional parametric procedures to non-normality and extreme values. The implemented procedure follows the rank-based logic introduced by [45], with centred daily ranks accumulated over multi-day event windows. [47] subsequently developed generalized rank procedures specifically designed for cumulative event-study inference, providing a broader methodological basis for rank-based analysis over multi-day windows. Tables 3-5 reports the parametric and non-parametric results for short and symmetric, post-event, and pre-event windows, respectively.

Table 3. Parametric and non-parametric tests of cumulative abnormal returns: short and symmetric event windows

Event window	N	CAAR	t_{CAAR}	Negative CARs (%)	$\hat{p}^-$	Z_{GS}	p_{GS}	Z_{RANK}	p_{RANK}
([-1,0])	4,183	-0.000352	-1.112	45.23%	44.59%	0.832	0.207	-0.768	0.443
([-1,+1])	4,183	-0.000185	-0.470	44.61%	44.59%	0.023	0.497	-0.296	0.767
([0,+1])	4,183	0.000072	0.225	44.25%	44.60%	-0.456	0.681	0.384	0.701
([0,+2])	4,183	-0.000223	-0.515	43.61%	44.60%	-1.296	0.905	1.039	0.299
([-2,+2])	4,183	-0.000676	-1.234	44.20%	44.58%	-0.496	0.696	-0.195	0.845
([-3,+3])	4,183	-0.000627	-1.003	44.06%	44.59%	-0.696	0.762	-0.384	0.701
([-5,+5])	4,183	-0.001159	-1.485	45.37%	44.59%	1.025	0.156	-0.671	0.502

Event window	N	CAAR	t_{CAAR}	Negative CARs (%)	$\hat{p}^-$	Z_{GS}	p_{GS}	Z_{RANK}	p_{RANK}
([-7,+7])	4,182	-0.001767**	-1.961	45.50%	44.57%	1.218	0.115	-1.473	0.141
([-10,+10])	4,182	-0.002916***	-2.680	45.58%	44.57%	1.313*	0.097	-2.313**	0.021
([-20,+20])	4,179	-0.004486***	-2.824	45.59%	44.55%	1.349*	0.091	-2.426**	0.015
([-30,+30])	4,177	-0.004192**	-2.097	44.65%	44.54%	0.145	0.448	-1.783*	0.075
([-60,+60])	4,164	-0.006422**	-2.028	44.76%	44.49%	0.355	0.367	-1.277	0.202

This table reports cumulative average abnormal returns (CAARs) and the associated parametric and non-parametric tests for short and symmetric event windows around the environmental penalty date. N denotes the number of valid unique firm-date events; CAAR is the cumulative average abnormal return; and Negative CARs (%) reports the percentage of events with a negative cumulative abnormal return. The table also reports the expected probability of a negative abnormal return estimated from the corresponding estimation periods, the generalized sign test statistic and its one-sided p-value, and the Corrado rank test statistic and its two-sided p-value. Day 0 is the environmental penalty date. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table 4. Parametric and non-parametric tests of cumulative abnormal returns: post- event windows.

Event window	N	CAAR	t_{CAAR}	Negative CARs (%)	$\hat{p}^-$	Z_{GS}	p_{GS}	Z_{RANK}	p_{RANK}
([0,+30])	4,177	-0.004097***	-3.084	45.25%	44.59%	0.851	0.202	-2.092**	0.036
([0,+60])	4,171	-0.005858***	-2.977	45.82%	44.58%	1.601*	0.056	-1.558	0.119
([+1,+5])	4,183	-0.001178**	-2.218	44.80%	44.60%	0.259	0.404	-0.663	0.507
([+2,+10])	4,182	-0.002432***	-3.456	45.41%	44.60%	1.054	0.150	-2.290**	0.022
([+10,+30])	4,177	-0.002037*	-1.899	45.18%	44.59%	0.757	0.229	-1.549	0.121

This table reports cumulative average abnormal returns (CAARs) and the associated parametric and non-parametric tests for post-event windows following the environmental penalty date. N denotes the number of valid unique firm-date events; CAAR is the cumulative average abnormal return; and Negative CARs (%) reports the percentage of events with a negative cumulative abnormal return. The table also reports the expected probability of a negative abnormal return estimated from the corresponding estimation periods, the generalized sign test statistic and its one-sided p-value, and the Corrado rank test statistic and its two-sided p-value. Day 0 is the environmental penalty date. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table 5. Parametric and non-parametric tests of cumulative abnormal returns: pre- event windows.

Event window	N	CAAR	t_{CAAR}	Negative CARs (%)	$\hat{p}^-$	Z_{GS}	p_{GS}	Z_{RANK}	p_{RANK}
([-5,-1])	4,183	0.000077	0.152	44.01%	44.59%	-0.748	0.777	-0.324	0.746
([-10,-1])	4,183	-0.000505	-0.699	44.82%	44.57%	0.333	0.375	-1.492	0.136

This table reports cumulative average abnormal returns (CAARs) and the associated parametric and non-parametric tests for pre-event windows preceding the environmental penalty date. N denotes the number of valid unique firm-date events; CAAR is the cumulative average abnormal return; and Negative CARs (%) reports the percentage of events with a negative cumulative abnormal return. The table also reports the expected probability of a negative abnormal return estimated from the corresponding estimation periods, the generalized sign test statistic and its one-sided p-value, and the Corrado rank test statistic and its two-sided p-value. Day 0 is the environmental penalty date. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

The results indicate that environmental penalties do not trigger a statistically detectable reaction within the narrowest event windows. The absence of an immediate response across

both parametric and non-parametric tests suggests that investors do not fully incorporate the implications of the sanction at the formal event date. This may reflect the time required to

assess the severity of the violation, its operational and regulatory consequences, and the associated reputational damage. It may also arise because the penalty date does not necessarily coincide with the first public disclosure of the underlying misconduct. This interpretation is consistent with evidence that the market consequences of environmental events may unfold gradually as investors reassess firms' future liabilities and reputational exposure [10, 41].

The evidence becomes stronger as the event horizon expands. Average abnormal performance turns negative over medium-term and post-event windows, indicating a gradual market adjustment rather than a concentrated announcement-day effect. The Corrado rank test broadly confirms this pattern, showing that the findings are not solely driven by the distributional assumptions of conventional cross-sectional inference or by a small number of extreme observations. This progressive deterioration in market value is consistent with prior evidence that environmental violations generate persistent valuation losses and heightened investor concerns regarding managerial and environmental performance [5, 21].

The generalized sign test provides a complementary perspective. Its weaker significance indicates that the negative average response is not driven by a uniform increase in the frequency of negative CARs across sanctioned firms. Rather, the market effect appears to reflect more pronounced losses among a subset of events. This interpretation reconciles the significant negative CAARs with the absence of a broadly diffused sign effect and suggests that investors differentiate across penalties according to their severity, visibility, and reputational implications, in line with evidence that market reactions to environmental and ESG-related events depend on the perceived relevance and credibility of the underlying information [15, 48].

The absence of significant abnormal performance in the pre-event windows further reduces concerns that the post-event results merely capture a pre-existing downward trend. Overall, the findings support H1: environmental penalties are followed by negative abnormal stock performance, particularly over medium-term and post-event horizons. The combined parametric and rank-based evidence is consistent with a gradual and heterogeneous repricing process through which investors progressively incorporate the expected financial, regulatory, and reputational consequences of environmental misconduct.

3.3. Second Phase Analysis: Regression Models

The second phase of the analysis tests the overarching hypothesis H2 and its dimension-specific sub-hypotheses H2a–H2d through a set of regression models. In this phase, the CARs obtained in the event study are used as the dependent variable, while various ESG scores are introduced as explanatory variables to assess their potential moderating effect. Particularly, the models aim to examine whether higher ESG scores act as a buffer, mitigating the negative impact of environmental penalties on firm value, or conversely, whether they amplify the negative effect. In the latter case, stakeholders might perceive the discrepancy between high ESG scores and the receipt of a penalty as a signal of hypocrisy, triggering a more severe market reaction. The explanatory variables include overall ESG performance, Environmental and Governance Pillar scores, and the ESG Controversies score, which reflects a firm's involvement in controversial activities. Table 6 summarizes the variables included in the regression models, together with their operational definitions, role in the empirical specifications, and respective data sources.

Table 6. Variables' description.

Variable Name	Description	Role in the model	Data source
CARs	Cumulative Abnormal Returns following environmental penalty	Dependent variable	Authors' elaboration on daily prices
ESG	Company's ESG Score	Explanatory variable	LSEG
Controversies	Company's ESG Controversies Score	Explanatory variable	LSEG
Env	Company's Environmental Score	Explanatory variable	LSEG
Gov	Company's Governance Score	Explanatory variable	LSEG
Size	Company's total assets (variable defined in ln)	Control variable	LSEG
Equity	Company's total debt to equity	Control variable	LSEG
ROA	Company's Return on Assets	Control variable	LSEG

This table provides a description of the variables used in the model, their role (dependent, explanatory, or control), and the data source. The variables include measures of firm performance, sustainability scores, and financial indicators, all of which are relevant for understanding the market reaction to environmental penalties.

Based on these variables, the following regression models are estimated:

$$CARs = \alpha + ESG_{t-1} + \sum ControlVariables_{t-1} + y_j \quad (14)$$

$$CARs = \alpha + Env_{t-1} + \sum ControlVariables_{t-1} + y_j \quad (15)$$

$$CARs = \alpha + Controversies_{t-1} + \sum ControlVariables_{t-1} + y_j \quad (16)$$

$$CARs = \alpha + Gov_{t-1} + \sum ControlVariables_{t-1} + y_j \quad (17)$$

To assess whether the Paris Agreement has altered market awareness of environmental violations and corporate ESG conduct, each of the regression models is estimated across three different time frames: (1) the full sample (2000-2024), (2) the pre-Paris period (2000-2015), and (3) the post-Paris period (2016-2024). This split permits us to evaluate whether, in the wake of increased regulatory pressure and stakeholder expectations following the Paris Agreement, ESG performance has become more effective as a reputational shield, or, conversely, whether discrepancies between ESG claims and environmental misconduct have intensified perceptions of corporate hypocrisy, leading to stronger negative market reactions. Pooled specifications include event-window fixed effects to absorb systematic differences across alternative CAR horizons. Since CARs computed around the same event may overlap and are therefore mechanically correlated, standard errors are clustered at the firm level. This approach accounts for within-firm dependence across event windows and repeated events, although longer windows remain potentially more exposed to unrelated firm-specific information.

4. Results

Tables 7-10 present the baseline regression results for the different dimensions of ESG standing examined in H2a–H2d. Table 7 reports the estimates for the Overall ESG Score. The coefficient is statistically insignificant in both the full sample and the pre-Paris period, whereas it becomes negative and highly significant in the post-Paris period. This evidence supports H2a and indicates that, after 2016, stronger pre-violation ESG standing is associated with more negative abnormal returns following an environmental penalty. This pattern is consistent with the expectation-breach mechanism underlying the proposed hypocrisy penalty. Table 8 reports a similar pattern for the Environmental Score. The coefficient is not statistically significant in either the full sample or the pre-Paris period, but becomes negative and highly significant after the Paris Agreement, providing support for H2b. The result is particularly relevant because the inconsistency occurs within the

same domain: firms previously characterized by stronger environmental performance experience more negative market reactions when subsequently sanctioned for environmental misconduct. Table 9 focuses on the ESG Controversies Score. The coefficient is negative and statistically significant in the full sample and in the pre-Paris period, but remains statistically insignificant in the post-Paris specification. Accordingly, H2c is not supported. This result suggests that the controversy-related dimension follows a different pattern from overall ESG and environmental performance and does not provide evidence of a stronger post-Paris association with abnormal returns. Finally, Table 10 examines the Governance Score. While the full-sample coefficient is statistically insignificant, the pre-Paris coefficient is positive and significant, whereas the post-Paris coefficient is negative and highly significant. The post-Paris evidence therefore supports H2d and is consistent with the argument that environmental violations involving firms with stronger prior governance credentials may be interpreted as failures of monitoring, compliance, and oversight. The results are consistent with the overarching mechanism proposed in H2 for overall ESG, environmental, and governance performance, while the controversy-related dimension provides no corresponding post-Paris evidence. Beyond their statistical significance, the post-Paris coefficients are also economically interpretable. For the Overall ESG, Environmental, and Governance Scores, a one-point increase is associated with approximately 1.09, 1.09, and 1.11 additional basis points of negative cumulative abnormal return, respectively. Thus, a 10-point difference in these scores corresponds to approximately 10.9–11.1 basis points of additional abnormal underperformance following an environmental penalty. The relatively low R-squared values are consistent with the nature of the dependent variable. CARs already exclude the component of stock returns explained by general market movements, leaving a largely firm- and event-specific residual component. Accordingly, the regressions are intended to identify systematic associations between ESG characteristics and abnormal market reactions rather than to maximize overall predictive power.

Table 7. Baseline Regression Results: Overall ESG Score and Cumulative Abnormal Returns.

VARIABLES	(1)	(2)	(3)
	All Sample	Pre-Paris	Post-Paris
	CAR	CAR	CAR
ESG	3.08e-06 (9.52e-06)	1.34e-05 (1.04e-05)	-0.000109*** (2.69e-05)
Size	-0.000206*** (3.83e-05)	-0.000237*** (3.93e-05)	-0.00133 (0.000961)
ROA	-0.000272*** (4.02e-05)	-0.000188*** (4.22e-05)	-0.00106*** (0.000148)
Equity	8.64e-07** (3.51e-07)	6.37e-07* (3.53e-07)	7.08e-06*** (2.34e-06)
Constant	0.00336*** (0.000704)	0.00336*** (0.000698)	0.0387 (0.0242)
Observations	95,935	88,872	7,021
R-squared	0.001	0.001	0.010

This table reports baseline regressions of cumulative abnormal returns (CARs) on the Overall ESG Score. Columns (1)–(3) report estimates for the full sample (2000–2024), the pre-Paris period (2000–2015), and the post-Paris period (2016–2024), respectively. All specifications include firm-level financial controls and event-window fixed effects. Standard errors are clustered at the firm level and reported in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Table 8. Baseline Regression Results: Environmental Score and Cumulative Abnormal Returns.

VARIABLES	(1)	(2)	(3)
	All Sample	Pre-Paris	Post-Paris
	CAR	CAR	CAR
Env	-1.37e-05 (8.66e-06)	-6.68e-06 (9.25e-06)	-0.000109*** (2.68e-05)
Size	-0.000171*** (3.73e-05)	-0.000194*** (3.79e-05)	-0.00124 (0.000962)
ROA	-0.000274*** (4.02e-05)	-0.000184*** (4.21e-05)	-0.00109*** (0.000150)
Equity	8.23e-07** (3.50e-07)	5.83e-07* (3.52e-07)	7.18e-06*** (2.34e-06)
Constant	0.00330*** (0.000704)	0.00329*** (0.000698)	0.0366 (0.0242)
Observations	95,935	88,872	7,021

	(1)	(2)	(3)
VARIABLES	All Sample	Pre-Paris	Post-Paris
	CAR	CAR	CAR
R-squared	0.001	0.001	0.010

This table reports baseline regressions of cumulative abnormal returns (CARs) on the Environmental Score. Columns (1)–(3) report estimates for the full sample (2000–2024), the pre-Paris period (2000–2015), and the post-Paris period (2016–2024), respectively. All specifications include firm-level financial controls and event-window fixed effects. Standard errors are clustered at the firm level and reported in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table 9. Baseline Regression Results: ESG Controversies Score and Cumulative Abnormal Returns.

	(1)	(2)	(3)
VARIABLES	All Sample	Pre-Paris	Post-Paris
	CAR	CAR	CAR
Controversies	-2.37e-05*** (6.11e-06)	-2.77e-05*** (6.38e-06)	-4.47e-05 (2.73e-05)
Size	-0.000151*** (3.49e-05)	-0.000149*** (3.54e-05)	-0.00193* (0.00103)
ROA	-0.000285*** (4.03e-05)	-0.000198*** (4.22e-05)	-0.000995*** (0.000148)
Equity	8.04e-07** (3.50e-07)	5.33e-07 (3.52e-07)	7.50e-06*** (2.34e-06)
Constant	0.00351*** (0.000705)	0.00348*** (0.000698)	0.0501* (0.0263)
Observations	95,935	88,872	7,021
R-squared	0.002	0.001	0.008

This table reports baseline regressions of cumulative abnormal returns (CARs) on the ESG Controversies Score. Columns (1)–(3) report estimates for the full sample (2000–2024), the pre-Paris period (2000–2015), and the post-Paris period (2016–2024), respectively. All specifications include firm-level financial controls and event-window fixed effects. Standard errors are clustered at the firm level and reported in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table 10. Baseline Regression Results: Governance Score and Cumulative Abnormal Returns.

	(1)	(2)	(3)
VARIABLES	All Sample	Pre-Paris	Post-Paris
	CAR	CAR	CAR
Gov	9.87e-06 (8.79e-06)	1.90e-05** (9.56e-06)	-0.000111*** (2.64e-05)

	(1)	(2)	(3)
VARIABLES	All Sample	Pre-Paris	Post-Paris
	CAR	CAR	CAR
Size	-0.000222*** (3.82e-05)	-0.000252*** (3.93e-05)	-0.00131 (0.000961)
ROA	-0.000274*** (4.02e-05)	-0.000191*** (4.23e-05)	-0.00105*** (0.000148)
Equity	8.86e-07** (3.51e-07)	6.60e-07* (3.53e-07)	6.95e-06*** (2.34e-06)
Constant	0.00337*** (0.000704)	0.00336*** (0.000697)	0.0383 (0.0242)
Observations	95,935	88,872	7,021
R-squared	0.001	0.001	0.011

This table reports baseline regressions of cumulative abnormal returns (CARs) on the Governance Score. Columns (1)–(3) report estimates for the full sample (2000–2024), the pre-Paris period (2000–2015), and the post-Paris period (2016–2024), respectively. All specifications include firm-level financial controls and event-window fixed effects. Standard errors are clustered at the firm level and reported in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

5. Robustness Test and Additional Analysis

To ensure the robustness of the results and to account for potential endogeneity problems, a robustness check was performed using the Generalized Method of Moments (GMM). This estimation technique is well-suited for addressing endogeneity by employing internal instruments (i. e., lagged values of the regressors), thus allowing for more reliable inference on the relationship between ESG characteristics and abnormal stock returns.

5.1. Robustness Test Results

Tables 11–14 reports the GMM robustness estimates for the same four ESG dimensions examined in the baseline analysis. Table 11 confirms the results for the Overall ESG Score; the coefficient remains statistically insignificant in the full sample and in the pre-Paris period, but becomes negative and highly significant in the post-Paris period, providing further support

for H2a. Table 12 shows an analogous pattern for the Environmental Score, whose post-Paris coefficient remains negative and highly significant, confirming H2b and reinforcing the evidence that investors react more negatively to environmental misconduct when it conflicts with previously stronger environmental performance. Table 13 reports the estimates for the ESG Controversies Score. The full-sample and pre-Paris coefficients remain negative and statistically significant, whereas the post-Paris coefficient does not provide statistically significant evidence in support of H2c. The controversy-related dimension therefore remains distinct from the other ESG components. Finally, Table 14 confirms the governance result: the post-Paris coefficient is negative and highly significant, providing further support for H2d and reinforcing the interpretation that environmental sanctions may generate stronger market reactions when they contradict prior expectations of effective governance, monitoring, and compliance. Overall, the GMM estimates closely reproduce the baseline pattern, strengthening the evidence for the post-Paris associations documented for overall ESG, environmental, and governance performance.

Table 11. GMM Robustness Estimates: Overall ESG Score and Cumulative Abnormal Returns.

VARIABLES	(1)	(2)	(3)
	All Sample	Pre-Paris	Post-Paris
	CAR	CAR	CAR
ESG	0.00000326 (0.33)	0.0000137 (1.26)	-0.000109*** (-4.18)
Size	-0.000206*** (-6.07)	-0.000237*** (-6.61)	-0.00133 (-1.52)
ROA	-0.000272*** (-5.33)	-0.000188*** (-3.46)	-0.00106*** (-6.71)
Equity	0.000000864** (2.97)	0.000000637* (2.27)	0.00000708*** (3.84)
Constant	0.00337*** (6.43)	0.00336*** (6.43)	0.0387 (1.76)
Observations	95,893	88,830	7,021

This table reports GMM robustness estimates for the relationship between cumulative abnormal returns (CARs) and the Overall ESG Score. Columns (1)–(3) report estimates for the full sample (2000–2024), the pre-Paris period (2000–2015), and the post-Paris period (2016–2024), respectively. The specifications include the same firm-level controls as the baseline models and use lagged regressors as internal instruments. t-statistics are reported in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table 12. GMM Robustness Estimates: Environmental Score and Cumulative Abnormal Returns.

VARIABLES	(1)	(2)	(3)
	All Sample	Pre-Paris	Post-Paris
	CAR	CAR	CAR
Env	-0.0000136 (-1.59)	-0.00000652 (-0.70)	-0.000109*** (-4.40)
Size	-0.000171*** (-5.14)	-0.000195*** (-5.62)	-0.00124 (-1.41)
ROA	-0.000274*** (-5.38)	-0.000184*** (-3.42)	-0.00109*** (-6.83)
Equity	0.000000823** (2.87)	0.000000583* (2.12)	0.00000718*** (3.90)
Constant	0.00330*** (6.31)	0.00329*** (6.29)	0.0366 (1.68)

	(1)	(2)	(3)
VARIABLES	All Sample	Pre-Paris	Post-Paris
	CAR	CAR	CAR
Observations	95,893	88,830	7,021

This table reports GMM robustness estimates for the relationship between cumulative abnormal returns (CARs) and the Environmental Score. Columns (1)–(3) report estimates for the full sample (2000–2024), the pre-Paris period (2000–2015), and the post-Paris period (2016–2024), respectively. The specifications include the same firm-level controls as the baseline models and use lagged regressors as internal instruments. t-statistics are reported in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table 13. *GMM Robustness Estimates: ESG Controversies Score and Cumulative Abnormal Returns.*

	(1)	(2)	(3)
VARIABLES	All Sample	Pre-Paris	Post-Paris
	CAR	CAR	CAR
Controversies	-0.0000237*** (-3.88)	-0.0000277*** (-4.33)	-0.0000447 (-1.72)
Size	-0.000151*** (-4.83)	-0.000149*** (-4.63)	-0.00193* (-2.06)
ROA	-0.000285*** (-5.56)	-0.000198*** (-3.65)	-0.000995*** (-6.28)
Equity	0.000000804** (2.80)	0.000000533 (1.95)	0.00000750*** (4.08)
Constant	0.00352*** (6.69)	0.00349*** (6.64)	0.0501* (2.14)
Observations	95,893	88,830	7,021

This table reports GMM robustness estimates for the relationship between cumulative abnormal returns (CARs) and the ESG Controversies Score. Columns (1)–(3) report estimates for the full sample (2000–2024), the pre-Paris period (2000–2015), and the post-Paris period (2016–2024), respectively. The specifications include the same firm-level controls as the baseline models and use lagged regressors as internal instruments. t-statistics are reported in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table 14. *GMM Robustness Estimates: Governance Score and Cumulative Abnormal Returns.*

	(1)	(2)	(3)
VARIABLES	All Sample	Pre-Paris	Post-Paris
	CAR	CAR	CAR
Govs	0.0000100 (1.10)	0.0000192 (1.88)	-0.000111*** (-4.15)
Size	-0.000222***	-0.000252***	-0.00131

	(1)	(2)	(3)
VARIABLES	All Sample	Pre-Paris	Post-Paris
	CAR	CAR	CAR
	(-6.55)	(-7.03)	(-1.50)
ROA	-0.000274***	-0.000191***	-0.00105***
	(-5.35)	(-3.51)	(-6.62)
Equity	0.000000886**	0.000000660*	0.00000695***
	(3.02)	(2.34)	(3.76)
Constant	0.00338***	0.00336***	0.0383
	(6.45)	(6.42)	(1.74)
Observations	95,893	88,830	7,021

This table reports GMM robustness estimates for the relationship between cumulative abnormal returns (CARs) and the Governance Score. Columns (1)–(3) report estimates for the full sample (2000–2024), the pre-Paris period (2000–2015), and the post-Paris period (2016–2024), respectively. The specifications include the same firm-level controls as the baseline models and use lagged regressors as internal instruments. t-statistics are reported in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

5.2. Additional Analysis

To further explore potential non-linearities in the relationship between ESG performance and abnormal returns, we estimate an extended specification that incorporates a quadratic

term for the ESG score. This allows us to assess whether the market reaction to environmental sanctions exhibits diminishing or increasing sensitivity across different levels of sustainability commitment. Table 15 reports the results for the full sample, as well as the pre- and post-Paris Agreement periods.

Table 15. Non-linear effects of ESG performance on abnormal returns (quadratic specification).

	(1)	(2)	(3)
VARIABLES	All Sample	Pre-Paris	Post-Paris
ESG	-0.000173*** (3.18e-05)	-0.000173*** (3.41e-05)	-0.000905*** (0.000158)
ESG-squared	2.16e-06*** (3.73e-07)	2.24e-06*** (3.92e-07)	1.02e-05*** (2.01e-06)
Size	-0.000146*** (3.96e-05)	-0.000163*** (4.14e-05)	-0.00232** (0.000979)
ROA	-0.000268*** (4.02e-05)	-0.000178*** (4.22e-05)	-0.000947*** (0.000150)
Equity	7.19e-07** (3.52e-07)	4.65e-07 (3.54e-07)	7.79e-06*** (2.34e-06)
Constant	0.00357*** (0.000705)	0.00354*** (0.000698)	0.0631** (0.0246)
Observations	95,935	88,872	7,021

VARIABLES	(1)	(2)	(3)
	All Sample	Pre-Paris	Post-Paris
R-squared	0.002	0.001	0.014

This table reports regression estimates of the relationship between cumulative abnormal returns (CARs) and ESG performance using a quadratic specification. The model includes the lagged ESG score and its squared term to capture potential non-linear effects. Results are presented for the full sample, the pre-Paris period (2000-2015), and the post-Paris period (2016-2024). All models include lagged financial controls (log total assets, ROA, and debt-to-equity ratio). Standard errors are reported in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The results reveal a clear and consistent non-linear pattern. Across all periods, the coefficient on the linear ESG term is negative and highly significant, whereas the quadratic term is positive and strongly significant. This indicates a U-shaped relationship between ESG performance and abnormal returns following environmental sanctions. In practice, firms with moderate ESG performance face the most negative market reactions, while firms at very low or very high ESG levels experience comparatively smaller penalties. This pattern is particularly pronounced after the Paris Agreement, where both coefficients increase in magnitude, suggesting that investor expectations regarding sustainability have become more sensitive and non-linear in the post-2016 period. The presence of

a significant curvature provides an important refinement to the baseline results and suggests that the “hypocrisy penalty” may be concentrated among firms whose ESG profiles place them at an intermediate level of credibility: high enough to trigger expectations, but not sufficiently high to earn stakeholder trust once a violation occurs.

To complement the quadratic specification and provide a more flexible assessment of non-linearity, we re-estimate the model by discretizing the ESG score into quintiles. This categorical approach avoids imposing a functional form and allows the comparison of market reactions across distinct ESG levels. Table 16 reports the estimates, using the lowest ESG quintile as the baseline group.

Table 16. ESG performance quintiles and abnormal returns (1st quintile as baseline).

VARIABLES	(1)	(2)	(3)
	All Sample	Pre-Paris	Post-Paris
ESG (quintile 2)	-0.000173*** (0.000900)	-0.000173*** (0.000954)	-0.000905*** (0.0130)
ESG (quintile 3)	-0.00365*** (0.000832)	-0.00417*** (0.000899)	0.0124** (0.00538)
ESG (quintile 4)	-0.00213** (0.000839)	-0.000869 (0.000918)	-0.0260*** (0.00276)
ESG (quintile 5)	0.000579 (0.000853)	0.000386 (0.000942)	-0.00208 (0.00240)
Size	-0.000144*** (4.02e-05)	-0.000151*** (4.23e-05)	0.000703 (0.00101)
ROA	-0.000262*** (4.04e-05)	-0.000178*** (4.24e-05)	-0.000951*** (0.000154)
Equity	7.17e-07** (3.52e-07)	4.53e-07 (3.54e-07)	9.62e-06*** (2.34e-06)
Constant	0.00362*** (0.000705)	0.00360*** (0.000698)	-0.0126 (0.0253)

VARIABLES	(1)	(2)	(3)
	All Sample	Pre-Paris	Post-Paris
Observations	95,935	88,872	7,021
R-squared	0.002	0.002	0.023

This table presents regression estimates of cumulative abnormal returns (CARs) using ESG performance quintiles in place of the continuous ESG variable. The analysis compares CARs for firms in the second through fifth ESG quintiles, with the first quintile serving as the omitted baseline. Results are reported for the full sample, as well as for the pre- and post-Paris Agreement periods. All models include lagged financial controls (log total assets, ROA, and debt-to-equity ratio). Standard errors are reported in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The quintile-based results provide strong and intuitive evidence of heterogeneous market reactions across the ESG distribution. In the full sample and pre-Paris period, firms in the intermediate ESG quintiles (2 and 3) exhibit significantly more negative CARs than firms in the lowest quintile, reinforcing the idea that moderate performers may face higher reputational risk when sanctioned. In contrast, the post-Paris period displays a markedly different pattern: the most penalized group shifts toward firms in the fourth quintile, while neither the second nor the top quintile shows a significant reaction. These patterns suggest that following the Paris Agreement, investor expectations regarding ESG alignment have intensified and become more selective. Firms positioned just below the top ESG tier appear to face the greatest reputational risk, consistent with a heightened “hypocrisy penalty” for firms perceived as falling short of the higher standards implied by their ESG positioning.

6. Conclusions

This study investigates the financial repercussions of environmental sanctions on firms listed in the S&P 500, with particular attention to the role of ESG performance in shaping investor reactions. Leveraging a comprehensive dataset of government-sourced environmental violations, we employ event study methodology and panel regressions to assess the market response. The results indicate that environmental sanctions are associated with statistically and economically significant negative abnormal returns, with the magnitude of the effect increasing in the post-Paris Agreement period. Notably, we find that firms with higher ESG, environmental, and governance scores experience more pronounced negative market reactions following a sanction, suggesting that investors interpret such events as inconsistencies between communicated sustainability commitments and actual behaviour. This effect - referred to as a “hypocrisy penalty” - appears to be amplified in the post-2016 regulatory context, characterized by heightened climate policy stringency and increased stakeholder scrutiny. By documenting this pattern using regulator-verified enforcement data, the study directly addresses long-standing concerns about selection bias in earlier research relying on media-based or self-reported ESG controversies, thereby

strengthening the credibility of the evidence.

These findings have important implications for both policymakers and market participants. Regulators may consider strengthening disclosure standards and enhancing the credibility of ESG reporting through third-party verification or independent oversight mechanisms. ESG data providers should improve the transparency and granularity of their scoring methodologies to better capture inconsistencies between firms’ stated policies and observed conduct. For institutional investors, incorporating measures of ESG controversies and sanction risk into investment decisions may enhance portfolio risk management and prevent mispricing of reputational risk. Moreover, the results highlight the need for investors to differentiate between “structural” ESG performance and “symbolic” sustainability claims, especially when evaluating firms with high reputational exposure.

Several limitations warrant acknowledgment. First, the analysis is restricted to the U. S. market, which may limit the generalizability of the findings to other jurisdictions with different regulatory and institutional frameworks. Second, while we control for firm characteristics and use lagged variables to mitigate endogeneity concerns, the observational nature of the data precludes strong causal inference. Third, ESG scores are derived from a single data provider, and alternative scoring frameworks may yield different results. A further limitation concerns the potential heterogeneity in the severity and visibility of environmental sanctions, which may influence both investor reactions and media coverage dynamics in ways that are not perfectly captured by our measures.

Future research could extend this work by exploring cross-national comparisons, particularly in jurisdictions with divergent ESG regulatory environments. Moreover, integrating alternative data sources, such as media sentiment or social media analytics, may provide a more nuanced understanding of how reputational events influence investor behavior. Future studies could also refine the event study approach by accounting for corporate events that may occasionally overlap with environmental sanctions, such as earnings releases and mergers and acquisitions (M&A) transactions, which could intro-

duce additional noise into short-term market reactions. Another promising direction would be to examine whether specific types of ESG strengths—such as stakeholder engagement, environmental innovation, or governance quality—atenuate or exacerbate the hypocrisy penalty. Finally, experimental or survey-based approaches could offer valuable insights into the behavioural mechanisms underlying investor sensitivity to perceived ESG hypocrisy. Such designs may help disentangle whether investors penalize firms for the environmental violation itself or for the perceived discrepancy between aspirational ESG narratives and observed misconduct.

Abbreviations

CAAR	Cumulative Average Abnormal Return
CAR	Cumulative Abnormal Return
CSR	Corporate Social Responsibility
ESG	Environmental, Social, and Governance
GMM	Generalized Method of Moments
LSEG	London Stock Exchange Group
M&A	Mergers and Acquisitions
S&P 500	Standard & Poor's 500 Index

Author Contributions

Daniela Lo Cascio: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing

Data Availability Statement

The data is available from the corresponding author upon reasonable request.

Conflicts of Interest

The author declares no conflicts of interest.

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