

The Impact of Environmental Pressure on Firm-Level Greenwashing

Abstract: This paper studies when and why firms' environmental communication diverges from real environmental performance. Using U.S. firms' earnings call transcripts from 2013 to 2023, we construct a firm-level measure of greenwashing that links positive climate-related communication to subsequent changes in environmental performance. We find that firms with higher pollution levels are more likely to engage in greenwashing, intensifying positive environmental communication while delivering weak environmental improvements. This finding is robust to alternative pollution measures and industry-year fixed effects. External environmental pressure increases greenwashing on average, while cheap talk is largely shaped by industry-level disclosure environments. Overall, the results show that greenwashing reflects firm-specific constraints on environmental performance rather than common disclosure trends.

Keywords: Greenwashing, Environmental Communication, Corporate pollution, Climate Disclosure, Environment Pressure

1. Introduction

Corporate claims about environmental performance have expanded rapidly in recent years (e.g. Lyon & Montgomery, 2015). These claims are often presented as evidence of firms' proactive efforts to address climate change and reduce environmental externalities. However, the credibility of such environmental narratives has come under increasing scrutiny from regulators, investors, and consumers. A prominent example is the class action lawsuit against Delta Airlines in 2023, which alleges the company's "carbon-neutral" pledge misleading.¹ This anecdotal example underscores a key challenge in sustainable finance and corporate governance: environmental disclosure is strategic and selective (Lyon & Maxwell, 2011; Marquis et al., 2016) while environmental performance is inherently difficult for outsiders to observe and verify (Marquis et al., 2016). In addition, genuine environmental improvements are costly, slow, and constrained by technological and operational factors (Delmas & Burbano, 2011). As a result, firm managers may be incentivized to spin environmental narratives regardless of the underlying green performance.

Environmental communication plays an important role in shaping investor and consumer perceptions while misleading climate narratives can distort capital allocation and generate real financial consequences (Sautner et al., 2023). This study measures a proxy for greenwashing behaviour. As firms emphasize carbon neutrality, net-zero targets, and sustainability commitments, external stakeholders must assess environmental performance in settings characterized by information asymmetry and limited verifiability. While environmental communication has become more frequent and sophisticated, real environmental outcomes, such as emissions reductions remain costly and slow, creating scope

¹ In 2023, a class action lawsuit was filed in the United States alleging that Delta Airlines' "carbon-neutral" marketing claims were false and misleading, as the company relied predominantly on low-quality carbon offsets that did not credibly neutralize its greenhouse gas emissions. The lawsuit argues that consumers paid price premiums based on these claims and could not independently verify the environmental benefits, characterizing Delta's strategy as greenwashing. Importantly, this case is not isolated: similar legal actions against firms such as KLM and Evian reflect a broader wave of litigation and public backlash against corporate environmental claims.

for divergence between communication and actual performance (Delmas & Burbano, 2011). Although prior research documents symbolic environmental behaviour and limitations of ESG-based measures (Berg et al., 2022), it remains difficult to distinguish firms that substantively improve environmental performance from those that primarily adjust their environmental narratives.

Moreover, two key forces shaping firms' environmental behaviour have not been jointly examined within a unified empirical framework. First, firms differ substantially in pollution intensity. This affects both the cost of real environmental improvement and the level of external scrutiny (King & Lenox, 2000). Second, external environmental pressure can increase suddenly following environmental incidents, regulatory violations, or negative shocks (Bansal & Clelland, 2004). Such pressure raises attention and monitoring and creates short-term incentives to respond when real performance cannot adjust quickly. Taken together, greenwashing should not be viewed as isolated misrepresentation. Instead, it reflects structural constraints and incentive asymmetries. This calls for measures that directly link environmental communication to changes in real environmental performance and for empirical analyses that explain how pollution exposure and external pressure shape the communication–performance gap.

This paper examines the divergence between firms' environmental communication and real environmental performance, and investigates which firms are more likely to engage in greenwashing and under what conditions such behaviour becomes more pronounced. Specifically, it studies whether higher pollution levels induce firms to overstate positive environmental communication to mask limited environmental improvements, and whether external environmental pressure affects greenwashing behaviour. In addition, our greenwashing measure is distinct from lower-cost and less consequential forms of communication, such as cheap talk (Bingler et al., 2023)

Using firm-level data that link environmental communication from earnings call transcripts to changes in environmental performance, this paper shows that greenwashing is systematic rather than random. Firms with higher pollution levels are significantly more likely to intensify positive environmental communication while delivering weaker real environmental improvements. We document a persistent gap between positive communication and performance that is robust to alternative pollution measures and industry-year fixed effects. External environmental pressure further increases greenwashing on average, whereas cheap talk is largely driven by industry-level disclosure environments, highlighting that greenwashing reflects firm-specific incentives arising from underlying environmental externalities.

Our contributions to the literature on environmental disclosure and corporate finance are three-fold. First, we propose a firm-level measure of greenwashing that explicitly links environmental communication to subsequent changes in environmental performance. Second, we extend the literature by relating greenwashing to firm-level pollution exposure and performance adjustment constraints, offering a systematic way to study heterogeneity in environmental communication across firms. Third, the paper differentiates greenwashing from low-cost cheap talk and shows how firm-specific characteristics and external pressure shape these behaviours differently. Our greenwashing measure thereby clarifies the economic content of environmental communication beyond industry-wide disclosure practices.

The remainder of the paper is organized as follows. Section 2 reviews the related literature on greenwashing, pollution, and external environmental pressure. Section 3 discuss the data, variable construction, and empirical methodology. In Section 4 we present the empirical results. Finally, Section 5 concludes the paper.

2. Literature Review

2.1 Greenwashing and the Gap between Environmental Communication and Performance

A large literature shows that firms' environmental communication often diverges from their actual environmental performance. Early conceptual work defines greenwashing as a situation in which firms with poor environmental performance engage in positive environmental communication, creating a gap between favourable environmental claims and unfavourable outcomes (Delmas & Burbano, 2011). Importantly, greenwashing is not random. They argue that when firms face strong environmental expectations and scrutiny, while real performance improvements are costly and slow to adjust, they are more likely to rely on low-cost and rapidly adjustable communication strategies. This asymmetry between the speed of narrative adjustment and substantive environmental change gives rise to a "talk first, walk later" pattern in corporate environmental disclosure.

Consistent with this view, Lyon and Montgomery (2015), in their comprehensive review of the greenwashing literature, conceptualize greenwashing as a subset of misleading communication. They argue that greenwashing is more likely to arise when two conditions are jointly satisfied: increasing stakeholder demand for environmental information and insufficient external verification or auditing, which sustains information asymmetries and allows firms to selectively present and exaggerate favourable narratives (Lyon and Montgomery, 2015). Providing direct empirical support, Marquis et al. (2016) show that when external scrutiny and disclosure pressure intensify, firms tend to engage in selective disclosure by emphasizing relatively benign or easily communicable dimensions, thereby projecting an image of transparency while masking unfavourable underlying performance. This evidence highlights how greenwashing can emerge through disclosure structure and textual narratives.

The likelihood and intensity of greenwashing further depend on firms' information environments and the degree of verifiability. Berg et al. (2022) emphasize that ESG ratings and the information processing behind them exhibit substantial methodological divergence and

flexibility. As a result, external evaluations may respond strongly to changes in disclosure content and narratives, while reflecting real environmental outcomes more slowly and inconsistently. In such an environment, firms can more easily obtain short-term recognition by strengthening positive environmental narratives, while actual environmental performance remains constrained by technological, capital, and operational rigidities. From a theoretical perspective, Lyon and Maxwell (2011) show that when firms face potential auditing or verification, but enforcement is imperfect and disclosures can be strategically manipulated, firms may optimally choose disclosure strategies that make them “appear greener” to influence external beliefs. This model provides a formal foundation for the institutional and strategic nature of greenwashing.

This study argues that the intensity of greenwashing is driven not only by disclosure incentives, but also by a systematic asymmetry between the speed at which communication can be adjusted and the speed at which environmental performance can improve. When firms face stronger external environmental expectations, their most immediate and flexible response is often to adjust narratives and communication. In contrast, substantive performance improvements typically require capital investment, process reorganization, and long-term planning, resulting in slow, delayed, or uneven adjustments. Greenwashing therefore should not be interpreted simply as deliberate misrepresentation, but rather as a structural outcome of the fact that firms can improve how well they “talk” in the short run, while being unable to improve how well they “act” over the same time horizon.

2.2 Pollution Levels and Incentives for Greenwashing

A growing literature suggests that firms’ pollution exposure fundamentally shapes their incentives to engage in greenwashing. Firms with higher pollution levels generate larger negative environmental externalities and therefore attract greater attention from regulators, investors, and other stakeholders. At the same time, substantive pollution reduction typically

requires substantial capital investment, technological upgrading, and organizational restructuring, making real environmental improvements costly and slow to implement (Aghion et al., 2016; Kahn et al., 2021). Our view is that this asymmetry, high external visibility combined with limited short-run adjustment capacity, creates fertile ground for greenwashing. When pollution is high, firms face stronger incentives to respond, yet the most feasible response in the short run is often communicative rather than operational.

Delmas and Burbano (2011) formalize this intuition by arguing that greenwashing is more likely among highly polluting firms because the marginal cost of real environmental improvement increases with pollution intensity, while the benefits of appearing environmentally responsible rise simultaneously. Lyon and Montgomery (2015) further emphasize that when firms face strong environmental expectations but lack the ability or willingness to deliver immediate performance improvements, they may substitute communication for action. Building on these insights, we argue that pollution level is not merely a background firm characteristic, but a structural driver of communication–performance divergence. Higher pollution increases both the cost of “doing” and the payoff to “saying,” systematically widening the gap captured by greenwashing measures.

Empirical evidence from financial economics reinforces this mechanism. Bolton and Kacperczyk (2021) show that carbon emissions are priced as a risk factor in capital markets, implying that pollution exposure has direct financial consequences. Facing such pricing pressure, firms may have incentives to mitigate perceived environmental risk through disclosure and narrative strategies. Duchin et al. (2025) provide particularly compelling evidence by showing that firms—especially those with more polluting assets—respond to environmental pressure primarily by divesting polluting assets rather than reducing emissions. While such actions improve ESG ratings and investor perceptions, they do not lower aggregate pollution.

We interpret these findings as indicating that high pollution amplifies incentives for symbolic or cosmetic responses. Rather than reducing emissions, firms adjust what is most easily adjustable, organizational boundaries or communication, thereby improving perceptions without improving outcomes. This logic directly motivates our hypothesis that higher pollution levels are associated with more severe greenwashing, defined as positive environmental communication that outpaces improvements in real environmental performance.

2.3 Environmental Pressure and Corporate Responses

Another strand of the literature examines how firms respond to external environmental pressure arising from negative environmental events, regulatory actions, or heightened public scrutiny. Environmental incidents such as pollution accidents or regulatory violations are highly visible shocks that immediately draw attention to firms' environmental conduct and intensify monitoring by external stakeholders. These events therefore constitute sudden increases in environmental pressure.

Prior research shows that firms frequently respond to such pressure through changes in disclosure and communication rather than through immediate operational improvements. Marquis et al. (2016) document that heightened scrutiny leads firms to increase sustainability-related disclosure, even when underlying environmental performance does not improve proportionally. Duchin et al. (2025) treats environmental risk incidents as quasi-exogenous shocks to environmental pressure and show that firms respond by adjusting organizational boundaries through asset divestment, a strategy that improves perceived environmental performance without reducing total emissions. We think that environmental pressure primarily triggers responses along dimensions that are fast, visible, and relatively low cost. Communication and symbolic actions can be implemented almost immediately, whereas real environmental improvements face technological, financial, and organizational constraints.

Indeed, a growing literature emphasizes that environmental outcomes respond slowly to regulatory and market signals. Kahn et al. (2021) show that emissions reductions and climate-related adjustments are subject to substantial rigidities, implying that real environmental performance cannot be rapidly altered following external shocks. As a result, firms facing sudden environmental pressure may be unable to improve performance in the short run, even if they are willing to do so. This timing mismatch is central to our argument. External environmental pressure raises the urgency to respond, but the feasible response margin in the short run is largely communicative. Consequently, pressure shocks increase the likelihood that environmental narratives will improve faster than real outcomes, leading to a temporary but economically meaningful increase in greenwashing.

Taken together, the existing literature establishes that greenwashing arises from a systematic divergence between environmental communication and real environmental performance. Prior studies emphasize that environmental disclosure is strategic, highly responsive to external expectations, and often weakly constrained by verification, while substantive environmental improvements are costly, slow, and subject to technological and organizational rigidities. This combination makes greenwashing more likely when firms face heightened scrutiny but lack the ability to deliver immediate performance improvements. At the same time, the literature suggests that both pollution exposure and external environmental pressure amplify these incentives by increasing the salience of environmental issues and the urgency to respond.

Despite these insights, existing research has largely examined symbolic responses, disclosure behaviour, or organizational adjustments in isolation, without directly quantifying the extent to which environmental communication outpaces actual improvements in environmental performance at the firm level. Prior studies have not systematically measured how pollution intensity and external environmental pressure jointly shape the communication—

performance gap over time. As a result, our understanding of when and why firms engage in greenwashing remains incomplete.

Guided by this logic, this study operationalizes greenwashing as the extent to which positive green communication outpaces changes in real green performance. Two key drivers are emphasized. First, higher pollution levels imply higher marginal costs and greater difficulty of achieving real environmental improvements, while simultaneously attracting greater external attention, thereby increasing the scope for communication–performance divergence. Second, external environmental pressure, such as environmental incidents, can sharply increase firms’ incentives to adjust narratives in the short run, while real performance remains slow to respond, leading to a temporary intensification of greenwashing following such events. This framework also explains why identifying greenwashing requires measures that jointly incorporate textual communication and changes in real environmental performance, rather than relying solely on disclosure intensity or ESG scores, which primarily capture what firms say or how they are perceived, rather than whether communication and performance are aligned.

3. Data and Variable Construction

Our textual data consist of earnings call transcripts of U.S. firms from 2013 to 2023, which provide a timely and forward-looking channel through which corporate managers communicate firm performance, strategic developments, and environmental issues to investors and financial analysts. Earnings call transcripts are obtained from Thomson Reuters. Firm-level ESG data and greenhouse gas emissions are collected from Thomson Reuters, which provides standardized and widely used measures of corporate environmental performance. Environmental incidents are from the U.S. Environmental Protection Agency’s Enforcement and Compliance History database.

We obtain earnings call transcripts for 1,595 U.S. firms over the sample period. This sample reflects all U.S. firms for which earnings call transcripts are available in Thomson Reuters between 2013 and 2023. All transcripts are processed at the firm-year level, whereby multiple earnings calls held by a firm within the same year are aggregated into a single firm-year document. Climate-related paragraphs are identified using ClimateBERT, and only paragraphs classified as climate-related are retained for subsequent analysis.

The construction of our greenwashing (*GWS*) measure requires the joint availability of earnings call transcripts, ESG scores, and greenhouse gas emissions (*GHG*) data. Although each individual data source covers a broader set of firms, their intersection substantially reduces the final sample size. Specifically, earnings call transcripts are available for 1,595 firms, ESG scores for 1,984 firms, and greenhouse gas emissions data for 5,348 firms.

Imposing the requirement that all three data sources be available continuously over the 2013–2023 period yields a balanced panel of 311 firms, corresponding to 3,421 firm-year observations.

3.1 Positive Green Communication

To measure the tone of firms' environmental communication, we construct a firm-year measure of Positive Green Communication (*GComm*) based on positive climate-related paragraphs in earnings call transcripts. We classify climate-related paragraphs according to their sentiment. Paragraphs expressing opportunity actions are labelled as positive climate-related paragraphs.

This approach builds on the established text-as-data literature in finance. We quantify firms' environmental communication using the fraction of climate-related textual units relative to total disclosure, which accounts for differences in transcript length and facilitates comparisons across firms and over time. Our identification of climate-related content draws on the climate exposure framework of Sautner et al. (2023), who show that earnings call

transcripts provide a timely and informative measure of firms' engagement with climate-related issues. Extending their approach, we focus on the positive tone of climate-related communication, thereby isolating proactive and opportunity-oriented environmental narratives from general climate discussions.

For firm i in the year t , $GComm$ is defined as:

$$GComm_{i,t} = \frac{\text{Number of Positive Climate Relate Paragraphs}_{i,t}}{\text{Total number of Paragraphs}_{i,t}} \quad (1)$$

where the denominator includes all paragraphs in the earnings call transcript to standardize the measure across firms and time.

3.2 Green Performance

We proxy firms' environmental performance using a composite measure that combines ESG environmental scores and greenhouse gas emission reflecting both perceived environmental quality and actual environmental impact. Specifically, both components are first standardized at the firm-industry level, where $Z_{EScore_{i,t}}$ denotes the standardized environmental score. $Z_{GHG_{i,t}}$ represents standardized greenhouse gas emissions, with higher values indicating poorer environmental performance.

$$GPerf_{i,t} = Z_{EScore_{i,t}} - Z_{GHG_{i,t}} \quad (2)$$

By construction, higher values of $GPerf$ indicate superior environmental performance, characterized by stronger ESG environmental ratings combined with lower levels of emissions.

To capture the dynamic evolution of firms' environmental performance, we further compute the year-over-year change in green performance as:

$$\Delta GPerf_{i,t} = GPerf_{i,t} - GPerf_{i,t-1} \quad (3)$$

3.3 Greenwash Score

Building on prior literature that conceptualizes greenwashing as a misalignment between environmental communication and actual environmental performance, we construct a firm-year Greenwashing Score (*GWS*) by comparing firms standardized green communication with changes in their green performance.

Our definition of greenwashing closely follows Delmas and Burbano (2011), who conceptualize greenwashing as the difference of two firm behaviours: poor environmental performance and positive communication about the real environmental performance. Consistent with this framework, our measure captures situations in which firms emphasize positive environmental narratives while exhibiting limited or deteriorating improvements in actual environmental outcomes.

Specifically, we define *GWS* as:

$$GWS_{i,t} = Z_{GComm_{i,t}} - \Delta GPerf_{i,t} \quad (4)$$

In this expression $Z_{GComm_{i,t}}$ denotes the standardized value of positive green communication, obtained by subtracting the sample mean and dividing by the sample standard deviation. Standardization is performed at the firm-year level to ensure comparability across firms and over industry and to place communication and performance measures on a common scale.

A higher value of *GWS* indicates that a firm's positive environmental communication exceeds improvements in its environmental performance, which is consistent with a higher degree of greenwashing behaviour. Conversely, lower, or negative values of *GWS* reflect a

closer alignment between communication and performance, suggesting more credible environmental disclosure.

3.4 Pollution level

To measure firms' environmental pollution, we use greenhouse gas (*GHG*) emissions as a proxy for firms' pollution levels. Specifically, we employ firms' total carbon emissions, defined as the sum of Scope 1 and Scope 2 emissions, following standard practice in the literature. Scope 1 emissions capture direct greenhouse gas emissions from firms' own operations, such as fuel combustion and on-site production processes, while Scope 2 emissions reflect indirect emissions associated with purchased electricity, steam, or heat. emissions data.

We use emission levels rather than emission intensities, consistent with Sautner (2023). Prior research demonstrates that firms' absolute emission levels are closely related to exposure to carbon-related risk premiums, represent the central focus of regulatory policies and investor-led initiatives pursuing net-zero emission targets, and are intrinsically tied to constraints imposed by global carbon budgets (Bolton & Kacperczyk, 2021). Moreover, emission intensity metrics have increasingly been questioned by investors, as they are highly sensitive to firm size and scaling effects, which may obscure firms' true environmental impact.

Finally, we take the natural logarithm of firms' total *GHG* emissions (Scope 1 + Scope 2) to construct the pollution level variable (*log_ghg*). This variable is measured at the firm-year level, with higher values indicating greater pollution intensity and worse environmental performance.

3.5 Environmental Pressure

To capture environmental pressure arising from negative environmental shocks, we construct a firm-year indicator variable, *EnvEvent*, based on the occurrence of environmental risk incidents. This measure follows the approach of Duchin et al. (2025). An environmental

risk incident represents a publicly visible negative environmental event that draws attention to a firm's environmental conduct and immediately intensifies external scrutiny. Such incidents typically trigger heightened monitoring, reputational damage, and potential regulatory or legal consequences. As a result, environmental risk incidents constitute a direct and realized manifestation of environmental pressure, rather than a proxy for latent or unobserved stakeholder preferences.

Specifically, $EnvEvent_{i,t}$ equals to 1 if firm i experienced at least one environmental risk incident in year t .

$$EnvEvent_{i,t} = \begin{cases} 1 & \text{if } N_{i,t}^{EnvIncidents} \geq 1 \\ 0 & \text{if } N_{i,t}^{EnvIncidents} = 0 \end{cases} \quad (5)$$

Here, $N_{i,t}^{EnvIncidents}$: number of environmental incidents for firm i in year t

Environmental incidents refer to negative events related to environmental misconduct, pollution, regulatory violations, or other environmentally harmful activities that attract adverse attention from stakeholder.

Consistent with Duchin et al. (2025), this binary specification focuses on the extensive margin of environmental pressure, capturing whether a firm is exposed to environmental scrutiny each year, rather than the intensity or severity of incidents. This approach mitigates concerns related to measurement error in incident counts and allows for a clean identification of environmental pressure shocks at the firm-year level.

3.6 Control Variables

To account for firm characteristics and market conditions that may jointly affect firms' environmental behaviour, disclosure practices, and investor responses, we include a comprehensive set of control variables at both the firm level and the stock level. At the firm level, we control for firms' financial performance, size, capital structure, and investment characteristics. *ROA* (return on assets) is included to capture firm profitability, which may

influence both environmental investment capacity and disclosure incentives. Firm size (*size*) is measured as the natural logarithm of market capitalization and controls for scale effects, as larger firms typically possess greater resources for environmental initiatives and face higher scrutiny from stakeholders, resulting in more extensive reporting. We also control for leverage, defined as total debt relative to total assets, to account for financial constraints and debtholder monitoring that may affect firms' environmental strategies. *Firm age* is included to capture differences in organizational maturity, reputation concerns, and accumulated disclosure practices. In addition, we include the capital expenditure ratio (*Capex/Assets*) to control for firms' investment intensity, as capital-intensive firms may face different environmental constraints and long-term adjustment costs.

At the stock level, we control for market-based measures that capture investor behaviour and stock characteristics. Annual stock return (*Ret*), defined as the total return to shareholders over the fiscal year, controls for investor satisfaction and tolerance for firm policies, including environmental actions. Stock return volatility (*Vol*), measured as the standard deviation of monthly stock returns within a year, captures financial instability and firm riskiness, which may affect both managerial incentives and investor reactions to environmental disclosures. Stock turnover, defined as annual trading volume divided by shares outstanding, as a proxy for stock liquidity and investor attention. Higher turnover reflects more active trading and greater visibility in capital markets, which may intensify pressure on firms to engage in or communicate about environmental activities.

4. Empirical results

This section first documents the divergence between firms' positive green communication and their actual environmental performance using descriptive statistics and time-trend analyses. It then examines whether pollution levels systematically drive this

divergence, distinguishes between cheap talk and substantive greenwashing behaviour, and finally investigates the dynamic role played by external environmental pressure.

4.1 Descriptive Analytics and Time Trend

Table 1 reports summary statistics for the main variables used in the analysis. Overall, the distributions indicate substantial cross-sectional and time-series variation in firms' green performance, communication behaviour, and pollution levels, supporting the suitability of the data for panel analysis. The average ESG environmental score is 47.15, with a wide dispersion, suggesting meaningful heterogeneity in firms' perceived environmental quality. Similarly, greenhouse gas emissions, measured in logarithmic form, display considerable variation across firms, reflecting large differences in pollution intensity.

[Insert Table 1 here]

Measures of environmental communication and greenwashing also exhibit substantial dispersion. While the mean level of positive green communication is low, consistent with climate-related discussion constituting only a small fraction of earnings call content, the wide range of values indicates that some firms engage much more intensively in environmental communication than others. The greenwashing score has a mean close to zero but a large standard deviation, suggesting pronounced differences in the alignment between firms' environmental communication and actual performance improvements.

The Cheap Talk Index further reveals that many firms make no climate-related commitments each year, while others rely heavily on non-specific commitments, highlighting heterogeneity in the quality of environmental disclosure. The environmental pressure indicator shows that approximately 19% of firm-year observations experience at least one environmental risk incident, indicating that negative environmental shocks are relatively common in the sample.

4.2 Pollution, Positive Green Communication and Green Performance

[Insert Figure 1 here]

Figure 1 illustrates a growing divergence between firms' environmental communication and environmental performance. Panel A shows that positive green communication increases significantly in the later part of the sample, with a particularly sharp acceleration in the late 2013 and around 2021. This pattern is consistent with prior literature documenting that investors increasingly view climate risk as financially material and demand more extensive climate-related disclosure from firms, thereby strengthening firms' incentives to emphasize environmental narratives in public communication (Krueger et al., 2020). In addition, the release of the Task Force on Climate-related Financial Disclosures (TCFD) recommendations in 2017 provided a standardized framework for climate disclosure, which may have contributed to the widespread expansion of climate-related narratives in corporate communications (TCFD, 2017). Following the peak, *GComm* exhibits a partial decline, which may reflect a normalization after an earlier disclosure surge as well as increasing scrutiny that disciplines overly positive environmental narratives. Consistent with this interpretation, prior research suggests that voluntary climate disclosure may be accompanied by vague or symbolic statements when verifiability is limited (Bingler et al., 2024).

In contrast, Panel B shows that green performance improves only modestly and remains volatile over time. This pattern is consistent with Bolton & Kacperczyk (2021), who emphasize that substantive emissions reductions and environmental performance improvements typically require long-term capital investment and technological adjustment, resulting in gradual and uneven progress. Moreover, emissions levels and changes are directly linked to risk premia in capital markets, implying that firms face meaningful economic trade-offs when undertaking emissions reductions.

[Insert Table 2 here]

Table 2 formally examines the relationship between firms' pollution levels and their green communication behaviour. Across all specifications, the coefficient on *log_ghg* is positive and highly statistically significant. In the baseline specification with year and industry fixed effects (column (1)), a one-standard-deviation increase in pollution is associated with a 0.145 standard deviation increase in green communication ($t = 6.84$). This effect becomes even stronger after controlling for firm-level and stock-level characteristics, rising to 0.203–0.207 in columns (2) and (3). Importantly, the association remains economically meaningful and statistically significant even after absorbing industry-year fixed effects in column (4), with a coefficient of 0.140 ($t = 5.91$). These magnitudes indicate that more polluting firms systematically engage more intensively in positive green communication, consistent with heightened scrutiny and reputational incentives.

[Insert Table 3 here]

In contrast, *Table 3* analyzes how pollution relates to changes in firms' actual environmental performance. The results reveal a consistently negative and statistically significant relationship between *log_ghg* and *Delta_GPerf*. In the baseline model, the coefficient on *log_ghg* is -0.126 ($t = -4.72$), implying that more polluting firms experience significantly smaller year-over-year improvements in green performance. This negative association strengthens slightly when controls are added, reaching approximately -0.155 to -0.159 in columns (2) and (3), and remains robust after including industry-year fixed effects in column (4), where the coefficient is -0.140 ($t = -4.47$). These estimates indicate that higher pollution levels are systematically associated with weaker environmental performance dynamics.

Taken together, Tables 2 and 3 reveal a clear and economically meaningful “say more, do less” pattern. While firms with higher pollution levels increase their green communication by roughly 0.14 - 0.21 standard deviations, they simultaneously experience significantly

smaller improvements in green performance. These regression results provide a firm-level explanation for the divergence observed in Figure 1, directly linking the growing gap between environmental communication and environmental performance to firms' pollution intensity.

Once fixed effects are included, the constant terms in both tables are generally statistically insignificant or not separately identified, indicating that baseline levels of positive green communication and changes in green performance are largely absorbed by time and industry effects. In specifications with high-dimensional fixed effects, particularly industry-by-year fixed effects, the constant term does not carry a separate economic interpretation and is therefore not reported. For completeness, we retain the associated t-statistics in the regression output. As a result, the estimated coefficients are identified from cross-sectional and within-firm variation relative to industry-year benchmarks, rather than from common trends in the data.

Second, stock returns play different roles across the two outcomes. In *Table 2*, *Ret* is positively related to green communication in specifications without industry-year fixed effects (e.g., column (3), coefficient = 0.074, $t = 4.72$), suggesting that firms with stronger stock market performance may attract greater investor attention or have more flexibility to engage in environmental communication. However, this association becomes statistically insignificant once industry-year fixed effects are included, and *Ret* is not significantly related to changes in green performance in any specification of *Table 3*. This contrast implies that favourable stock market conditions may facilitate environmental communication, but do not translate into tangible improvements in firms' environmental performance.

Overall, the evidence in this section indicates that pollution plays a dual role: it significantly increases firms' incentives to engage in positive green communication, while simultaneously being associated with weaker improvements in actual environmental

performance. This systematic divergence between talk and action lays the foundation for the subsequent analysis of greenwashing behaviour.

4.3 Pollution-induced Greenwashing

[Insert Table 4 here]

Table 4 examines whether the divergence between environmental communication and environmental performance documented in the previous section manifests as systematic greenwashing among more polluting firms. The dependent variable, *GWS*, is constructed as the difference between standardized green communication and changes in green performance, thereby directly capturing the extent to which firms' environmental narratives outpace actual performance improvements.

Across all specifications, the coefficient on *log_ghg* is positive with highly statistically significant. In the baseline specification with year and industry fixed effects (column (1)), a one-standard-deviation increase in pollution is associated with a 0.214 standard deviation increase in the greenwashing score ($t = 7.89$). This relationship remains stable after controlling for firm-level and stock-level characteristics, with coefficients of 0.242 in columns (2) and (3) and remains strongly significant even after absorbing industry-year fixed effects in column (4), where the coefficient equals 0.232 ($t = 6.88$). The persistence of these magnitudes indicates that the positive association between pollution and greenwashing is not driven by unobserved industry-level shocks or common time trends but instead reflects firm-level behaviour.

These results provide direct evidence that higher pollution levels are associated not merely with increased environmental communication or weaker environmental performance in isolation, but with misalignment between the two. In other words, more polluting firms are significantly more likely to emphasize positive environmental narratives without delivering

corresponding improvements in environmental performance, consistent with greenwashing behaviour.

The coefficients on control variables further support this interpretation. Firms with higher environmental scores exhibit significantly lower greenwashing scores, suggesting that firms with stronger underlying environmental reputations are less prone to overstating performance. Firm size is negatively related to greenwashing once controls are included, indicating that larger firms may face stronger monitoring or reputational constraints. In contrast, company age is positively associated with greenwashing, implying that more established firms may rely more heavily on symbolic environmental communication. Among stock-level controls, return volatility is consistently negatively related to greenwashing, suggesting that firms operating in riskier market environments engage less in overstated environmental narratives, potentially due to heightened scrutiny and monitoring by investors and other stakeholders, this a mechanism consistent with prior studies showing that greater uncertainty and risk increase information acquisition and reduce managers' incentives to engage in opportunistic or symbolic disclosure (Dyck et al., 2010)

As in earlier specifications, the constant term is not separately identified once fixed effects are included, reflecting that baseline levels of greenwashing are absorbed by time and industry, or industry-year effects. Consequently, the estimated coefficients should be interpreted as capturing within-firm variation relative to industry-year benchmarks rather than absolute levels of greenwashing.

Pollution simultaneously increases firms' incentives to communicate positively about environmental issues while constraining real environmental improvements, resulting in a systematic divergence between talk and walk. This pattern motivates the subsequent analysis distinguishing greenwashing from cheap talk and examining the conditions under which symbolic communication intensifies.

4.4 Cheap Talk versus Greenwashing

[Insert Figure 2 here]

Panel A of Figure 2 displays pronounced phase-based fluctuations in the average greenwashing score over the sample period. From 2016 to 2018, *GWS* rises steadily and peaks in 2018, consistent with an asymmetry in the adjustment speed of environmental communication and environmental performance during the early institutionalization of climate disclosure. The release of the TCFD recommendations in 2017, together with the launch of Climate Action 100+ and major policy initiatives in 2018, intensified investor and stakeholder attention to corporate climate behaviour and likely strengthened incentives for firms to expand climate-related narratives. In contrast, substantive emissions reductions typically require long-term investment and technological adjustment, making real performance improvements less responsive in the short run and temporarily widening the communication and performance gap.

Between 2018 and 2019, *GWS* declines sharply, likely reflecting a normalization following the initial disclosure surge. As the EU sustainable finance framework moved toward greater standardization, including progress on the EU Taxonomy, firms' disclosures may have shifted from aspirational narratives toward more compliance-oriented and comparable reporting, while increased scrutiny curtailed overly symbolic communication. From 2019 to 2021, *GWS* increases again. This renewed rise coincides with the rapid expansion of net-zero pledges and the growing prominence of climate considerations in capital markets. Evidence from the UNFCCC indicates that net-zero commitments increased sharply around 2020, while major asset managers further emphasized climate risk and Climate Action 100+ introduced its Net-Zero Company Benchmark in 2021. These developments may have once again accelerated climate-related narratives, while real environmental performance continued to adjust more slowly, resulting in a renewed increase in greenwashing (Montgomery et al., 2023).

In contrast to the pronounced and phase-based fluctuations observed for greenwashing in Panel A, Panel B shows that the Cheap Talk Index (*CTI*) follows a smoother and more synchronized upward trend over time, with a particularly noticeable increase from 2013 to 2021. This pattern closely aligns with the findings of Bingler et al. (2024), who document a broad rise in vague and non-specific climate commitments following the diffusion of climate disclosure frameworks and the widespread adoption of net-zero pledges. The relative smoothness of *CTI* and the common timing of its increase suggest that cheap talk is primarily shaped by industry-level institutional environments and disclosure norms, rather than by firm-specific characteristics.

To systematically capture the extent to which firms rely on vague and non-committal climate-related promises, we construct a firm-year *CTI* following the conceptual and methodological framework proposed by Bingler et al. (2024). In line with their definition, cheap talk refers to climate-related communication that articulates intentions or commitments without sufficient specificity to enable verification or accountability. They first identify commitment-related statements in firms' climate disclosures, defined as expressions of intentions, goals, or plans regarding future environmental or climate actions. Each identified commitment is then classified according to its level of specificity. Commitments that lack quantitative targets, explicit timelines, or clearly articulated implementation measures are categorized as non-specific commitments, reflecting a lower degree of credibility and verifiability.

Formally, the *CTI* for firm i in year t is defined as the proportion of non-specific commitments relative to all climate-related commitments:

$$CTI_{i,t} = \frac{Commitment \cap Non_Specific_{i,t}}{Commitment_{i,t}} \quad (6)$$

By construction, the *CTI* ranges from zero to one, with higher values indicating a greater reliance on vague or non-specific climate commitments. Accordingly, a higher *CTI*

reflects a higher degree of cheap talk, whereas lower values suggest that firms' climate commitments are more specific, verifiable, and potentially credible.

[Insert Table 5 here]

Table 5 complements this descriptive evidence by formally examining whether firms' pollution levels differentially explain cheap talk and greenwashing behaviour. Columns (1) - (3) show that when only year fixed effects are included, *log_ghg* is positively and significantly associated with *CTI*, with coefficients of 0.0873, 0.0420, and 0.0373, respectively. These results indicate that more polluting firms are initially more inclined to issue superficial and weakly enforceable climate commitments as a low-cost response to external expectations. However, once industry-year fixed effects are introduced in column (4), the coefficient on *log_ghg* becomes statistically insignificant. This attenuation suggests that variation in cheap talk is largely driven by common, time-varying industry-level shocks, and that once such institutional heterogeneity is absorbed, firms' pollution levels have limited explanatory power for cheap talk.

By contrast, column (5) shows that pollution remains a strong and economically meaningful predictor of greenwashing behaviour. When the dependent variable is GWS, the coefficient on *log_ghg* remains large and highly significant even after controlling for industry-year fixed effects ($\beta = 0.2320$, $t = 6.88$). This finding indicates that greenwashing is not merely a reflection of industry-wide disclosure practices or symbolic commitment waves but is instead directly and structurally linked to firms' underlying pollution levels. Unlike cheap talk, greenwashing reflects firm-specific strategic incentives to misalign environmental communication with actual environmental performance.

Cheap talk appears to be a more institutionalized and homogeneous phenomenon, characterized by synchronized time trends and sensitivity to industry-level disclosure environments. Greenwashing, in contrast, is heterogeneous and pollution-driven, reflecting

strategic firm-level behaviour in response to environmental pressure. This distinction underscores the importance of separating symbolic communication shaped by disclosure regimes from greenwashing that arises from firms' real environmental externalities when evaluating corporate environmental communication.

4.5 Robustness to Alternative Pollution Measures

[Insert Figure 3 here]

Over the sample period, firms' average greenhouse gas emissions exhibit a gradual downward trend, albeit with noticeable short-term fluctuations. This pattern is consistent with broader decarbonization efforts and increasing regulatory and market pressure to reduce emissions. Importantly, the decline in aggregate emissions does not eliminate substantial cross-sectional heterogeneity in firms' pollution exposure, which remains a central determinant of differences in environmental communication and greenwashing behaviour (Figure 3).

[Insert Table 6 here]

To examine whether the main findings depend on the specific measurement of pollution, Table 6 re-estimates the baseline greenwashing regressions using four alternative proxies for firms' pollution levels. Column (1) uses total emissions measured by the logarithm of greenhouse gas emissions. Columns (2) - (4) replace this measure with emission intensity (*GHG* scaled by sales), quartile rankings based on total emissions, and quartile rankings based on emission intensity, respectively. Across all specifications, the estimated coefficients on the pollution measures remain positive, highly statistically significant, and economically meaningful. For instance, the standardized coefficient on *log_ghg* equals 0.2320 ($t = 6.88$), while the coefficient on *ghg_intensity* is 0.2563 ($t = 7.03$), indicating that both absolute emissions and emissions relative to firm activity are strongly associated with higher levels of greenwashing. Similarly, the quartile-based measures yield positive and significant coefficients,

implying that firms classified as heavier polluters consistently exhibit a greater misalignment between environmental communication and actual performance improvements.

Overall, these robustness tests confirm that the positive relationship between pollution and greenwashing is not driven by a particular choice of pollution metric. Whether pollution is measured in absolute terms, scaled by firm activity, or captured through relative rankings, more polluting firms systematically display stronger incentives to exaggerate environmental improvement through communication. Together, the evidence reinforces the interpretation that greenwashing is structurally linked to firms' underlying pollution exposure rather than being an artifact of measurement choice or aggregate emission trends.

4.6 Environmental Pressure and Greenwashing

[Insert Figure 4 here]

Environmental scores display a gradual upward trend (Figure 4), suggesting an overall improvement in perceived environmental quality, this improvement remains uneven and does not necessarily imply proportional advances in firms' actual environmental performance. ESG scores largely reflect external assessments and reputational perceptions, which may adjust more rapidly than real environmental outcomes (Berg et al., 2022). This divergence underscores the continued relevance of external scrutiny and reputational concerns in shaping firms' environmental communication strategies.

[Insert Table 7 here]

Table 7 provides direct evidence that external environmental pressure significantly increases greenwashing behaviour. Across all specifications, *Environmental_Pressure* measured by the occurrence of at least one environmental risk incident each year, enters with a positive and statistically significant coefficient. The estimated effects range from 0.0632 to 0.0841 and remain significant at the 1% level even after controlling for firm characteristics,

stock-level variables, and industry-year fixed effects (Column 4: $\beta = 0.0643$, $t = 3.06$). These results indicate that when firms face negative environmental incidents, they systematically increase greenwashing behaviour by intensifying positive environmental communication relative to actual performance improvements. Marquis et al. (2016) prove that firms respond to legitimacy threats by deploying symbolic actions and narrative strategies to restore social acceptance. Environmental incidents heighten public visibility and reputational risk, thereby strengthening incentives for firms to engage in impression management rather than costly real adjustments.

Firms with higher environmental scores exhibit systematically lower *GWS*, suggesting that firms with stronger environmental reputations are less inclined to overstate environmental improvements. This finding aligns with the reputation insurance view of ESG, which argues that firms with established environmental credibility face higher reputational costs from misleading disclosure and therefore rely less on symbolic communication (Godfrey, Merrill, and Hansen, 2009; Albuquerque, Koskinen, and Zhang, 2019). Moreover, high-scoring firms may possess more substantive environmental capabilities, reducing the gap between communication and performance and limiting the scope for greenwashing.

[Insert Table 8 here]

Table 8 further examines whether external environmental pressure moderates the relationship between pollution levels and greenwashing behaviour. While pollution levels remain positively and highly significantly associated with greenwashing across all specifications, the interaction term *Environmental_Pressure* $\times$ *log_ghg* is statistically insignificant. This result indicates that external pressure does not further amplify the greenwashing tendency of already high-polluting firms. Instead, environmental pressure appears to operate as a broad catalyst that increases greenwashing across firms, regardless of their baseline pollution exposure. This pattern suggests that high-polluting firms already face

persistent scrutiny and possess strong baseline incentives to manage perceptions, leaving limited scope for additional amplification when discrete environmental incidents occur.

External environmental pressure triggers symbolic responses aimed at legitimacy restoration, increasing greenwashing on average. However, firms with stronger environmental reputations are less prone to such behaviour, while the marginal impact of environmental pressure does not disproportionately intensify greenwashing among the most polluting firms.

5. Conclusion

This paper examines when and why firms' environmental communication diverges from real environmental performance. Using a novel firm-level measure of greenwashing that directly links positive green communication to changes in environmental performance, we document systematic evidence that greenwashing is not random, but instead reflects structural incentives faced by firms reflects persistent firm-level constraints on environmental improvement, consistent with prior work emphasizing the strategic and weakly verifiable nature of environmental disclosure (Delmas and Burbano, 2011; Lyon and Montgomery, 2015).

Our findings show that firms with higher pollution levels are significantly more likely to engage in greenwashing. More polluting firms simultaneously intensify positive environmental communication while exhibiting weaker improvements in environmental performance, resulting in a pronounced gap between the communication and performance. This pattern is consistent with evidence that pollution-intensive firms face higher marginal costs of emissions reductions due to technological lock-in and path dependence (Aghion et al., 2023). At the same time, firms with higher emissions are subject to greater investor attention and market discipline as climate risk becomes increasingly priced in capital markets (Pankratz & Zeisberger, 2023). This divergence is further facilitated by the limited verifiability of

environmental disclosures and disagreement across ESG assessments, which increases the scope for symbolic communication (Berg et al., 2022). This relationship is robust across alternative pollution measures and persists after controlling for industry-year fixed effects, indicating that greenwashing is fundamentally tied to firms' underlying environmental externalities rather than common disclosure trends.

We further demonstrate that external environmental pressure, captured by the occurrence of environmental risk incidents, increases greenwashing behaviour on average. This finding complements prior evidence that firms respond to heightened environmental risk and stakeholder attention primarily through disclosure adjustments rather than immediate changes in real outcomes (Pankratz & Zeisberger, 2023; Sautner et al., 2023). Such pressure induces firms to respond rapidly through symbolic communication, while real environmental outcomes adjust more slowly. However, external pressure does not further amplify the greenwashing behaviour of already highly polluting firms, suggesting that these firms face persistent baseline incentives to manage perceptions even in the absence of discrete shocks.

Importantly, we distinguish greenwashing from cheap talk. While pollution levels initially correlate with vague and non-committal climate statements, this relationship disappears once industry-year effects are accounted for, indicating that cheap talk is largely shaped by institutional disclosure environments and common reporting norms rather than firm-specific characteristics (Christensen et al., 2021). In contrast, greenwashing remains strongly pollution-driven, reflecting firm-specific strategic behaviour rather than industry-wide communication norms.

Overall, the results highlight that greenwashing arises from an asymmetric adjustment process: environmental narratives can be modified quickly, whereas substantive environmental improvements are costly, slow, and constrained.

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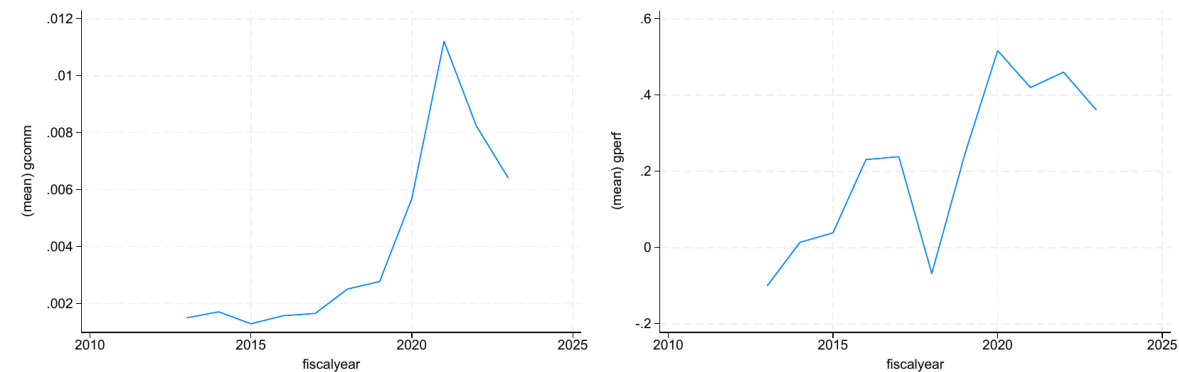
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Figure 1: Time Trends of Green Communication and Green Performance

This figure plots the time-series evolution of average positive green communication and average green performance for U.S. firms over the sample period. Panel A shows the annual mean level of positive green communication, Panel B shows the annual mean level of green performance, measured using firm-level environmental performance indicators. In both panels, the horizontal axis reports the fiscal year, and the vertical axis reports the cross-sectional mean of the corresponding variable. All variables are computed at the firm-year level, and each point represents the average across firms in a given fiscal year.

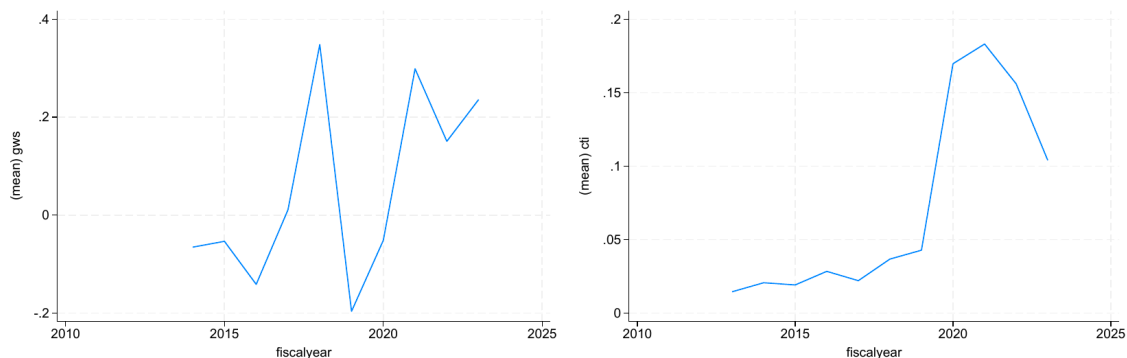


(a) **Panel A:** Time Trend of Average Positive Green Communication (GComm) (b) **Panel B:** Time Trend of Average Green Performance (GPerf)

Figure 1: Time Trends of Green Communication and Green Performance

Figure 2: Time Trends of Green Communication and Green Performance

This figure plots the time-series evolution of average greenwashing and average cheap talk for U.S. firms over the sample period. Panel A shows the annual mean greenwashing score, which captures the gap between firms' positive green communication and subsequent changes in environmental performance. Panel B shows the annual mean Cheap Talk Index, measured as the share of non-specific climate-related commitments among all climate-related commitments. In both panels, the horizontal axis reports the fiscal year, and the vertical axis reports the cross-sectional mean of the corresponding variable. All variables are constructed at the firm-year level, and each data point represents the average across firms in a given fiscal year.



(a) **Panel A:** Time Trend of Average Greenwashing Score (GWS) (b) **Panel B:** Time Trend of Average Cheap Talk Index (CTI)

Figure 2: Time Trends of Greenwashing and Cheap Talk Index

Figure 3: Time Trend of Average *GHG*

This figure plots the time-series evolution of average greenhouse gas emissions for U.S. firms over the sample period. Greenhouse gas emissions are measured at the firm-year level and aggregated as the cross-sectional mean in each fiscal year. The horizontal axis reports the fiscal year, and the vertical axis reports the average level of greenhouse gas emissions across firms. Each point represents the mean emissions of all sample firms in a given fiscal year.

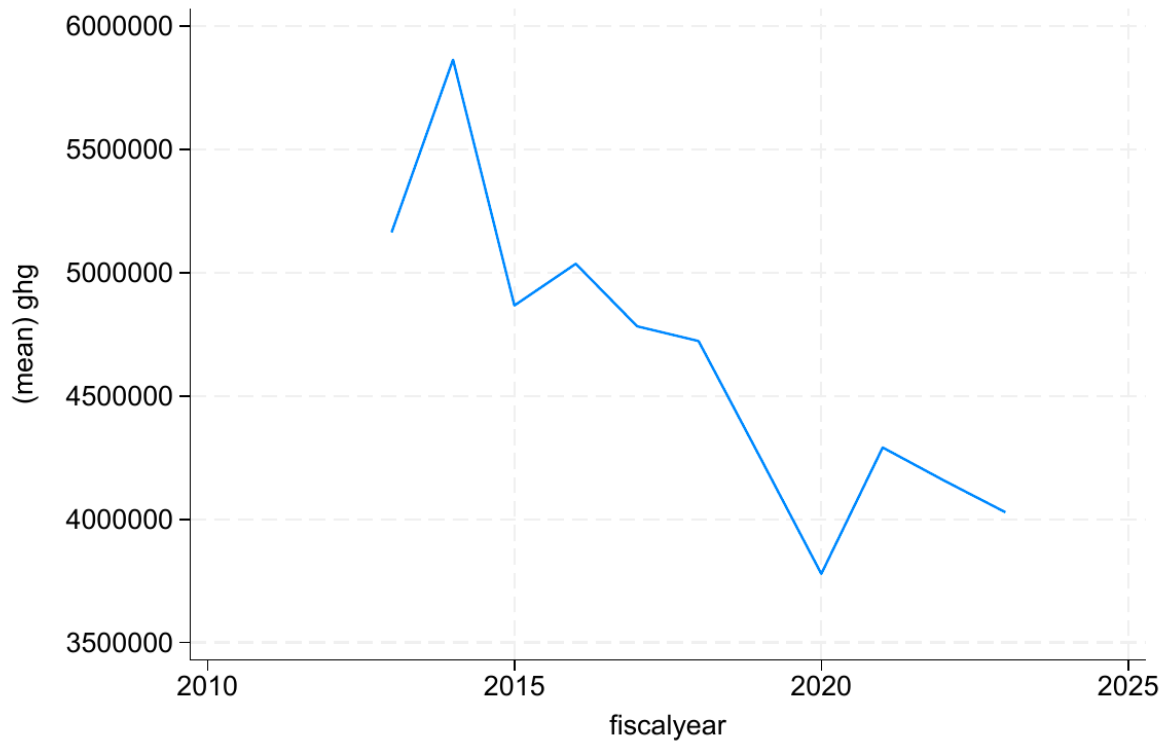


Figure 3: Time Trend of Average GHG

Figure 4: Time Trend of Average Environment Score

This figure plots the time-series evolution of the average environmental score for U.S. firms over the sample period. The environmental score is the E component of firms' ESG ratings and is measured at the firm-year level. In each fiscal year, scores are aggregated as the cross-sectional mean across firms. The horizontal axis reports the fiscal year, and the vertical axis reports the average environmental score. Each point represents the mean environmental score of all sample firms in a given fiscal year.

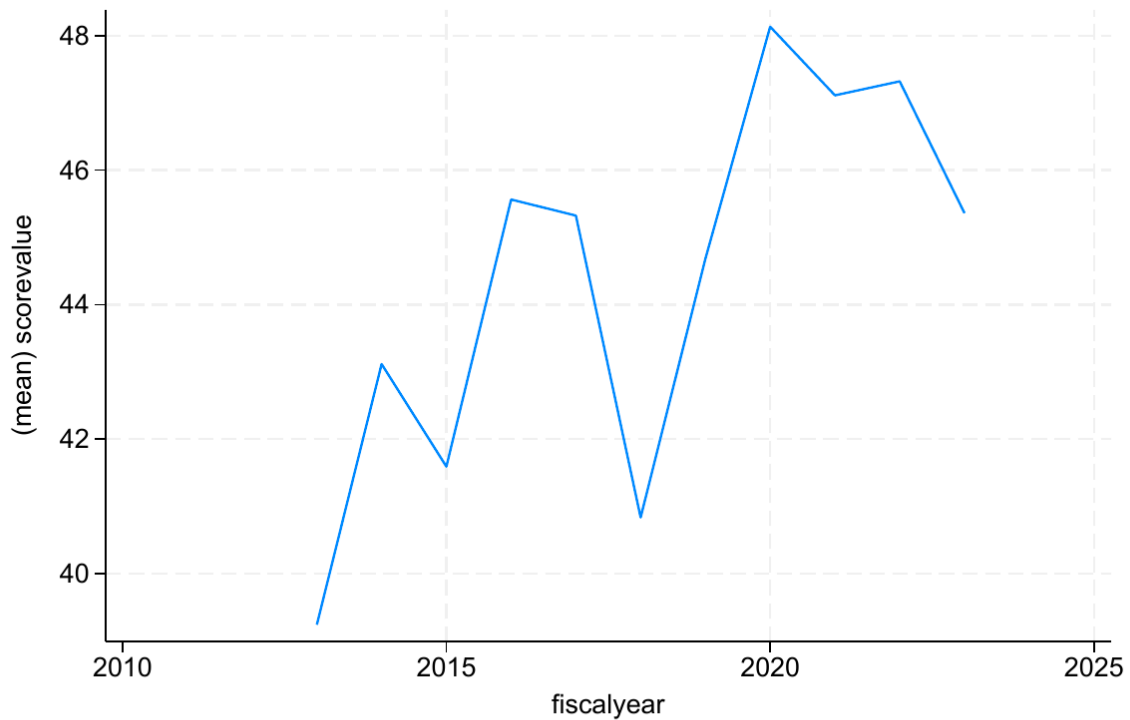


Figure 4: Time Trend of Average Environment Score

Table 1: Summary Statistic

The sample consists of annual observations for publicly listed firms in US from 2013 to 2023. Reported statistics include the mean, standard deviation (*sd*), median (*p50*), maximum (*max*), and minimum (*min*). *Environment_Score* is the ESG environmental score. *Log_ghg* is the natural logarithm of total greenhouse gas emissions (Scope 1 + Scope 2). *GPerf* is green performance, defined as the standardized environmental score minus standardized greenhouse gas emissions. *Delta_GPerf* is the year-over-year change in green performance. *GComm* measures positive green communication, defined as the ratio of positive climate-related paragraphs to total climate-related paragraphs in firms' earnings call transcripts. *GWS* is the greenwashing score, defined as standardized green communication minus the change in green performance. *CTI* is the proportion of non-specific climate commitments among all climate-related commitments. *Environmental Pressure* is an indicator variable equal to one if the firm experiences at least one environmental risk incident each year, and zero otherwise. Firm-level control variables include *ROA*, measured as return on assets; *Size* is the natural logarithm of market capitalization; *Leverage*, defined as total debt divided by total assets; *Company_age*, measured as the number of years since firm incorporation; and *Capex_ratio*, defined as capital expenditures scaled by total assets. Stock-level control variables include *Ret*, defined as annual total stock return; *Vol* defined as stock return volatility, measured as the standard deviation of monthly stock returns within a year; and *Stock_Turnover*, is annual trading volume divided by shares outstanding. All continuous control variables (*ROA*, *Ret*, *Size*, *Vol*, *Stock_Turnover*, *Leverage*, and *Capex_ratio*) are winsorized at the 1st and 99th percentiles to mitigate the influence of extreme observations.

	mean	sd	p50	max	min
<i>Environment_Score</i>	47.15	19.86	46.00	99.00	5.00
<i>Log_ghg</i>	13.39	2.11	13.27	18.81	4.07
<i>GPerf</i>	0.26	1.48	0.30	4.16	-10.68
<i>GComm</i>	0.00	0.01	0.00	0.13	0.00
<i>GWS</i>	0.06	1.17	-0.13	9.46	-5.20
<i>CTI</i>	0.07	0.21	0.00	1.00	0.00
<i>Delta_GPerf</i>	0.05	0.65	0.04	7.89	-6.42
<i>ROA</i>	0.07	0.07	0.06	0.28	-0.17
<i>Ret</i>	0.15	0.29	0.13	1.04	-0.47
<i>Size</i>	23.96	1.11	23.85	26.84	21.70
<i>Vol</i>	0.08	0.04	0.07	0.21	0.03
<i>Stock_Turnover</i>	0.00	0.00	0.00	0.01	0.00
<i>Leverage</i>	0.66	0.19	0.66	1.25	0.25
<i>Company_age</i>	85.87	48.21	80.00	250.00	11.00
<i>Capex_ratio</i>	0.04	0.03	0.03	0.16	0.00
<i>Environmental Pressure</i>	0.19	0.39	0.00	1.00	0.00
<i>Observations</i>	3421				

Table 2: Pollution and Green Communication

This table presents OLS estimation of the association between firms' pollution levels and positive green communication. The dependent variable in all columns is *GComm*, a measure of firms' green communication intensity. The key independent variable is *log_ghg*, which captures firms' pollution levels. We additionally include *Environment_Score*, which reflects the environmental component of firms' ESG ratings. Columns (2) - (4) progressively incorporate firm-level and stock-level controls. Firm-level controls include *ROA*, *Size*, *Leverage*, *Company_age*, and *Capex_ratio*, while stock-level controls include *Ret*, *Vol*, and *Stock_Turnover*. All specifications include year fixed effects and industry fixed effects, while column (4) further includes industry-year fixed effects. The regressions report standardized beta coefficients, and t-statistics are shown in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1) <i>GComm</i>	(2) <i>GComm</i>	(3) <i>GComm</i>	(4) <i>GComm</i>
<i>log_ghg</i>	0.1453*** (6.84)	0.2033*** (8.05)	0.2074*** (8.23)	0.1400*** (5.91)
<i>Environment_Score</i>		0.0365** (2.21)	0.0424** (2.57)	0.0197 (1.25)
<i>ROA</i>		0.0549*** (3.36)	0.0365** (2.17)	-0.0150 (-0.91)
<i>Size</i>		-0.0775*** (-3.86)	-0.1093*** (-5.06)	-0.0526** (-2.57)
<i>Leverage</i>		-0.0419** (-2.52)	-0.0428** (-2.57)	-0.0356** (-2.28)
<i>Company_age</i>		0.0195 (1.18)	0.0166 (0.99)	0.0158 (1.02)
<i>Capex_ratio</i>		-0.0383** (-2.00)	-0.0308 (-1.60)	0.0249 (1.34)
<i>Ret</i>			0.0736*** (4.72)	0.0143 (0.85)
<i>Vol</i>			-0.0429* (-1.93)	-0.0777*** (-3.36)
<i>Stock_turnover</i>			-0.0116 (-0.54)	-0.0175 (-0.84)
<i>Constant</i>	0.0000*** (-6.50)	0.0000 (0.44)	0.0000* (1.90)	0.0000 (0.86)
Observations	3421	3380	3380	3380
R-squared	0.365	0.370	0.375	0.539
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Industry-Year FE	No	No	No	Yes

Table 3: Pollution and Green Performance

This table reports OLS regression results that assess how firms' pollution levels are associated with year-to-year change in green performance. The dependent variable in all specifications, *Delta_GPerf*, measures the annual change in firms' green performance. The primary explanatory variable, *log_ghg*, captures firms' pollution levels. Columns (2) - (4) incorporate additional covariates, including both firm-level and stock-level controls. All regressions are estimated with year and industry fixed effects, while column (4) further accounts for industry-by-year fixed effects to absorb time-varying shocks within industries. The coefficients are standardized beta estimates, and t-statistics appear in parentheses. Statistical significance at the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively. All variable definitions appear in the Appendix.

	(1) <i>Delta_GPerf</i>	(2) <i>Delta_GPerf</i>	(3) <i>Delta_GPerf</i>	(4) <i>Delta_GPerf</i>
<i>log_ghg</i>	-0.1260*** (-4.72)	-0.1554*** (-4.98)	-0.1589*** (-5.09)	-0.1404*** (-4.47)
<i>Environment_Score</i>		0.2250*** (11.06)	0.2210*** (10.83)	0.1926*** (9.26)
<i>ROA</i>		0.0186 (0.92)	0.0186 (0.89)	0.0161 (0.73)
<i>Size</i>		-0.0458* (-1.85)	-0.0501* (-1.87)	-0.0529* (-1.95)
<i>Leverage</i>		-0.0090 (-0.44)	-0.0083 (-0.40)	-0.0055 (-0.27)
<i>Company_age</i>		-0.0091 (-0.45)	-0.0069 (-0.33)	-0.0056 (-0.27)
<i>Capex_ratio</i>		-0.0142 (-0.60)	-0.0103 (-0.43)	-0.0191 (-0.78)
<i>Stock_Turnover</i>			-0.0631** (-2.38)	-0.0595** (-2.16)
<i>Ret</i>			0.0026 (0.14)	0.0193 (0.87)
<i>Vol</i>			0.0732*** (2.66)	0.0695** (2.26)
<i>Constant</i>	0.0000*** (4.27)	0.0000*** (3.18)	0.0000*** (2.99)	0.0000*** (2.87)
Observations	3110	3074	3074	3074
R-squared	0.090	0.126	0.128	0.262
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Industry-Year FE	No	No	No	Yes

Table 4: Greenwashing in High Polluters

This table reports regression results examining the relationship between firms' pollution levels and their greenwashing behaviour. The dependent variable in all columns is *GWS*, which is constructed as the difference between firms' Green Communication and the change in their green performance, thereby capturing the extent to which firms overstate environmental improvement relative to actual performance changes. The key explanatory variable, *log_ghg*, measures firms' pollution levels. Columns (2) - (4) progressively add control variables, include firm-level and stock-level. All specifications include year fixed effects and industry fixed effects, while column (4) additionally incorporates industry-year fixed effects to capture time-varying heterogeneity within industries.

	(1) <i>GWS</i>	(2) <i>GWS</i>	(3) <i>GWS</i>	(4) <i>GWS</i>
<i>log_ghg</i>	0.2141*** (7.89)	0.2423*** (7.53)	0.2421*** (7.55)	0.2320*** (6.88)
<i>Environment_Score</i>		-0.0760*** (-3.62)	-0.0712*** (-3.39)	-0.0527** (-2.36)
<i>ROA</i>		-0.0003 (-0.02)	-0.0257 (-1.19)	-0.0260 (-1.09)
<i>Size</i>		-0.0322 (-1.26)	-0.0788*** (-2.86)	-0.0780*** (-2.68)
<i>Leverage</i>		-0.0291 (-1.38)	-0.0291 (-1.38)	-0.0321 (-1.45)
<i>Company_age</i>		0.0574*** (2.72)	0.0434** (2.04)	0.0418* (1.90)
<i>Capex_ratio</i>		0.0278 (1.14)	0.0398 (1.63)	0.0412 (1.57)
<i>Stock_Turnover</i>			-0.0351 (-1.29)	-0.0417 (-1.41)
<i>Ret</i>			0.0255 (1.30)	0.0129 (0.54)
<i>Vol</i>			-0.0944*** (-3.34)	-0.0874*** (-2.66)
<i>Constant</i>	0.0000*** (-7.36)	0.0000* (-1.91)	0.0000 (0.45)	0.0000 (0.48)
Observations	3110	3074	3074	3074
R-squared	0.062	0.071	0.079	0.151
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Industry-Year FE	No	No	No	Yes

Table 5: CheapTalk Index and Pollution

This table presents regression results examining the relationship between firms' pollution levels and two types of behaviour: cheap talk and greenwashing. Columns (1) - (4) use *CTI* as the dependent variable, where *CTI* quantifies the share of superficiality in companies' climate commitments. Column (5) uses *GWS*, capturing the extent to which firms overstate environmental improvement relative to actual performance changes. The key explanatory variable across all specifications is *log_ghg*, measuring firms' pollution levels. Columns (1) - (3) include year fixed effects only, without industry fixed effects. Columns (4) - (5) extend the specification by adding industry-year fixed effects, thereby controlling for time-varying industry-specific shocks. The table reports standardized beta coefficients, and t-statistics are shown in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. All variable definitions appear in the Appendix.

	(1) <i>CTI</i>	(2) <i>CTI</i>	(3) <i>CTI</i>	(4) <i>CTI</i>	(5) <i>GWS</i>
<i>log_ghg</i>	0.0873*** (5.37)	0.0420** (2.00)	0.0373* (1.77)	0.0198 (0.65)	0.2320*** (6.88)
<i>Environment_Score</i>		0.0717*** (4.05)	0.0716*** (4.04)	0.0790*** (3.92)	-0.0527** (-2.36)
<i>ROA</i>		-0.0261 (-1.47)	-0.0404** (-2.21)	-0.0299 (-1.41)	-0.0260 (-1.09)
<i>Size</i>		-0.0179 (-0.94)	-0.0428** (-2.11)	-0.0360 (-1.37)	-0.0780*** (-2.68)
<i>Leverage</i>		-0.0115 (-0.69)	-0.0126 (-0.76)	0.0006 (0.03)	-0.0321 (-1.45)
<i>Company_age</i>		0.0187 (1.10)	0.0103 (0.60)	0.0052 (0.26)	0.0418* (1.90)
<i>Capex_ratio</i>		0.0519*** (2.61)	0.0662*** (3.26)	0.0363 (1.52)	0.0412 (1.57)
<i>Stock_Turnover</i>			-0.0489** (-2.09)	-0.0387 (-1.46)	-0.0417 (-1.41)
<i>Ret</i>			0.0298 (1.63)	0.0161 (0.74)	0.0129 (0.54)
<i>Vol</i>			-0.0186 (-0.75)	-0.0257 (-0.87)	-0.0874*** (-2.66)
<i>Constant</i>	0.0000*** (-4.00)	0.0000 (0.02)	0.0000 (1.54)	0.0000 (0.79)	0.0000 (0.48)
Observations	3421	3380	3380	3380	3074
R-squared	0.101	0.107	0.110	0.243	0.151
Year FE	Yes	Yes	Yes	Yes	Yes
Industry FE	No	No	No	Yes	Yes
Industry-Year FE	No	No	No	Yes	Yes

Table 6: Alternative Proxies for High Polluters

This table presents regression estimates examining the relationship between firms' pollution levels and their greenwashing behaviour using four alternative pollution measures. The dependent variable in all columns is *GWS*, which captures the extent to which firms overstate improvements in environmental performance relative to actual changes. The key independent variable differs across columns. *log_ghg* is the logarithm of total greenhouse gas emissions. *ghg_intensity* is computed as firms' greenhouse gas emissions scaled by sales (*GHG/Sales*). *ghg_quartile* and *ghg_intensity_quartile* are the quartile-ranked versions of total emissions and emission intensity, respectively. All specifications include year fixed effects, industry fixed effects, and industry-year fixed effects to absorb both time-invariant and time-varying heterogeneity at the industry level. Each regression also incorporates a full set of firm-level controls and stock-level controls. The table reports standardized beta coefficients, and t-statistics are shown in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. All variable definitions appear in the Appendix.

Pollution Measure	<i>log_ghg</i>	<i>ghg_intensity</i>	<i>ghg_quartile</i>	<i>ghg_intensity_quartile</i>
Dep.Var: <i>GWS</i>	(1)	(2)	(3)	(4)
<i>Pollution</i>	0.2320*** (6.88)	0.2563*** (7.03)	0.2042*** (6.44)	0.1908*** (5.65)
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes
Firm-level Control	Yes	Yes	Yes	Yes
Stock-level Control	Yes	Yes	Yes	Yes
Observations	3074	3074	3074	3074
R-squared	0.151	0.151	0.149	0.146

Table 7: Environmental Pressure and Greenwashing

This table reports regression results examining the relationship between external environmental pressure and firms' greenwashing behaviour. The dependent variable in all columns is *GWS*, which measures the extent to which firms overstate improvements in environmental performance relative to actual changes. The key explanatory variable, *Environmental_Pressure*, represents the number of environmental risk incidents a firm experiences each year, capturing the intensity of external environmental pressure; it takes the value of one when at least one environmental risk incident occurs during the year. Columns (2) - (4) progressively add firm-level and

stock-level control variables. All specifications include year fixed effects and industry fixed effects, while columns (3) and (4) additionally incorporate industry-year fixed effects to absorb time-varying shocks within industries. The table reports standardized beta coefficients, and t-statistics are shown in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. All variable definitions appear in the Appendix.

	(1) <i>GWS</i>	(2) <i>GWS</i>	(3) <i>GWS</i>	(4) <i>GWS</i>
<i>Environmental_Pressure</i>	0.0841*** (4.28)	0.0689*** (3.43)	0.0632*** (3.15)	0.0643*** (3.06)
<i>Environment_Score</i>		-0.0705*** (-3.34)	-0.0663*** (-3.14)	-0.0496** (-2.21)
<i>ROA</i>		-0.0332 (-1.61)	-0.0579*** (-2.72)	-0.0624*** (-2.69)
<i>Size</i>		0.0483** (2.11)	0.0025 (0.10)	0.0036 (0.14)
<i>Leverage</i>		-0.0276 (-1.29)	-0.0275 (-1.29)	-0.0295 (-1.33)
<i>Company_age</i>		0.0695*** (3.27)	0.0561*** (2.62)	0.0529** (2.40)
<i>Capex_ratio</i>		0.0684*** (2.87)	0.0807*** (3.37)	0.0834*** (3.26)
<i>Stock_Turnover</i>			-0.0437 (-1.59)	-0.0499* (-1.68)
<i>Ret</i>			0.0209 (1.06)	0.0046 (0.19)
<i>Vol</i>			-0.0845*** (-2.97)	-0.0786** (-2.37)
<i>Constant</i>	0.0000 (-1.27)	0.0000** (-2.25)	0.0000 (0.11)	0.0000 (0.05)
Observations	3110	3074	3074	3074
R-squared	0.048	0.057	0.065	0.138
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Industry-Year FE	No	No	No	Yes

Table 8: Interaction Between Environmental Pressure and Pollution on Greenwash

This table reports OLS regression estimates examining whether external environmental pressure moderates the relationship between firms' pollution levels and their greenwashing behaviour. The dependent variable in all columns is *GWS*, which captures the extent to which firms overstate improvements in environmental

performance relative to actual changes. *Environmental_Pressure* measures the number of environmental risk incidents a firm experience within a given year, reflecting the external environmental pressure. The interaction term *Environmental_Pressure* $\times$ *log_ghg* is included to assess whether the effect of pollution levels on greenwashing varies with the degree of external environmental pressure.

	(1) <i>GWS</i>	(2) <i>GWS</i>	(3) <i>GWS</i>	(4) <i>GWS</i>
<i>Environmental_Pressure</i> $\times$ <i>log_ghg</i>	0.0000 (1.26)	0.0000 (0.86)	0.0000 (0.81)	0.0000 (1.18)
<i>Environmental_Pressure</i>	-0.1213 (-0.88)	-0.0801 (-0.58)	-0.0783 (-0.57)	-0.1360 (-0.94)
<i>log_ghg</i>	0.1852*** (6.26)	0.2192*** (6.30)	0.2218*** (6.39)	0.2057*** (5.63)
<i>Environment_Score</i>		-0.0754*** (-3.58)	-0.0707*** (-3.36)	-0.0516** (-2.31)
<i>ROA</i>		-0.0024 (-0.12)	-0.0271 (-1.25)	-0.0289 (-1.21)
<i>Size</i>		-0.0309 (-1.21)	-0.0768*** (-2.79)	-0.0749** (-2.57)
<i>Leverage</i>		-0.0298 (-1.41)	-0.0297 (-1.41)	-0.0327 (-1.48)
<i>Company_age</i>		0.0539** (2.54)	0.0408* (1.91)	0.0394* (1.79)
<i>Capex_ratio</i>		0.0295 (1.21)	0.0411* (1.68)	0.0430 (1.64)
<i>Stock_Turnover</i>			-0.0350 (-1.29)	-0.0418 (-1.42)
<i>Ret</i>			0.0253 (1.29)	0.0122 (0.51)
<i>Vol</i>			-0.0918*** (-3.24)	-0.0835** (-2.53)
<i>Constant</i>	*** (-6.11)	(-1.63)	(0.61)	(0.63)
Observations	3110	3074	3074	3074
R-squared	0.064	0.072	0.080	0.152
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Industry-Year FE	No	No	No	Yes

Appendix A

Variable	Definition
<i>Environment_Score</i>	Environmental (E) score value from the ESG dataset. Represents the numeric value of the "E" pillar.
<i>GHG</i>	This is defined as the total absolute greenhouse gas emissions of a firm, measured as the sum of Scope 1 and Scope 2 emissions.
<i>Gperf</i>	Green performance defined as the difference between the standardized environmental score and standardized greenhouse gas emissions, capturing a firm's overall environmental performance in year t .
<i>Delta_Gperf</i>	Change in Green Performance measures the year-to-year change in a firm's green performance and is calculated as the difference between the firm's green performance in year t and its green performance in the preceding year.
<i>Gcomm</i>	The ratio of positively toned climate-related paragraphs to the total number of paragraphs in a firm's earnings call transcripts in year t .
<i>GWS</i>	The difference between standardized positive green communication and the change in green performance, capturing the extent to which firms' environmental communication outpaces improvements in actual environmental performance.
<i>CTI</i>	The proportion of non-specific climate-related commitments among all climate-related commitments made by a firm in year t , with higher values indicating greater reliance on vague and non-committal climate promises.
<i>Environmental Pressure</i>	An indicator variable capturing external environmental pressure, equal to one if the firm experiences at least one environmental risk incident each year, and zero otherwise. Environmental incidents include publicly disclosed events such as environmental accidents, regulatory violations, pollution releases, or other environmentally harmful activities that increase external scrutiny and pressure on the firm.
<i>ROA</i>	Return on Assets is measured as net income divided by total assets and captures a firm's operating profitability.
<i>Ret</i>	Annual total return to shareholders. Controls for investor satisfaction and tolerance.
<i>Size</i>	Firm size is measured as the natural logarithm of market capitalization and captures differences in firm scale and resources available for disclosure.
<i>Vol</i>	Stock return volatility is measured as the standard deviation of monthly stock returns and captures a firm's financial risk and instability.
<i>Stock_Turnover</i>	The turnover ratio is calculated as trading volume divided by shares outstanding and captures stock liquidity and investor attention.

<i>Leverage</i>	The debt ratio is measured as total liabilities divided by total assets and captures a firm's financial leverage and constraints.
<i>capex_ratio</i>	Capital expenditure intensity is measured as capital expenditures divided by total assets and controls for differences in firms' investment intensity that may affect greenwashing behaviour and related outcomes.
<i>Company_age</i>	Firm age, measured as the number of years since the firm's incorporation. Controls for organizational maturity, accumulated experience, and structural rigidity that may influence firms' environmental strategies and communication behaviour.
