ESG Engagement and Stock Volatility: The Moderating Role of Risk Disclosure Tone from Textual Analysis of Egyptian Annual Reports

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ESG Engagement and Stock Volatility: The Moderating Role of Risk Disclosure Tone from Textual Analysis of Egyptian Annual Reports

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Abstract: This study investigates the impact of Environmental, Social, and Governance (ESG) engagement on stock return volatility, and whether the risk disclosure tone in Egyptian mandatory corporate filings moderate this relationship. While prior research suggests that ESG stabilizes firm performance, this study challenges that assumption by investigating whether ESG uniformly reduces volatility or if its effects depend on risk communication strategies. Using publicly listed Egyptian firms, we employ fixed-effects panel regressions, Propensity Score Matching (PSM), standard deviation (SD)-based volatility, and Generalized Autoregressive Conditional Heteroskedasticity (GARCH) models to assess static and dynamic volatility effects. Risk Tone is measured using textual analysis of Egyptian annual reports based on the Loughran-McDonald dictionary. Our findings indicate that before accounting for Risk Tone disclosure, ESG engagement is linked to higher stock volatility, where ESG initiatives could be perceived as resource-intensive and uncertain. Pillar-level analysis reveals that Environmental initiatives heighten volatility, Governance mitigates risk over the long term but has a weaker short-term effect, and social responsibility stabilizes short-term fluctuations in GARCH analyses. However, when controlling for Risk Tone and its interaction with ESG, the relationship shifts. ESG's volatility-reducing effect strengthens, suggesting that firms with clear, measured risk disclosures experience lower volatility. In contrast, negative or uncertainty-laden risk disclosures overshadow ESG's stabilizing benefits, amplifying stock fluctuations. These findings are important for investors, regulators, and managers by considering the firm's ESG engagement and their risk disclosure tone, as investor responses are not only influenced by ESG performance, but also how companies communicate risks in mandatory reports.

Keywords: ESG, Stock Volatility, Risk Disclosure, Corporate Risk Management, Emerging Markets, GARCH Model, Textual Analysis, Propensity Score Matching (PSM).

1. Introduction

Over the last several years, companies in a variety of industries have put more focus on Environmental, Social, and Governance (ESG) efforts. This trend is driven in part by investor demand and regulatory developments, leading firms to pursue ESG frameworks to promote sustainability and corporate social responsibility. In the emerging markets, ESG is vital for their businesses to align with international practices while tackling the regional economic and environmental issues. Moreover, ESG adoption is consistent with a broader set of sustainability goals, such as UN's Sustainable Development Goals (SDGs), which many organizations incorporate into their long-term business strategies (Lassala et al., 2017; Aboud & Diab, 2018).

Firms engaged in ESG initiatives often attract greater investor attention, especially when rated by global agencies such as Refinitiv, Bloomberg. High visibility amplifies market reactions to ESG-related news (both positive and negative) potentially increasing stock return volatility. Prior research suggests that investor responses to ESG activities are stronger when firms are more visible (Servaes & Tamayo, 2013). Larger, high-profile firms also receive extensive media coverage and analyst scrutiny, making their stock prices more sensitive to ESG signals (Gode and Mohanram, 2003; El Ghoul et al., 2011).

Studies have shown that the effects of these ESG signals on investor perceptions and market dynamics is complex. Despite indications that ESG activities reduce risks and enhance trust regarding investors (Kim et al., 2012; Kim et al., 2014; Cheng et al., 2014), ESG practices are also shown to result in higher operational costs, as well as uncertainties (Barnea & Rubin, 2010; Gao et al., 2022). The financial impact of ESG initiatives is not always straightforward. For instance, environmental efforts are regarded positively, but their financial benefits usually take time to materialize. This creates the potential for strong environmental engagement firms to be undervalued by investors before recognizing their long-term advantages (Derwall et al., 2010). Long-term studies, on the other hand, indicate that organizations with superior environmental performance achieve superior financial returns and reduced risk premiums over time (Friede et al., 2015). Additionally, different aspects of firm value are affected by social and governance practices as well. Investors are more likely to favor companies that maintain positive labor relations and engage with their communities (Ioannou & Serafeim, 2012; Dhaliwal et al., 2011). However, the benefits of virtue are not necessarily

priced in the market promptly which can result in fluctuations in stock performance (Hong & Kacperczyk, 2009). Rather, wealth in the governance dimension tends to increase returns and investor confidence when firms have well-structured policies in place (Gompers et al., 2003). However, the effect of governance can differ depending on the specific practices and regulatory environment. These mixed results underscore the difficulty in understanding the relationship between ESG and market behavior, particularly in emerging markets, where economic, cultural, and regulatory circumstances differ widely from those experienced in developed countries (Balboula and Shemes, 2025; Balboula and Elfar, 2023, 2024).

Although previous literature has explored the dynamics between the ESG engagement and stock volatility, the role of tone in corporate risk disclosures in this relationship is still unexplored, especially in emerging markets such as Egypt. That prior studies show that ESG activities facilitate transparency and reduce volatility (Cheng et al., 2014) but don't fully account for whether risk-rich language in mandatory corporate filings could negate these benefits. Prior research has suggested that negative or uncertainty-filled risk disclosures increase investor uncertainty which has higher volatility (Loughran & McDonald, 2011; Kravet & Muslu, 2013). Nonetheless, this interplay has not been methodically explored concerning Egyptian firms, where regulatory environments and emotional biases could distinctly shape investor sentiment and market dynamics Sourial & Amico, 2015; Kumar & Lee, 2006; Chen & Yang, 2020). Previous research (Moussa & Elmarzouky, 2024) find that ESG disclosures in the U.K. market help alleviate market uncertainty, especially when firms also disclose on carbon-emission related items. But if the disclosures are overly complex or vague, they note, they will introduce uncertainty rather than alleviate it. This raises an important question: **Does risk-related information in Egyptian corporate annual report disclosures moderate the impact of ESG initiatives on stock volatility?**

Typically, annual reports are mandated and standardized reflections of a firm operations and financial activities, including risk disclosures (Loughran & McDonald, 2011). As these reports are closely followed by investors and analysts, their tone can influence market sentiment and investor responses (Loughran & McDonald, 2014). While voluntary ESG reports differ in both scope and format, annual reports have a more standardized structure, allowing for more reliable comparisons (Christensen et al., 2021).

Furthermore, as these reports cover business risks, especially the ESG related risks, they give a macro view of corporate risk profile (Kravet & Muslu, 2013). Moreover, the regulatory scrutiny adds to the credibility of these annual reports, rendering the information they contain, such as risk disclosures, a decisive element in investors' decisions (Hope et al., 2016). Consequently, firms' framing of risk-related information in these reports could either heighten or alleviate investor concerns about ESG initiatives.

Applying Signaling Theory (ST) (Spence, 2002), this study interprets ESG initiatives as signals of sustainability and long-term value creation. Yet, risk disclosures that pack an uncertain tone can dilute these signals and form inferences through repricing of investments and corresponding actions by the investors in the market. Moreover, Resource Allocation Theory (RAT) (Barnea & Rubin, 2010) explains how ESG-related expenditures may have an impact on market volatility, especially when disclosures indicate that resource allocations are inefficient or misaligned. This is useful in understanding why ESG initiatives may worsen volatility, as risk disclosures threaten some of the projects and ultimately their social value. Through its integration of theoretical perspectives, this study aims to deepen the understanding of the intricate dynamics between ESG performance, risk disclosure tone, and market fluctuations in the context of emerging markets. Thus, the study research questions are:

RQ1: Does visible ESG engagement consistently increase or decrease stock return volatility among Egyptian companies??

RQ2**:** How do the different ESG pillars impact stock return volatility in Egyptian companies?

RQ3: Does the tone of risk disclosures in annual reports moderate the relationship between ESG engagement and stock return volatility in Egyptian companies?

To address these research questions, the study employs a combination of statistical matching techniques and textual analysis. First, Propensity Score Matching (PSM) is applied to mitigate selection bias and construct a balanced sample of visible and non-visible ESG engagement. In emerging markets like Egypt, ESG disclosure remains largely voluntary, leading to significant variation in visibility. Some firms receive ESG ratings from global agencies, increasing investor awareness, while others remain unrated due to limited disclosure or coverage gaps. This creates a natural segmentation between

ESG-visible firms (rated) and ESG-non-visible firms (unrated), allowing for an investigation into how this distinction influences stock volatility. This approach ensures a more equitable comparison of market outcomes by aligning firms with similar characteristics. Second, a textual analysis of annual reports incorporates the Loughran and McDonald lexicon to measure risk-related language, such as references to uncertainty, litigation, and negativity. Using a matched panel of 304 firm-year observations, we estimate regression models with industry and year fixed effects to assess the direct impact of ESG engagement on stock volatility and the moderating role of risk-laden disclosure tone in shaping this relationship.

This study has several important theoretical contributions to the literature on ESG and market volatility in emerging markets. First, it extends our understanding of how ESG initiatives influence stock volatility by focusing on an emerging market context—a critical gap in existing research, as most prior studies have centered on developed markets (Said & ElBannan, 2024). It offers empirical evidence on the differential impacts of each ESG pillar—Environmental, Social, and Governance-on market volatility. Notably, this study refine ST theory (Spence, 2002) by demonstrating how the stabilizing signals of ESG can be weakened when firms convey uncertainty or negativity in mandatory disclosures, and they enrich RAT theory (Barnea & Rubin, 2010) by showing that ESG-related expenditures may not always yield intended stability if overshadowed by risk-laden narratives.

Second, this study takes a fresh approach to examining how ESG factors influence market volatility in emerging markets especially Egypt. It addresses selection bias, a common issue in observational studies, through a combination of Propensity Score Matching (PSM) and regression analysis complemented by textual analysis of Arabic annual reports while also investigating the effect of disclosure tone. Arabic corporate address is often neglected in ESG studies - but this research brings them into focus and highlights for financial stakeholders how the context and language employed can affect market responses. Moreover, using the Loughran & McDonald (2011) lexicon to assess the extent of risk-related language in Arabic financial reports brings new evidence related to how firms' communication strategies interplay with ESG performance in shaping investor perceptions.

Lastly, the study contributes useful knowledge to investors, regulators and corporate practitioners. Investors consider ESG performance as one variable in a wide-ranging strategy for assessing risk, and identifying how the

tone of risk disclosures interacts with ESG initiatives improves their assessment of firm risk profiles, particularly in the contexts where regulatory oversight and transparency is still emerging. For regulators, the results point to how mandatory disclosures can influence the market's reaction to ESG efforts. This might even inform the crafting of reporting standards to ensure that risk disclosures accurately reflect business vulnerabilities without unintentionally stoking market volatility. This is most relevant in the emerging markets sphere, where ESG reporting is still evolving. These insights are also useful to corporate managers. The actual wording of how firms describe risk in their annual reports can shape market perceptions and ultimately affect their bottom line. Understanding this relationship can assist managers in balancing transparency/strategic journey communication, sustaining investor confidence whilst ensuring long-term sustainability.

2. Literature Review and Hypotheses Development

2.1.Contextual Background on Egypt

Egypt is an intriguing case study of emerging market dynamics and the relationship between ESG activities and the market. Being one of the largest countries in the Middle East and North Africa (MENA) region, Egypt economy finding its path towards sustainability holds a high priority for region's stability. Egypt has introduced new regulations that position it as a frontrunner in embedding ESG principles into corporate governance. In 2021, the Egyptian Financial Regulatory Authority (FRA) set mandatory ESG reporting for larger companies, and criteria according to firm size. Annual ESG report must be submitted by non-banking financial activity companies listed on the Egyptian Stock Exchange (EGX), with issued capital or net ownership rights of at least EGP 100 million. Furthermore, companies with capital exceeding EGP 500 million are mandated to integrate climate-related financial disclosures in their annual report of the board of directors, consistent with the Task Force on Climate-related Financial Disclosures (TCFD) guidelines (FRA, 2021). Such measures seek to improve transparency, draw foreign investment to Egypt, and bring the country in line with international sustainability benchmarks. This initiative follows earlier efforts to demonstrate Egypt's commitment to sustainable development and modernization of its market such as launching the S&P/EGX ESG index in 2007 as well as the first of its kind in the MENA region to take place in 2020 by issuing USD 750 million of sovereign green bonds (Otaify, 2021; MOF, 2021).

However, Egypt's market has very specific features that make it a valuable place to empirically explore ESG performance, investor behavior, and market volatility. Contrary to more institutionalized markets, retail investors dominate the Egyptian stock market as they represent 15% of the total market capitalization but 80% of the trading volumes (Sourial & Amico, 2015). Such investors have a short-term investment horizon and have a little knowledge of the ESG standards and thus are more likely to be emotionally affected by corporate disclosures, leading to an increase in market volatility (Kumar & Lee, 2006; Chen & Yang, 2020). Empirical evidence in Egypt shows that the external shocks, including the COVID-19 pandemic, led to a substantial increase in stock return volatility of Egyptian banks, indicating the sensitivity of the market to firm disclosures and macroeconomic uncertainty (Balboula & Metawea, 2021). Such visibility- or lack thereof, whether due to crisis events or corporate disclosures collectively- can create a reinforcing effect on pricing variation of Egyptian stocks. Regulatory challenges also persist, particularly in the enforcement and standardization of ESG disclosures. Differences in ESG rating methodologies and inconsistent reporting practices make it difficult for investors to accurately assess firms' sustainability efforts (Dorfleitner et al., 2015; Erhart, 2022). These motives give rise to an important need to study the interplay between the tone of risk disclosures in annual reports and ESG performance and its impact on shaping investor perceptions and market reactions.

2.2.Theoretical Framework

A theoretical basis is necessary to comprehend the connection between market dynamics and ESG initiatives. This study highlights both internal operational consequences and external disclosure effects as it explains how ESG efforts affect investor behavior and market volatility using Resource Allocation Theory (RAT) and Signaling Theory (ST).

RAT studies the impact of ESG investments on the operational and financial resources of a firm. Accordingly, adopting ESG initiatives usually demands reallocating resources to sectors such as sustainable technology, enhanced governance structures, or employee wellbeing (Barnea & Rubin, 2010). Though these reallocations can create long-term value, they can also draw on financial resources in the short-run, increasing costs or limiting resources available, creating concern from investors. There need not be a policy change; if investors perceive ESG spending to be excessive or inefficient, they will perceive higher risk, which will be identified with

greater market instability. Conversely, if they perceive these investments as strategic decisions that enhance a firm's resilience and profitability, ESG efforts might help stabilize market perceptions. In contrast with theories focused on explicit ESG disclosures, RAT suggests that investor reactions might not directly derives from ESG reporting, but rather indirectly, through financial performance and operational results. This view helps explain how shifts of capital towards or away from ESG-related resources can affect market volatility through perceived risk.

In contrast, ST emphasizes a role for disclosure in affecting investor impressions. By publicly reporting their ESG initiatives, firms indicate a commitment to sustainability, strong governance, and long-term value creation (Spence, 2002). Transparent ESG reporting helps reduce information asymmetry, enhancing investor confidence and may help to mitigate the volatility in the markets. But the framing of those disclosures matter, as they shape how they are perceived and interpreted. Reports that exhibit clarity and confidence usually underpin stability, whereas disclosures with emphasis on uncertainties/disruptions, financial strain, or uncertainty about risks, especially in mandatory filings, may weaken positive signals and heighten volatility. This lens connects to the study's emphasis on risk-related language in annual reports, highlighting how the tone and framing of disclosures can influence responses in the market.

2.3.ESG Initiatives and Market Reaction

As outlined in the Theoretical Framework, ST suggests that ESG disclosures help reduce information asymmetry, strengthening investor confidence and potentially bringing stability to financial markets (Spence, 2002; Moussa and Elmarzouky, 2024). At the same time, RAT highlights the potential downsides, arguing that shifting resources toward ESG initiatives can create short-term financial strain, raising concerns about risk and volatility (Barnea & Rubin, 2010). Together, these perspectives illustrate why the overall impact of ESG on market behavior remains uncertain—it can either reassure investors or introduce new financial pressures, depending on how firms allocate and communicate their ESG commitments.

Empirical research emphasizes the complexity of ESG's effect on market behavior. In developed markets, certain studies reveal a negative relationship between strong ESG practices, most notably around governance, and volatility due to improved managerial oversight and transparency (Kim et al., 2012; Ignatov, 2023; Cheng et al., 2014). On the other hand, other

findings suggest that large-scale environmental and social initiatives can generate new risks, such as uncertainty surrounding introducing technologies or changing regulations, leading to greater market fluctuations (Gao et al., 2022; Assous, 2022; Lashkaripour, 2023). Moreover, work by Hong and Kacperczyk (2009) and Barnea and Rubin (2010) suggests ESG-related expenditures can put pressure on operational budgets or inhibit firms' willingness to take risk which create ambiguous effects on valuation and volatility.

Such dynamics can be more potent in emerging markets wherein regulatory systems are still developing, ESG rating agencies utilize disparate approaches, and there are predominant retail investors in trading activities who may respond to disclosed risks based on emotions (Kumar & Lee, 2006; Chen & Yang, 2020). In Egypt, for instance, retail investors account for almost 80% of trading volumes, so market reactions to ESG disclosures is likely to be less predictable, particularly when such disclosures seem unclear or financially burdensome (Sourial & Amico, 2015). Other studies (Aboud & Diab, 2018; Pasha et al., 2024) indicate that strong ESG engagement in Egypt does enhance financial performance and liquidity, while the impact on market volatility is still inconclusive. ESG commitments can, on the one hand, ease investor concerns by signaling long-term sustainability goals. On the other, mismatched reporting standards, or capital-intensive ESG projects could signal concerns over cost burdens and regulatory challenges.

On the other hand, firms actively engaged in ESG initiatives and rated by global agencies are often large and more prominent. This high visibility attracts investor attention, amplifying market reactions to ESG-related news (both positive and negative) and increasing stock return volatility. Prior research highlights that firm visibility shapes investor responses to ESG activities. Servaes and Tamayo (2013) emphasize that firms' social responsibility influences firm value primarily when investors are aware of it, leading to stronger market reactions for those highly visible firms. Larger firms also receive extensive media coverage and analyst scrutiny, intensifying investor reactions. Gode and Mohanram (2003) and El Ghoul et al. (2011) suggest that while transparency benefits these firms, it also exposes them to greater market sensitivity and more pronounced stock price fluctuations. Similarly, aligning with Barber and Odean (2008), who show that investors react more swiftly to news about widely recognized companies. Therefore, high-visibility firms could experience sharper market fluctuations due to closer scrutiny.

Overall, ESG initiatives consist of various elements that can either reduce or increase market volatility, depending on firm-specific factors and broader market conditions. Theoretical and empirical findings present a complex picture, while ESG engagement and greater transparency can help stabilize investor perceptions, costly or poorly communicated initiatives may create uncertainty, particularly in markets with weaker regulatory oversight. Given these dynamics in the Egyptian context, we propose the following hypothesis:

H1: *Egyptian firms that actively engage in ESG initiatives (as evidenced by having an ESG score from global rating agency) experience higher stock return volatility compared to firms with lower ESG engagement (i.e., those without such scores).*

2.4.ESG Components and Differential Impacts on Market Volatility

ESG initiatives are often considered as a whole, but their Environmental (E), Social (S), and Governance (G) components can have distinct and, at times, opposing effects on market volatility. Examining these pillars separately provides a clearer understanding of their individual impact, which is sometimes masked by broad ESG scores (Gao et al., 2022; Assous, 2022).

Environmental projects, for example investments in renewable energy or pollution control, usually need large up-front investments and long paybacks at uncertain returns. Such projects usually rely on nascent technologies, operate in continually evolving regulatory environments and do not externally guarantee demand from consumers for sustainable products, increasing perceived risk and volatility (Barnea & Rubin, 2010; Gao et al., 2022; Lashkaripour, 2023). Assous (2022), for example, found that environmental commitments often lead to short-term stock price fluctuations resulting from operational adjustments and investor uncertainty, even though such commitments can help ensure long-term sustainability. In emerging markets such as Egypt, the impact can actually be magnified. Weak oversight and inconsistencies of rating methodologies in ESG add to investor concerns and make market reactions more volatile (Dorfleitner et al., 2015; Erhart, 2022).

Social initiatives, such as workforce diversity programs, employee welfare improvements, and community engagement efforts, are often associated with reputational advantages that can contribute to market stability (Dhaliwal et al., 2011; Friede et al., 2015). By demonstrating corporate responsibility, these initiatives help build stakeholder trust and reduce

reputational risks, which may, in turn, temper market volatility (Krüger, 2015). However, their financial impact in the short term is less predictable (Servaes & Tamayo, 2013). This uncertainty is particularly relevant in retail-driven markets like Egypt, where investor awareness of social factors remains limited. Since retail investors tend to react emotionally to financial risks, they may overlook the potential stabilizing effects of social initiatives, instead focusing on immediate financial performance (Kumar & Lee, 2006; Chen & Yang, 2020).

Among the three ESG components, governance is often considered the most influential due to its direct link to managerial oversight, transparency, and accountability. Strong governance mechanisms, such as independent boards and rigorous auditing practices, have been shown to enhance firm value by reducing agency conflicts and fostering investor confidence (Ararat et al., 2017). This stabilizing effect is particularly significant in emerging markets, where institutional weaknesses make effective governance even more critical (Claessens & Yurtoglu, 2013; Ararat et al., 2017). However, governance quality can vary depending on regulatory enforcement and assessment methodologies. Inconsistencies in scoring frameworks can make it difficult to evaluate the extent to which governance improvements are effectively implemented (Bruno & Claessens, 2010a, 2010b).

In summary, the distinct effects of each ESG component highlight why relying on a single, aggregated ESG score can obscure important differences in how firms experience market volatility. A company may perform well in environmental initiatives while struggling with governance oversight, or vice versa (Assous, 2022). In Egypt, where regulatory enforcement varies and retail investors dominate trading activity, these distinctions become even more pronounced. Investors may respond differently depending on how environmental risks, social commitments, and governance practices are disclosed, leading to complex market reactions (Sourial & Amico, 2015; Chen & Yang, 2020). Given these factors, breaking down ESG into its separate pillars is essential for understanding which aspects contribute to or mitigate volatility. Based on these considerations, we propose:

H2: *Among firms engaging in ESG initiatives, the Environmental, Social, and Governance components have distinct effects on market volatility.*

2.5.Risk Tone Disclosure Moderating Role

A growing body of research emphasizes that corporate narratives in annual reports decisively shape investor perceptions of firm risk and future prospects (Loughran & McDonald, 2011; Henry, 2008; Moussa and Elmarzouky, 2024). While ESG performance often signals proactive stakeholder engagement, reduced agency conflicts, and in turn, lower stock-price volatility (Kim et al., 2012; Ignatov, 2023; Cheng et al., 2014), the stabilizing effect of ESG may be contingent on how firms communicate (tone of) broader uncertainties or risks in their mandatory disclosures. Specifically, when annual reports contain a high prevalence of negative or risk-laden language—covering uncertainty, litigation, or adverse contingencies—investors can become skeptical of the favorable ESG signals (Merkl-Davies & Brennan, 2007; Ertugrul at al., 2017).

Building on textual-analysis insights, negative or uncertain words (e.g., "contingent," "litigious," "insecure") consistently amplify perceived firm risk (Loughran & McDonald, 2011; Soliman & Amar, 2020). This negativity can lead investors to re-evaluate a firm's strategic prospects (Henry, 2008; Davis et al., 2012), thus diluting the usual "confidence premium" that robust ESG engagement might confer (Cho et al., 2010). Therefore, when investors detect high negativity or uncertainty in annual report narratives, they may discount favorable ESG signals, viewing sustainability projects as costly or overshadowed by broader corporate risks (Tetlock et al., 2008). This can weaken the volatility-reducing benefits typically linked to strong ESG practices (Ertugrul et al., 2017).

Firms often use narrative tone strategically in risk disclosures to shape stakeholder perceptions (Enslin et al., 2023). By emphasizing certain risk management aspects while downplaying material risks through overly positive language, companies may contribute to information asymmetry, particularly affecting non-professional investors who rely on qualitative disclosures (Elliott et al., 2024; Enslin et al., 2023). In emerging markets, weaker regulatory oversight further allows firms flexibility in framing risk-related information.

Although ESG initiatives can enhance investor trust and mitigate perceived risks (Kim et al., 2012; Cheng et al., 2014), excessive risk-related wording may counteract these benefits. Highlighting uncertainties or liabilities can overshadow positive ESG messaging, prompting investors to question whether ESG efforts truly reduce firm risk (Merkl-Davies &

Brennan, 2007). Frequent use of negative language -conveying litigation, operational threats, or unpredictable returns- raises doubts about ESG's risk-mitigation value (Henry, 2008). Ultimately, excessive negativity in mandatory disclosures can diminish the expected inverse relationship between ESG performance and stock volatility. As negativity heightens perceived uncertainty, the stabilizing effect of ESG may weaken or even disappear.

From an impression management perspective, managers sometimes embed negative or risk-oriented language—addressing litigation, market headwinds, or operational uncertainties—in annual reports (Merkl-Davies & Brennan, 2007; Loughran & McDonald, 2016). While certain cautionary disclosures may be mandatory or factually warranted, excess negativity can overshadow any positive connotations of the firm's ESG initiatives (Cho et al., 2010). Specifically, in highly uncertain business contexts, even substantial ESG commitments might appear costly, risky, or insufficient to skeptical investors, especially those tracking narrative disclosures (Lu, et al., 2019).

Additionally, nonprofessional investors often react strongly to negative language in corporate disclosures (Elliott et al., 2024). When an annual report emphasizes risks and uncertainties, the stabilizing effect of strong ESG performance may diminish. If terms like "contingent litigation," "impending losses," or "uncertain regulations" dominate the narrative, investor confidence in the firm's long-term outlook may erode. Moreover, ESG initiatives framed with risk-heavy language, especially regarding future expenditures, can appear financially burdensome rather than beneficial (Henry, 2008; Davis et al., 2012). This perception may lead investors to view sustainability efforts as potential liabilities rather than safeguards. Instead of reinforcing stability, excessive negativity could signal strategic or financial strain, weakening the expected volatility-reducing effect of ESG engagement (Kim et al., 2012; Ignatov, 2023). As a result, investors may question whether the firm's ESG commitments are strong enough to withstand economic or regulatory challenges.

Kahneman's dual-process theory of decision-making could provide explanation for how the narrative tone of disclosures influences investor perceptions and help explain the variability in investor reactions based on the type of cognitive processing they employ. Two types of thinking processes are distinguished by Kahneman's dual-process theory: System 1 and System 2 (Kahneman, 2011). System 1 involves fast, instinctual, and emotional reactions, which can be triggered by negative or risk-laden language in annual

disclosures, potentially leading to increased market volatility. This is especially relevant in markets with a high proportion of retail investors who may respond impulsively to perceived risks. On the other hand, institutional investors are more likely to rely on System 2 thinking, carefully analyzing disclosures before making investment decisions. In such cases, the stabilizing effect of ESG initiatives may remain intact, as these investors assess long-term value rather than reacting to short-term narrative cues. However, when risk-related language overshadows ESG messaging, even institutional investors may view sustainability efforts as insufficient to offset broader uncertainties, potentially leading to increased volatility.

In this context, the tone of risk disclosures can act as a moderating factor, influencing how ESG performance affects stock price fluctuations. While strong ESG engagement typically signals responsible governance and reduced risk, a predominantly negative disclosure tone may counteract this benefit by amplifying investor concerns. This leads to the following hypothesis:

H3: *Higher levels of risk disclosure tone in annual reports amplify the volatility impact of ESG engagement for Egyptian public firms.*

3. Methodology

3.1.Sample and Data Source

This study uses a dataset compiled from multiple sources to examine the impact of ESG initiatives on market valuations among Egyptian public firms. The primary datasets used are from Refinitiv, Compustat Global, and the Egyptian Stock Exchange (EGX).

The first source of stock market data is the Compustat Global-Security Daily. Specifically, focusing on Egyptian firms from 2010 to 2024, which includes 282 unique Egyptian firms, totaling 963,244 firm-daily observations. This dataset is crucial for obtaining high-frequency stock data, which allows for detailed analysis of market behaviors and firm-specific financial health. Second source we used is the Egyptian Stock Exchange (EGX) official website (www.egx.com.eg) to obtain the full document of the annual reports and governance from 2016 to 2023, encompassing 262 unique firms with 710 firm-year observations. These reports provide essential insights into the governance structures and financial statements of the firms, which are vital for constructing out the moderator (Risk Tone Disclosure) and control variables in our models.

Final data source, Refinitiv, is a well-known ESG rating provider, which assess firms' ESG performance. Refinitiv Global was chosen for its comprehensive coverage of ESG ratings, and its appropriateness and value in capturing detailed financial and ESG metrics essential for nuanced market analysis (Said & ElBannan, 2024). Refinitiv's ESG coverage tends to concentrate on larger, more frequently traded companies, such as those in the EGX30 Index, due to more extensive public disclosures and higher levels of international investor interest. Consequently, some smaller or domestically focused firms in Egypt may lack Refinitiv ratings (see Refinitiv, 2024). This dataset encompasses 229 firm-year observations for 43 unique Egyptian public firms spanning from 2008 to 2023. These firms were listed in EGX30 Index and are more established, with substantial public disclosures and international investor interest.

3.2. Data Integration and Sample Construction

The integration process involved matching firm identifiers and financial years across the three datasets to create a comprehensive panel. Initially, a subset of 160 firm-year observations was identified after linking the datasets which mainly include firms with ESG scores (ESG-Visible firms, i.e., Refinitiv ESG-rated). The remaining 550 firm-year observations corresponded to firms with no Refinitiv ESG ratings (ESG-Non-Visible firms). This distinction between ESG-visible (rated) and ESG-non-visible (unrated) creates a natural segmentation. We can thus compare whether and how recognized ESG visibility influences market volatility. To ensure comparability and control for potential selection bias, we employ Propensity Score Matching (PSM). The final balanced sample consists of 304 firm-year observations (2018–2023), evenly distributed between ESG-visible and ESG-non-visible firms. Table 1 summarizes the data selection process and the industry distribution of the sample is detailed in Table 2.

Table 1. Sample Selection Process

Description	Firm-Year Obs
Initial ESG Data from Refinitiv	229
Initial (Financial and Security Data)	710
Data Linking (Refinitiv, Financial, Security Data) (Treatment Group)	160
Unmatched ESG Data (Control Pool)	550
Final Sample (Post-PSM)	304

Table 2. Industry Distribution of Sampled Firms

Industry	Firm-Year Obs	Perc %
Food, Beverages and Tobacco	32	10.53
IT , Media & Communication Services	11	3.62
Trade & Distributors	7	2.30
Shipping & Transportation Services	10	3.29
Education Services	9	2.96
Non-financial Services	15	4.93
Industrial Goods, Services and Automobiles	10	3.29
Health Care & Pharmaceuticals	42	13.82
Travel & Leisure	11	3.62
Real Estate	67	22.04
Utilities	2	0.66
Contracting & Construction Engineering	12	3.95
Textile & Durables	19	6.25
Building Materials	8	2.63
Basic Resources	49	16.12
Total	304	100.00

3.3. Variables Measurement

3.3.1. Volatility

The dependent variable, *Volatility*, was calculated using data from Compustat Global - Security Daily, which includes daily trading information such as prices and volumes. To compute volatility, we first transformed price data into daily log returns. This transformation stabilizes variance and normalizes the data distribution. To convert raw stock price data into a measure of volatility, daily log returns are calculated as

$$r_t = \ln\left(\frac{P_t}{P_{t-1}}\right)$$

where P_t is the daily closing price on day t. Once log returns are computed, a rolling standard deviation is applied using a 252-day window with minimum 126-day window, reflecting the approximate number of trading days in a year. This rolling volatility at day t, denoted σ_t, is obtained by

$$\sigma_t = \sqrt{\frac{1}{N-1}\sum_{k=1}^{N}(r_{t-k} - \bar{r_t})^2}$$

where N is set to 252 and $\bar{r_t}$ is the mean of the log returns over the past 252 days. The resulting variable, denoted *volatility*, thus represents the firm's rolling volatility of log returns over the year.

To focus the analysis on a meaningful period, the annual volatility measure is derived as the average rolling volatility from the final three months of the outcome year (e.g., October 1 to December 30 for each year t). This approach captures a recent but concentrated snapshot of market behavior, reflecting investor responses to firm activities during the outcome year. While the rolling volatility calculation inherently incorporates daily returns from earlier periods, the focus on the final three months ensures that the measure primarily reflects forward-looking market dynamics relevant to t, minimizing excessive overlap with the treatment year $(t-1)$. This design ensures the volatility metric captures market behavior influenced by current-year conditions while avoiding contamination from the treatment year's events.

3.3.2. ESG-Related Variables

The independent variables in this study derive from ESG scores for Egyptian firms listed on Refinitiv database from 2008 to 2023. Each firm-year record includes a total ESG score, as well as scores for ESG pillars. The Environmental score captures a firm's environmental policies and impact on natural systems, the Social score reflects workforce relations and societal engagement, and the Governance score measures transparency and shareholder rights. The dataset is then including firm-year Environmental (*EnvScore*), Social (*SocScore*), and Governance (*GovScore*) pillar scores alongside the overall ESG score (*ESGScore*). Additionally, a binary variable, *ESG_presence*, indicates whether a firm-year has an ESG score in Refinitiv

(1) or not (0). Rated firms tend to be more visible to investors, while non-rated firms may lack sufficient ESG disclosures or transparency. This distinction between ESG-visible engagement (rated) and ESG-non-visible (unrated) firms, creates a natural segmentation. We can thus compare whether and how recognized ESG visibility influences market volatility. In Egypt, some firms, especially smaller or domestically focused ones, may not disclose ESG information due to the absence of mandatory reporting, resource constraints, or limited investor pressure. While an ESG score signals engagement in sustainability reporting, its absence does not imply poor governance or financial instability. However, it may affect investor perception, particularly for ESG-focused investments.

Table 3. Variable Definition and Measurement

Variable	Definition	Measurement
Volatility	Stock return fluctuations	252-day rolling SD of daily log returns, averaged over last 3 months. Sourced from Compustat Global - Security Daily
ESG_presence	ESG engagement visibility	Binary variable, whether a firm-year has an ESG score in Refinitiv (1) or not (0). Rated firms are more visible to investors, while unrated firms may lack ESG disclosures due to voluntary reporting, resource constraints, or limited investor pressure. The variable helps segment firms into ESG-visible and ESG-non-visible categories, allowing comparison of their impact on market volatility.
ESGScore	Overall ESG performance	Last recorded ESG score in a year from Refinitiv
EnvScore	Environmental score	Environmental ESG component from Refinitiv
GovScore	Governance score	Governance ESG component from Refinitiv
SocScore	Social score	Social ESG component from Refinitiv
RiskTone	Sentiment-based risk disclosure	Negative, uncertainty, and litigation word count using Loughran & McDonald lexicon, processed with OCR and NLP from annual reports (EGX)
FirmSize	Company size	Log of total assets
Cash	Cash holdings	Cash and equivalents divided by total assets
Leverage	Debt-to-assets ratio	Total debt divided by total assets
ROA	Return on assets	Net income divided by total assets
ROE	Return on equity	Net income divided by shareholder equity
Liquidity	Current ratio	Current assets divided by current liabilities
FirmAge	Years since incorporation	Years since founding
OwnCon	Ownership concentration	Largest shareholder ownership percentage
EPS	Earnings per share	Net income divided by number of shares
EarVar	Earnings variability	Standard deviation of net income over time (past 3 years)

3.3.3. Risk Tone Disclosure: Lexicon-Based Text Analysis

The *Risk Tone* variable is constructed using data from Egyptian firms' annual reports between 2016 and 2023. These reports serve as a primary source for corporate disclosures, offering insights into firms' financial and operational standing. Since most of the reports are in PDF format, the first step is converting them into plain text. This task presents unique challenges due to the complexities of Arabic script, such as connected letters and right-to-left alignment. To extract text effectively, Optical Character Recognition (OCR) is applied using Tesseract, an open-source OCR engine. The extraction process is automated through custom Python scripts, designed to handle large batches of reports efficiently. Ensuring accuracy in text recognition requires fine-tuning the OCR settings to address common issues in Arabic documents, such as fragmented letters and misinterpretations of diacritics. Careful adjustments help improve the quality of extracted text, ensuring that it faithfully represents the original disclosures.

After converting the reports into text, the next step is preparing the data for analysis by cleaning and standardizing the content. This involves removing non-text elements such as numbers and special characters, ensuring consistent punctuation and spacing, and correcting common OCR errors that occur with Arabic text, such as misinterpretations of similar-looking letters. Once the text is cleaned, we apply the Loughran and McDonald lexicon, a well-established tool for analyzing financial language (Loughran & McDonald, 2011). This lexicon classifies words based on their sentiment and financial relevance, covering categories such as negative, uncertain, litigious, and constraining terms. Previous studies have shown its effectiveness in evaluating corporate disclosures and investor sentiment (Elmarzouky et al., 2021; Mousa et al., 2022; Elmarzouky et al., 2022). Research in emerging markets, including Pakistan, has also demonstrated its applicability, as highlighted by Sufi et al. (2024), who used it to analyze annual reports from non-financial firms.

For this study, we focus on negative, uncertain, and litigation-related words from the lexicon, as they are most relevant for capturing the risk tone in corporate reports. To extract these terms accurately, we systematically scan each cleaned report, ensuring that only exact matches are counted. Given the morphological complexity of Arabic, special attention is paid to variations in word forms and suffixes, allowing for precise identification and quantification of relevant terms. This approach ensures that the analysis captures the true sentiment of the disclosures without misclassification.

The final step in the construction of the risk tone disclosure variable involves the aggregation of the total occurrences of all keywords for each firm-year. This aggregated data forms the *RiskTone* Disclosure variable, which quantifies the prevalence of risk-oriented language within the corporate disclosures. This variable is important for investigating the moderating effect of disclosure tone on the relationship between ESG initiatives and market valuations. Throughout this process, multiple rounds of OCR calibration are conducted along with manual verification of a random sample of the converted texts to ensure the integrity of the data.

$$\text{RiskTone}_{i,t} = \sum_{w \in \{\text{Negative, Uncertain, Litigation}\}} \text{Count}_{i,t}(w)$$

Where, $RiskTone_{i,t}$ is the risk tone score for firm i in year t. $Count_{i,t}(w)$ denotes the number of times risk-related words (negative, uncertain, litigation-related) appear in firm's i annual report for year t. The set of risk-related words, $w \in \{Negative, Uncertain, Litigation\}$, is derived from the Loughran and McDonald (2011) financial sentiment lexicon.

3.4.Analytical Framework and Model Specifications

To capture both direct effects of ESG on volatility and the moderating role of risk disclosure tone, we employ multiple regression analyses, incorporating fixed effects for industry and year. Recognizing that ESG adoption may be endogenously related to firm characteristics, we use Propensity Score Matching (PSM) to form a balanced sample of treated (ESG-visible) and control (non-ESG visible) firms. Additionally, to account for temporal causality and avoid simultaneity bias, all models use a one-year lag for all predictors, including ESG metrics and control variables. This ensures that all predictors reflect conditions preceding the measurement of volatility, thereby mitigating reverse causality concerns and enhancing the interpretability of the causal relationships.

3.4.1. Propensity Score Matching (PSM)

PSM is used in this setting to correct for potential selection bias, as ESG-visible firms may differ systematically from non-visible firms in ways that also influences volatility. PMS is used to balance the observed covariates between treated group (rated firms) and control group (unrated firms); rated and unrated firms are statistically similar in given observed covariates (Rosenbaum & Rubin, 1983). Such a method allows for comparison where treatment effects can at least be assumed responsible for differences in

outcome variables rather than any confounding factors aiding a credible estimation of how acknowledged ESG visibility may impact market volatility and, therefore, providing insights into the relationship between transparency, investor perception, and risk.

The matching process starts with the data preparation stage, which involves firm-level balance sheet metrics and ESG data over a number of years. Given the aforementioned relationship between ESG adoption and accounting-based performance metrics, covariates employed in the matching process were selected based on both their importance in identifying firms that adopt ESG principles as well their importance in determining firm performance (Gupta & Wowak, 2017; Said & ElBannan, 2024): Firm Size, Leverage, Return on Assets (ROA), Return on Equity (ROE), Cash Holdings, Firm Age and Ownership Concentration. These variables are standardized by z-score transformation to ensure comparability across scales. The normalization step scales all covariate variables to zero mean and one unit variance so that differences between covariate variable cannot disproportionately impact estimates of the propensity score.

Propensity scores, which represent the probability of ESG adoption given a firm's characteristics, are estimated using logistic regression. The binary ESG presence indicator serves as the dependent variable, while the standardized covariates function as predictors. For the matching process, we employ Nearest Neighbor Matching with a caliper width set to 0.05 times the standard deviation of the propensity scores. This caliper ensures that matched firms have propensity scores within a narrow range, enhancing match quality by limiting discrepancies between treated and control firms. A 1:1 matching ratio without replacement is employed, ensuring that each treated firm is paired with only one control firm, the closest match based on propensity scores.

To evaluate the success of the matching process, standardized mean differences (SMDs) are calculated for all covariates before and after matching. A successful match is indicated by substantial reductions in SMDs, demonstrating that pre-treatment differences between the treatment and control groups have been minimized. The outcome of this procedure results in a refined sample comprising 304 firm-year observations (152 ESG-visible firms and 152 matched non-ESG visible firms). The matched sample serves as the foundation for the subsequent analysis of ESG's impact on market volatility. By ensuring balance between the treated and control groups, PSM enhances the robustness of causal inferences drawn from the regression models. Descriptive statistics of the matched sample are in the results section.

3.4.2. Baseline Model: ESG Visibility, ESG Scores, and Volatility

To investigate the relationship between ESG engagement and stock return volatility, we first examine whether ESG-Visible firms exhibit higher volatility than ESG-Non-Visible firms. This comparison is conducted in two steps.

- Binary ESG Presence Model: Compares volatility between firms with and without an ESG score.

$$Volatility_{i,t} = \alpha + \beta_1 ESG\_presence_{i,t-1} + \gamma X_{i,t-1} + \mu_i + \lambda_t + \epsilon_{i,t}$$

- ESG Score Model: Examines how continuous ESG scores influence volatility among only ESG-rated firms.

$$Volatility_{i,t} = \alpha + \beta_1 ESGScore_{i,t-1} + \gamma X_{i,t-1} + \mu_i + \lambda_t + \epsilon_{i,t}$$

where $\text{Volatility}_{i,t}$ denotes the annualized rolling volatility for firm i in year t, $\text{ESG\_presence}_{i,t-1}$ is a binary variable indicating whether the firm has any ESG score recorded in the prior year, and $ESGScore_{i,t-1}$ represents the continuous ESG score for rated firms. $X_{i,t-1}$ is a vector of control variables such as $FirmSize$, $Leverage$, $FirmAge$, and other financial metrics. The terms μ_i and λ_t represent industry and year fixed effects, capturing unobserved heterogeneity across industries and time, respectively. β_1 is the coefficient, for example in first model, it captures whether firms with ESG visibility exhibit systematically different volatility than firms without ESG visibility, after controlling for firm-specific factors.

3.4.3. Disaggregated ESG Component and Volatility

To address Hypothesis 2—that, among firms with ESG initiatives, the Environmental (E), Social (S), and Governance (G) components have differential impacts on market volatility—we restrict the sample to only those firms that genuinely report ESG scores (Treated Group). In this subset of firms, we estimate a disaggregated model:

$$Volatility_{i,t} = \alpha + \beta_1 EnvScore_{i,t-1} + \beta_2 SocScore_{i,t-1} + \beta_3 GovScore_{i,t-1} + \gamma X_{i,t-1} + \mu_i + \lambda_t + \epsilon_{i,t}$$

Here, $\text{EnvScore}_{i,t-1}$, $\text{SocScore}_{i,t-1}$, and $\text{GovScore}_{i,t-1}$ represent the firm's environmental, social, and governance pillar scores from the previous year. The coefficients β_1, β_2, and β_3, test whether these individual pillars correspond to higher, neutral, or lower volatility. This approach highlights the

possibility that an aggregated ESG score may conceal offsetting effects—e.g., environmental efforts that raise uncertainty and governance practices that mitigate it.

3.4.4. Moderation by Negative Disclosure Tone

Hypothesis 3 posits that negative or risk-laden disclosure tone in mandatory annual reports (captured by the *RiskTone* Disclosure variable) moderates the effect of ESG on volatility, such that ESG efforts may be overshadowed by negative language, or these efforts become even riskier. To examine this interaction, we introduce an interaction term between the ESG measure (or specific ESG pillars) and the *RiskTone* Disclosure variable in the regression:

$$Volatility_{i,t} = \alpha + \beta_1 ESG\_Score_{i,t-1} + \beta_2 RiskTone_{i,t-1} + \beta_3 \left(ESG\_Score_{i,t-1} \times RiskTone_{i,t-1}\right) + \gamma X_{i,t-1} + \mu_i + \lambda_t + \epsilon_{i,t}$$

Here, $RiskTone_{i,t}$ is the count of negative, uncertain, and litigation keywords extracted from firm's i annual disclosure in year t. The coefficient β_3 measures how the presence of negative language modifies the baseline effect of ESG on volatility. A statistically significant interaction term would suggest that negative language in disclosures can either magnify or dampen the volatility associated with ESG scores.

4. Empirical Results

4.1.Matching Results and Descriptive Statistics

The propensity score matching was conducted to ensure comparability between the treated firms (those with ESG scores) and the control group (without ESG scores). The matching quality is assessed by examining the Standardized Mean Differences (SMDs) before and after matching across various covariates. As shown Table 4, SMDs significantly decreased post-matching, suggesting an effective alignment of the covariate distributions between the treated and control groups. For instance, the SMD for *FirmSize* decreased from 1.331 pre-matching to 0.176 post-matching, indicating a substantial improvement in covariate balance. Similar improvements were observed for other financial characteristics, such as *Leverage*, *ROA*, *Liquidity* and *OwnCon*, where SMDs reduced to near zero, confirming the efficacy of the matching process.

Post-matching, Table 5 provide the descriptive statistics of the matched sample. Volatility, a key variable of interest, showed a mean of 0.065 with a standard deviation of 0.156, indicating a moderate spread of firm-level volatility across the sample. The ESG scores, which are pivotal to this study, ranged from a low of 0.049 to a high of 0.618, with a mean of 0.302 for *ESGScore*. This indicates a moderate level of ESG engagement among the firms, with a skewness of 0.193 suggesting a slight concentration towards the lower end of ESG scores. The *EnvScore*, *GovScore*, and *SocScore* reflected similar trends with varying degrees of engagement, highlighting the diverse approaches to ESG adoption within the sample. Furthermore, the distribution of *RiskTone*—a metric representing the intensity of risk-related disclosures—ranged broadly from 16 to 357, with a mean of 109.729, reflecting significant variation in how firms disclose risk information. *FirmAge* and *FirmSize* show that the sample includes both relatively younger and smaller firms as well as older, more established companies. These metrics, along with others such as *Cash*, *Leverage*, and *OwnCon*, underscores the financial and ownership diversity within our sample.

Table 4. Covariate Balance Before and After Propensity Score Matching (PSM)

Covariate	**Pre-Match**			**Post-Match**		
	Mean (Treatment) n = 160	**Mean (Control) n = 550**	**SMD**	**Mean (Treatment) n = 152**	**Mean (Control) n = 152**	**SMD**
FirmSize	22.395	20.370	1.331	22.281	22.029	0.176
Cash	0.068	0.103	-0.346	0.068	0.090	-0.262
Leverage	0.062	0.043	0.239	0.084	0.084	-0.001
ROA	0.073	0.053	0.231	0.071	0.079	-0.096
ROE	0.150	0.116	0.222	0.165	0.167	-0.009
Liquidity	2.182	2.924	-0.228	2.012	1.901	0.046
FirmAge	30.441	35.707	-0.281	29.093	31.590	-0.140
OwnCon	0.571	0.661	-0.418	0.619	0.606	0.066
EPS	1.046	0.967	0.005	1.327	1.619	-0.093

Table 5. Descriptive Statistics of Matched Sample

Variable	N	Mean	STD	Min	Max	Skewness
Volatility	304	0.065	0.156	0.000	0.705	2.814
ESGScore	152	0.302	0.172	0.049	0.618	0.193
EnvScore	152	0.209	0.237	0.000	0.765	1.012
GovScore	152	0.452	0.219	0.062	0.832	0.199
SocScore	152	0.255	0.171	0.010	0.648	0.427
RiskTone	304	109.729	53.675	16.000	357.000	1.233
FirmSize	304	20.764	1.752	17.227	23.733	-0.117
Cash	304	0.099	0.119	0.001	0.427	1.654
Leverage	304	0.045	0.081	0.000	0.289	1.991
ROA	304	0.060	0.091	-0.136	0.256	0.254
ROE	304	0.127	0.162	-0.185	0.524	0.425
Liquidity	304	2.365	2.085	0.432	7.858	1.734
FirmAge	304	34.669	18.518	9.000	54.000	-0.187
OwnCon	304	0.646	0.238	0.253	1.000	-0.159
EPS	304	0.959	1.640	-1.060	5.000	1.484
EarVar	304	0.557	0.721	0.000	2.255	1.414

Notes: The descriptive statistics presented post-propensity score matching (PSM) are based on the original, unstandardized values of the variables.

4.2. Correlation Matrix

Table 6 provides a detailed look into the relationships between different variables in our dataset. The correlation matrix shows that there is a slight negative correlation between *Volatility* and overall ESG scores (r = -0.05), suggesting that higher ESG scores might be associated with slightly lower stock volatility. For ESG Pillars: *EnvScore* show a positive correlation with *Volatility* (r = 0.13), potentially suggesting that environmental initiatives might be associated with higher volatility. Conversely, *GovScore*, and *SocScore* are negatively correlated with *Volatility* (-0.03 and -0.16, respectively), hinting that governance and social initiatives could be associated with lower volatility. *RiskTone* shows positive correlations with all ESG scores (r = 0.34 with *ESGScore*, 0.38 with *EnvScore*, 0.33 with *GovScore*, 0.19 with *SocScore*), suggesting that higher ESG engagements are reported with more risk-laden language, possibly reflecting transparency in disclosing potential risks. Similarly, *RiskTone* shows positive correlations but not significant with *Volatility* (r = 0.22). The control variables show that

larger (*FirmSize*) and older firms (*FirmAge*) tend to have higher ESG initiatives (r = 0.33, 0.11 with *ESGScore,* respectively), which aligns with the expectation that bigger firms might have more resources to invest in ESG or have more established ESG practices. *Cash* are negatively correlated with overall *ESGScore* (r = -0.15) and its pillars, indicating that firms with more cash holdings have less ESG investments. Additionally, *Leverage* and *OwnCon* is negatively correlated with *ESGScore* and its pillars but not significant. These correlations offer insights into how ESG factors are intertwined with corporate characteristics, their risk tone disclosure and market behavior.

Table 6. Correlation Matrix

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**	**(15)**	**(16)**
(1) Volatility	1															
(2) ESGScore	-0.05	1														
(3) EnvScore	0.13*	0.83	1													
(4) GovScore	-0.03*	0.79*	0.46*	1												
(5) SocScore	-0.16	0.91*	0.72*	0.56	1											
(6) RiskTone	0.22	0.34*	0.38	0.33*	0.19*	1										
(7) FirmSize	-0.26*	0.33	0.37	0.29*	0.26	0.20	1									
(8) Cash	-0.19*	-0.15*	-0.06	-0.32*	-0.07*	-0.02	-0.03*	1								
(9) Leverage	0.14	-0.29	-0.16	-0.36	-0.22	0.3	-0.03	0.01	1							
(10 ROA	-0.09	-0.12*	-0.16	-0.13*	-0.10*	0.01	-0.03*	0.27	-0.10	1						
(11) ROE	-0.01	-0.14	-0.05*	-0.19*	-0.11*	0.11*	0.06*	0.20	0.01*	0.84	1					
(12) Liquidity	-0.25*	0.13	-0.09	0.37*	-0.02	-0.30*	0.08	0.08	-0.13*	0.25	0.06	1				
(13) FirmAge	-0.16	0.11*	0.08	0.17	0.11	0.13	0.18	-0.02*	-0.08*	-0.14	-0.07	-0.12	1			
(14) OwnCon	-0.06	-0.25	-0.20	-0.19	-0.19	0.11	0.2*	0.22*	0.08	0.29	0.2*	0.19	-0.11*	1		
(15) EPS	0.04*	-0.29*	-0.15*	-0.34*	-0.22	-0.04	-0.17	0.27	0.01	0.27	0.39	0.01*	0.00	0.11	1	
(16) EarVar	-0.09*	-0.30*	-0.16*	-0.29*	-0.27*	0.15	0.21*	0.16	0.17*	-0.08*	-0.07*	-0.11	-0.05*	0.34*	0.25*	1

*Note: * significant at 5%*

4.3.T-Test and Average Treatment Effect on the Treated Results(ATET)

Our analysis begins with a comparison of stock volatility between firms that engage in ESG practices (treated group) and those that do not (control group). The results in Table 7 show that the treated group exhibiting a significantly higher average volatility (0.402) compared to the control group (0.026). The mean difference in volatility between the two groups is 0.376, which is statistically significant (T-Statistic = 3.790, P < 0.001). This finding suggests a strong association where ESG practices are linked with higher levels of stock volatility, contrary to expectations that ESG involvement typically stabilizes stock performance. The effect size, measured by Cohen's d, is 0.890, suggesting a large impact relative to the variability observed within the groups. This indicates that the average volatility score of the ESG-engaged firms is 0.890 standard deviations higher than the average score of the non- visible ESG firms. Additionally, the Average Treatment Effect on the Treated (ATET) is 0.376, meaning that engaging in ESG practices is associated with an increase in stock volatility by approximately 0.376 points on our volatility scale.

To test how the narrative tone within corporate disclosures might modulate this relationship, we conducted a subgroup analysis (Table 8) focusing on the level of risk tone expressed in the firms' annual reports. Firms characterized by a high-risk tone in their disclosures showed even more pronounced differences in volatility. The treated firms, which had engaged in ESG practices, displayed a mean volatility of 0.586 compared to a mere 0.028 in the control group. The mean difference was 0.558, with a T-Statistic of 3.531, which was highly significant (P < 0.01). This subgroup analysis reveals that not only does a high-risk tone coincide with greater volatility, but it also seems to amplify the volatility effect associated with ESG practices (Cohen's d = 1.185). The ATET of 0.558 with a standard error of 0.158 further solidifies the argument that high-risk disclosures might exacerbate the volatility effect in ESG-engaged firms. In contrast, the effect in firms with a low-risk tone, though still present, was less pronounced. The treated firms reported a mean volatility of 0.209 compared to 0.023 in the control group, with a mean difference of 0.186. This result was significant (T-Statistic = 1.751, P <0.1), suggesting a moderate impact of ESG on volatility in low-risk contexts. The effect size was lower (Cohen's d = 0.592), and the ATET was 0.186 with a standard error of 0.106, indicating that while ESG practices still influence volatility, the effect is dampened when the risk tone of disclosures

is lower. These results suggest that ESG initiatives are associated with increased volatility, however, this increased volatility appears to be influenced significantly by the risk tone in the annual reports. This indicates that how firms communicate about risks in their disclosures can impact investor perceptions and market reactions, possibly overshadowing or modifying the expected benefits of ESG initiatives.

Table 7. T-Test and Average Treatment Effect on the Treated (ATET) for Volatility

Panel A. T-Test Results

Outcome	**Mean (Treatment) ESG-Visible Firms n = 152**	**Mean (Control) ESG-Non-Visible Firms n = 152**	**Mean Difference**	**T-Statistic**	**P-Value**
Volatility	0.402	0.026	0.376	3.790***	0.000

Panel B. Effect Size and ATET

Outcome	**Cohen's d**	**ATET**	**Std Error of ATET**
Volatility	0.890	0.376	0.099

*Notes: This table presents both the t-test and effect-size estimates for ESG-Visible and ESG-Non-Visible firms. *p < 0.1; **p < 0.05; ***p < 0.01.*

Table 8. Subgroup Analysis of Volatility by Risk Tone Level: T-Test and ATET Estimates

Panel A. T-Test Results by Risk Tone

Outcome: Volatility	Group	n	Mean	Mean Difference	T-Statistic	P-Value
High RiskTone	ESG-Visible Firms	78	0.586	0.558	3.531***	0.002
	ESG-Non-Visible Firms	80	0.028			
Low RiskTone	ESG-Visible Firms	74	0.209	0.186	1.751*	0.095
	ESG-Non-Visible Firms	72	0.023			

Panel B. Effect Size and ATET by Risk Tone

Outcome: Volatility	Group	Cohen's d	ATET	Std Error of ATET
High RiskTone	ESG-Visible Firms ESG-Non-Visible Firms	1.185	0.558	0.158
Low RiskTone	ESG-Visible Firms ESG-Non-Visible Firms	0.592	0.186	0.106

*Notes:Panel A shows subgroup t-test results for High and Low Risk Tone. Panel B reports effect size (Cohen's d) and ATET estimates. *p < 0.1; **p < 0.05; ***p < 0.01.*

4.4.Regression Analyses

To further understand the distinct impacts of ESG and each ESG pillar, we conduct regression analysis with separate analyses for the environmental, social, and governance scores. This could reveal nuanced effects of each pillar on stock volatility and how these effects are perhaps moderated by the risk tone of corporate disclosures. Such an analysis would provide deeper insights into the specific mechanisms through which ESG initiatives influence market perceptions and firm volatility.

4.5.Direct Effects: ESG Factors and Stock Volatility

In Table 9, the first regression model (n = 304) includes the entire matched sample and examines the relationship between a binary indicator of *ESGPresence* (i.e., whether a firm has ESG initiatives) and stock volatility. This model provides a broad test of H1, which posits that firms with ESG initiatives experience lower market volatility than firms without such

initiatives. The second and third models (n = 152 each) focus solely on those firms that actually disclose ESG scores, allowing us to test H2, which states that among ESG-reporting firms, the individual Environmental (E), Governance (G), and Social (S) pillars exhibit distinct influences on volatility.

In the Model 1, the coefficient for *ESGPresence* is positive and highly significant (β = 0.273, p<0.001). Contrary to H1, which anticipated a volatility-reducing effect, these results suggest that in this sample, firms with ESG initiatives are linked to higher volatility relative to those without such engagements. This outcome is generally consistent with the earlier T-test findings, wherein the treated group exhibited notably higher mean volatility. Hence, rather than offering a stabilizing effect, the presence of ESG appears to coincide with a higher level of market fluctuation. When focusing strictly on overall ESG Score among ESG-adopting firms (Model 2), the coefficient of *ESGScore* is negative (B = -0.042) but not statistically significant (P > 0.1). While the sign suggests a possible volatility-dampening trend for higher ESG scores, the lack of significance means we cannot rule out that the effect is essentially neutral in this dataset. This result partially reconciles the difference between the first regression and the T-tests: although *ESGPresence* indicates a rise in volatility, deeper gradations of ESG performance (as captured by *ESGScore*) do not yield a robustly significant effect, suggesting that simply reporting a higher ESG score does not consistently translate into a volatility shift either up or down.

In the Model 3 Disaggregated ESG Components (*EnvScore*, *GovScore*, and *SocScore*) are included together, illuminating how each pillar drives volatility among the treated sample. *EnvScore* shows a positive and significant coefficient (B = 1.952, $p < 0.01$) indicates that stronger environmental initiatives tend to increase volatility. These results suggest that market participants may perceive environmental projects as resource-intensive or fraught with regulatory/policy uncertainties, thereby contributing to higher fluctuations in the firm's stock price. However, *GovScore* shows negative and significant coefficient with stock volatility (B = -0.828, p <0.05) implies that robust governance practices reduce volatility. This aligns well with governance theory, where transparent oversight and robust internal controls can mitigate risks and foster more stable market perceptions. Similarly, *SocScore* coefficient is negative (B = -0.572) but fails to reach statistical significance ($p > 0.1$), hinting at a potential but inconclusive stabilizing effect from social initiatives. The minimal impact of the social

practices could reflect the complexity of stakeholder relationships, variations in the maturity of social programs, or insufficient variability in social scores among the sample firms. Thus, H2 is partially supported. While Environmental and Governance pillars exert statistically significant but opposing effects on volatility, Social remains insignificant. These differential outcomes underscore that aggregated ESG results can mask highly varied pillar-level influences. These regression patterns align with the T-test comparisons, in which we observed higher volatility overall for ESG-engaged firms. ESG practices show larger mean volatility for ESG adopters, whereas Models 2 and 3 clarify that the Environmental pillar is mostly responsible for this upward pressure on volatility, while Governance exerts a stabilizing counterbalance.

4.6.Interaction Effects: Risk Tone as a Moderator Between ESG and Volatility

In line with our third hypothesis that the risk tone disclosed in annual reports may alter the link between ESG and stock volatility, this set of models, in Table 10, introduces interaction terms between each ESG measure (overall score or pillar scores) and the firm's risk-tone variable. The dependent variable in all four models is stock volatility, and the sample consists of 152 firm-year observations from ESG-reporting firms. In Model 1, the baseline coefficient for $ESGScore$ is negative and statistically significant (B = −1.993, p<0.01), suggesting that, in the absence of high-risk tone, a higher ESG score is associated with reduced volatility. However, the interaction term ($ESGScore \times RiskTone$) is positive (B= 0.013, p<0.01), indicating that the beneficial (volatility-reducing) effect of strong ESG practices weakens—or even reverses—as the firm's risk tone increases. In other words, while higher ESG scores can calm market fluctuations, disclosing considerable uncertainties or adverse contingencies seems to undercut this stabilizing effect, leading to higher volatility than would otherwise be observed.

When focusing on the environmental pillar (Model 2), $EnvScore$ alone is negatively and significantly related to volatility (B = −1.672, p<0.05), aligning with a stabilizing view for environmental efforts when risk tone is relatively low. Yet, the interaction with $RiskTone$ (B = 0.012, p<0.01) again points to a diminished calming effect under conditions of heightened risk disclosure. As firms detail more contingent or adverse environmental impacts (or operational complexities related to sustainability projects) in their annual reports, the initially stabilizing role of environmental practices decrease, and volatility may rise accordingly. For the governance pillar (Model 3),

$GovScore$ is negative and significant (B= -1.317, p<0.05), reaffirming that strong governance frameworks can reduce market volatility. However, $GovScore \times RiskTone$ (B = 0.009, p<0.05) suggests that even well-structured governance practices may offer less stability when firms adopt a strongly cautionary tone in disclosures. This implies that, if a company simultaneously emphasizes high governance standards and highlights numerous risks or uncertainties, investors might focus on the latter, offsetting the governance-driven stability and ultimately driving higher volatility than expected.

Similarly, the final Model 4 reveals that $SocScore$ alone is significantly negative (B = −1.545, p<0.05), indicating that more robust social engagements tend to lower volatility—an effect that might be driven by better stakeholder relations or reputational benefits. However, as with the other pillars, the positive interaction term (B= 0.011, p<0.01) shows that abundant risk disclosures or negative language can erode the stabilizing impact of social initiatives. Evidently, articulating social achievements while simultaneously highlighting a host of contingent liabilities or uncertainties can lead investors to reassess the net effects, resulting in less volatility reduction than would otherwise be achieved under low-risk communications.

These moderation models collectively indicate that the volatility-reducing potential of ESG measures—particularly when focusing on $EnvScore$, $GovScore$, and $SocScore$ —may be offset or even reversed by extensive risk tone communication. The more firms emphasize uncertainties, contingencies, or negative prospects in their annual reports, the less effective ESG commitments become at curbing volatility. These results underscore the strong interplay between corporate behavior (as reflected in ESG strategies) and corporate communication (as conveyed in risk-laden disclosures), highlighting that neither factor alone fully determines volatility. Instead, the market's perception of a firm's overall risk profile emerges from how ESG actions are framed within the broader disclosure narrative.

Table 9. Regression Analysis of ESG Presence and ESG Pillars' Effects on Stock Volatility

Dependent Variable: Stock Volatility	**Model 1**	**Model 2**	**Model 3**
ESGPresence	0.273*** (6.465)		
ESGScore		-0.042 -(0.165)	
EnvScore			1.952*** (2.728)
GovScore			-0.828** -(2.387)
SocScore			-0.572 -(1.234)
FirmSize	-0.059** -(2.092)	0.072 (0.644)	-0.034 -(0.293)
Cash	-0.061** -(2.445)	-0.058 -(0.840)	-0.035 -(0.515)
Leverage	0.047*** (3.075)	0.093** (2.085)	0.025 (0.510)
ROA	-0.108*** -(2.632)	0.047 (.565)	0.028 (0.360)
ROE	0.108*** (2.942)	-0.045 -(0.653)	-0.046 -(0.703)
Liquidity	-0.005 -(0.684)	-0.022 -(1.624)	-0.014 -(0.907)
FirmAge	-0.025 -(1.297)	-0.133*** -(3.298)	-0.159*** -(4.004)
EarVar	0.026*** (3.656)	0.047*** (2.874)	0.076*** (4.016)
Intercept	0.253*** (3.656)	0.463*** (2.874)	0.746*** (4.016)
Year FE	Included	Included	Included
Industry FE	Included	Included	Included
R-squared:	0.567	0.798	0.823
Adj. R-squared:	0.510	0.729	0.754
F-statistic:	10.020	11.510	11.920
No. Observations:	304	152	152

***Notes**: *p < 0.1; **p < 0.05; ***p < 0.01. t-statistics are in parentheses.*

Table 10. Moderation Effects of Risk Tone on the ESG–Volatility Relationship

Dep. Variable: Stock Volatility	**Model 1**	**Model 2**	**Model 3**	**Model 4**
ESGScore	-1.993*** -(2.873)			
ESGScore x RiskTone	0.013*** (3.028)			
EnvScore		-1.672** -(2.152)		
EnvScore x RiskTone		0.012*** (2.707)		
GovScore			-1.317** -(2.443)	
GovScore x RiskTone			0.009** (2.302)	
SocScore				-1.545** -(2.490)
SocScore x RiskTone				0.011*** (2.665)
RiskTone	-0.004** -(2.498)	-0.002* -(1.793)	-0.004* -(1.905)	-0.003** -(2.112)
FirmSize	0.071 (0.638)	0.077 (0.689)	-0.004 -(0.037)	0.109 (0.961)
Cash	-0.078 -(1.166)	-0.073 -(1.069)	-0.049 -(0.723)	-0.080 -(1.173)
Leverage	0.055 (1.151)	0.061 (1.305)	0.078 (1.598)	0.055 (1.124)
ROA	0.054 (0.687)	0.062 (0.781)	0.032 (0.402)	0.053 (0.665)
ROE	-0.055 -(0.826)	-0.052 -(0.771)	-0.058 -(0.843)	-0.041 -(0.606)
Liquidity	-0.018 -(1.340)	-0.021 -(1.557)	-0.005 -(0.309)	-0.028** -(2.008)
FirmAge	-0.118*** -(3.057)	-0.105** -(2.540)	-0.118*** -(2.957)	-0.128*** -(3.287)
EarVar	0.098*** (4.220)	0.068*** (3.832)	0.109*** (3.627)	0.080*** (3.924)
Intercept	0.965*** (4.220)	0.674*** (3.832)	1.073*** (3.627)	0.784*** (3.924)
Year FE	Included	Included	Included	Included
Industry FE	Included	Included	Included	Included
R-squared:	0.826	0.822	0.817	0.820
Adj. R-squared:	0.758	0.753	0.746	0.750
F-statistic:	12.150	11.860	11.450	11.70
No. Observations:	152	152	152	152

***Notes**: *p < 0.1; **p < 0.05; ***p < 0.01. t-statistics in parentheses*

5. Robustness Checks: Alternative Volatility Measures

5.1.Alternative Temporal Linkages and Shorter Rolling Window

To verify that our findings are not sensitive to the choice of volatility measurement, we tested alternative temporal linkages. While the primary approach calculates volatility using a 252-day rolling window for the last three months of the fiscal year, we also computed mean volatility over the full year and the final month of the following year. The results remained consistent across these measures, confirming that our conclusions are robust to different volatility definitions. Additionally, we tested a shorter 126-day rolling window to assess sensitivity to the window length. Findings remained unchanged, indicating that our results are not driven by the specific choice of window length.

5.2.GARCH-Based Volatility Model:

To further validate our findings, we estimate an alternative measure of volatility using a Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model. Unlike standard deviation (SD)-based volatility, which assumes volatility is constant within a fixed period, GARCH accounts for time-varying volatility clustering, a common feature in financial markets where high volatility tends to persist over time. This approach provides a more dynamic assessment of the relationship between our study variables.

Results from Model 1 and Model 2 in Table 11 confirm that ESGScore remains positively related to GARCH-based volatility ($\beta = 0.345$, $p < 0.1$). This finding aligns with our SD-based model, suggesting that firms with higher ESG ratings tend to experience greater short-term market fluctuations, possibly due to increased investor attention or uncertainty about the long-term financial implications of ESG commitments. The effect of environmental engagement remains significant in the GARCH model, as EnvScore continues to be positively associated with stock volatility ($\beta = 1.719$, $p < 0.01$). This finding is consistent with prior literature suggesting that environmental initiatives introduce short-term uncertainty due to compliance costs, regulatory risks, and capital expenditures. Governance scores, however, which were significantly negatively associated with volatility in the SD-based model, lose significance in the GARCH framework ($\beta = –0.036$, $p > 0.10$). This suggests that while governance structures mitigate long-term volatility, their immediate impact on short-term market fluctuations may be weaker. One possible explanation is that governance mechanisms function as structural safeguards that stabilize firm risk over extended periods rather than reducing short-term price movements. In contrast, social responsibility appears to have a stronger influence in the GARCH model than in the SD-based results. Whereas SocScore was negative but not significant in the SD model, it is negative and significant in GARCH ($\beta = –1.518$, $p < 0.01$). This

suggests that social responsibility initiatives may reduce short-term stock price fluctuations as investors respond positively to corporate commitments to employee welfare, diversity, and community engagement.

Table 11. GARCH-Based Regression Results: Direct and Moderation Effects of ESG and Risk Tone on Volatility

Dependent Variable:	**GRACH Volatility**					
	Direct Effects		**Moderation Effects**			
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
ESGScore	0.345*		-2.735***			
	(1.820)		-(5.725)			
ESGScore x RiskTone			0.019***			
			(6.784)			
EnvScore		1.719***		-2.784***		
		(7.137)		-(6.898)		
EnvScore x RiskTone				0.022***		
				(9.28)		
GovScore		-0.036			-1.468***	
		-(0.195)			-(3.901)	
GovScore x RiskTone					0.010***	
					(4.151)	
SocScore		-1.518***				-2.183***
		-(5.642)				-(4.834)
SocScore x RiskTone						0.014***
						(4.482)
RiskTone			-0.005***	-0.004***	-0.003***	-0.003***
			-(5.350)	-(3.198)	-(5.639)	-(3.028)
Intercept	0.322***	0.5502***	1.017***	0.951***	0.757***	0.876***
	(3.879)	(6.071)	(7.569)	(5.455)	(8.967)	(6.398)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared:	0.891	0.894	0.905	0.899	0.901	0.902
Adj. R-squared:	0.851	0.850	0.866	0.858	0.860	0.862
F-statistic:	22.53	20.52	23.18	21.86	22.08	22.41
No. Observations:	152	152	152	152	152	152

***Notes**: *p < 0.1; **p < 0.05; ***p < 0.01. t-statistics are in parentheses.*

Consistent with our SD-based volatility analysis, incorporating Risk Tone as a moderator in Model 3, Model 4, and Model 5 supports our main results. The interaction terms between ESG pillars and Risk Tone remain positive and significant, suggesting that the presence of excessive risk-related language amplifies the volatility associated with ESG activities. Specifically, the interaction effects range between $\beta = 0.010$ and $\beta = 0.022$ ($p < 0.01$). These findings indicate that firms with high ESG engagement but risk-heavy disclosure language experience increased volatility. This may occur because investors interpret excessive risk-related disclosures as a signal of financial instability, reducing the potential volatility-dampening benefits of ESG engagement.

Overall, our robustness checks using GARCH confirm that the relationship between ESG and volatility is not an artifact of the volatility measure used. While some coefficient magnitudes and significance levels vary across models, the directional consistency of the results reinforces the conclusion that ESG engagement is an important determinant of stock price volatility. The findings further suggest that social responsibility plays a stronger role in reducing short-term volatility, while governance structures primarily act as long-term stabilizers. Additionally, the persistence of positive and significant ESG × RiskTone interactions across models highlights the importance of firms' risk communication strategies in shaping market responses to ESG disclosures.

6. Discussion and Conclusion

The current study sought to clarify how ESG initiatives influence stock volatility in Egyptian public firms, particularly when considering the individual ESG pillars (Environmental, Social, Governance) and the role of risk tone in mandatory disclosures. Our findings challenge the notion that ESG universally reduces firm risk. Instead, our analysis suggests that ESG is not a monolith, and its impact on volatility depends on both the ESG pillar in question and how firms communicate risks in their annual reports.

First, our results indicate that firms with visibly engaged ESG practices exhibit higher volatility compared to their less visible counterparts, a finding that diverges from the conventional view that ESG stabilizes firm performance (e.g., Lassala et al., 2017; Aboud & Diab, 2018). This effect is pronounced in an emerging market context, where ESG initiatives may be seen as resource-intensive and subject to evolving regulations, potentially increasing rather than reducing market uncertainty. However, our findings

align with previous research, such as Servaes and Tamayo (2013), Gode and Mohanram (2003) and El Ghoul et al. (2011), which illustrate that higher visibility, resulting from ESG ratings by global agencies, often amplifies investor reactions to both positive and negative ESG-related news. This heightened sensitivity can lead to greater stock price fluctuations, particularly in firms that receive extensive media and analyst attention, supporting the idea that transparency, while beneficial, also exposes firms to increased market sensitivity. Thus, our study extends this narrative to the Egyptian market, suggesting that high-visibility ESG firms experience more pronounced market fluctuations due to intensified scrutiny and the dual-edged sword of high transparency.

Second, disaggregating ESG into its Environmental, Social, and Governance components reveals that each pillar affects volatility differently, and these effects shift when controlling for risk disclosure tone (Risk Tone). Before controlling for Risk Tone, environmental engagement is associated with increased volatility, reinforcing the view that green investments, sustainability projects, and regulatory compliance efforts introduce financial uncertainty (Kim et al., 2014). This is particularly evident in the GARCH model, which highlights that environmental risks are not just immediate shocks but persist over time, amplifying stock price fluctuations. Governance structures consistently mitigate volatility, but their effect is stronger in the long run and less pronounced in short-term models. While governance enhances corporate oversight, transparency, and risk management, its stabilizing impact is gradual rather than immediate. Unlike in the SD-based model, where governance played a more direct role in reducing volatility, its effect loses statistical significance in the GARCH framework, suggesting that investors respond to governance improvements over longer horizons rather than in short-term price movements. Social responsibility, which showed weaker effects in SD-based models, emerges as a significant stabilizing factor in GARCH models. This suggests that firms emphasizing employee welfare, diversity, and stakeholder engagement experience lower short-term stock price fluctuations, likely due to improved investor sentiment and confidence in corporate social responsibility commitments.

Third, our findings highlight the crucial role of risk disclosure tone (Risk Tone) in shaping how ESG affects volatility. Across both models, Risk Tone exerts a significant moderating effect, meaning that ESG alone is not enough to reduce firm risk—how firms communicate ESG, and risk-related information matters just as much. After controlling for Risk Tone and its interaction with ESG, the results indicate that ESG Score and its individual pillars all exhibit a stabilizing effect on volatility. Importantly, our

moderation analysis shows that risk tone can either enhance or diminish ESG's impact on volatility. When firms emphasize uncertainties (high RiskTone), investors respond more negatively, overshadowing ESG's potential stabilizing benefits. This suggests that when ESG strategies are framed within a firm's broader risk disclosures, they contribute to reducing market uncertainty rather than increasing it. These findings imply that the initially observed positive volatility effect of environmental engagement may have been partly due to the omission of corporate risk disclosure factors. Investors do not respond to ESG performance in isolation; rather, how firms communicate their ESG efforts alongside risk-related information significantly shapes market reactions. However, when firms emphasize risks extensively in their annual reports, the volatility-reducing benefits of ESG diminish. The positive interaction between ESG/pillars and Rik Tone across models suggests that excessive risk-related disclosures can amplify investor uncertainty, leading to heightened stock price fluctuations. This dual signaling effect, where ESG signals stability but risk disclosures signal uncertainty, creates mixed investor perceptions, potentially offsetting some of ESG's expected benefits. These findings align with signaling theory and information-processing perspectives, which suggest that investors not only react to ESG initiatives but also to how those initiatives are framed in corporate communications.

In conclusion, our results challenge the idea of generalized stabilizing effects of ESG. ESG engagement's impact on stock volatility depends not only on which ESG pillars are most prominent but also on how companies articulate potential risks and the visibility of the firms in the market. This emphasizes the need for a nuanced approach in evaluating ESG's influence, especially in emerging markets where regulatory and market dynamics can be very different.

These findings have several implications for both academic research and practitioners. Our results underscore the potential for mandatory regulatory filings to overshadow or dilute the stabilizing effects often associated with strong ESG performance scores. From a theoretical standpoint, these findings suggest that investor perceptions of ESG benefits are intertwined with how firms frame risks in compulsory filings, a nuance that extends beyond the common assumption that higher ESG ratings naturally translate into lower volatility. Additionally, firm visibility plays a crucial role in amplifying investor responses to ESG disclosures. Highly visible firms, particularly those rated by global agencies, are more susceptible to market scrutiny, which can increase stock price fluctuations when ESG-related information is disclosed.

Scholars investigating the effectiveness of ESG strategies should therefore consider not only ESG metrics themselves, but also how broader corporate communication of risks and firm visibility interact to shape market responses.

In practice, even if a company achieves high Environmental, Social, or Governance ratings, extensive negative or uncertain language in its annual reports can amplify market anxiety and, consequently, short-term volatility. This highlights the need for companies to align their risk communication strategies more closely with their ESG narratives, ensuring that the tone and framing of mandatory disclosures accurately reflect both the firm's risk outlook and its ESG-driven mitigation efforts. From an accounting perspective, this finding underscores the role of financial reporting and disclosure quality in shaping investor perceptions. Given that firm risks are increasingly disclosed in annual reports, auditors and accountants play a crucial role in ensuring that ESG engagement and efforts align with financial reality and do not inadvertently increase uncertainty through inconsistent or ambiguous reporting. In practical terms, corporate managers should integrate their ESG objectives with deliberate, balanced risk disclosures, ensuring that firms with robust Environmental, Social, or Governance pillars do not inadvertently trigger market uncertainty through excessively negative or alarmist language in annual reports. Investors and finance professionals likewise benefit from adopting a more holistic appraisal of firm risk, one that takes into account both ESG scores and the tone of mandatory disclosures to better gauge a company's overall resilience. Meanwhile, policy makers and regulators might refine reporting standards by recognizing that risk statements and ESG reporting are not siloed processes; rather, they jointly affect how stakeholders perceive firm stability. Ultimately, the interplay between ESG performance and risk tone highlights the need for coherent, transparent communication strategies if firms are to fully realize the volatility-mitigating potential of their sustainability initiatives.

This study, while providing significant insights into the interplay between ESG initiatives, risk disclosure tone, and market volatility, acknowledges certain limitations that pave the way for future research. The focus on Egyptian public firms provides valuable context-specific insights but also limit the generalizability of the findings across different regulatory environments, cultural contexts, and market structures. Future research could enrich these initial findings by exploring similar models in a broader array of countries, thereby enhancing our understanding of global ESG impacts.

Additionally, the use of the Loughran and McDonald lexicon, though rigorously adapted for Arabic, may not capture all linguistic nuances that influence the perception of risk tone in corporate disclosures. Future studies could develop more sophisticated text analysis tools, including custom lexicons tailored to specific cultural and industry contexts, to improve the precision of risk tone assessment. Moreover, the reliance on publicly reported ESG scores and annual report disclosures might not encompass the full range of a firm's sustainability activities, particularly those that are non-public or qualitative in nature. Subsequent research could look into these less visible aspects of ESG practice, such as internal sustainability initiatives and informal stakeholder engagement efforts, to provide a more comprehensive view of how ESG influences market dynamics. The study's approach to disaggregating ESG into environmental, social, and governance pillars is another area ripe for further investigation. Delving deeper into the specific types of initiatives within each pillar—such as comparing the impacts of different types of environmental innovations—could yield more nuanced insights into how particular ESG actions influence stock volatility. By addressing these areas, future work can build on this study's foundation to offer more detailed guidance on managing ESG strategies and communication to mitigate risk and enhance market stability.

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أثر الالتزام بالمعايير البيئية والاجتماعية وحوكمة الشركات (ESG) على تقلبات الأسهم: الدور المعدل لنغمة الإفصاح عن المخاطر من خلال التحليل النصي للتقارير السنوية المصرية

الملخص:

تهدف هذه الدراسة إلى بحث أثر التزام الشركات بالمعايير البيئية والاجتماعية وحوكمة الشركات (ESG)على تقلب عوائد الأسهم، وكذلك دراسة الدور المعدل لنغمة الإفصاح عن المخاطر في التقارير الإلزامية للشركات المصرية على هذه العلاقة. فبينما أشارت الدراسات السابقة إلى أن الالتزام بمعايير ESG يسهم في استقرار أداء الشركات، إلا ان هذه الدراسة تعيد النظر في ما إذا كان الالتزام بتلك المعايير يقلل التقلبات بشكل ثابت أم أن تأثيرها يعتمد على نوع تلك المبادرات وكذلك استراتيجية الإفصاح عن المخاطر. بالتطبيق على الشركات المدرجة في البورصة المصرية، تستخدم تلك الدراسة نماذج الانحدار ذات التأثيرات الثابتة، ومطابقة درجات الميل(PSM) ، والانحراف المعياري (SD) كمقياس للتقلب، إضافةً إلى نموذج (GARCH) لتحليل التأثيرات الثابتة والديناميكية للتقلب، كما يتم قياس نغمة المخاطر باستخدام التحليل النصي للتقارير السنوية اعتمادًا على قاموس Loughran-McDonald.

وقد توصلت الدراسة إلى أنه قبل أخذ نغمة الإفصاح عن المخاطر في الاعتبار، يرتبط الالتزام بمعايير ESG بزيادة تقلبات الأسهم، حيث يُنظر إلى مبادرات ESGعلى أنها تتطلب استثمارات كبيرة، وتنطوي على درجة من عدم التأكد، كما أن المبادرات البيئية تؤدي إلى ارتفاع التقلبات، في حين تسهم الحوكمة في الحد من المخاطر على المدى الطويل، بينما تعمل المسؤولية الاجتماعية على استقرار التقلبات قصيرة الأجل وفقًا لنموذج GARCH. وعند اخذ نغمة الإفصاح عن المخاطر في الاعتبار كمتغير رقابي يظهر ان تأثير تلك المبادرات تحد من التقلبات بشكل عام، مما يشير إلى أن الشركات التي تقدم إفصاحات واضحة وشفافة حول المخاطر المحتملة يكون لديها مستويات أقل من التقلب. في المقابل، تؤدي الإفصاحات السلبية أو غير المؤكدة عن المخاطر إلى الحد من التأثير الإيجابي للالتزام بمعايير ESG، مما يزيد من تقلبات الأسهم.

تقدم هذه الدراسة رؤى مهمة للمستثمرين وصناع السياسات ومديري الشركات، إذ تؤكد على أهمية النظر إلى التزام الشركات بمعايير ESG بالتوازي مع أسلوب الإفصاح عن المخاطر، حيث لا يعتمد رد فعل المستثمرين فقط على أداء ESG، بل أيضًا على الطريقة التي تعبر بها الشركات عن المخاطر في تقاريرها الإلزامية.

الكلمات المفتاحية: المعايير البيئية والاجتماعية والحوكمة ESG، تقلبات أسعار الأسهم، الإفصاح عن المخاطر، إدارة مخاطر الشركات، التحليل النصي، مطابقة درجات الميل(PSM) ، الأسواق الناشئة