

Attention or Sentiment: How Social Media React to ESG?

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Abstract: The ESG (environmental, social, and corporate governance) practice has become very important in contemporary business, and it is believed to have a profound impact on firm value and the stakeholders. However, how investors on social media react to firms' ESG performance is still not clear. Exploiting investor-generated content from a popular online investment community (Seeking Alpha) and ESG performance scores from a professional provider (Sustainalytics), we first run multiple regressions to find ESG's ability to predict social media attention and its inability to predict social media sentiment. Then, we conduct a battery of robustness checks by shifting the prediction window, considering changes in ESG rating methodology, or using other data sources of ESG scores as instrumental variables to ensure the reliability of these findings. In addition, we conduct two event-study analyses upon classifying ESG performance changes into upgrade events and downgrade events to further confirm our main findings. Moreover, our mechanism analysis reveals that the predictive power of ESG on social media attention is mainly driven by environmental and social factors, whereas its predictive inability for social media sentiment is attributable to social and governance factors. Our work makes contributions to both academic literature and managerial practice related to corporate social responsibility by identifying the nuanced relationship between ESG and retail investors' reactions in the social media era.

Keywords: environmental, social, and governance (ESG); investor attention; investor sentiment; online investment communities; social media; sustainable business; user-generated content

1. Introduction

Since the beginning of the concept in 2012, sustainable investing has increased rapidly to become a mainstream investing approach (Allianz 2018). According to a report by US SIF Foundation (2020), investors held about \$17 trillion in assets chosen based on sustainable investing criteria at the end of 2019, a 42 percent increase since 2018. At the beginning, however, sustainable investing only considers corporate social responsibility (CSR) which mainly focuses on environmental and social factors (Flammer 2015), ignoring corporate governance, which is equally if not more important for investors to decide whether or not to invest in a business (Allianz 2018). To emphasize the importance of corporate governance, sustainable investing is then re-defined as an investment approach that simultaneously takes the factors of environmental, social, and corporate governance (ESG) into consideration for portfolio management (Allianz 2018).

ESG investing considers business performance, society, and environment together and aims to generate a positive impact in all these aspects. This approach is becoming increasingly important, especially after the global pandemic of COVID-19. The US SIF Foundation's survey on sustainable investing trends up to 2025, especially post-COVID-19, reveals that respondents prioritize a shift towards a low-carbon economy, human capital management, diversity, health, and wellness (US SIF Foundation 2020). A JP Morgan survey also concurs that COVID-19 marks a pivotal moment for ESG investing, with heightened investors' awareness of ESG factors. Over 70% of investors believe that high-impact risks like COVID-19 will likely spur global awareness and action in addressing risks like climate change and biodiversity loss (J.P. Morgan 2020). To meet the needs of investors, especially younger ones, brokerage firms, mutual fund companies and even Robo-advisors have begun to offer financial products that follow the ESG investing approach (Chen 2021).

Given the increasing significance of ESG, a growing number of academics examine the consequences of ESG from various perspectives. These include firm value (Flammer 2015, Hawn and Ioannou 2016), consumer's perception (Chernev and Blair 2015, Servaes and Tamayo 2013), and stock analyst recommendations (Ioannou and Serafeim 2015, Luo et al. 2015). However, research on ESG from the perspective of information systems (IS) is scarce. Watson et al. (2010) point out this issue and call for

studies on environmental sustainability within the IS community. In response to this, our study tries to fill this gap by investigating investors' reactions to firms' ESG performance in the social media context. Despite the increasing attention associated with ESG investing, a natural yet overlooked question is how investors would react to the ESG performance of firms, which can ultimately impact firm performance (Antweiler and Frank 2004, Jiang et al. 2014).

Nowadays, it is very common for individual investors to express their attitudes toward stocks on social media, enabling us to easily track investors' reactions to firms' activities. Investors' reactions on stock investment involves at least two aspects. First, they pay attention to a stock or the related company. Second, they evaluate the stock to consider whether to purchase it or not. Therefore, investors' reactions can be divided into two dimensions: *investor attention* and *investor sentiment*. The relationship between investors' reactions on social media and financial market is of great interest to investment practitioners and academic researchers in both IS and finance fields. For instance, Da et al. (2011) propose a novel and important measure for investor attention based on stocks' Google search intensity and confirm the usefulness of these search data in stock market; Xu and Zhang (2013) find that Wikipedia's information weakens investors' negative reaction to bad news, confirming the helpfulness of Wikipedia in improving the information environment for the financial market; Luo et al. (2013) confirm the impact of social media on firm value; Investors' sentiment exhibited on Twitter is also found to have a significant association with the stock market (Bollen et al. 2011) as well as the cryptocurrency market (Mai et al. 2018).

Although these studies confirm the value of investors' online reactions and ESG for the financial market, the unexamined relationship between ESG and investor reactions still remains an obstacle to understanding how ESG affects firm value. Online investment communities (OICs), as an increasingly popular channel among various types of social media, greatly facilitate and boost the exchange of investment opinions between individual investors (Gu et al. 2014). OICs' power in influencing investors' behavior and moving the market has been well confirmed by prior research (Antweiler and Frank 2004, Clarke et al. 2020, Deng et al. 2018, Jiang et al. 2014). Hence, OICs provide us with a good context to investigate investors' reactions on social media, in terms of *social media attention* and *social media sentiment*, to firms' ESG activities.

Utilizing investor-generated content from Seeking Alpha, which is one of the most popular OICs all over the world (Chen et al. 2014, Chen and Hwang 2022), we construct measures of *social media attention* and *social media sentiment*. More specifically, the former is measured by the volume of articles posted on Seeking Alpha about a particular stock, while the latter is based on the average sentiment indicated by the investors to it. Previous studies have investigated the effects of *investor attention* (Da et al. 2011) and *investor sentiment* (Antweiler and Frank 2004, Jiang et al. 2014) reflected by social media messages, and find that they are associated with stock price movements. We further contribute to the understanding of online investor reactions by investigating the following main research questions: (i) Can ESG be used to predict *social media attention*? (ii) Can ESG be used to predict *social media sentiment*? And if so, (iii) Which factor (environmental, social, or governance) contributes to ESG's predictive ability most and which least?

We first apply a set of regression models to establish the ESG-*social media attention* and ESG-*social media sentiment* relations based on the data for S&P 500 companies.¹ For each company, besides collecting investor-generated content data from Seeking Alpha, we also obtained its ESG performance scores from Sustainalytics, which is also adopted by existing influential studies (Servaes and Tamayo 2013). After identifying ESG's ability in *social media attention* prediction and inability in *social media sentiment* prediction, several robustness checks, upon shifting the prediction window or using other sources of ESG scores as instrumental variables, are conducted to robustly confirm these findings. Besides, we conduct two additional event-study analyses by classifying ESG performance changes into upgrade events and downgrade events to further confirm ESG' ability in *social media attention* prediction and its inability in *social media sentiment* prediction. In addition, we also examine the mechanism underlying ESG's predictive (in)ability by analyzing the relations between different ESG dimensions (environmental, social, and governance) and investors' reactions on social media.

We obtain three main findings through this study. First, in general, we find that ESG performance positively predicts future *social media attention* but it has no predictive ability for future *social media*

¹ S&P 500 firms are those with relatively large market values whose ESG practice can be relatively visible and accurately measured.

sentiment. Second, for our event study, the significant positive association between ESG and social media attention holds for both ESG downgrade events and ESG upgrade events. Third, the positive association between ESG performance and *social media attention* is driven by the *environmental* and *social* factors, whereas the uncorrelation between ESG and *social media sentiment* is determined by the *social* and *governance* factors.

Our work makes several contributions. First, our results suggest that ESG affects stock market through *social media attention* rather than *social media sentiment*. Second, we leverage event study and instrumental variable regression as robustness checks, to confirm ESG's predictive ability for *social media attention* and conduct additional analyses to establish the underlying mechanism. Third, from a practical perspective, our study demonstrates the differential importance of ESG: Although ESG upgrades cannot promptly improve a firm's *social media sentiment*, ESG downgrades can be responsible for the decrease of *social media attention*. Our research offers implications for regulators, public firms, and investors.

2. Theoretical Background and Hypothesis Development

2.1. Theoretical Background

According to the definition by the World Business Council for Sustainable Development (WBCSD), corporate social responsibility (CSR) entails the commitment of businesses towards contributing to economic development (WBCSD 1998) and it is treated as an integral part of sustainable economic development (WBCSD 2016). However, in an increasingly complex financial landscape, CSR is no longer enough for sustainability (Alva 2020). Hence, a new movement, i.e., ESG, which is the latest evolution of the intentions behind CSR, starts to dominate the corporate landscape.

ESG stands for three elements (environmental, social, and corporate governance) that are used to assess the sustainability and societal impact of investing in a company or business. (Wikipedia 2021). The environmental aspect pertains to a company's efforts in reducing resources, cutting emissions, and innovating products that are environmentally friendly. The social aspect emphasizes a company's attention to social responsibilities, community engagement, human rights, diversity, training and development, health and safety, and employment quality (Luo et al. 2015). The governance aspect centers on the governance structure of a company, including board composition, audit committee structure, lobbying activities,

political contributions, bribery and corruption (Cuñat and Gine 2012). We review the value of CSR or ESG and focus on the relation between ESG and investors next.

The value of CSR or ESG is widely investigated in a variety of domains such as marketing, strategy, IS, finance, and accounting. CSR and ESG are found to affect customers, investors, and firms. Considering space restraints, we relegate a detailed literature review on the value of CSR or ESG to Appendix I.

In particular, we review related studies on CSR or ESG from the IS perspectives here. Unlike researchers in some other disciplines that examine E, S, and G issues together, the scholars in the IS field pay more attention to environmental sustainability. Malhotra et al. (2013) review prior studies on green IS/IT and organize a special issue on IS and environmental sustainability to highlight the need for related research work. In response to emerging environmental concerns, Seidel et al. (2013) develop a theoretical framework by identifying four important functional affordances reigning in information systems using case study method. Loock et al. (2013) investigate the role of IS in motivating energy-efficient behaviors in private households using data from a field experiment. Some other scholars, such as Kranz et al. (2022), Melville (2010), Gholami et al. (2016), and Elliot and Webster (2017), also encourage researchers in the IS community to immerse themselves in finding IS solutions to environmental sustainability.

In order to tackle economic and societal challenges through IS means, some scholars have proposed new frameworks/models and designed better decision support systems. For example, Ketter et al. (2020) put forward an “ESG-ICE” framework that relates ESG activities to desirable outcomes including individual wellbeing, community welfare, and economic resilience (ICE). Lausen et al. (2020) propose automatic techniques to detect financial intermediary misconduct, which can benefit investors and help regulators to maintain a sound financial environment. Han et al. (2020) investigate strategies for the harnessing of crowd wisdom to develop better solutions to complex environmental issues. Cruz (2009) builds a decision support framework to investigate the importance of CSR in supply chain management and finds that social responsibility activities can potentially increase profits and reduce risk and environmental impact. Vo et al. (2019) develop a Deep Responsible Investment Portfolio (DRIP) model that involves ESG factors of firms to predict stock returns, and find the model effective in achieving stronger financial performance and better social impact. Petrini and Pozzebon (2009) propose a conceptual model that

integrates socio-environmental indicators into an organizational strategy for sustainability based on grounded theory.

In line with and to advance the stream of research on how CSR/ESG affects corporate stakeholders, our study aims to examine how ESG predicts investor reactions in terms of *social media attention* and *social media sentiment*, both of which have an important impact on firm value ultimately (Barber and Odean 2008, Chen et al. 2014, Da et al. 2011).

2.2. Hypotheses

2.2.1. ESG and *Social Media Attention*

Burke and Logsdon (1996) identify five strategic dimensions of CSR to assess the value generated for the firms with CSR advantages: centrality, specificity, proactivity, voluntarism, and visibility. Among them, visibility is a term that encompasses both the observable nature of a company's activities and its ability to gain recognition from internal and external stakeholders. ESG can be linked to investors' attention through both stock market and market participants.

Pedersen et al. (2021) put forward a theory to explain how the increasing popularity of ESG has an impact on portfolio selection and the equilibrium asset prices. Due to ESG's direct impact on investors, increasingly more investors try to incorporate firms' ESG performance into their investment process. Therefore, it is reasonable to argue that ESG can influence investors' attention within the stock market.

For ESG's indirect impact on investors, it can be established through other market participants such as stock analysts and media. According to the findings of Luo et al. (2015), stock analysts attach importance to CSR information and they would incorporate it to their recommendations for individual investors, indicating that ESG can change investors' awareness through stock analysts' recommendations. Besides, firms' ESG activities have come under increasing scrutiny by the media, such as newspapers or TV reports, which can also help draw attention to the firms and corresponding stocks. Firms with better ESG performance that involve more ESG activities will have more chance to be reported by the media, and this exposure would attract both stock analysts' and individual investors' attention. In other words, a company's ESG engagement can promote its visibility, which induces more discussions about it among investors.

ESG's direct impact on investors and indirect impact through market participants lead us to propose a

hypothesis as below:

Hypothesis 1 (H1). *Firms with a higher level of ESG performance will attract more social media attention.*

2.2.2. ESG and Social Media Sentiment

According to a report by Allianz (2018), a firm's ESG activities can influence consumers' attitudes toward the firm, and its ESG profile plays a significant role in its overall reputation, as most consumers believe that firms attaching importance to ESG activities have more promising long-term prospects. Consistent with this, Vo et al. (2017) find that a company's CSR engagement enhances its corporate image, which subsequently impacts customer word-of-mouth (WOM) about it transmitted through social media. Specifically, airlines with superior CSR performance tend to accumulate more positive while less negative WOM. In turn, consumers' attitude can influence investors' sentiment.

Furthermore, ESG can also influence investors' attitudes toward a firm's stock. A company's CSR engagement is usually associated with good reputation and positive sentiment for the company (Burke and Logsdon 1996). Firms that are more socially responsible receive more favorable media coverage (Cahan et al. 2015), indicating that firms' ESG performance is also positively related to media sentiment, which can ultimately trigger investors' sentiment. Besides, stock analysts can also value ESG and lead to positive investor sentiment. Ioannou and Serafeim (2015) find that more experienced analysts produce more positive assessments for firms with high CSR ratings. Following this stream of studies, a higher level of firm's ESG performance may predict an increase in its subsequent investor sentiment on social media.

However, it should be borne in mind that from the perspective of investors, a higher level of ESG performance is not necessarily positive news. If the ESG performance originates from outward commitment mainly in the environmental dimension of the firm, this will come at a cost to the firm and may hurt its financial performance. Thus, the effect of ESG performance on social media sentiment will be attenuated due to the environmental factor.

Based on a synthesis of these ideas, we have our second hypothesis:

Hypothesis 2 (H2). *Firms with better ESG performance will obtain more positive social media sentiment.*

However, such a relationship could be attenuated due to the offsetting of environmental factor.

3. Methodology

3.1. Data

We use the firms covered by the S&P 500 index as our research sample and collect their investor-generated content data from Seeking Alpha (seekingalpha.com). The S&P 500 includes leading U.S. stocks and they are selected based on sector representation and account for almost 80% of the market value of the U.S. equity markets.² The constituents of the index are among the largest companies in the U.S. markets most visible for their ESG activities. ESG performance of these companies are more accurately and fairly measured.

For each company, we collect its financial data from Compustat, and the information on stock returns from CRSP. As for their ESG scores, we obtained data from a total of six ESG rating agencies, which are summarized in Table 1. This table also shows ESG score names for all data sources. We describe why we use or do not use each dataset in Column 3 of the table.

Table 1. ESG Data Source Overview

Agency name	Score name	Usage in our study
Sustainalytics	ESG Risk Rating	Used in the main analysis.
RepRisk	Reputation Risk Index	Used to construct an instrumental variable in the noise correction process.
Refinitiv	TRESG Score	Used to construct an instrumental variable in the noise correction process.
S&P Global	Total Sustainability Rank	Not used as it has too many missing values.
Arabesque	ESG Overall Score	Not used as the time period covered is too short.
MSCI	IVA Industry Weighted Score	Not used as it does not pass the overidentification test of instruments.

Due to space constraints, the detailed procedure of data collection is elaborated in Appendix II. After excluding the firms which have never been discussed in Seeking Alpha and those whose ESG scores, financial data, or stock return data are missing, 429 firms are included for our study.

3.2. Variables and Measurement

3.2.1. Dependent Variables

We investigate investors' social media reactions from two aspects: *social media attention (Attention)* and *social media sentiment (Sentiment)*. The former is measured by the volume of articles posted on Seeking

² <https://www.slickcharts.com/sp500>

Alpha in each month related to a stock, and the latter is measured by the average sentiment of these articles as explained below.

For articles obtained from Seeking Alpha, we utilize sentiment analysis to obtain their sentiment scores. Following the approach suggested by extant works (Da et al. 2011), we apply a dictionary-based classification tool to obtain the sentiment score of each article ranging from 0 to 1. The dictionary we use is the LM (Loughran and McDonald) dictionary, which is specially developed for sentiment analysis in the finance domain (Loughran and McDonald 2011). To better interpret the results, we use the opposite value of the proportion of negative words in an article as the sentiment score measure. We calculate the monthly average sentiment score for each stock to measure *social media sentiment*.

3.2.2. Independent Variable

ESG is the independent variable, which is measured by the monthly ESG scores obtained from Sustainalytics. According to the methodology adopted by Sustainalytics, ESG scores fall into the interval between 0 and 100.

3.2.3. Control Variables

In order to estimate our regression models, we also include multiple control variables, which may influence investors' social media reactions: *Firm size*, *ROA*, *Intangible assets*, *Financial leverage*, *Beta*, *Momentum*, *Volatility*, *Industry FE*, and *Month FE*. *Firm size* is measured by the logarithmic value of the focal firm's total assets; *ROA* represents return on assets, which is calculated as the ratio between operating income and firm size ; *Intangible assets* is the ratio between intangible assets and firm size; *Financial leverage* is the ratio between long-term debt and firm size; *Beta* is the market beta estimated from historical monthly returns; *Momentum* is the cumulative return during a given historical time interval; *Volatility* is the monthly standard deviation of returns, estimated from daily returns during a given historical time interval; *Industry FE* is included to control for the fixed effects of industry; *Month FE* is included to control for the fixed effects of calendar month. We summarize how we measure all variables involved in our study in Appendix III.

3.3. Models

3.3.1. Empirical Models

Our regression models are described by Equations (1) and (2):

$$Attention_{it} = \alpha_1 + \beta_1 \times ESG_{i,t-1} + \gamma_1 \times X_{i,t-1} + \varepsilon_{it} \quad (1)$$

$$Sentiment_{it} = \alpha_2 + \beta_2 \times ESG_{i,t-1} + \gamma_2 \times X_{i,t-1} + \delta_{it} \quad (2)$$

where i is used to index a firm; t is used to indicate a month. $Attention_{it}$ represents the quantity of articles Firm i received in Month t ; $Sentiment_{it}$ indicates the average sentiment of articles; $ESG_{i,t-1}$ is the overall ESG performance for Firm i in Month $t-1$; $X_{i,t-1}$ is a vector of controls consisting of *Firm size*, *ROA*, *Intangible assets*, *Financial leverage*, *Beta*, *Return Momentum*, and *Volatility* at the firm-month level. $X_{i,t-1}$ also includes the fixed effects of industry and month. T -statistics are calculated with robust standard errors clustered at industry-month level.

3.3.2. Prediction Models

After we confirm the relationship between ESG and investor reactions on social media, we further examine ESG's ability in predicting future investor social media reactions. Table 2 shows variables included in each regression model for the prediction of investor reactions on social media. Model 1 and Model 3 are used as baseline models, wherein Model 3 includes the fixed effects of industry and month. To evaluate the prediction performance of each regression model, we focus on multiple indicators, including *AIC* (Akaike Information Criterion), *MSE* (Mean Squared Error), *MAE* (Mean Absolute Error), and *RMSE* (Root Mean Square Error).

Table 2. Variables Included in Regressions for the Prediction of Social Media Reactions

Variable	Model 1	Model 2	Model 3	Model 4
$ESG_{i,t-1}$		×		×
$C_{i,t-1}$	×	×	×	×
<i>Industry FE</i>			×	×
<i>Month FE</i>			×	×
<i>Intercept</i>	×	×	×	×

Note. The vector of controls ($C_{i,t-1}$) includes *Firm size*, *ROA*, *Intangible assets*, *Financial leverage*, *Beta*, *Return Momentum*, and *Volatility* at firm-month level.

4. Main Analysis

4.1. Descriptive Statistics

Tables 3 and 4 report the summary statistics of and correlations between variables included in our main analysis respectively. As we can see from Table 3, the mean of $Attention_{it}$ is 2.091, indicating that the average number of articles for a firm in a month is 2.091. We use its logarithm in our correlation analysis and regression analyses to reduce the skewness. The mean of $Sentiment_{it}$, which is between -0.056 and 0, is -0.015. $ESG_{i,t-1}$, which is the overall ESG score for Firm i in Month $t-1$, ranges from 38 to 88 with an average of 59.117.

Table 3. Descriptive Statistics for Main Analysis

Variable	Obs.	Mean	S.D.	Min	Max
$Attention_{it}$	26,281	2.091	4.681	0	127
$Sentimen_{it}$	13,868	-0.015	0.006	-0.056	0
$ESG_{i,t-1}$	26,281	59.117	8.612	38	88
$Firm_size_{i,t-1}$	26,281	67,590.57	229,000.7	362.109	2,764,661
$ROA_{i,t-1}$	26,281	0.036	0.027	-0.199	0.476
$Intangible_assets_{i,t-1}$	26,281	0.254	0.227	0	0.901
$Financial_leverage_{i,t-1}$	26,281	0.267	0.186	0	2.361
$Beta_{i,t-1}$	26,281	1.023	0.469	-0.620	4.124
$Momentum_{i,t-1}$	26,281	0.318	0.320	-1.481	2.610
$Volatility_{i,t-1}$	26,281	0.015	0.005	0	0.059

Note. To intuitively describe our data set, the original values of social media attention and firm size are reported here, and their logarithmic values are used in the correlation matrix and regression analyses.

Table 4. Correlation Matrix and VIF Values for Main Analysis

Variable	1	2	3	4	5	6	7	8	9	10	VIF
1 $Sentimen_{it}$	1.000										
2 $Attention_{it}$	-0.130	1.000									
3 $ESG_{i,t-1}$	-0.005	0.201	1.000								1.58
4 $Firm_size_{i,t-1}$	-0.134	0.412	0.246	1.000							2.00
5 $ROA_{i,t-1}$	0.117	0.046	0.083	-0.345	1.000						1.48
6 $Intangible_assets_{i,t-1}$	0.090	-0.128	0.001	-0.114	0.026	1.000					1.80
7 $Financial_leverage_{i,t-1}$	-0.016	-0.031	0.053	-0.094	0.083	0.168	1.000				1.36
8 $Beta_{i,t-1}$	-0.080	0.015	-0.010	0.024	-0.161	-0.233	-0.112	1.000			2.02
9 $Momentum_{i,t-1}$	0.151	-0.008	-0.071	-0.105	0.172	0.010	-0.131	0.057	1.000		1.15
10 $Volatility_{i,t-1}$	-0.134	0.032	-0.151	-0.232	-0.108	-0.170	0.026	0.398	-0.084	1.000	1.57

As shown in Table 4, all correlations are generally small, implying a low possibility of

multicollinearity issue. We further calculate the variance inflation factor (VIF) values for independent and control variables. Obviously, there is no concern of multicollinearity in the data set, as the maximum VIF value is far below 5.

4.2. Main Results

4.2.1. ESG and Social Media Reactions

We adopt a stepwise regression method to estimate our empirical models, and the results are reported in Tables 5 and 6, respectively. As shown in Table 5, the coefficient of $ESG_{i,t-1}$ is significantly positive, indicating that ESG can positively predict *social media attention*. Therefore, $H1$ is supported. The dependent variable, *social media attention*, is the logarithmic value of the number of articles a firm receives in a given month. Therefore, if a firm's ESG performance score increases by one point, the firm/stock would receive over 0.6% (i.e., $0.006 \times 100\%$) more articles. Given that a one-point change in ESG score is very slight whereas each article in Seeking Alpha is considerably long and informative with various formats of content always attracting thousands of users in the community to read, like, forward, and comment on it, such a magnitude is definitely nontrivial. This finding implies ESG's ability in predicting *social media attention*, which we will discuss in more detail in Section 4.2.2.

Table 5. Relationship Between ESG and Social Media Attention

Variable	Model 1	Model 2	Model 3
$ESG_{i,t-1}$			0.006(0.001)***
$Firm_size_{i,t-1}$	0.315(0.011)***	0.354(0.012)***	0.337(0.013)***
$ROA_{i,t-1}$	8.109(0.784)***	4.303(0.543)***	4.097(0.521)***
$Intangible_assets_{i,t-1}$	-0.124(0.061)*	-0.515(0.050)***	-0.493(0.049)***
$Financial_leverage_{i,t-1}$	-0.002(0.057)	-0.180(0.038)***	-0.181(0.038)***
$Beta_{i,t-1}$	-0.082(0.031)**	-0.140(0.020)***	-0.149(0.020)***
$Momentum_{i,t-1}$	0.020(0.027)	0.067(0.022)***	0.076(0.023)***
$Volatility_{i,t-1}$	29.187(2.174)***	13.756(2.177)***	15.137(2.160)***
<i>Intercept</i>	-3.067(0.134)***	-2.775(0.137)***	-2.993(0.136)***
<i>Industry FE</i>	NO	YES	YES
<i>Month FE</i>	NO	YES	YES
Cluster SE	<i>Industry-Month</i>	<i>Industry-Month</i>	<i>Industry-Month</i>
Obs.	26,281	26,281	26,281
R^2	0.2416	0.3990	0.4020

Notes. Robust standard errors clustered at industry-month level are reported in parentheses; *: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.005$.

The results in Table 6 show that ESG has no significant relationship with investors' *social media sentiment*, rejecting $H2$. This finding implies that ESG's increase of a firm cannot be expected to bring about an improvement of subsequent social media sentiment. In other words, ESG cannot be used to predict *social media sentiment*, which we will also illustrate in the next section.

Table 6. Relationship Between ESG and Social Media Sentiment

Variable	Model 1	Model 2	Model 3
$ESG_{i,t-1}$			-0.001(0.001)
$Firm_size_{i,t-1}$	-0.063(0.004)***	-0.069(0.006)***	-0.066(0.006)***
$ROA_{i,t-1}$	0.742(0.252)**	0.901(0.264)***	0.931(0.266)***
$Intangible_assets_{i,t-1}$	0.143(0.033)***	0.235(0.037)***	0.232(0.037)***
$Financial_leverage_{i,t-1}$	-0.081(0.034)*	-0.080(0.034)*	-0.078(0.033)*
$Beta_{i,t-1}$	-0.018(0.015)	0.040(0.017)*	0.041(0.017)*
$Momentum_{i,t-1}$	0.211(0.021)***	0.199(0.020)***	0.196(0.020)***
$Volatility_{i,t-1}$	-15.288(1.327)***	-19.344(1.340)***	-19.595(1.338)***
Intercept	-0.658(0.063)***	-0.958(0.085)***	-0.922(0.088)***
Industry FE	NO	YES	YES
Month FE	NO	YES	YES
Cluster SE	<i>Industry-Month</i>	<i>Industry-Month</i>	<i>Industry-Month</i>
Obs.	13,868	13,868	13,868
R^2	0.0644	0.1212	0.1213

Notes. Robust standard errors clustered at industry-month level are reported in parentheses; *: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.005$; To make ESG's coefficient more interpretable, sentiment is magnified 100 times.

As for the control variables, $Firm_size_{i,t-1}$ and $Volatility_{i,t-1}$ positively predict firms' *social media attention* but negatively predict *social media sentiment*. $ROA_{i,t-1}$ and $Momentum_{i,t-1}$ positively predict both *social media attention* and *social media sentiment*. $Financial_leverage_{i,t-1}$ negatively predict both *social media attention* and *social media sentiment*. $Intangible_assets_{i,t-1}$ and $Beta_{i,t-1}$ negatively predict *social media attention* but positively predict future *social media sentiment*.

4.2.2. ESG's Predictive Ability for Social Media Reactions

In this section, we further examine ESG's ability in predicting subsequent *social media reactions*. The

prediction models are presented in Section 3.3. To investigate the prediction accuracy of our models, we apply a k -fold cross-validation procedure. Specifically, we randomly divide our data set into $k=13$ subgroups with each containing 33 firms. Then we repeat the hold-out method 13 times with each of the four models for *Attention* and *Sentiment* (see Table 2), respectively. One of the 13 firm subsets is used as the hold-out (testing) data set and the other 12 subsets are used as the training set. We calculate the average values for *AIC*, *MSE*, *MAE*, and *RMSE* across 13 trials for each model and report the results for *attention* and *sentiment* in Table 7 and Table 8, respectively.

Model 1 and Model 3 are used as baseline models, wherein Model 3 includes the fixed effects of industry and month. As we can see from Table 7, Model 2, which makes use of ESG and other firm-related factors, has lower *AIC*, *MSE*, *MAE*, and *RMSE*, compared with Model 1, which only does not include the ESG factor. Also, Model 4 beats Model 3 with better performance. These results well confirm ESG’s ability in predicting *social media attention*.

Table 7. Predictive Power of ESG on *Social Media Attention*

Indicator	Model 1		Model 2		Model 3		Model 4	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
<i>AIC</i>	52,242.903	63.910	51,871.424	62.825	52,056.709	64.239	51,741.790	63.075
<i>MSE</i>	0.505	0.016	0.497	0.016	0.501	0.016	0.495	0.016
<i>MAE</i>	0.562	0.008	0.556	0.007	0.560	0.009	0.555	0.008
<i>RMSE</i>	0.710	0.011	0.705	0.011	0.708	0.011	0.703	0.011

As shown in Table 8, the *MSE*, *MAE*, *RMSE* of Model 2 show no difference with those of Model 1, indicating ESG’s uselessness in improving Model 2’s prediction ability. Similarly, Model 4 cannot beat Model 3 with higher *AIC* and similar *MSE*, *MAE*, *RMSE*. These results also confirm ESG’s inability in predicting *social media sentiment*.

Table 8. Predictive Power of ESG on *Social Media Sentiment*

Indicator	Model 1		Model 2		Model 3		Model 4	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
<i>AIC</i>	23,607.639	70.851	23,606.175	70.637	23,527.626	71.191	23,528.953	71.117
<i>MSE</i>	0.370	0.025	0.370	0.025	0.368	0.025	0.368	0.025
<i>MAE</i>	0.460	0.012	0.460	0.012	0.459	0.012	0.459	0.012

<i>RMSE</i>	0.608	0.020	0.608	0.020	0.606	0.020	0.606	0.020
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4.3. Robustness Checks

4.3.1. Different Time Windows

Considering the above-mentioned assumption that a firm's monthly financial indicators are equivalent to the corresponding quarterly values, different time windows between firm performance and investors' *social media reactions* may induce different findings. To address this concern, we re-conduct our analyses using firms' earlier (i.e., 2- and 3-month before) performance values. Due to space constraints, we report the results under Models 2 and 3 of Tables A3 and A4 in Appendix IV, respectively. Obviously, they are consistent with the results of the main analysis, which are shown under Model 1. These findings further confirm ESG's ability in the prediction of *social media attention* and its inability in the prediction of *social media sentiment*.

4.3.2. Before and After the Methodology Change of Sustainability

Sustainalytics, the data agency from which we obtained ESG rating data, changed its rating methodology in the end of 2017. To check the possible impact of the change in methodology on our findings, we examine the relationship between ESG and *social media reactions* using the ESG data based on the new methodology after 2017 and the ESG data based on the old methodology until 2017 separately as a robustness check in this section. As seen from Table 9, we still obtain consistent findings: ESG positively predicts *social media attention* but cannot predict *social media sentiment*. Thus, the methodology change has no impact on our results.

Table 9. Relationships Between ESG and Social Media Reactions (Under Rating Methodology Change)

Variable	DV= <i>Social Media Attention</i>		DV= <i>Social Media Sentiment</i>	
	Model 1 (before change)	Model 2 (after change)	Model 3 (before change)	Model 4 (after change)
<i>ESG_{i,t-1}</i>	0.006(0.001)^{***}	0.005(0.001)^{***}	-0.0018(0.00097)	-0.000(0.001)
<i>Firm_size_{i,t-1}</i>	0.373(0.013) ^{***}	0.288(0.014) ^{***}	-0.059(0.007) ^{***}	-0.083(0.010) ^{***}
<i>ROA_{i,t-1}</i>	4.477(0.524) ^{***}	3.879(0.698) ^{***}	1.144(0.307) ^{***}	-0.087(0.495)
<i>Intangible_assets_{i,t-1}</i>	-0.542(0.052) ^{***}	-0.281(0.055) ^{***}	0.201(0.043) ^{***}	0.279(0.064) ^{***}
<i>Financial_leverage_{i,t-1}</i>	-0.124(0.048) [*]	-0.148(0.043) ^{***}	-0.117(0.046) [*]	-0.034(0.063)
<i>Beta_{i,t-1}</i>	-0.197(0.021) ^{***}	-0.126(0.029) ^{***}	0.029(0.021)	0.041(0.030)

<i>Momentum</i> _{<i>i,t-1</i>}	0.001(0.023)	0.297(0.038) ^{***}	0.218(0.023) ^{***}	0.177(0.033) ^{***}
<i>Volatility</i> _{<i>i,t-1</i>}	16.323(2.406) ^{***}	19.645(2.789) ^{***}	-15.943(1.590) ^{***}	-28.009(2.541) ^{***}
<i>Intercept</i>	-3.225(0.146) ^{***}	-2.752(0.164) ^{***}	-0.949(0.108) ^{***}	-0.785(0.139) ^{***}
<i>Industry FE</i>	YES	YES	YES	YES
<i>Month FE</i>	YES	YES	YES	YES
Cluster SE	<i>Industry-Month</i>	<i>Industry-Month</i>	<i>Industry-Month</i>	<i>Industry-Month</i>
Obs.	18,026	8,255	9,816	4,052
<i>R</i> ²	0.4413	0.3638	0.1231	0.1490

Notes. Robust standard errors clustered at industry-month level are reported in parentheses; *: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.005$; To make ESG's coefficients more interpretable, the dependent variable of *Social Media Sentiment* is magnified 100 times.

4.3.3. ESG Ranking Noise Correction Using Instrumental Variable Method

As widely known, there are many rating agencies providing ESG performance data. Here, we aim to resolve the potential issue of noise in Sustainalytics ESG rankings. Following the instrumental variable approach to correct the noise (Berg et al. 2022), we use ESG scores provided by Sustainalytics as independent variable and use ESG scores obtained from other rating agencies as instruments. The results are shown in Table 10. Our main findings still hold after correcting the noise in ESG rankings, further indicating the robustness of our findings.

Table 10. Relationships Between ESG and Social Media Reactions (Based on 2SLS Regression)

Variable	DV= <i>Social Media Attention</i>		DV= <i>Social Media Sentiment</i>	
	1 st stage	2 nd stage	1 st stage	2 nd stage
<i>ESG</i> _{<i>i,t-1</i>}		0.009(0.004)*		-0.004(0.003)
<i>ESG(Refinitiv)</i> _{<i>i,t-1</i>}	0.252(0.013) ^{***}		0.260(0.017) ^{***}	
<i>ESG(RepRisk)</i> _{<i>i,t-1</i>}	0.029(0.021)		0.032(0.025)	
<i>Firm_size</i> _{<i>i,t-1</i>}	0.673(0.256) ^{**}	0.332(0.041) ^{***}	0.266(0.332)	-0.062(0.016) ^{***}
<i>ROA</i> _{<i>i,t-1</i>}	16.221(11.284)	4.913(1.483) ^{***}	8.193(10.625)	1.342(0.486) ^{**}
<i>Intangible_assets</i> _{<i>i,t-1</i>}	-0.224(0.962)	-0.459(0.142) ^{***}	0.813(1.197)	0.275(0.061) ^{***}
<i>Financial_leverage</i> _{<i>i,t-1</i>}	-1.682(1.466)	-0.164(0.079) [*]	-0.019(2.040)	-0.126(0.045) ^{**}
<i>Beta</i> _{<i>i,t-1</i>}	0.680(0.586)	-0.147(0.054) ^{**}	0.956(0.736)	0.050(0.030)
<i>Momentum</i> _{<i>i,t-1</i>}	0.544(0.473)	0.072(0.069)	-0.172(0.471)	0.166(0.046) ^{***}
<i>Volatility</i> _{<i>i,t-1</i>}	-80.787(42.131)	18.948(6.341) ^{***}	-121.391(47.051) [*]	-20.179(2.633) ^{***}
<i>Industry FE</i>	YES	YES	YES	YES
<i>Month FE</i>	YES	YES	YES	YES
Cluster SE	<i>Industry-Month</i>	<i>Industry-Month</i>	<i>Industry-Month</i>	<i>Industry-Month</i>

Obs.	22,977	22,977	12,366	12,366
F -statistic for 1 st stage	201.93***		122.12***	
Cragg–Donald F -statistic		4,160.31***		2,231.37***
10% Maximal IV size		19.93		19.93
Hansen J statistic		3.108		0.196

Notes. Robust standard errors clustered at industry-month level are reported in parentheses; *: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.005$; To make coefficients more interpretable, *social media sentiment* is magnified 100 times; $ESG_{i,t-1}$ are ESG scores obtained from Sustainalytics; $ESG(Refinitiv)_{i,t-1}$ indicates ESG scores obtained from Refinitiv; $ESG(RepRisk)_{i,t-1}$ indicates reputation risk index obtained from RepRisk.

4.3.4. Additional Robustness Checks for ESG and Social Media Sentiment

As we can see in the descriptive statistics of Section 4.1, the proportion of the sample missing sentiment values is as large as 47%. The method we used to deal with this issue is dropping missing observations, which is widely used. To confirm the robustness of our results, we use three additional methods to fill missing values for *Sentiment* and re-conduct the analyses. More specifically, the first method is filling missing values in Month t with the average sentiment of all non-missing sentiment values in Month t ; the second one is filling all missing values with the average of all non-missing sentiment values; The last one is filling missing values for Firm i with the average of all non-missing sentiment values for Firm i .

Due to space constraints, the results are reported in Table A5 of Appendix IV. The results are also consistent with our main analysis, which is reported in Section 4.2.1. These findings robustly confirm ESG's inability in *social media sentiment* prediction.

5. Additional Analyses

Our main analysis confirms the positive relationship between ESG performance and *social media attention*, but finds no evidence for the relation between ESG and *social media sentiment*. To further confirm these findings, we exploit several event-study tests for more analyses.

5.1. Event-Study Analyses

For our event study, *ESG* is operationalized by comparing a firm's overall ESG score in a month with the average ESG score of the industry the firm belongs to in the same month, which is different from the absolute measure in our main analysis. Therefore, we can identify the events about firms' ESG performance changes based on the sign of ESG scores. To be more specific, we identify two types of ESG score changes:

ESG upgrade, when an ESG score turned from negative to positive (depicted by Figure 1); and *ESG downgrade*, when the score turned from positive to negative (Figure 2). From our data set, we identified 519 events in total, 233 out of which are *ESG upgrades* and the remaining 286 are *ESG downgrades*.

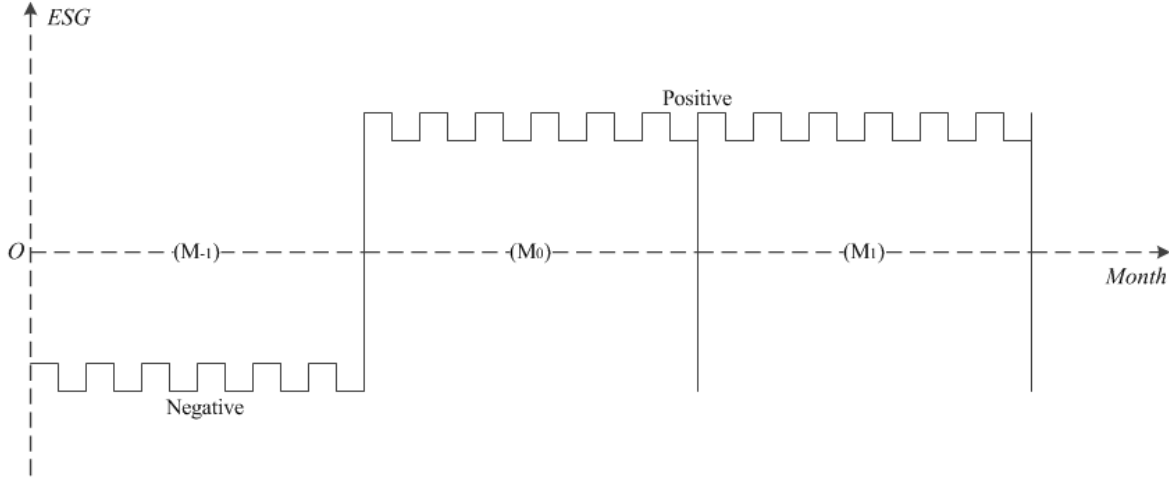


Figure 1. ESG Upgrade from Negative to Positive

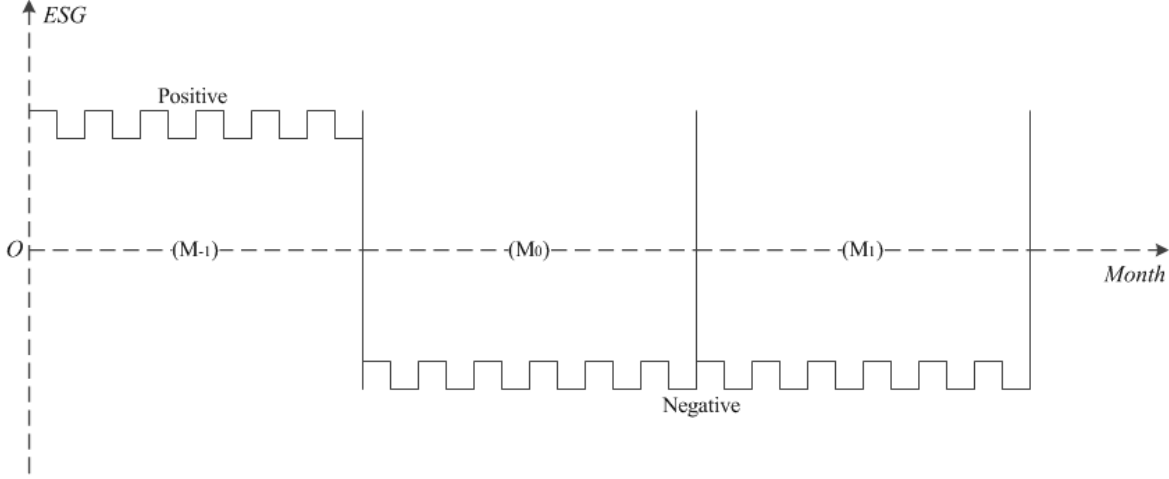


Figure 2. ESG Downgrade from Positive to Negative

We summarize the drivers for overall ESG upgrades or downgrades using two tree diagrams in Appendix V. For the 233 upgrade events, 109 out of them are along with upgrade in at least one dimension of ESG, making it possible for us to confirm which dimension(s) drive(s) the upgrade event. 81 out of them are driven by the upgrade of one factor: 30 environmental upgrades; 26 social upgrades; 25 governance

upgrades. 25 out of them are driven by two factors: 9 are caused by environmental and social upgrades; 9 are driven by environmental and governance upgrades; 7 are caused by social and governance upgrades. 3 out of them are induced by the upgrades of environmental, social, and governance factors simultaneously. For the 286 downgrade events, 75 of them are along with downgrade in at least one dimension of ESG. Therefore, we can infer the drivers behind these 75 events. More specifically, 59 out of them are caused by one factor: 21 environmental downgrades; 23 social factor downgrades; 15 governance downgrades. 12 events are caused by two factors: 3 are caused by the environmental and governance factors; 7 are caused by environmental and social factors; 2 are caused by social and governance downgrades. 4 out of 75 are induced by the decrease of the three factors simultaneously.

The change in *social media attention* for each ESG upgrade or downgrade event are calculated to test the significance of the change. Suppose the event occurs in *Month t*, the change is calculated as $Attention_{t+1}$ minus $Attention_{t-1}$ for each stock. The detailed results are summarized in Table 11. For *ESG upgrade* events, the improvement of *social media attention* is significant. For *ESG downgrade* events, the decrease in *social media attention* is also significant. In other words, we find decrease in *social media attention* with respect to ESG downgrade events, while increase with respect to upgrade events.

Table 11. Change in Social Media Attention After Events

Obs.	Mean	Std. Err	Min	Max	T-statistic	ESG performance change
233	0.373	0.169	-11	20	2.210*	<i>ESG upgrade</i>
286	-0.332	0.165	-17	17	-2.009*	<i>ESG downgrade</i>

Notes. The change in *social media attention* is calculated by the difference between the quantity of articles in the month just after the event and that in the month just before the event; The *T*-statistics test the significance of the change; *: $p < 0.05$.

Table 12. Change in Social Media Sentiment After Events

Obs.	Mean	Std. Err	Min	Max	T-statistic	ESG performance change
77	-0.001	0.001	-0.026	0.014	-1.605	<i>ESG upgrade</i>
99	0.00005	0.0007	-0.014	0.023	0.073	<i>ESG downgrade</i>

Notes. The change in *social media sentiment* is calculated by the difference in sentiment between the month just after the event and the month just before the event; *T*-statistics test the significance of the change. The number of observations is smaller than the number of total events, as for some months, given firms have no related articles published in the community, inducing the difference between the sentiment before and after the event to be missing.

We report the changes in *social media sentiment* for these events and the significance of the changes in Table 12. The changes are not significant for both types of events, further implying that an ESG score change has no prominent influence on future *social media sentiment*.

From our event study, we can conclude that *ESG upgrades* predict an increase in *social media attention*, while *ESG downgrades* predict a decrease in *social media attention*; both *ESG upgrades* and *downgrades* cannot predict a change in *social media sentiment*. This finding is still consistent with the main findings from our main analysis.

5.2. Mechanism Analysis

As mentioned earlier, ESG can be divided into three dimensions: environmental, social, and governance. The relations between different dimensions and investors' *social media reactions* may be different. To investigate this issue and explore the mechanism behind the relationship between ESG and investors' reactions, we conduct another series of regressions on the three ESG dimensions.

Table 13. Relations Between E, S, G Performance and Social Media Attention

Variable	Model 1	Model 2	Model 3
<i>Environment_score</i> _{<i>i,t-1</i>}	0.003(0.001)***		
<i>Social_score</i> _{<i>i,t-1</i>}		0.006(0.001)***	
<i>Governance_score</i> _{<i>i,t-1</i>}			0.001(0.001)
<i>Firm_size</i> _{<i>i,t-1</i>}	0.339(0.013)***	0.340(0.013)***	0.354(0.012)***
<i>ROA</i> _{<i>i,t-1</i>}	4.131(0.525)***	4.130(0.533)***	4.299(0.541)***
<i>Intangible_assets</i> _{<i>i,t-1</i>}	-0.499(0.049)***	-0.493(0.049)***	-0.514(0.050)***
<i>Financial_leverage</i> _{<i>i,t-1</i>}	-0.186(0.037)***	-0.166(0.038)***	-0.181(0.038)***
<i>Beta</i> _{<i>i,t-1</i>}	-0.147(0.020)***	-0.150(0.020)***	-0.141(0.020)***
<i>Momentum</i> _{<i>i,t-1</i>}	0.075(0.022)***	0.073(0.023)***	0.068(0.022)***
<i>Volatility</i> _{<i>i,t-1</i>}	14.553(2.157)***	15.110(2.138)***	13.854(2.213)***
<i>Intercept</i>	-2.797(0.134)***	-2.988(0.131)***	-2.819(0.169)***
<i>Industry FE</i>	YES	YES	YES
<i>Month FE</i>	YES	YES	YES
Cluster SE	<i>Industry-Month</i>	<i>Industry-Month</i>	<i>Industry-Month</i>
Obs.	26,279	26,279	26,279
<i>R</i> ²	0.4004	0.4031	0.3991

Notes. Robust standard errors clustered at industry-month level are reported in parentheses; *: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.005$.

As reported in Table 13, the relation between environmental performance and *social media attention* is positive. It indicates that investors do care firms' investment in environmental protection and firms with higher environmental performance attract more investor attention subsequently. The relation between social performance and *social media attention* is also significantly positive, implying that firms' investment in social issues can attract investors' *social media attention* as well. As for governance, it has no significant relation with *social media attention*, indicating that although corporate governance has been added into sustainable investing, it has not received enough attention from investors yet. As seen from Table 14, environmental score is significantly related to *social media sentiment*, while both social and governance scores have no significant relation with *social media sentiment*. This implies that investors do care firms' investment in environmental efforts, consistent with extant literature such as Chava (2014).

Table 14. Relations Between E, S, G Performance and Social Media Sentiment

Variable	Model 1	Model 2	Model 3
<i>Environment_score_{i,t-1}</i>	-0.002(0.001)***		
<i>Social_score_{i,t-1}</i>		0.0002(0.0007)	
<i>Governance_score_{i,t-1}</i>			0.001(0.001)
<i>Firm_size_{i,t-1}</i>	-0.060(0.007)***	-0.069(0.006)***	-0.069(0.006)***
<i>ROA_{i,t-1}</i>	0.995(0.267)**	0.896(0.266)***	0.896(0.264)***
<i>Intangible_assets_{i,t-1}</i>	0.225(0.037)***	0.235(0.037)***	0.234(0.037)***
<i>Financial_leverage_{i,t-1}</i>	-0.071(0.033)*	-0.081(0.034)*	-0.081(0.034)*
<i>Beta_{i,t-1}</i>	0.044(0.017)*	0.040(0.017)*	0.040(0.017)*
<i>Momentum_{i,t-1}</i>	0.193(0.019)***	0.199(0.019)***	0.199(0.019)***
<i>Volatility_{i,t-1}</i>	-19.853(1.336)***	-19.271(1.341)***	-19.176(1.345)***
<i>Intercept</i>	-0.938(0.086)***	-0.965(0.086)***	-1.008(0.100)***
<i>Industry FE</i>	NO	YES	YES
<i>Month FE</i>	NO	YES	YES
Cluster SE	<i>Industry-Month</i>	<i>Industry-Month</i>	<i>Industry-Month</i>
Obs.	13,866	13,866	13,866
R ²	0.1220	0.1211	0.1212

Notes. Robust standard errors clustered at industry-month level are reported in parentheses; *: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.005$; To make the coefficients more interpretable, sentiment is magnified 100 times.

According to these analyses, we obtain two interesting and important findings: (1) The positive

relationship between ESG and *social media attention* is driven by the environmental and social factors, not by the governance factor; (2) Higher environmental performance is associated with lower subsequent *social media sentiment*, and the non-significant relation between ESG and *social media sentiment* is driven by the social and governance factors.

6. Conclusion and Discussions

6.1. Main Findings

We examine two aspects of investors' social media reactions to ESG: *social media attention* and *social media sentiment*. Our analyses are mainly based on a combined data set of ESG performance scores from Sustainalytics and investor-generated content from Seeking Alpha. We first utilize a panel data set to examine the predictive ability of ESG for *social media reactions*. Then, we carry out several robustness checks and two additional event-study analyses to further confirm ESG's predictive ability for *social media reactions*. In addition, we also conduct a mechanism analysis to find out the key driver (environmental, social, or governance dimension) for the relations between ESG and investors' *social media reactions*.

Our study yields at least three findings that contribute to the existing literature. First, we find that ESG performance positively predicts subsequent *social media attention* but it cannot be used to predict future *social media sentiment*. This finding implies that a firm's ESG activities can affect its firm value mainly through the *social media attention* channel (exposure effect) rather than the *social media sentiment* channel (persuasion effect). Second, we also find out the mechanism behind this finding: ESG's predictive ability for *social media attention* is mainly driven by the environmental and social dimensions and its inability in *social media sentiment* prediction is mainly driven by the social and governance factors. It is also worth noting that environmental score negatively predicts social media sentiment. In fact, this is much consistent with some existing studies in that investors tend to deem firm's high performance in environmental commitment more as a financial burden. Third, the significantly positive relationship between ESG and *social media attention* holds for both ESG downgrade events and upgrade events, and the non-significant relation between ESG and *social media sentiment* also holds for both types of events.

With regard to the asymmetry for the relationship between ESG and *social media attention* vs. *social*

media sentiment, we provide a conjecture under *H2*. As a recent study (Li et al. 2023) investigating how retail investors react to ESG news finds, investors indeed care about firms' ESG-related activities, but only when deeming them financially material (pecuniary) to the firms' stock performance. Within our research context, investors can hardly figure out whether the comprehensive but superficial ESG ratings (unlike ESG news, which are much more easily judged pecuniary or non-pecuniary) has implications for firms' financial performance at least in the short run (within several months), even though they may believe it has in the long run. Thus, their sentiment will not show a timely propensity (positive/negative).

6.2. Implications

We make contributions to both academic research and business practice by helping researchers and practitioners understand how firms' ESG affects investors.

From the angle of theoretical development, our study makes multiple contributions. First, different from most prior studies of sustainable investing mainly focusing on CSR including firms' social or environmental aspects (Flammer 2015), our study takes corporate governance into account. Second, previous studies have shown that ESG affects firm value, customer perception, and stock analyst recommendation. This paper adds to the knowledge repository by showing how ESG affects investors' reaction on *social media* in terms of two most important aspects—attention and sentiment. Third, to robustly examine our findings, we leverage an event study approach and noise correction method to conduct more analyses. We believe such methodological contributions will turn out valuable in future studies of ESG.

For practice, our study also provides valuable implications. Our findings help managers understand the importance of ESG in the social media era by finding that the decrease in ESG performance significantly reduces investors' *social media attention* and the improvement of ESG performance helps increase *social media attention*. Hence, firm managers should pay close attention to keeping and improving their firms' ESG advantage. They should also be aware of the investor-based mechanisms, which may account for firm value ultimately. Additionally, we find evidence that environmental and social aspects of ESG performance are more important than the governance aspect in affecting investors' *social media reactions*. Governance has been incorporated into sustainable investing for a long time; however, investors' *social media reactions* have not well reflected the importance of it yet. Besides, ESG's inability in predicting *social media*

sentiment also indicates individual investors' limited awareness of the importance of ESG. Therefore, it is pressing for regulators to take actions to boost the function of sustainable investing and ESG values. Our findings also help managers shed light on the picture of the return of their firms' investment in ESG by taking investor behavior into account. Our work uncovers an interesting strategic mechanism: ESG-oriented efforts enhance the attention paid to the focal firm but cannot easily change the sentiment of investors in the utilitarian stock market at least until now.

6.3. Limitations and Future Work

Several limitations inherent in our study warrant future research efforts. First, our research sample consists of a not too large volume of firms, i.e., S&P 500 firms, which are those with relatively large market values whose investment in ESG may be relatively visible and accurately measured. Although S&P 500 firms are important and representative of the firms most relevant for ESG investment, it would be worth extending the sample to a larger set of firms in future research. Second, we identify two types of events (ESG upgrades and downgrades) for the event-study analyses, which are based on firms' ESG scores relative to their industry averages. Our study can also be extended by investigating the influence of other ESG related events (e.g., events from the news database such as RavenPack) on investor behavior. Finally, besides online investment communities, other media platforms such as Twitter, Yahoo! Finance, or Google can also be used to measure investors' *social media reactions*; hence, investigating the research questions by incorporating other research data sources may generate new insights in future work.

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