

Does ESG Ratings matter? An empirical study on Sustainalytics's ESG risk scores and US stocks' returns

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Abstract

This empirical study examines the importance of ESG (Environmental, Social, and Governance) ratings in the context of US stocks returns, utilizing Sustainalytics' ESG risk score serving as a crucial metric. ESG-related news is initially used for selecting firms, followed by a secondary screening process based on Sustainalytics' ESG Risk Scores. Eighteen firms, initially characterized by higher ESG risk but later improving their ESG risk scores, underwent comprehensive individual and holistic event studies in the US stock market. The results revealed a minor impact at the individual level but a significant collective influence. Additionally, six firms initially with lower ESG risk but deteriorating risk scores were also examined, but other external factors potentially influenced the outcome. Understanding the influence of ESG ratings on financial performance is critical for investors, legislators, and corporate decision-makers as the emphasis on sustainable investing grows. The research findings have the potential to impact investment strategies and corporate practices, contributing to a deeper understanding of the emerging landscape of responsible and sustainable finance.

1 INTRODUCTION

On August 4, 2023, S&P Global, which had introduced ESG credit indicator scores for select sectors and asset classes in 2021, revealed its decision to discontinue the publication of alphanumeric ESG credit indicators. Instead, S&P would include "dedicated narrative paragraphs" on ESG

in their reports, citing investor dissatisfaction with the effectiveness of the scores as the primary motive behind this change (Ghosh, 2023).

Generally, ESG ratings indicate a firm's exposure to long-term environmental, social, and governance risks. Companies with traditional credit ratings of AAA or lower numerical values are considered ESG leaders, while those with ratings of CCC or higher numerical values are considered ESG laggards (Plaut, 2022).

S&P Global's decision raises a pertinent question: Does ESG rating effectively communicate firms' risks to investors and other stakeholders while incentivizing companies to improve their behavior in the public eye? With the increasing importance of sustainability in the contemporary global context and the widespread discussions surrounding ESG ratings in the financial sector, there is an inevitable need to assess their real impact and effectiveness.

Previous studies have proved there are certain correlations between ESG ratings and stock return. Some conclude that improvement in ESG ratings will bring additional returns for investors, while others argue that the influence is not significant.

This paper endeavors to meticulously examine the interaction between ESG ratings, specifically Sustainalytics' ESG risk scores, and stock returns. The primary focus is on examining the influence of improvements in ESG ratings on stock returns for firms initially characterized by lower ratings. However, some analysis will also be conducted to assess the effects of risk increases for firms initially positioned with good ESG ratings. The empirical core of this paper lies in its utilization of an event study methodology. The selected corporations are identified based on the publication of ESG-related news, followed by a comprehensive selection process: using maximum quantity change and percentage change of ESG risk score with data includes the ESG risk scores of Sustainalytics of 50 US individual corporations from 2018.12.3 to 2023.3.1. The primary empirical procedure relies on analyzing the deviation between expected and actual stock returns, with meticulous calculations of abnormal returns based on *alpha* and *beta* coefficients derived from the market model, and comparing CAR with confidence intervals. The study extends this individual firm analysis to a holistic examination of groups of firms, calculating average CAR and discerning collective impact. The empirical analysis yields nuanced insights, demonstrating that the effects of ESG risk scores on stock returns vary, impacting both individually and collectively, albeit to

differing degrees.

The remaining sections of this paper encompass the Literature Review, which details previous studies and highlights the contribution of this paper. Following that, the Methodology section explains the firm selection process and introduces the key mathematical model used for calculations. Subsequently, the Detailed Calculations and Analysis section will systematically outline the processes detailed in the methodology, incorporating specific ESG risk scores and firm prices in comparison to the S&P 500. Finally, the paper concludes with the Conclusion and Evaluation section, summarizing the main ideas, discussing limitations, and suggesting avenues for further exploration.

2 Literature Review

2.1 Historical Discussion about Sustainability

Our several critical assumptions are as follows: For decades, investors have been working on improving the sustainability of firms to achieve their social responsibility and get acknowledged by society. There is a booming trend in investigating the relationship between sustainability and business growth. Scoones, I.(2007) discussed the history and significance of sustainability in different aspects such as financial investment. The original definition of “sustainable development” can be traced back to the 1980s and 1990s. It is defined as “development that meets the present needs without exploiting the ability of future generations to meet their needs”. In that period, there was a rising global awareness of potential environmental risks, which led to unprecedented innovation and revolution in various fields of industry.

2.2 Significance of Improving Sustainability

However, it is unreasonable if firms just improve sustainability for ethical reasons since this is not the first aim of business. In the business study, Handy, C (2002) considered humans as selfish animals if selfish refers to behavior that maximizes their welfare. Although humans are inspired by the community, they tend to avoid risk without additional return. Instead, customer awareness

is the prior factor contributing to improvement in firm sustainability and supply chain management (Gong. M. 2019). Gong. M. investigated factors influencing the development of firms. They proposed four hypotheses and proved them with specific data and calculations. They conclude that sustainability efforts are proxied by customer awareness of sustainable resources, as well as their stakeholder engagement. Hutchins, M. J., & Sutherland, J. W. (2008) published similar research about sustainability, while they focus on the social dimension of sustainability for firms. They maintain that the rising demand for sustainable development and corporate social responsibility accelerated the formation of tools guiding people in social aspects. These tools are auxiliary indicators for investors when making decisions. Therefore, experts suggested different indexes to measure firms' awareness of environmental protection and social sustainability. Among various types of tools, ESG rating has been widely applied in research on sustainability and corresponding economic development.

2.3 Contrary results of ESG rating and return

As ESG rating focuses on “Environmental”, “Social”, and “Governance” risks, it is an implication for investors to learn about the performance of firms in sustainable improvement and avoid the risk of environmental adverse impact on the stock price and return to some extent. Campbell, J. Y (1996) used an intertemporal pricing model to prove that stock return is strongly associated with long-term aggregate stock market risk. Theoretically, deterioration in a firm's ESG rating leads to falling expectations for the stock and hence influences firms' stock price and return. Therefore, investors usually monitor firms' ESG behavior, which is described as ESG screening. Verheydon (2016) suggested that ESG screening does not worsen firms' stock performance. Moreover, this improves the risk-adjusted return. ESG information is also essential assistance when fund managers aim to create risk-adjusted outperformance in the long run. This research considers investors' attention on ESG scores as a factor that influences firms' stock performance. Nonetheless, the materiality of the ESG system has been questioned by La Torre, M. in 2020. They argued that the impact of “overall ESG” on return is indistinctive in their model, while the effectiveness varies from firm to firm. Statistical results showed that only a few firms get external returns with their ESG efforts. ESG performance is an effective factor for specific industries such as energy

and utilities. A study by Cornell, B. (2021) showed another different result. He holds no brief for the view that investors will benefit from the portfolio attempts to high ESG scores. Although this portfolio encourages green innovation and reduces the cost of capital, higher expected returns are not along with them. However, ESG efforts bring a certain level of social benefit, but the jury is still on whether there are ESG risk factors or not. For firms, there is a trade-off between a better ESG rating and a higher expected return.

Therefore, prior research indicates the existence of conflicting aspects of results, so the relationship between ESG ratings and a firm's returns remains uncertain. Further exploration is therefore needed.

2.4 Deviations from recent research's methodology

Previous research has followed the below approaches in terms of firm selection, consideration of ESG factors, and analysis of the relationship with returns. La Torre et al. (2020) opted to analyze companies by selecting all those included in the Eurostoxx50 index and relied on ESG ratings provided by CSRHub. Giese et al. (2020) deconstructed ESG ratings and analyzed the components - "E", "S", and "G" - separately. Halbritter and Dorfleitner (2015) centered their research on the creation of ESG stock portfolios and subsequently assessed ESG rating impact on returns of different portfolios. However, for this paper, the firm selection process is not random; instead, it is tied to specific news, incorporating the concept of substantiating ESG rating assessments with factual information. Furthermore, in this research, the concept of ESG is still considered as a cohesive unit. This means that the study directly links the impact of ESG ratings to returns without dissecting "E", "S", and "G" separately, allowing for a comprehensive and direct assessment of effectiveness. Moreover, although this paper does not construct stock portfolios, it analyzes individual firms both separately and collectively. It places a particular emphasis on assessing the dynamic impact of changes in ESG ratings rather than relying solely on single ratings.

3 Methodology

3.1 General procedure

ESG risk scores generated by the rating agency Sustainalytics included in the database Wharton Research Data Services has been adopted as the data source for our research. Firms with bad news or good news related to ESG have been selected. Then, firms' ESG risk scores in the range of 2018.12.3 to 2023.3.1 have been collected and used to calculate the maximum value change and "FieldDate" listed in the raw data is used as event dates to do event studies. After that, selected firms' stock prices before and after event dates are collected. With all data, event studies can be done for individual firms or as a whole. Lastly, the results generated from event studies would be analyzed.

3.2 Sustainalytics' ESG rating

Several ESG rating agencies offer assessments, and for this paper, Sustainalytics' ESG risk score is selected as the data source. The choice of Sustainalytics is supported by several advantages:

1. It's a prominent ESG rating agency, having evaluated the ESG performance of over 14,000 companies.
2. Sustainalytics provides specific scores rather than general gradings, offering a more detailed assessment.
3. It conducts a comprehensive evaluation, considering not only common aspects like corporate governance and material ESG issues but also the impact of specific (black swan) events (Sustainalytics).
4. The agency's emphasis on the concept of "risk" aligns with this research's expectation: balancing risk and return is the key for a more sustainable future.

3.3 Firms selection methodology

The premise in this study is that firms who have published some ESG news will have a rating change reflected in their ESG risk score. News might cover a wide range of topics, such as energy use, trash disposal, corporate governance, and so on.

The importance for mapping each firms with real-world ESG-related occurrences is it helps to bridge the gap between the conceptual nature of ESG ratings and their tangible, real-world implications. This research is predicated on the notion that alterations in a firm's ESG rating are not arbitrary but are substantively anchored in their actions and engagements with societal and environmental considerations. ESG rating should not be a theoretical construction but grounding on the substantial incidents and practices.

Then, an additional selection procedure would be employed to select firms that will take part in the event study. Following data processing steps illustrate the selection process:

First, the following two formulas have been used in data processing of rating for each firm:

1. Quantity change of ESG risk score, $Q = ESG\ risk\ score_{current} - ESG\ risk\ score_{last}$.

2. Change of percentage of ESG risk score, $P\% = (ESG\ risk\ score_{current} - ESG\ risk\ score_{last}) / ESG\ risk\ score_{last} 100\%$.

Data related to each firm's maximum quantity change of ESG risk score, Q_{max} , will be recorded, including firm's name, $ESG\ risk\ rating_{current}$, Q_{max} , $P\%_{max}$ (maximum change of percentage of ESG risk rating), and its corresponding event date.

Firms with negative Q_{max} and firms with positive Q_{max} would be separated into two categories during the statistics collection process. For each category, either negative Q_{max} or positive Q_{max} , the average score of Q_{max} and $P\%_{max}$ will be calculated. The particular selection criteria might then be defined.

3.4 Event study methodology

3.4.1 Overview

The data analysis of this research paper is based on Event Study invented by Ball and Brown. The event study could investigate the impact of a typical occurrence on the direction and magnitude of stock price movements.

3.4.2 For individual firms

For the individual stock, the null hypothesis, H_0 , is that the event has no influence on the return of the firm's stock and the alternative hypothesis, H_a , is that the event has an influence on the return. The relationship between a stock's returns and market returns could be estimated through constructing a market model using ordinary least square regression (Armitage, 1995):

$$R_t = \alpha + \beta R_{mt} + \epsilon_t, \text{var}(\epsilon_t) = \sigma^2 \quad (1)$$

Whereby: R_t is the return of a stock at time t .

R_{mt} is the return of the market at time t .

α is one of the regression coefficients, standing for idiosyncratic return of the stock, and β is the other one of regression coefficients, measuring the systematic risk of the stock. ϵ_t is the error term and σ measures the variability of the idiosyncratic shock. For this study, returns of 250 trading days before the event of the stock and S&P 500 index prices have been used to estimate $\bar{\alpha}$ and $\bar{\beta}$. The expected return, ER_t , during the event window should also follow the market model, which could be determined using the following equation (Armitage, 1995):

$$ER_t = \bar{\alpha} + \bar{\beta} R_{mt}, t = 1, \dots, T \quad (2)$$

where T is the total time for the event window. For this study, $T = 10, 15, 20, 25, 30, 35, 40$ days are taken for trials. As the abnormal return is actual return minus estimated return, abnormal

return at time t during the event window could be calculated as below (Armitage, 1995):

$$AR_t = R_t - \bar{\alpha} + \bar{\beta}R_{mt}, t = 1, \dots, T \quad (3)$$

Suppose the uncertainty of AR_t comes from ϵ_t . Under the null hypothesis, AR_t satisfy the following distribution:

$$AR_t = \epsilon_t \sim N(0, \sigma^2), t = 1, \dots, T \quad (4)$$

The Cumulative Abnormal Return, $CAR(T)$, for each t in the event window, T , could be computed from equation (4) (Armitage, 1995):

$$CAR(t) = \sum_{t=1}^T AR_t = \sum_{i=1}^T \epsilon_t \sim N(0, t\sigma^2) \quad (5)$$

Finally, $CAR(t)$ needs to be compared with the confidence interval $(-z_{\alpha/2}\sqrt{t\sigma^2}, z_{\alpha/2}\sqrt{t\sigma^2})$, $t = 1, \dots, T$ for two sided *alpha*-level test. In this study, $\alpha = 0.05$ is used as a standard, so the confidence interval here is $(-1.96\sqrt{t\sigma^2}, 1.96\sqrt{t\sigma^2})$, $t = 1, \dots, T$. If $CAR(t)$ exceeds the confidence level, the null hypothesis should be rejected with 95% certainty, which the event has either negative or positive effect on a single firm's return.

3.4.3 Analyze as a whole

Instead of only evaluating one firm, the event study approach might potentially assess a group of firms. For a group of firms, the null hypothesis, H_0 , is that events have no influence on returns of this group of firms' stock and the alternative hypothesis, H_a , is that events have influence on returns. The processes of calculation still include using formula (1), (2), (3), and (4) to obtain CAR for each firm's stock at a particular time t . In order to do event study for a group of firms, the CAR of every firm at each t should be summed up then divided by the total number to give out the average CAR of a group of firms' stocks at time t . The equation below shows how to calculate it for a group of firms' stocks with total number N :

$$CAR_t^N = \frac{\sum_{i=1}^N CAR_{it}}{N}, t = 1, \dots, T \quad (6)$$

Whereby: CAR_t^N stands the average cumulative abnormal return of N firms' stocks at time t. CAR_{it} represents the cumulative abnormal return of firm i's stock at time t. At last, the confidence interval still needs to be processed out. The confidence interval at each t with $\alpha = 0.05$ level depends on the σ^2 of N firms:

$$\left(-1.96\sqrt{\frac{\sum_{i=1}^N t\sigma_i^2}{N^2}}, 1.96\sqrt{\frac{\sum_{i=1}^N t\sigma_i^2}{N^2}}\right), t = 1, \dots, T \quad (7)$$

If $CAR(t)$ exceeds the confidence level, the null hypothesis should be rejected with 95% certainty, which means, on average, this kind of events have effect on returns.

4 Detailed Calculations and Analysis

4.1 Firm selection

4.1.1 Firms with news related to ESG

Table 1 below summarizes ESG-related news associated with specific firms, which are then utilized for the subsequent phases of investigation.

4.1.2 Processed ESG risk score and risk change standards

The processed ESG risk score is summarized in Table 2. There are a total of 29 firms with negative Q_{max} and just 21 with positive Q_{max} . Notably, the average absolute value of negative Q_{max} , 4.27, is bigger than that of positive Q_{max} , 3.04. It's also worth to mentioning that PG&E's Q_{max} value is 11.19, which largely influences its average value. Excluding this data result in only 2.64 for average value of positive Q_{max} . Therefore, the extension of a declining risk score is considerably bigger than a rising risk score, and potential explanations for this will be covered in more detail later in the article.

The risk change standards used for further analysis are $|Q_{max}| > 3$ and $|P\%_{max}| > 10\%$. As a result, there are total 18 firms with negative Q_{max} and 6 firms with positive Q_{max} will be taken in conducting event studies, which are highlighted in yellow color.

Table 1: 50 Firms with news related to ESG

Firms	News	Firms	News
1.3M	Lawsuit over contaminating of many U.S. public drinking water system (The Associated Press, 2023)	2.Adidas	Used more environmentally friendly material, reduced plastic in manufactured processes, and designed clothes that are more durable (Murphy & Vakulina, 2022)
3.Alphabet	US\$5.75bn in sustainability bonds, covering a lot of environmental and social projects (Steer-Stephenson, 2022)	4.Amazon	Operated more environmentally sustainable through using renewable energy to run data centers and 7% decrease in carbon intensity (Rosenblatt, 2023)
5.American Electric Power	Since 2005, there has been a substantial decrease of 66% in greenhouse gas emissions from Scope 1 sources, and sold nearly 13,500 megawatts of coal-powered generation in the past decade (Yahoo finance, 2023)	6.Apple	Poor policy related to product take-back and recycling before; Clean energy projects conducted (Price, 2017)
7.AT&T	Excluded details regarding the hazards presented by the lead cables to both employees and the surrounding environment (Miller, 2023)	8.Bank of America	Issued a 2billion sustainability bond, the eighth ESG-themed corporate bond, raising almost 10billion for investments with environmental and social benefits (Business wire, 2020)
9.Barclays	Barclays has injected £84 million into pioneering startups, assisting them in expanding their solutions to address environmental issues and bridging funding gaps during their growth stages (ESG News, 2022)	10.BHP	Catastrophic collapse of the Fundão tailings dam in 2015 (Jones, 2020)
11.BlackRock	Started moving away from fossil fuel system since 17 Jan 2020 (McKibben, 2020)	12.Boeing	Boeing 747 and other similar craft with four engines have noise and air pollution issues, mentioned by Israel (Scheer, 2022)
13.BP	discharged elevated levels of cancer-causing benzene into wastewater streams and released excessive volatile organic compounds and other dangerous air pollutants; installed benzene removal devices later (Saenz, 2023)	14.Coca Cola	Targeting a 25% global packaging reusability goal by 2030 after being criticized for plastic pollution (Russ, 2022)
15.Delta Air Lines	Faced lawsuit over its carbon neutrality claim (Greenfield, 2023)	16.Denka	The EPA has requested a federal court to require Denka to promptly lower its chloroprene emissions from its chemical plant (Ahmad, 2023)
17.Disney	Commit to using carbon-free electricity by 2030, waste reduction, and save water (Ellis, 2021)	18.Duke Energy Corporation	Starting to construct two new solar power plants in Florida that could remove approximately 600 million pounds of carbon dioxide emissions (Banerjee, 2020)
19.DuPont	Chemical leak occurred at the LaPorte plant in 2014 (Worthy, 2023)	20.Exxon Mobil	Announced a new five-year plan to reduce greenhouse gas emissions in 2020 (Rosenbaum, 2020)
21.Gap	Progressing as planned to achieve its objective of utilizing 100% renewable energy for its worldwide owned and operated facilities by 2030 (Wright, 2021)	22.General Electric	GE had intentions to construct several coal-fired power plants abroad, as reported by NRDS in September 2019 (Chen, 2019)
23.General Motors	GM is presently manufacturing a significant number of fuel-inefficient vehicles and incurring fines as a result (Motavalli & Vincent, 2023)	24.Glencore	In 2020, a commitment was made to attain net zero emissions by 2050, and in 2021, interim objectives were introduced, aiming for a 50% reduction in absolute emissions by 2035 encompassing Scope 1, 2, and 3 emissions (Segal, 2023)
25.Halliburton	Moved to cloud-based digital platforms under the agreement with microsoft (Accenture, 2020)	26.Johnson & Johnson	Committed to 100% recyclable, reusable, or compostable plastic packaging, along with certified and post-consumer recycled paper packaging by 2025 (Kaplan, 2020)
27.L'Oreal	In 2022, achieved an 81% reduction in CO2 emissions across its plants and distribution centers since 2005 (Ambrose, 2022)	28.Macdonald's	More than 53 million tonnes of carbon dioxide per year (The Energy Mix, 2021)
29.Marathon Petroleum Corporation	Reduce scope 1 and 2 GHG emissions intensity 30% by 2030 from 2014 levels; progressed at 21% in 2020 (PR Newswire, 2022)	30.Meta Platform	Critics' concerns regarding its approach to and protection of user privacy (BBC news, 2022)
31.Microsoft	Carbon footprint grew 21% in 2021 (Stiffler, 2022)	32.Nestle	Managed to reduce 4.0 million tonnes of CO2 equivalents by transitioning to renewable electricity and promoting the use of natural fertilizers in agriculture (Myers, 2022)
33.Nike	Launched "move to 0" since 2019 (Paulson-Ellis, 2021)	34.Novartis	Signed five VPPAs, paving the way to achieve 100% renewable electricity for its European operations by 2023 (Knopp, 2022)
35.Oracle	Announced plans to power its global operations with 100% renewable energy by 2025 (Barbaschow, 2021)	36.Pepsico	New Sustainability Goals such as halving Virgin Plastic Use by 2030 (PepsiCo, 2021)
37.Pfizer	Faced business ethics issues related to its vaccines (Baker et al., 2021)	38.PG&E	Associated with a string of California wildfires; bankruptcy issues (Hedstrom, 2019)
39.Philips Morris International	Created an inclusive workplace and supported mental health (Hope, 2022)	40.Procter	Challenges in the supply chain are complicating the acquisition of eco-friendly packaging materials (O'connell & Kumar, 2021)
41.Shell	Environmental law firm ClientEarth argued that Shell failure to align with the Paris Agreement (Meredith, 2022)	42.Sony	Announced five-year action plans to decrease CO2 emission and the use of plastics (Inagaki, 2021)
43.Starbucks	Global distribution of approximately 6 billion disposable cups and mugs annually (Rouziec & Yum, 2021)	44.Tesla	Minimizing lifecycle emissions through the development of the most efficient EVs (Fox, 2020)
45.Toyota	received its largest-ever civil penalty of \$180 million for a decade of knowingly breaching federal clean air emissions regulations in Jan, 2021 (Oge, 2021)	46.Unilever	Released new goals of cutting food waste and increasing plant-based sale in 2020 (Poinski, 2021)
47.Verizon	Raised almost \$1 billion for renewable energy, energy efficiency, green buildings, and biodiversity and conservation (Hurtado, 2022)	48.Visa	Issued \$500 million green bonds in 11 August, 2020 (Mehra et al., 2020)
49.Walmart	Managed to divert its waste worldwide away from landfills (Spicer & Hyatt, 2023)	50.Xcel Energy	Plan to decommission all remaining coal power plants by 2030 (McLaughlin, 2022)

Table 2: ESG risk score processed data for total 50 firms

Firms with negative Q_{max}

	Firms	$ESG\ risk\ score_{current}$	Q_{max}	$P\%_{max}(\%)$	Event date
1	Marathon Petroleum Corporation	28.56	-9.94	-25.82	2020/3/14
2	Barclays	23.91	-7.66	-24.25	2020/12/24
3	Apple	16.58	-7.07	-29.89	2020/10/28
4	Meta Platform	24.78	-6.83	-21.62	2021/4/16
5	Alphabet	22.83	-6.79	-22.92	2020/8/5
6	BHP	27.55	-6.41	-18.87	2020/10/26
7	Xcel energy	23.59	-5.97	-20.20	2021/11/30
8	Duke energy corporation-	28.76	-5.10	-15.07	2021/4/27
9	Philips Morris International	24.56	-4.88	-16.57	2020/10/2
10	Pfizer	25.26	-4.76	-15.85	2021/2/26
11	American electric power	25.81	-4.74	-15.51	2022/7/1
12	Glencore	34.61	-4.40	-11.28	2021/4/6
13	DuPont	30.09	-4.32	-12.55	2019/7/27
14	Pepsico	17.52	-4.12	-19.04	2020/11/1
15	Nestle	24.20	-4.10	-14.48	2021/10/1
16	Halliburton	30.91	-3.70	-10.68	2019/1/17
17	Oracle	14.47	-3.38	-18.92	2021/9/16
18	Walmart	27.98	-3.23	-10.34	2019/7/6
19	BP	34.95	-3.11	-8.17	2021/6/10
20	Exxon mobil	37.46	-3.04	-7.51	2019/11/12
21	L'Oreal	16.91	-2.68	-13.67	2021/10/29
22	Amazon	27.42	-2.61	-8.69	2020/9/11
23	Novartis	16.85	-2.46	-12.57	2021/3/25
24	Tesla	28.54	-2.31	-7.48	2019/10/21
25	BlackRock	18.29	-2.28	-11.10	2022/8/23
26	Coca Cola	22.48	-2.28	-9.19	2021/9/25
27	Verizon	18.12	-2.24	-11.01	2020/8/14
28	Sony	11.46	-1.89	-14.13	2020/10/6
29	Denka	32.65	-1.55	-4.53	2021/11/29
	AVG		-4.27	-13.41	/

Table 3: ESG risk score processed data for total 50 firms (continue)

		Firms with positive Q_{max}			
Firms	$ESG\ risk\ score_{current}$	Q_{max}	$P\%_{max}(\%)$	Event date	
30	PG&E	40.58	11.19	38.07	2019/1/28
31	Boeing	39.65	5.09	14.74	2022/12/22
32	Johnson & Johnson	35.81	4.98	16.16	2019/11/21
33	General electric	46.76	4.49	10.62	2019/12/13
34	Starbucks	24.67	3.72	17.77	2021/12/27
35	Delta air lines	29.52	3.39	12.96	2022/9/7
36	Unilever	23.98	2.82	13.33	2022/8/30
37	AT&T	22.12	2.79	14.44	2021/10/14
38	Visa	19.19	2.67	16.14	2019/11/14
39	Shell	37.65	2.66	7.59	2022/10/1
40	Procter	26.97	2.55	10.43	2021/8/11
41	Bank of America	27.73	2.54	10.07	2019/11/12
42	General motors	29.74	2.12	7.67	2019/8/2
43	Toyota	29.54	2.05	6.49	2019/12/23
44	3M	34.53	2.04	6.29	2019/11/25
45	Gap	15.28	1.76	13.06	2021/6/11
46	Disney	16.28	1.72	11.79	2020/5/4
47	Adidas	14.72	1.54	11.66	2022/12/10
48	Nike	16.58	1.53	10.15	2021/10/25
49	Microsoft	15.24	1.48	10.75	2022/8/2
50	Macdonald's	25.33	0.78	3.19	2019/11/22
	AVG		3.04	12.54	/

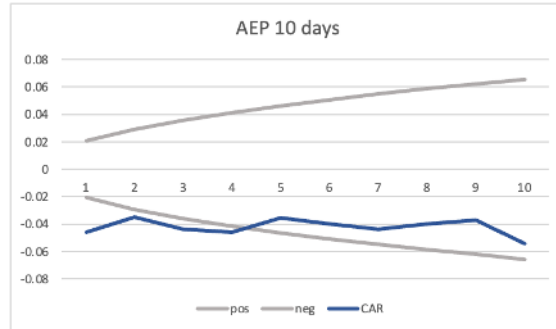


Figure 1: Event study result for America Electric Power with event window = 10 days

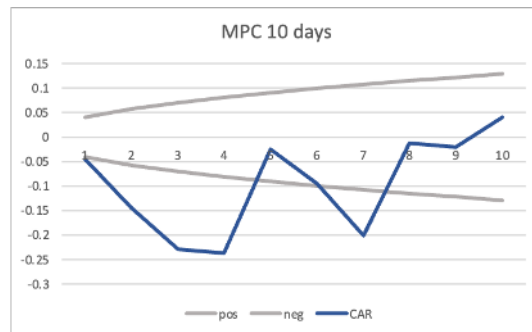


Figure 2: Event study result for Marathon Petroleum Corporation with event window = 10 days

4.2 Event study result analysis

4.2.1 Result for firms with negative Q_{max}

According to the results of the event studies, only five, 27.78%, out of eighteen firms' $CAR(t)$ surpass their confidence intervals: American Electric Power, BHP, DuPont, Marathon Petroleum Corporation, and Nestle. Five firms demonstrate the different forms of influence events have on their stocks' returns. For Marathon Petroleum Corporation and American Electric Power, their returns have been influenced before the event date, which could be considered as “early influence” cases, while for BHP and Nestle, their $CAR(t)$ exceed the confidence intervals at around $t = 32$ and $t = 23$ respectively, which could represent “delayed influence” cases. For the early influence cases, there could be information disclosure or insider tradings beforehand so that returns of stocks have been affected earlier. The third case is “normal, not early or delayed, influence”, represented by DuPont: $CAR(t)$ passes confidence interval at $t = 5$, the fifth trading day after the event happened.

Although only five firms have $CAR(t)$ goes over the confidence interval within 40 trading

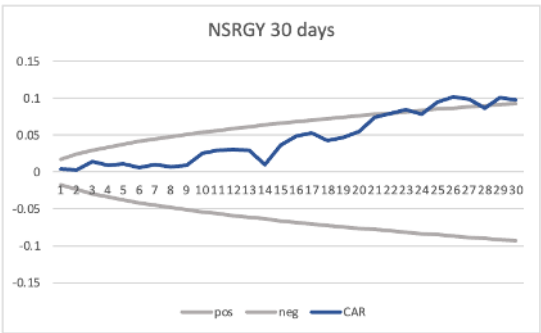


Figure 3: Event study result for Nestl with event window = 30 days

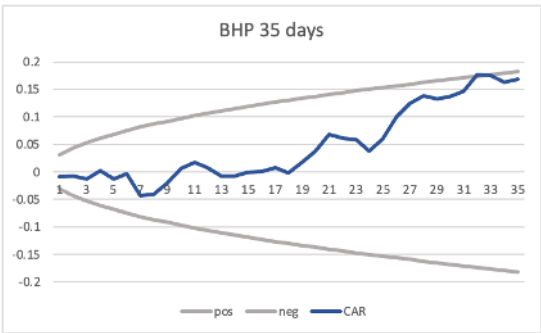


Figure 4: Event study result for BHP with event window = 35 days

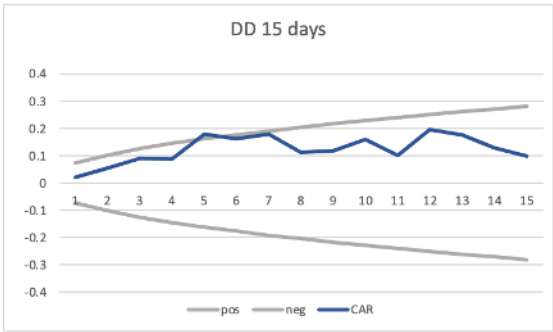


Figure 5: Event study result for DuPont with event window = 15 days

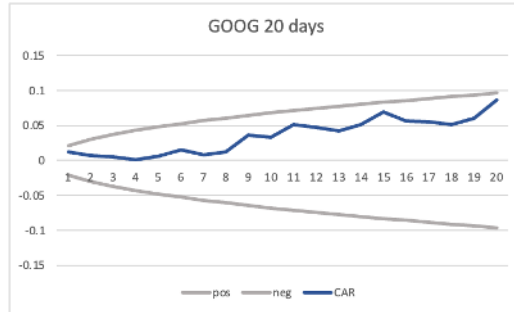


Figure 6: Event study result for Alphabet with event window = 20 days

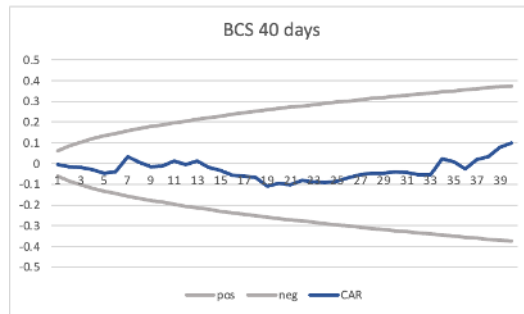


Figure 7: Event study result for BCS with event window = 40 days

days. Within 40 trading days, eight, 61.54%, out of the remaining thirteen firms either exhibit a positive trend in returns or have their $CAR(t)$ s mainly above 0, which means they are close to the positive boundary.

The event studies result of these eight firms, including Alphabet, BCS, Duke Energy Corporation, Glencore, Meta platform, Oracle, Pfizer, and Xcel Energy, are shown above.

The tendency of deviating toward the positive side indicates that a single event may have a positive effect on a single stock, but the impact is inadequate for $CAR(t)$ to exceed the confidence

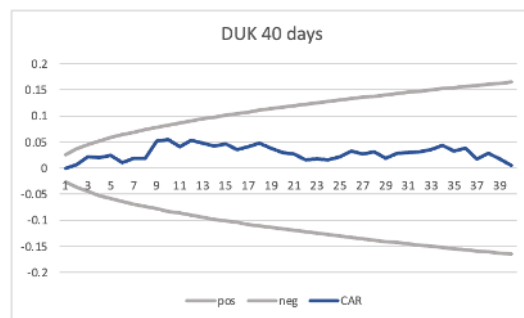


Figure 8: Event study result for Duke Energy Corporation with event window = 40 days

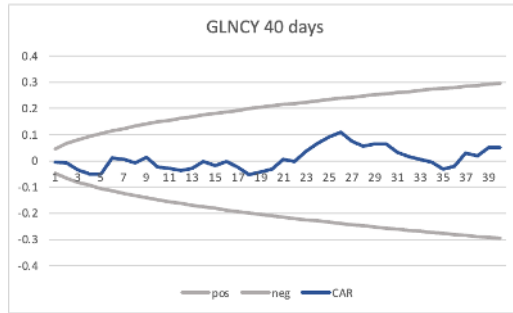


Figure 9: Event study result for Glencore with event window = 40 days

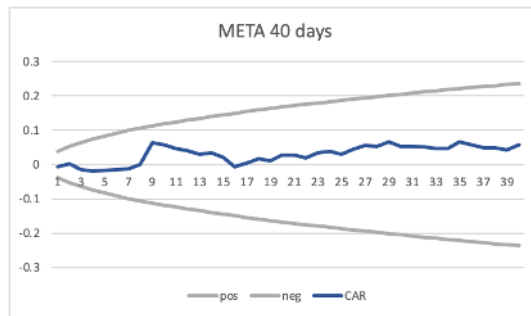


Figure 10: Event study result for Meta Platform with event window = 40 days

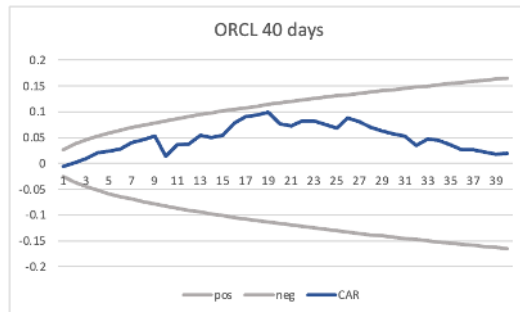


Figure 11: Event study result for Oracle with event window = 40 days

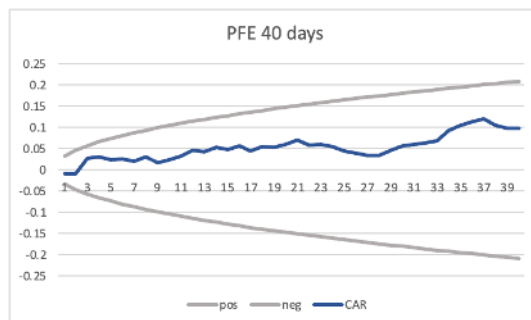


Figure 12: Event study result for Pfizer with event window = 40 days

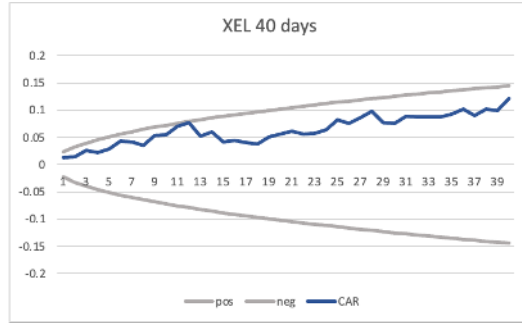


Figure 13: Event study result for Xcel Energy with event window = 40 days

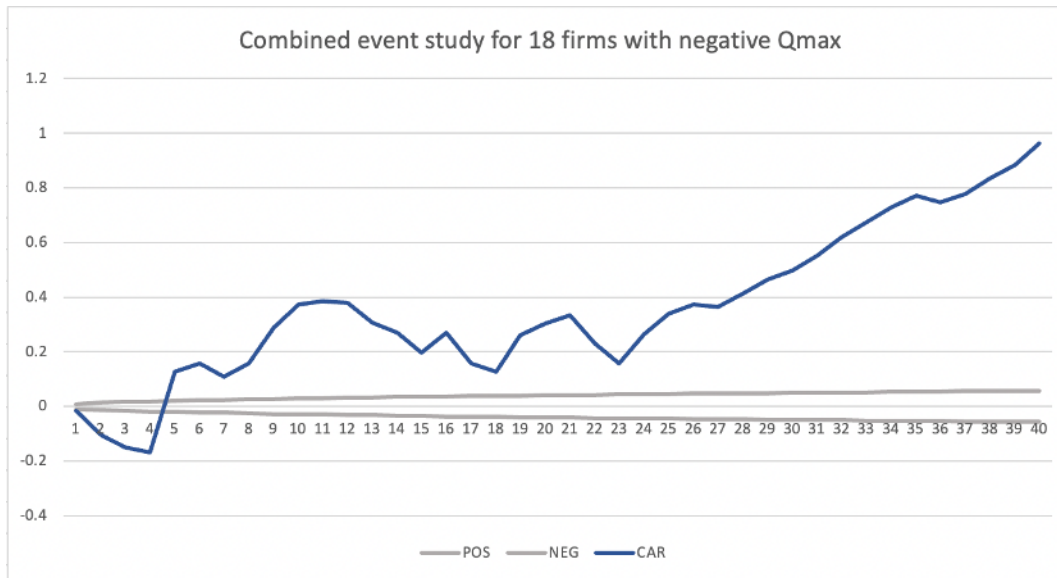


Figure 14: Event study result 18 firms with negative ESG risk rating change

interval. To delve further, this paper attempts to evaluate the combined effect of a series of specific events in order to establish if stocks have been positively affected overall. Part 4.3.3 describes the calculating process, and the overall event study result for these 18 firms together is presented below:

Starting from the first trading day, CAR_t^{18} , the average cumulative abnormal return of 18 firms' stocks with negative Q_{max} at time t, goes beyond the negative boundary of the confidence interval but it soon arises and passes through the positive boundary on the fifth trading day. Then, during the rest thirty-five trading days, CAR_t^{18} exhibits a positively growing trend and deviates further and further from the confidence interval without returning back. The findings of this event study strongly justify the potential positive effect of these events on this collective set of stocks.

Table 4: Comparison analysis for firms with negative Q_{max}

	Firms	ESG Risk Score	Initial ESG Risk Score	#	Market Cap [1]	Industry[2]
Event has statistically significant influence	Marathon Petroleum Corporation	28.56	38.50	-9.94	57.57B	Oil & Gas Refining & Marketing
	American Electric Power	25.81	30.55	-4.74	40.869B	Utilities—Regulated Electric
	BHP	27.55	33.96	-6.41	139.803B	Other Industrial Metals & Mining
	Nestle	24.20	28.30	-4.10	324.363B	Packaged Foods
	Dupont	30.09	34.41	-4.32	34.264B	Specialty Chemicals
AVG			33.14	-5.90		
Event does not have statistically significant influence	Glencore	34.61	39.01	-4.40	66.409B	Other Industrial Metals & Mining
	Pepsico	17.52	21.64	-4.12	246.986B	Beverages—Non-Alcoholic
	Halliburton	30.91	34.61	-3.70	34.28B	Oil & Gas Equipment & Services
	Oracle	14.47	17.84	-3.38	315.017B	Software—Infrastructure
	Walmart	27.98	31.21	-3.23	424.984B	Consumer Defensive
	Barclays	23.91	31.57	-7.66	28.312B	Banks—Diversified
	Apple	16.58	23.65	-7.07	2.792T	Consumer Electronics
	Meta Platform	24.78	31.61	-6.83	734.637B	Communication Services
	Alphabet	22.83	29.62	-6.79	1.642T	Internet Content & Information
	Xcel Energy	23.59	29.56	-5.97	31.757B	Utilities—Regulated Electric
	Duke Energy Corporation	28.76	33.86	-5.10	69.811B	Utilities—Regulated Electric
	Philip Morris International	24.56	29.44	-4.88	147.582B	Tobacco
	Pfizer	25.26	30.01	-4.76	205.4B	Drug Manufacturers—General
AVG			29.51	-5.22		

Hence, even though only 27.78% of individual firm stocks have shown statistically significant impacts, the cumulative influence on a group of stocks is substantial. This finding yields several noteworthy implications. Firstly, it suggests that changes in ESG risk scores do not exert a significant influence on individual stocks. This could be attributed to investors not paying sufficient attention or possibly losing trust in firms with poor initial ESG ratings. Secondly, if the majority of stocks within a portfolio align with environmentally beneficial trends, even small effects can accumulate to exert a strong influence on the overall return trend. However, the cause behind the initial negative cumulative abnormal return remains unclear, as it could be attributed to statistical fluctuations or other specific factors requiring more in-depth analysis. A statistically significant reaction from the first trading day suggests that there might be news or information preceding the ESG rating change that impacts stock returns in advance. In this scenario, investors could have mixed reactions to newly released information, leading to a delay in their ability to respond appropriately.

Through comparison analysis, the paper also tries to explore why events have statistically significant effects on these five firms (Marathon Petroleum Corporation, American Electric Power, BHP, Nestle, and DuPont) rather than other thirteen firms.

The Table 3 below summarizes the information of 18 firms, including ESG Risk Score, Initial ESG Risk Score, Q_{max} , Market Cap, and Industry that each belongs to.

When compared to remaining firms, firms whose stocks have been statistically significantly influenced have some distinguishing features. First, they have a higher average initial ESG score of 33.14. In the Sustainalytics' ESG risk score assessment methodology, 33.14 falls into the

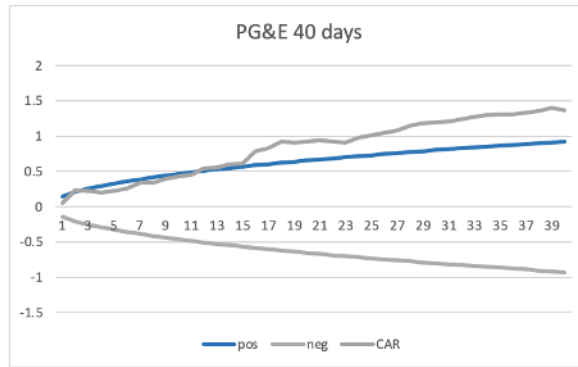


Figure 15: Event study result for PG&E with event window = 40 days

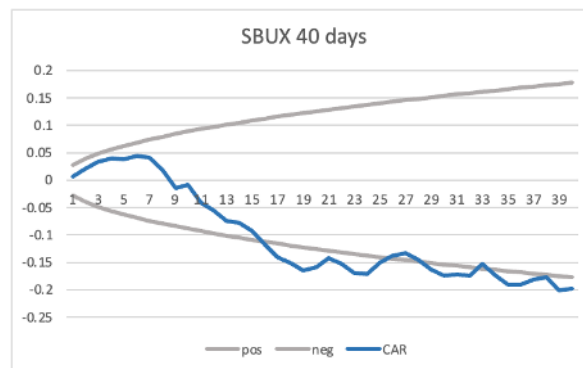


Figure 16: Event study result for Starbucks with event window = 40 days

range 30-40 with a label of “high risk” while the rest of firms have an average initial risk score of 29.51 that falls into the range 20-30 with a label of “medium risk”. Along with higher average initial risk score, these five firms have a higher average Q_{max} : $|-5.90| > |-5.22|$. Moving away from quantitative data, qualitative features indicate why these five firms’ ESG risk score changes have a greater impact. These companies are involved in more environmentally related sectors, such as oil or gas refining and mining. Their methods of functioning are critical to the entire society. More devastating consequences would occur if they failed to implement environmentally sustainable initiatives. As a result, it is probable that more individuals are more concerned about their ESG risk, leading to greater influence of the score. Besides, market capitalization also plays a role in it. Marathon Petroleum Corporation and Halliburton are in similar industries which relate to oil and gas but the former one has a higher market cap than that of the latter one: 57.57B compared to 34.28 B. Similarly, American Electric Power and Xcel Energy, BHP and Glencore, and Nestle and Pepsico are in such situations.

In summary, quantitative factors such as the magnitude of change in ESG risk score and the initial risk score, along with qualitative factors like proximity to environmentally related aspects and market capitalization, collectively contribute to the extent of the impact of ESG risk scores on stocks' returns.

4.2.2 Result for firms with positive Q_{max}

Event studies have been conducted for PG&E, Boeing, Johnson & Johnson, General Electric, Starbucks, and Delta Air Lines. Out of these five, two companies, PG&E and Starbucks, or 40% of the sample, have been statistically significantly influenced by the ESG risk score change. Notably, both PG&E and Starbucks experienced stock returns that crossed certain thresholds without returning.

However, there was a notable divergence between these two event studies. PG&E's stock returns exceeded the positive threshold, while Starbucks' stock returns surpassed the negative threshold. In theory, one might have expected all the influences to follow a pattern similar to Starbucks, but this was not the case.

However, PG&E's unusual performance is intertwined with other factors that exert a stronger positive influence compared to the negative impact of its ESG risk score. PG&E's ESG risk score deteriorated initially because it filed for bankruptcy with a liability exposure as high as \$30 billion, approximately triple the company's market value of \$9.12 billion (Hedstrom, 2019). This bankruptcy was attributed to its alleged responsibility for wildfire-related issues in 2017 (Hedstrom, 2019). However, just one week later, California investigators absolved PG&E of causing the wildfire, instead attributing it to the effects of climate change (Hedstrom, 2019). This shift in perception pushed PG&E's stock prices higher, resulting in the subsequent situation.

5 Conclusion and Evaluation

This paper focuses on evaluating the effectiveness of ESG ratings, utilizing Sustainalytics' ESG Risk Scores as the primary data source. Firms for this study were selected based on ESG-related news over the past few years. The selection of firms for the continued event study was determined

by assessing both the quantitative change and the percentage change in their ESG risk scores.

To measure returns, the study employed the stock prices of these firms in the US market alongside S&P 500 prices. The research used the date of ESG risk score change as a reference point and employed estimation windows spanning 250 trading days before this date. Then, the research examined cumulative abnormal returns over varying time frames, including 10, 15, 20, 25, 30, 35, and 40 days from the reference point.

The findings of this study reveal that a minority of stocks, approximately 27.78%, exceeded the confidence interval during the event window when ESG risk decreased. Conversely, a larger proportion of stocks, accounting for 61.54%, displayed a positive trend in returns, with their cumulative abnormal returns (CAR) predominantly exceeding 0. Potential reasons for why some firms' stocks were more affected than others are proposed in the paper. Additionally, the collective event study demonstrated an overall significant positive effect. Hence, while the impact of ESG ratings on individual firms may often be overlooked, it can have a significant influence on the returns of a portfolio of firms.

Furthermore, in the case of firms experiencing a substantial increase in ESG risk, approximately 40% of their returns were influenced, which is higher than the 27.78% observed for risk decreases. This suggests that investors may be more responsive to ESG risk increases, potentially due to a greater aversion to risk. However, it's worth noting that the sample size for firms with significantly increased ESG risk scores is relatively small, making it less representative. There could be several reasons behind the relatively smaller number of firms with considerably increased ESG risk scores, positive Q_{max} , compared to those with decreased scores, negative Q_{max} . These reasons might include: 1. ESG risks are challenging to assess before major events occur, as some firms may conceal negative aspects. 2. Rating agencies may be cautious about substantially increasing risk ratings to avoid potential disputes. 3. Given the current socio-economic environment, where sustainability is emphasized by both institutions and individuals, more firms may be striving to adhere to ESG standards, resulting in fewer with considerably higher risk scores. Moreover, as elucidated in the paper, there may be firms like PG&E that are influenced by other external factors unrelated to ESG. These factors can be challenging to disentangle without conducting case-by-case analyses, potentially leading to deviations from results solely influenced by changes in ESG risk

scores.

In addition to potential concerns and limitations related to the methodology and data used in this research, there are other limitations stemming from the frameworks of ESG.

The notion of ESG has not yet achieved a state of uniformity and clarity. Furthermore, the selection of the specific ESG indicator is subject to variation among different dimensions and organizations. Consequently, the influence and trustworthiness of the ESG definition are impacted. (Li, T.-T., Wang, K., Sueyoshi, T. and Wang, D.D. 2021)

Hence, the evaluation of firms' ESG performance reveals a significant lack of uniformity. This paper utilizes Sustainalytics' standards, yet there are ratings available from other agencies such as MSCI and Refinitiv.

Discrepancies exist between ratings offered by different agencies due to varying standards and the independent nature of their rating updates. Therefore, further research should aim to provide a more comprehensive analysis of the effectiveness of ratings from different agencies, either through combining these ratings or establishing a unified standard.

Overall, the realm of ESG presents numerous unexplored facets. Many researchers maintain a skeptical stance regarding the fundamental role of ESG systems. Consequently, there exists an urgent necessity for deeper exploration within the realm of ESG analysis. This exploration should place a particular emphasis on the potential role of ESG ratings as a standardized mechanism for regulating firms and encouraging greater social responsibility among them.

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