Corporate resilience and financial performance following climate-induced events: Evidence from the US

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Abstract

This thesis examines the role of environmental, social, and governance (ESG) factors in providing firms with financial resilience to climate-induced events. Using the exhaustive NCEI and EM-DAT database of natural disasters and Refinitive and Bloomberg ESG scores from 2009 to 2019, I show that firms with higher ESG scores experience lower cumulative abnormal returns (CARs) and are then less resilient in terms of performance. This finding contrasts with prior studies that frequently find a positive relation between ESG ratings and corporate resilience. High ESG scores do not bring resilience to firms operating in primary affected states. However, in terms of volatility firms with higher post-ante ESG scores, return on assets (ROA), size, and Tobin's q are less volatile and thus more resilient to the exogenous shocks of natural events, while undervalued firms are more volatile. The results are persistent across firms operating in various industries and primary affected states.

Keywords: *ESG scores; natural disasters, financial performance, corporate resilience, climate change, volatility, stock price performance*

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1. Introduction

Multiple market failures, environmental crises, human and non-human made disasters, and most recently the Coronavirus (COVID-19) outbreak have shocked the international financial markets and caused economic problems during the last few decades. Specifically, the 2008 financial crisis raised alarms regarding corporate ethical behavior, the reliability of risk oversight, and the capability to consider interests of stakeholders (Nicholson et al., 2011; Galbreath, 2013). Environmental, social and governance (ESG) scores, socially responsible investments (SRI), or corporate social responsibility (CSR) measure the impact of corporations on internal and external stakeholders. Authorities, the public, institutional investors, and corporate managers have become sensitive to sustainability concerns. They increasingly have been demanding that companies must implement initiative-taking and active strategies to enhance the quality and availability of corporate responsibility and sustainability reports to address financial and non-financial interests (Bannier et al., 2019; Abhayawansa et al., 2021).

Moreover, the interest in investing sustainably has been rapidly growing among the financial markets participants. The amount of assets invested under ESG strategies increased 15% from 2018-2020, reaching $35.3 trillion globally making up 36% of total professionally managed assets (Global Sustainable Investment Review (GSIR), 2020). The share of sustainably managed investment in the U.S., Canada, and Europe is respectively 33%, 62%, and 42% relative to total assets under management in the world (GSIR, 2020). This highlights the ample interest in sustainable investments.

Financial institutions are more vulnerable to climate-related or environmental disasters and their concomitant financial risks, and this level of exposure to environmental events should be a necessary part of their investment decision-making processes (Boermans et al., 2019; Braun et al., 2019; Breitenstein et al., 2021). According to a Carbon Disclosure Project report (2019), $693 billion of assets undermanagement is at risk accumulated in the financial sector due to climate change impacts[1] and these risks will materialize within the next five years (Breitenstein et al., 2021). Dietz et al. (2016) find an expected "*climate Value-at-Risk*" of $2.5 trillion for global financial assets, and Battiston et al. (2017) emphasize that financial portfolios and climate public policies are interconnected and dependent.

Stakeholders are pressuring companies to engage in sustainable behavior and reduce their negative footprint on our society and the environment while disclosing sustainability measures through comprehensive and appropriate disclosure policies (See Eliwa et al., 2019; Manes-Rossi et al., 2020; Raimo et al., 2021). Hence, along with financial information, stakeholders consider non-financial data a crucial element in making robust financial decisions. To bridge the gap in capital allocation, the disclosure of sustainability measures could have a positive impact.

Recent publications in accounting, finance, and economics journals show that CSR measurements, through SRI and ESG information, can improve corporate financial performance by creating and maintaining positive relationships with major (non-)institutional investors and stakeholders (see Birindelli et al., 2015; Widyawati, 2020; Hoepner et al., 2021). Friede et al. (2015) and Gillan et al. (2021) provide a thorough literature review on the connection between ESG practices and financial performance and show that there is robust evidence in the literature

[1] CDP Financial Services Disclosure report (2020) states that different financial institutions may consider the realization of the risk under various categories: *"credit risk, market risk, liquidity funding, capital adequacy risk, operational risk, policy and legal risk, reputational risk, strategic risk".*

that ESG activities improve financial performance. Companies, through their environmental regulations and commitments, can enhance their profitability and increase productivity since ESG indicators capture additional scopes of financial performance not reflected in accounting data and financial reports. This is because ESG measures contain the important non-financial data stakeholders consider information concerning a firm's environmental, social and governance performance (Bassen et al., 2020).

The recent literature finds either positive or mixed effects for ESG measurements and generally concludes that it increases the ability to sense opportunities and improved financial returns long-term. Specifically, several studies argue that the risk-adjusted returns will be enhanced, and the cost of capital will decrease when ESG considerations come into play, they do so by mitigating long-term risk, reducing idiosyncratic risk, and limiting the agency costs of companies. Firms integrating sustainable factors into their corporate strategy will thus be rewarded by lower risks and are able to better capture business opportunities (Nollet et al., 2016; Polbennikov et al., 2016; Radhi et al., 2019).

However, Gillan et al. (2021) notes that prior studies include inconclusive findings on the effects of ESG and its dimensions on financial performance, and that the results are mixed, containing positive, negative, or neutral impact when one or multiple aspects of ESG are investigated. This study reflects upon research that investigates the effect of either one or more dimensions of ESG or aggregate ESG scores on firms' financial performance (see, e.g., Barnett et al., 2006 & 2012; Brammer et al, 2008; Gillan et al., 2010; Fisher-Vanden et al, 2011; Yeom, 2012; Balatbat et al., 2012; Friede et al., 2015; Han et al., 2016; Galbreath, 2013; Sahut et al., 2015; Sharma et al., 2016; Tarmuji et al., 2016; Nollet et al., 2016; Velte, 2017; Alareeni et al., 2020).

The economic effect of unsustainable business practices and climate events has been studied thoroughly in the economics literature (see, e.g., Schlenker et al., 2009; Dell et al., 2012; Nakamura et al., 2013; Zivin et al., 2014; Hsiang et al., 2014; Burke et al., 2015; Campiglio et al., 2018; Colacito et al., 2019; Khan et al., 2019; Sarkodie et al., 2020; Duqi et al., 2021). The correlation between carbon emission and the US GDP, for example, is strong and suggests that macroeconomic shocks induce cyclical fluctuations in output which instigate the cyclical behavior of carbon emissions (Khan et al., 2019). The literature, in general, argues that climate change and its consequences are a systematic risk to the entire economy and affect all economic institutions, not just specific firms or industries.

The World Economic Forum (WEF, 2022) categorizes extreme weather events as the number one global risk in terms of becoming a critical threat in a two-year horizon; it recognizes climate action failure will become a major threat in a five- to 10-year horizon. Natural disasters, which have become more frequent and severe, and non-natural catastrophes have significant impacts on a macro- and microeconomic level resulting in shareholders paying a premium for firms with robust environmental policies to tackle unexpected natural shocks perceived financial value. Countries' economies and the financial markets have experienced shocks from such events (e.g., carbon emissions, temperature changes, hurricanes, floods, and aviation disasters) (Antoniuk et al., 2021; Bolton et al., 2021). As a case in point, Storelvmo et al. (2016), Gulev et al. (2021), Kotz et al. (2021), and Yuan et al. (2021) show how changes in temperature and precipitation patterns around the globe lead to adverse effects – a trend that has increased.

Climate risks can be divided into two main categories. The first one is physical risk which is mostly related to weather events. In other words, the direct effects of natural disasters include the destruction of physical infrastructure of companies and disruption of the general supply chain (Leiter et al., 2009). The second climate risk relates to transitional risks, such as moving toward a low-carbon economy. The literature argues that climatic trends and weather patterns - temperature, precipitation, tornados, etc. - could deeply affect economic activities, and that low-carbon transition is a sustainable practice that can be used to reduce the influence of climate change on the economy and help companies to mitigate risk. Such risks, expressed through local and global regulatory bodies, can result in unexpected expenses and limit growth, which investors will consider in their investment decisions.

The reaction of the stock market to climate-related policy events (e.g., Paris Climate Accord, Trump presidency, etc.) is an important area of research. This research suggests that introduction and implementation of climate policies instigate a market reaction based both on the structure and content of the policy and on the timing of its introduction (see e.g., Koch et al., 2016; Battiston et al., 2017; Monasterolo et al., 2020; Antoniuk et al., 2021; Birindelli et al., 2021). Other studies, such as Qian et al., (2020) and Alsaifi et al., (2020), attest to the positive impact on the market of the climate-friendly measures companies undertake. These studies show that voluntary carbon disclosure and better carbon performance have a positive impact on market return. The literature also suggests that the market - retail or institutional investors - encourages firms to improve their CSR performance (see, e.g., Dyck et al., 2019; Ilhan et al., 2019; Choi et al., 2020; Krueger et al., 2020; Huang et al., 2022).

Another strand of literature investigates the effects of natural and non-natural disasters on stock markets, real-estate, and the banking industry. The Intergovernmental Panel on Climate Change (IPCC) reports that a warmer climate changes the precipitation pattern around the globe, which can adversely affect food and water resources as well as increasing the risk of floods resulting in the destruction of necessary physical infrastructure (IPCC, 2018). An interesting study by Leiter et al. (2009), examining the changes in company size due to floods in Europe, found that companies in the regions hit worst by flooding experience higher rates of growth in total assets and employment than those in the unaffected regions.

Kumar et al., (2017, 2019) find that stock returns are different between the level of firms being exposed to temperature changes. They studied the relationship between the carbon intensity of firms and their stock returns by defining a risk factor – carbon efficient minus inefficient – and developed a specific multi-factor pricing model. Huang et al. (2022) examine the relationship between corporate CSR activities and different attitudes and beliefs toward climate change. They use natural disasters as exogenous shocks and show a positive correlation between CSR activities and climate change perception. Companies could improve their ESG scores, reduce the negative consequences and improve social concerns over how companies address climate change issues as natural disasters significantly alter perceptions about climate change (Huang et al., 2022). Non-institutional investors react to warmer than usual temperatures by selling carbon-intensive assets in their investment portfolios (Choi et al., 2020). Institutional investors, especially those that signed the United Nations Principles for Responsible Investment (UN PRI), also positively associate with the environmental and social (ES) performance of companies and force firms to improve their ES responsibilities after environmental shocks (Dyck et al., 2019). Krueger et al. (2020) survey global institutional investors and find that investors take climate risk seriously and proactively engage in climate risk management in their portfolio investments. The existing literature documents the positive association between ESG information and the financial performance of companies (Amel-Zadeh et al., 2018).

Bolton et al. (2021) find that investors ask for carbon premium and price carbon-related climate risks when they invest in stocks associated with higher rate of carbon emission. To mitigate and control the risk of extreme disasters, firms can use insurance and make strategic decisions to manage the negative impacts of disasters. However, the prevalence and intensity of disasters may have a negative effect on the choices they make and have a significant effect on the firms themselves (Seetharam, 2017). In asset pricing theory (APT) the net premium of temperature fluctuations as a systematic risk is significantly negative (Balvers et al., 2017).

Wang et al. (2013) study the effect of natural disasters on the insurance industry, composite indices in Japan and the U.S., and the spillover of the volatility from one market to the other. Bourdeau-Brien et al. (2017) extend the event horizon window and show that two to three months after hurricanes, floods, and extreme temperatures, abnormal returns emerge and the volatility of the U.S. firms closest to the affected regions would be doubled. Branikas et al. (2021) employ ESG and Environmental Protection Agency (EPA) data and suggest that corporations improve their environmental sustainability standards after wildfires. Apergis et al. (2022) investigate how information regarding the total number of confirmed Covid cases and deaths would affect the returns and volatility of the Chinese stock market. Both measures have a significant negative effect on returns and volatility. Tornados may cause a price drop in the housing sector and, as well, have a negative impact on stock returns (Donadelli et al., 2020), but the negative effect is limited to the consumer discretionary and telecommunications sectors.

Finally, researchers have investigated aviation disasters. Walker et al. (2014) study the effect of aviation disaster on short- and long-term stock return performance of airlines and airplane manufacturers and the factors causing the performance differences. They find that anticipated legal liability claims are the main cause of different performance. Moreover, their findings suggest mixed results regarding the efficient market hypothesis (EMH). The stock returns drop one day after a disaster, followed by further decline within a week; this contradicts the EMH. However, the market is somewhat more efficient depending on the different types of accidents and their expected future liability costs on long-term horizon.

As discussed, economic and finance researchers have widely studied the effects of climate change and natural disasters on economies and financial markets, showing the growth of ESG/CSR activities. Research in finance has paid particular attention to investigating the relationship between the implementation of ESG ranking and corporate financial performance. However, it appears that inquiry into how the ESG rating of a firm could influence their performance after natural disasters has not been fully answered yet. Since understanding and implementation of ESG and sustainable practices has increased in the last decade, we expect that firms with higher ESG ratings will be more resilient to shocks caused by natural disasters.

2. Literature Review

Environmental disasters and climate change may affect the future performance of a firm, and public awareness pushes them to devise, implement, and refine sustainable strategies and information disclosure policies (Nor et al., 2016; Buallay et al., 2019). Wagner et al. (2004) investigated the connection between environmental and economic performance of European companies under the heading “corporate environmental strategies.” They conclude that there is a positive association between these factors for firms that employ these strategies, which are also value-oriented for shareholders.

According to Roberts et al. (2013), it is an arduous task to infer causality from correlations between different corporate variables. They argue that high profitability may enable firms to allocate the necessary funds to improve their ESG score; that is, higher ESG scores are the result of better financial performance. Thus, discerning endogenous and exogenous ESG dimensions is crucial. That is, firms performing better can allocate extra resources to ESG activities and performance pushes ESG activities forward (causality moves in the opposite direction). Literature suggests that ESG performance and firm value are positively correlated and greater ESG performance can increase firm value through two channels. First, ESG activities could decrease the discount rate and cost of capital or increase cash flow and then create value and increase shareholder wealth. Second, ESG activities may maximize shareholder utility and result in creating value (Fatemi et al., 2017). From the agency theory perspective, however, ESG activities could reflect that corporate managers take sustainability measures to improve their reputation. This is an example from empirical studies suggesting that ESG activities are not in the interests of shareholders but an outcome of agency problems (Hvidkjær, 2017).

Though a positive relationship is the predominant view, studies have provided contradictory or inconclusive results when examining whether financial performance is positively affected by corporate social responsibility (CSR), a broader concept than ESG. Some studies have suggested financial performance is positively related to CSR activities by improving stakeholder relations which in turn reduces firms costs and increases market opportunities (Dhaliwal et al., 2011; Kim et al., 2014). CSR practices, such as corporate strategies, would enhance financial performance since CSR impacts company reputation and customer satisfaction (Taneja et al., 2011).

Kim et al. (2013) show that in the Korean stock market, CSR activities increase firm values. The greater disclosure of CSR measurements increases the value and financial performance of firms, improves performance in the debt market and emerging markets, and reduces company risks (Dhaliwal et al., 2011; Kim et al., 2013). Firms disclosing ESG information benefit from lower cost of capital (Dhaliwal et al., 2011; Cheng et al., 2014). Firms disclosing sustainability information experience greater price informativeness and lower negative stock reaction if they have higher predictive nonfinancial performance and disclosure levels (Grewal et al., 2019; Grewal et al., 2021). Barnett et. al (2012) considers CRS activities as the main tool to foster stakeholder trust and confidence and to positively affect profit and financial performance.

Friede et. al (2015), Hvidkjær (2017), and Gillan et. al (2021) analyze the literature and find that researchers have employed financial and accounting variables with a variety of statistical techniques to study firm performance and ESG scores. The ESG metrics are more applicable since the subparts are measurable and there is sufficient information regarding its metrics. Tarmuji et al. (2016) show that higher levels of ESG would bring higher financial performance. In research on the effects of news-based ESG scores on yearly return on assets (ROA), Pasquini-

Descomps et. al (2013) find that improvements to the image of a firm image due to its ESG variation increases the ROA. Amiraslani et al. (2022) find firms with high ESG score benefit from bonds with higher prices and lower return.

The relationship between ESG activities and accounting-based performance measures such as ROA and return on equity (ROE) have also been investigated, and the findings suggest a positive relationship. Gillan et al. (2010) examines the association between firm ESG ratings and firm performance. They found that companies having a higher ESG score will perform better in terms of operating performance and Tobin's q. Borghesi et al. (2014) find that higher CSR levels and ESG ratings are better performing and have greater free cash flow. Gao et al. (2015) find ESG scores and Tobin's q are positively correlated. Ferrell et al. (2016) find firm value increases as ESG scores increase. Chang et al. (2019) ESG measurements create firm value, and firms with higher ESG scores have higher value of additional cash holdings.

Bolton et al. (2020) find that lower CO2 emission have low stock returns since such firms have a low cost of capital. ESG positive effects have also been evaluated for their positive relationship with stock returns. Dimson et. al (2015) and Edmans (2011) observed that ESG practices create value and find a positive relation between returns and ESG performance. The results also suggest that ESG firms have slowly diminishing high stock returns since the market considers the ESG measurements as intangibles and will be correctly priced as those become tangible to investors.

The study of the performance of ESG firms during crises showed that higher ESG scores will perform better and then these firms will earn higher returns relative to other firms (Lins et al., 2017). Cornett et al. (2016) examine US banks and find a positive relationship between ESG scores and bank ROE. Statman et al. (2009) examine the portfolios of firms with higher ratings and find a positive relationship between ESG ratings and firm performance. Krüger (2015) studies US market reaction to sustainability events and finds a significant difference in the market reaction to positive and negative events. Tang et al. (2020) examine the benefits of issuing green bonds for shareholders and find market positively reacts and subsequently, liquidity and institutional ownership will increase.

Flammer (2021) concludes that the issuance of green bonds changes ESG activities of firms and instigates stock market positive reaction. Serafeim et al. (2021) present the first evidence that attempts to distinguish the most important ESG dimensions (material) from less important ones, and they find performance is positively correlated with ESG criteria. Bannier et. al. (2019) examine the probability of investing according to ESG criteria in the U.S. and Europe and find that "portfolio[s] long in stocks with the highest ESG scores and short in those with the lowest scores yield a significantly negative abnormal return" (p.1).

There are, however, a myriad of studies whose results suggest a mixed or negative relation between ESG and financial performance. Han et al. (2016) find that ESG disclosure has mixed results by studying the Korean market companies. They showed that corporate governance has either positive or inverse U-shape relationship with the financial performance, and the environmental factor has a negative U-curve relationship and did not find any significant relationship between social metrics and financial performance.

Fiasher-Vanden et al. (2011) study abnormal stock returns around announcements from firms that they have joined two voluntary environmental programs. Their results reveal a statistically and economically significant 1% (3 billion USD) drop in market values when firms join the

Climate Leaders program and another 1% drop in the market value when firms announce their specific reduction targets. They conclude that CSR activities have a negative effect on financial performance. Krüger (2015) studies the stock market response to 2,116 corporate events. He finds negative ESG events negatively and significantly affect the cash flow. Brammer et al. (2008) study charity activities of corporations and show that higher levels of CSR mean higher levels of financial performance and vice versa. Their results suggest a U-Shaped relationship.

Engaging in SRI activities does not necessarily increase costs; however, by increasing their levels of social responsibility practices, firms do often suffer higher costs (McWilliams et al., 2001). There is empirical evidence in the literature which shows that the relationship between sustainable and regulatory measures and financial performance is weak. Elsayed et al. (2005) measured accounting measures of financial performance, e.g., ROA, return on sales, and Tobin's q and found evidence that shows environmental practices have a weak impact on financial performance.

Di Giuli et al. (2014) find no statistically significant relationship between revenue growth and change in ESG scores when examining the relationship. Moreover, they find a significant negative relationship between ESG score changes and changes in ROA or stock returns. Buchanan et al. (2018) use the Bloomberg ESG rating and find a significant negative relation between ESG/CSR activities and Tobin's q after the 2008 financial crisis. They conclude agency conflicts became intensified after the crisis, and firms value decline larger for firms with higher ESG/CSR activities which over-invested in ESG.

Literature on climate change and natural disasters explores corporate performance from different perspectives trying to understand the links, if any, between two. Carbon emissions, natural disasters, and weather changes such as hurricanes, floods, as well as temperature fluctuations in the US, EU, Japan, China, and Australia are at the center of attention. The literature falls short in providing conclusive evidence on the significance of natural disasters on stock valuation and return. No meaningful change (e.g., Wang et al. (2013)), negative (e.g., Lanfear et al. (2019)), or positive (Leiter et al. (2009)) outcomes have been reported.

Stock prices incorporate damage and destruction information of natural disasters and respond based on the capacity of a firm to deal with the aftermath. Companies exposed to natural disasters, on average, experience lower market pricing in the US market (Seetharam, 2017). Seetharam's research employs an event study and includes daily stock data of public firms between 1980-2014. Examining 122 natural disasters, the study finds that exposed firms lost value long after the day of the disaster. Baker et al. (2013) study natural disasters, terrorist attacks, and unexpected political shocks, and the results convey that the stock market reaction to disaster is insignificant. Koerniadi et al. (2016) suggest differences in stock market reactions based on the nature of the disasters and related industries.

In et al. (2017) define a carbon related risk factor, efficient minus inefficient (EMI), and study US firms from 2005-2015. They find a large positive cumulative return in the EMI portfolio and argue that the portfolio explains the results. They also suggest characteristics of carbon-efficient firms and argue that those firms usually have lower book-to market ratios, higher Tobin's q, ROA, coverage and dividend payout ratios, and lower leverage ratios. By employing the daily and monthly returns of US firms, Kumar et al. (2019) estimate the excess market return and the abnormal temperature through a time-series regression model to assess the potential of temperature changes to predict stock returns. Their results suggest that stocks with higher climate sensitivity have lower returns, and that the higher climate sensitivity, abnormal temperature observations from the average temperature over 30-year window, predict lower profits.

Corporate default risk measure is negatively correlated to the carbon emission of companies; that is, the distance-to-default signals of the carbon-intensive company signal the market to ask for higher premiums for corporate bonds and loans (Capasso et al., 2020). The cost of debt is higher for companies which are more vulnerable to climate risk and data does not support the theory that vulnerability affects the cost of equity according to Kling et al., (2021). They create an index for climate vulnerability and employ the panel instrumental variable regression and structural equation models to demonstrate that companies in developing countries whose economies are more influenced by the climate stresses are more financially constrained and are burdened with higher financing costs. Companies exposed to higher levels of climate risk encounter financial consequences such as higher cost of capital, wider yield spread, and lower credit scores. Even the institutional investor composition is subject to change (Seltzer et al., 2021).

The market return in the EU ETS, which has the largest cap-and-trade system in the world, responds positively to carbon emission roadmaps for 2020 and 2030 (Koch et al., 2016). Battiston et al. (2017), by studying EU banks, illustrate that a stable and credible framework of introducing and employing climate policy results in a smooth response by investors. On the other hand, abrupt and uncertain policies to address climate events, such as extreme weather changes, brings systematic risk to the financial system. Monasterolo et al. (2020) investigate whether low-carbon investments, by reducing the systematic risk, add value to investment portfolios in global stock markets after the Paris agreement (PA) announcement, and find the correlation between two indices decreases and the markets reward the low-carbon indices, increasing the weight of such investments and consequently their performance.

Antoniuk et al. (2021) using the PA and Fukushima disaster show that investors, specifically stock markets and ETFs in all sectors better realize the climate transition risks after these events and adjust prices accordingly. Their results are in line with Battiston et al. (2017). In another study, Birindelli et al. (2021) suggest that sector where companies are operating are more influential than their commitment to the environmental policies introduced by the EU, and that those would mostly react negatively to the climate-related policies. Diaz-Rainey et al. (2021) provide evidence that the oil and gas sector implied volatility is increased and impacted by the Paris Agreement (PA). Companies in regions affected by the flooding and with larger intangible assets have a higher growth rate in terms of total assets and employment. Though the productivity of firms drops, the drop is higher if the intangible asset share is larger (Leiter et al., 2009). The authors use the difference-in-difference methodology and cross-sectional data of the EU companies to study the effect of flooding on capital accumulation, employment, and productivity of two groups of companies.

Bolton et al. (2021) study the relation between US stock returns and carbon emission intensity and find that carbon emission is significantly and positively correlated to stock returns. Institutional investors consider carbon emission in their decision making and ask for premiums in specific industries. They argue that carbon-intensive stocks have lower demand which supports the idea that some institutional investors tilt toward ESG investment practices. Hong et al. (2019) state that climate change risks for the food industry caused by drought are not appropriately captured by investors. Their results suggest that the market is inefficient in responding to climate risks in the food industry.

Hwang et al. (2021) provide evidence that managers and investors who are interested in SRI sacrifice firm value or return on their portfolios. Huang et al. (2022) employ the Yale climate opinion maps database and find that companies operating in counties whose residents believe in the adverse effects of climate change have higher ESG scores; they translate this association into a higher level of commitment to CSR activities of such firms, demonstrating that firms improve their ESG score after natural disasters. The correlation is even stronger if local investors have invested in the companies. Choi et al. (2020) show that retail investors adjust their portfolios after extreme temperature increases. Natural disasters could influence ESG disclosure policies. Companies implement environmentally friendly technologies and practices more quickly after wildfires, especially in counties more inclined to negative climate change outcomes (Branikas et al., 2021). Moreover, the business activity of firms may have a pronounced effect on the impact of natural disasters (Apergis et al., 2020). They demonstrate that carbon-intensive stocks significantly underperform after such events and substantiate their results by showing that underperformance does not originate from future cashflow expectations. Instead, they argue that short-term trends are taken more seriously by retail investors rather than by institutional investors.

Where institutional ownership is greater, so too is investor demand for higher social and environmental improvement from firms. The outcome is consistent for firms in various countries whose communities have different views regarding sustainable business practices Dyck et al., (2019). Ilhan et al. (2019), Krueger et al. (2020), and Chen et al. (2020) find equivalent results. They state that climate change risks are important to institutional investors, and that the larger, ESG-oriented investors are actively engaged in managing climate risks in their investment portfolios. Institutional investors consider financial and non-financial motives when managing their portfolios; they believe that the monetary impact of climate change has materialized. In other words, a larger presence of institutional investors may yield better CSR ratings.

Siddikee et al. (2017) show that shocks from bushfires in Australia have a long-term influence on the capital market and the resultant volatility caused could be transmitted to capital markets in other countries. Bushfires, storms, cyclones, floods, and earthquakes are common in Australia. Worthington (2008) finds a positive reaction from the market to bushfires, a significant negative one after cyclones, and mixed results after earthquakes. Lanfear et al. (2019) investigate the anomalies and abnormal returns after US landfall hurricanes. They use a factor model to sort the US daily stocks across various portfolios based on the market equity, book-to-market equity ratio, momentum, ROE, and investment to assets ratio and provide evidence showing that portfolios reveal different reactions to natural disasters.

Bansal et al. (2016) states that “virtually all US equity portfolios have negative exposure (beta) to long-run temperature fluctuations. The elasticity of equity prices to temperature risks across global markets is significantly negative and has been increasing in magnitude over time along with the rise in temperature” (p.1). After controlling for global risk factors, their results imply that if increases in temperatures continues, the net value of equities around the world will decrease dramatically. Balvers et al. (2017) hypothesize that tracking portfolios based on value, size, and industry has a notable risk premium and negative effect on cost of equity capital. They show that future temperature changes inject uncertainty into the financial system and increase the cost of capital. Wang et al. (2013) employ the GARCH models to investigate the wealth and risk effects of natural disaster on the composite indices and insurance industries in Japan and the US. They argue that since both composite indices are perfectly diversified against various risks, they could safeguard market returns. However, while the insurance industry in the US is vulnerable to natural shocks and loss, the Japanese markets gain. The US composite index and insurance industries in both countries are affected by natural disaster risk, but the Japanese composite index is immune to the risk of natural disasters.

Bourdeau-Brien et al. (2017) suggest that extreme weather events have no significant effect on stock returns in the short term, and meaningful abnormal returns emerge two to three months after the events. They argue that understanding and incorporating relevant information regarding the consequence of events takes time, and that markets are not able to immediately capture all necessary information to price stocks. The sizes, industry, and proximity to the affected regions could not, alone, explain abnormal returns. Donadelli et al. (2020) show that tornados reduce house prices in the US South and Midwest. This negative pressure is transferred to adjacent regions in a contemporaneous and lagged manner, and the depth of the pressure is determined by the intensity of tornado and income drop of regions. The results also suggest that stock returns are positively influenced in the Midwest, while they are negative for the South. Consumer discretionary and telecommunications sectors are responsible for the negative stock returns: "the financials and healthcare (consumer goods, industrials, healthcare, technology) sectors in the South (Northeast)" (p.14) are the main negatively affected sectors (Donadelli et al., 2020).

Finally, employing a comprehensive sample of civil aviation disasters from the U.S. National Transportation Safety Board (NTSB) from 1995-2009, Walker et al. (2014) analyze the stock performance of airlines and airplane manufacturers after aviation disasters. They employ multiple regression models to control interconnection among various explanatory variables. The results suggest that the average price decline of airlines within the first two trading days is larger than that of the airplane manufacturers. Moreover, the abnormal return is negative and significant up until three months after the crash, while the negative abnormal return resulting from aviation disasters is not persistent for manufacturers. They show that factors related to the disasters explain investors reactions and the resulting differences in cumulative abnormal returns (CAR). The expected legal liability claims and expected large increases in insurance premiums shape investor reactions to a disaster announcement. Domestic incidents, massive casualties, and criminal/terrorist disasters instigate price decreases, and larger airlines experience more severe negative and abnormal returns. Finally, Walker et al. (2014) highlight that, in contrast to the EMH expectations, the downward price movement will persist even after a week. Kaplanski et al. (2010) provide another example that aviation disasters trigger increases in implied volatility and huge losses to firms with weaker financial stability.

3. Data & Methodology

To study corporation resilience to natural disasters, namely the relation between the stock performance and ESG score, I employ the US daily stock returns and corporate level control variables and merge them with the natural disaster data. I consult two major databases: the Emergency Events Database (EM-DAT) by the Centre for Research on the Epidemiology of Disasters (CRED) and the National Centers for Environmental Information (NCEI) of the National Oceanic Atmospheric Administration (NOAA). The former includes a comprehensive list[2] of disaster types, such as natural (geophysical, meteorological, hydrological, climatological, biological) and technological (industrial and transport accidents). The list contains the date, geographic location (all affected regions), net US dollar and CPI-adjusted damage, number of deaths, and classification of events type. The latter[3] includes state-level data on the frequency of environmental disasters (drought, flooding, frost, severe storm, tropical cyclone, wildfire, and winter storm), the geographic location, the CPI-adjusted damage, and the total number of deaths for the US territory.

The first step is to select a sample of events from a wide range of natural disasters that happened from 2009-2019. EM-DAT categorizes the natural events into six relevant categories[4] from geological and meteorological studies. I use two categories relevant to finance literature: disaster group (natural and technological) and disaster subtype (convective/severe storm, tropical cyclone, winter storm). I include the NCEI state-level and the EM-DAT data to filter the number of applicable events. According to the data, seventy-two severe storms and tropical cyclones occurred between 2009-2019. Table 1 summarizes the total number of events, number of deaths and CPI-adjusted damage of the events. Total cost for all events was 563.3 billion dollars (CPI-adjusted), and tropical cyclones and severe storms constitute 73.7% of the total damage and 84.27% of total deaths (NCEI, 2022) with a number equal to 1559 people.

Insert Table 1 about here

Droughts could be candidates as well; however, droughts are long-term events lasting more than six months, and defining a specific event date to study the abnormal returns (AR) and cumulative abnormal returns (CAR) for such events is technically impossible. The state-level data reveals that the eastern and south-eastern regions of the US are most frequently hit by natural disasters. Texas, Colorado, and Illinois are frequently hit by severe storms and tropical cyclones. In terms of cost of damages, Texas ($185.2 billion), Florida ($93 billion), New York ($84.6 billion) and North Carolina ($39.9 billion) are the top four states. Table 2 summarizes the state level frequency, the CPI-adjusted damage costs, and the number of casualties.

Insert Table 2 about here

I use two criteria to filter the relevant events for this study: the state-based number/frequency of events and damage cost. The first natural events database contains 215 events; however, the events cluster around certain months and certain states. The second criterion is the total CPI-adjusted cost (above one billion dollars) and the number of states affected by the event.

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[2] For further description of the database refer to https://emdat.be/classification

[3] For further description of the database refer to https://www.ncei.noaa.gov/access/billions/

[4] Disaster Group, Disaster Subgroup, Disaster Type, Disaster Subtype, Disaster Sub subtype, and Event Name.

The next step is to extract the company financial information. I consulted four major databases: the Reuters Refinitive, Bloomberg, CRSP and Compustat from Wharton research data services. I use the Reuters database to obtain information on NASDAQ and NYSE listed companies along with their yearly ESG scores. After trimming the database for duplicate observations and missing data points, the sample reduces to 2,417 firm observations. I match the ticker and the name of the companies from the Reuters database with CRSP and Compustat to find the Global Company (8 and 10 digit) key codes (GCK), PERMCO, PERMNO, and CUSIP and then download the IPO date and headquarters information from CRSP and Compustat.

I compile the companies list by including all datasets and create an exhaustive list of 2,417 companies based on the availability of the company names, GCK, CUSPI, PERMNO, PERMCO, states, and ESG scores. The data contains 1,252 companies from NASDAQ and 1,165 companies from NYSE. Table 3 presents a summary of companies and industries in the sample. I then use the Bloomberg terminal and download the financial data for the control variables suggested by the literature including ROA, total assets (TA), Tobin's q (TQ), market capital (MC), and book-to-market ratio (BM). ROA is an accounting performance measure of company profitability over its total assets. It is conventional in finance literature to calculate the natural logarithm of total assets as a proxy for company size. TQ is a ratio of TA market value and its replacement cost, and it is proxy for future investment opportunities. Finally, MC is the market value of outstanding common shares of a company, and BM is ratio of book value of equity to its market value and a proxy for the market price of a company.

Insert Table 3 about here

To study whether companies with higher ESG score are more resilient in the event of a natural disaster, I estimate the ARs and CARs around an event for a given company and then regress its CAR against the ESG score and companies and events control variables. To calculate ARs and CARs, I employed the event study methodology. Finance researchers use the event study methodology to study stock price fluctuations around certain events affecting corporation stock prices ranging from corporate announcements to external shocks, such as natural disasters. The logic is that stock price fluctuations reflect information important to pricing company stocks, and capital markets should price all available information regarding firms.

A natural disaster can disturb the status quo for corporations in the capital market and may initiate price fluctuation. To study the event effect, researchers analyze either positive or negative divergence from the expected normal return of the market; they employ various models such as market, market-adjusted, and Fama-French models to estimate the normal return and deduct the observed returns (actual returns) from normal expected return to estimate abnormal company returns. The expected excess normal return ($r_{i,t}$) estimation on a specific day (t) for a firm (i) is:

$$r_{i,t} - r_f = \alpha + \beta_i\left(r_{m,t} - r_f\right) \tag{1}$$

The abnormal return ($AR_{i,t}$) is the deduction of the estimation and the realized return ($R_{i,t}$), and the cumulative abnormal returns (CAR) are the sum of AR for a given event window:

$$AR_{i,t} = R_{i,t} - r_{i,t} \tag{2}$$

$$CAR_{i,\tau} = \sum_{t=\tau_1}^{\tau_2} AR_{i,t} \text{ , } event\ window\ \epsilon\ [\tau_1, \tau_2] \tag{3}$$

There are several statistical procedures in the literature which test whether the abnormal returns are significantly different from zero. This includes the parametric, e.g., cross-sectional t test, standardized cross-sectional t test, Pattel's Z test, and non-parametric tests, e.g., Willcoxon signed test, sign test, generalized sign and rank test. I used the standardized cross-sectional t test as the reference since the test is robust when used for variances induced when the events are clustered according to Boehmer, Musumeci, and Poulsen (1991). The formula is as follows:

$$t_{scs} = \frac{\frac{1}{N}\sum_{i=1}^{N} SCAR_{i,t}}{\sqrt{\frac{1}{N(N-1)}\sum_{i=1}^{N}[SCAR_{i,t} - \frac{1}{N}\sum_{i=1}^{N} SCAR_{i,t}]^2}} \tag{4}$$

$$SCAR_{i,t} = \frac{CAR_{i,t}}{\sqrt{N.Var(\varepsilon_{AR_i})}} \tag{5}$$

I use the panel regression model to further investigate the relationship between the CARs and ESG score and related control variables. The panel regression model is a widely employed econometric model used to study longitudinal data (cross-sectional data) across time. Panel regression is a combination of pure cross-sectional regression, where the number of units is large, and time series, where the number of time units are large. Such a model considers panel units and time effects and allows the researcher to control for "idiosyncratic" unit effects across time and for units in a specific time. Thus, the panel regression model can provide a better, more robust estimation of the unknown parameters than the ordinary least square (OLS) model and is flexible in modeling units behavior differences (Greene, 2017, pp. 375-380). Hsiao (2010) mentions several advantages of the panel regression model. The model can provide a greater understanding of data due to its power to capture unobserved effects in cross-sectional and time series models, its high degree of freedom, more robust estimation, and reduction of collinearity between covariates.

Fixed-effect (FE) and random-effect (RE) models are the two main regression models researchers employ in the literature. If the units unobserved effects correlate with the explanatory variables observed effects, the model is FE. The FE investigates the within unit (also entity or group) variation of dependent and independent variables and whether within characteristics of dependent variables can influence the dependent variable (see Brooks, 2008; Greene, 2017). The formulation of FE and RE models is as following for unit (i) at time unit (t):

$$Y_{i,t} = \alpha + \beta_i X_{i,t} + \varepsilon_{i,t} \tag{6}$$

Unit individual constant effect μ_i and unobserved time and unit varying term $\delta_{i,t}$ comprise the error term $\varepsilon_{i,t}$ and the regression model becomes:

$$\varepsilon_{i,t} = \mu_i + \delta_{i,t} \tag{7}$$

$$Y_{i,t} = \alpha + \beta_i X_{i,t} + \mu_i + \delta_{i,t} \tag{8}$$

The FE model coefficients are constant, and the intercept is time-invariant but varies within units (cross-sectionally). The FE model explains the sample of study but is not able to provide out of sample predictions. However, the RE model may explain the variations when the unit effects are uncorrelated with the independent variables and variation among units are randomly distributed (Brooks, 2008); the RE is applicable when the variation among units can influence the variation in the response variable. It is common to use the Durbin-Wu-Hausman test to check whether the RE model is appropriate or not. The final characteristic of the panel regression model is a balanced or unbalanced panel. If the number of time observations are equal across all units, the panel is balanced and if they are not equal the panel is unbalanced.

The next step is to construct a portfolio of events-companies to do the event study by compiling the events, Refinitive ESG scores, and Bloomberg control variable matrices. I apply three conditions to create the portfolio; the conditions are that a company in the main and adjacent states must be active within the event horizon, and that the ESG scores and control variables are available. I also adjust the event dates for holidays in the US calendar to fully capture all events across the sample. Table 4 summarizes the number of observations per year.

Insert Table 4 about here

Since the literature includes size, natural logarithm of total assets, as a control variable, I pick the same control variable and take MC out of the study. I form the final study matrix including CAR as the dependent variable, and ESG and other control variables as the independent variable. Thus, the study regression model is as follows where (i) is the number of units and (t) is the number of periods in the panel data:

$$CAR_{i,t} = \beta_0 + \beta_1 ESG_{i,t} + \beta_2 ROA_{i,t} + \beta_3 TQ_{i,t} + \beta_4 BM_{i,t} + \beta_5 Size_{i,t} + \beta_6 DMG_{i,t} + \beta_7 DTH_{i,t} + \varepsilon_{i,t} \quad (7)$$

4. Results

I use the US daily event study provided by WRDS to estimate the ARs and CARs from the event matrix. The software estimates the AR and CAR both cross-sectionally and individually. The results corroborate existing finance literature, showing that markets react a few days after the events because it takes time for market participants to realize the damage and consequences of natural disasters. Moreover, the results also suggest that on average, cross-sectional CARs are significantly negative seven days after an event, indicating that the market reacts negatively to natural disasters. The average AR at the end of event window, day seven, is -0.1128% and is significant at 1%; the CAR at the end of the event window is -0.1263% and is significant at 1%. The drop in the CAR from day six to seven is large and suggests a significant negative reaction suggesting that the market might take time to realize the destruction caused by the natural disasters. Table 5 shows the event study results.

Insert Table 5 about here

I download the available CARs of each company from 2009-2019 and allocate an identification number as the unit number to prepare the data to run the panel regression analysis. Table 4 shows that the number of firm-year observations is different for the study period, which includes CARs, ESG scores, and companies and events control variables, which forms an unbalanced panel data. Table 6 presents the descriptive statistics of the sample.

Insert Table 6 about here

The correlation matrix shows that the correlation between ESG and market cap and size is high and is equal to 0.4 and 0.56, respectively. This suggests that larger companies have higher ESG scores and supports, and that, on average, larger companies are capable of investing in their ESG score to increase it. The coefficient between market cap and size is 0.828 which is statistically significant and raises the alarming possibility of collinearity in the model. To further investigate the multicollinearity in the model, I use the variance inflation and observe that the centered VIF for is 2.374 and 1.9 for market cap and size, which results in a collinearity issue. The VIF analysis provides a threshold to judge the collinearity issue and suggests if the VIF value is above 1.7, an independent variable is significantly correlated with another independent variable (Kutner, 2004). Table 7 contains the correlation (panel A) and the independent variables VIF (panel B) matrices.

Insert Table 7 about here

I apply univariate tests to provide an insight into the data before running the regression analysis. I examine the significance of the difference between cumulative abnormal returns means for two subsamples by using the two-sample t-test. I find the median for each independent variable and then divide the CARs into two subsamples including observations above and below the median of the respective independent variable. The CARs differences are surprising and suggest there is no significant difference between the two subsamples for the ESG score, ROA, and Size, and a higher number of deaths experience higher CAR. The CARs mean are -0.48 and -0.229 which means that the higher the book-to-market ratio (more undervalued companies), the greater the negative reaction from the market. Tobin's q means difference is significant, and for the higher values of Tobin's q, CAR equals 0.114. The result suggests that companies with a higher capability of reinvestment benefit from a more positive reaction from the market. Finally, higher damage is equivalent to lower CARs, -0.345%, and more negative reaction from the market. Table 8 summarizes the two-sample t-test results.

One possible reason that the CAR/ESG relationship is unexpected could be outliers. Our descriptive statistics, presented in Table 6, indeed suggest the presence of outliers. To address this issue, I winsorized the data at the 5% level and reestimated the regression model. The results from the fixed-effect panel regression are consistent with the previous results; that is, the ESG coefficient is -0.019874 and significant at the 1% level. The ROA coefficient becomes significant at the 10% level and is -0.012644. The coefficients of Size, Damage, Deaths, and the Book-to-Market ratio are -0.4163, 0.007, -0.002 and -2.08, respectively, and are all significant at the 1% level. Finally, the coefficient for Tobin's q is 0.186 and significant at the 5% level. The result suggests that outliers seemingly are not the main cause behind the inconsistent results. To further investigate the data, I also studied the volatility of returns by using the two-sample t-test. The results are consistent with the literature and suggest that CARs of the companies with higher ESG scores are less volatile. Companies above the ESG median experience 0.523%, while other volatility is 0.58%. The results also predict that higher ROA means lower volatility (0.395% for above median and 0.709% for below median) of CARs, higher book-to-market ratio means more volatility (0.865% and 0.239%), higher Tobin's q translates into higher volatility (0.276% and 0.828%), and higher number of deaths (0.55% and 0.473%) and increased damage (0.573% and 0.507%) mean higher levels of volatility.

Insert Table 8 about here

I estimate the coefficients with the RE settings to be able to apply the Hausman specification test to determine whether the FE or RE model is appropriate to estimate the coefficients of the model. The Chi-squared statistic of the test is 59.99 and is significant at 1% level. According to the Durbin–Wu–Hausman test decision making rule, I reject the null hypothesis. This means that the panel data should be studied using the FE model and that the RE model estimations are biased and inefficient. Table 9 presents the results of the Hausman specification test.

Insert Table 9 about here

I estimate the FE coefficients and find that the ESG, BM, Damage, and the intercept coefficients are -0.022, 0.0091, and 4.92 respectively and are significant at 1% level. The ESG suggests, surprisingly, that companies with higher ESG are less resilient to natural disasters. The ROA coefficient is -0.0022 and insignificant, Tobin's q, deaths, and size coefficients are 0.051, -0.0025, and -0.39 and all are significant at 5% level. If we only consider the ESG in the model, the coefficient is -0.0189 and the intercept is 0.62 and both are significant at the 1% level. Table 9 summarizes the panel regression results. These results suggest that large companies experience more negative CAR. Tobin's q, on the contrary, suggests that companies with higher reinvestment opportunities have less negative CARs, and the higher number of deaths indicates more negative CARs.

Insert Table 10 about here

To substantiate my findings, I again winsorized the data at the 5% level and reestimated the regression model. The results from the fixed-effect panel regression are consistent with the previous results; that is, the ESG coefficient is -0.00497 and significant at the 5% level. The coefficients for ROA, Size, Tobin's q, and the Book-to-Market ratio coefficients are -0.15, -0.57, 0.43, and 2.93 and significant at the 1% level. Damage and Deaths are insignificant. The results suggest that higher values of Tobin's q, and larger reinvestment and growth opportunities, are associated with higher volatility, which is an unexpected result. The literature does not recommend minorizing as a reliable technique to deal with outliers, and recommends the use of m-, s-, or mm-estimation techniques. However, these are beyond the scope of this research.

The literature suggests that the effects of natural disasters are not identical in strength and significance among various industrial sectors. I employ the Global Industry Classification Standard (GICS) to study industry reaction to natural disasters. I apply the GICS sector ID and name and create multiple panels for industries. The results corroborate the findings in the literature since the natural disasters and ESG have a significant relationship at 1% in only two of the industries considered, e.g., industrials and consumer discretionary, and have a significant relationship of 10% with consumer staples. The coefficients are -0.037532 for the industrial sector, -0.061975 for the consumer discretionary sector, and -0.037391 for the consumer staples sector. Table 11 summarizes the coefficients of significant industrial sectors[5].

Insert Table 11 about here

[5] I also employed the North American Industry Classification System (NAICS) to explore whether natural disasters have a unique effect on firms in the manufacturing sector (SIC codes 31xx-33xx). In a subsample regression for manufacturing firms, the ESG score coefficient is -0.04 and significant at the 1% level; the Book-to-Market ratio is -2.28 and significant at the 1% level, and Tobin's q is 0.06 and significant at the 5% level. The results are consistent with the findings in related studies.

I investigate the primary affected states by climate events as well. Tropical cyclones and severe storms swiftly sweep across states, and they affect several states during the event period. I consulted the NCEI, EM-DAT and the US national weather service to locate the primary affected states. Though the results are consistent in terms of magnitude and sign, the ESG coefficient is -.029 and insignificant. The damage and deaths coefficients are respectively 0.011 and -0.097 and are significant at the 5% level, Size and Tobin's q are significant at 10% level, and book-to-market is -2.829 and significant at the 1% level. The results do not suggest resilience for primary affected states. Table 12 presents the panel results.

Insert Table 12 about here

There is some debate in the literature regarding the inconsistency of ESG scores and these surprising results may be the result of such inconsistencies. Therefore, I performed a robustness test by using the Bloomberg ESG scores instead of the Reuters Refinitive ones to test whether the results are different. ESG scores provided by Bloomberg are qualitative; that is, scores are based on the annual reports of the firms and their disclosure of quantitative and policy related ESG data. The new panel data results are consistent with the previous results. The ESG, book-to-market ratio, CPI-adjusted damage coefficients and intercept are -0.0269, -1.7612, 0.009, and 4.336 and are significant at 1% level. Size is -0.31 and the number of deaths is -0.002, and both are significant at 5% level. However, ROA and Tobin's q coefficients are now insignificant. The results suggest that the higher the ESG score is, the lower the CARs will be, and thus companies with higher ESG are less resilient in terms of experiencing more negative abnormal returns. Table 13 represents the robustness test results.

Insert Table 13 about here

The relationship between CARs and ESG scores is surprising since the literature suggests that higher EGS scores may increase the resilience of companies, and firms may experience higher returns after climate shocks. There is evidence in the literature that companies with higher ESG scores have lower levels of volatility (see Engelhardt et al., 2021; Albuquerque et al., 2020). The univariate test results in Table 8 also suggest that studying volatility may shed light on the resilience of firms to natural events shocks. I calculate the volatility of returns for each firm during the event window and re-run the panel regression. The ESG score coefficient is negative and equals to -0.055, significant at the 1% level. The ROA, Size, book-to-market ratio, and the number of deaths coefficients are respectively -0.063, -2.933, 6.91, and -0.0102 and are significant at the 1% level. Tobin's q is -0.0934 and significant at 10%, and damage is 0.0034 and insignificant.

The results are important and consistent with the literature. These results indicate that firms with higher ESG scores have lower volatility, and larger firms, better performing firms, and companies with better reinvestment opportunities show lower levels of volatility. The book-to-market ratio predicts higher levels of volatility for undervalued companies. Though the damage coefficient is insignificant, it indicates that higher damage may increase the volatility of returns after natural disasters. Table 14 summarizes the results of the volatility panel regression.

Insert Table 14 about here

Finally, I reinvestigate the primary affected states and industries[6] by using the volatility of returns. The results are significant and consistent and suggest that the ESG coefficient is -0.1 and significant at the 5% level, and the ROA and the book-to-market coefficients are -0.79 and 8.69 and significant at the 1% level. This means that even though firms whose ESG score do not make CARs resilient to natural events, the ESG score nevertheless positively affects the volatility of returns and provides investors and firms with a form of resilience. The industry volatility results are also significant and more inclusive than the CARs analysis. According to Table 11, only the industrials, consumer discretionary, and consumer stables sectors are somewhat significant and demonstrate that firms operating in these sectors are less resilient as their ESG scores increase; however, the volatility results are more inclusive, and the direction and the order of magnitude are consistent among various sectors. The industrials, consumer discretionary, financials, information technology, communication services, and utilities sector volatility fluctuates less for firms with higher ESG scores, larger ROA, and for larger companies. The undervalued firms with a higher book-to-market ratio are less resilient in terms of volatility. Table 15 summarizes the panel regression results of the primary affected states and various sectors.

Insert Table 15 about here

I also included additional variables in the study to test whether other variables can lead to a better model and can increase the explanatory power of the base model. Firms under financial distress may experience pronounced reactions from the market since they may have access to limited financial resources to compensate costs due to climate events. Altman's z-score is a metric determining the odds of whether a company will go bankrupt in near future. The measure considers liquidity, leverage, and financial ratios and assigns a numeric value to each firm. I calculated[7] the cash and cash equivalents and total tangible asset quotient to measure the amount of cash available to cover unexpected costs. I also included financial leverage as another independent variable. The CAR analysis shows that when including these variables as additional controls, the ESG coefficient is -0.026 and significant at the 1% level. Cash and cash equivalents to tangible assets and financial leverage are insignificant and do not add power to the model. The Altman z-score coefficient is significantly positive meaning that higher scores decrease the CARs. Size is still negative, -0.45, and Tobin's q is 0.06; both are significant at the 5% level; the Book-to-Market ratio, Deaths and Damages are -2.035, -0.004 and 0.016, respectively, and are significant at the 1% level. Volatility panel regression results suggest that ESG scores have a negative relationship with volatility since the coefficient is -0.048 and significant at the 1% level. ROA, Size, Tobin's q and the Book-to-Market ratio are consistent with the previous findings although the magnitude has changed slightly. Altman z-score is -0.08 and significant at the 1% level; this reflects the fact that less financially distressed firms are less volatile and more resilient. Firms with a higher cash to tangible assets ratio are more volatile, which is an unexpected result. Table 16 summarizes the results.

Insert Table 16 about here

[6] I again employed the North American Industry Classification System (NAICS) and studied the manufacturing sector (31xx-33xx). When running a subsample regression for this industry, the ESG score coefficient is -0.02 and insignificant; the Book-to-Market ratio is 7.68 and Size is -3.4; both are significant at the 1% level.
[7] Data from 2009 to 2019 was downloaded from Bloomberg.

5. Conclusion

As the prevalence and intensity of climate change-induced shocks have continued to grow in recent decades, global authorities, institutional and private investors, and the public have become increasingly interested in sustainable business practices. ESG-related activities have provoked substantive discussion in the finance and economics literature regarding whether reporting and improving ESG practices and performance are valuable assets to firms and investors. The literature suggests that ESG activities are positively correlated to financial performance and would improve corporate financial performance by creating and maintaining positive relationships with major (non-)institutional investors and stakeholders. The literature specifically provides evidence that firms with higher ESG scores are more resilient in terms of both stock performance and abnormal returns after natural exogenous shocks.

I study the effects of multiple natural events, tropical cyclones, and storms on firms operating in the US market to test whether firms and higher ESG scores may increase stock performance resilience to climate-related events. I include data for the period of 2009-2019 and download the NCEI and EM-DAT events lists, Refinitive and Bloomberg ESG scores, and company characteristics from Bloomberg. Firms experience negative and significant CAR seven days after natural disasters; this corroborates the literature results that indicate firms have a lagged negative reaction to natural disasters. The CARs panel regression results are surprising and suggest that firms with higher ESG scores are less resilient to natural events. One explanation could be that the US investors are less oriented toward sustainability practices. Borovkova et al. (2020) use the same ESG scores from Refinitive and find the same results, that compared to European investors, US investors are less interested in ESG investment.

However, the literature suggests volatility resilience, meaning that companies stock returns with higher ESG scores are less volatile. I investigate the relationship between the volatility of returns and ESG scores and find that firm returns with higher ESG scores are significantly less volatile and thus are more resilient to natural event shocks. Larger and better financially performing firms and companies with better reinvestment opportunities are more resilient to shocks, and undervalued companies are more volatile. The volatility study results are more inclusive and persistent across various industries and subsamples. Firms operating in primary affected states, industrials, consumer discretionary, financials, information technology, communication services, and utility sectors are less volatile and more resilient. The number of studies exploring the importance of ESG scores has grown in recent decades, but the findings suggest that in times of distress, the market mostly relies on classic accounting and financial measures to make investment decisions. Each component of the ESG score can contribute to overall firm resilience. G, which stands for governance, has been studied thoroughly in the finance and management literature, and there is strong evidence that governance affects firm performance. The environmental criterion (E) is highly correlated with environmentally friendly measures that firms take from energy consumption to climate change and carbon emission. However, social criteria (S) can help firms to tackle climate shocks since they deal with people, communities, and more importantly firms' employees. Firms with higher S scores may better sustain stress because they benefit from stronger relationships with (and more support from) their employees, which in turn may help firms to deal with climate shocks and concomitant consequences. In other words, higher social responsibility can enhance effective employee commitment.

There are several limitations to this study. Omitted variables or reverse causality is a common issue in the ESG literature and may cause endogeneity. Moreover, the clustering of events in the event study may decrease the explanatory power and increase the noise in the CARs analysis. I try to reduce the number of events by applying a threshold to the CPI-adjusted damage size to better tackle the issue. However, the most important limitation relates to the consistency of ESG ratings. Investors have raised concerns regarding the lack of a clear definition for SRI, CSR, and ESG ratings and categorizations. The absence of standards for SRI investments, and the quality of available data on ESG ratings of companies may trigger biased assessment and analysis (Avetisyan et. al, 2017; Friede, 2019). Changes in the ESG information market is a constant factor affecting ESG ratings, since as new agencies are launched and established and data providers enter the market, the complexity of methodology and transparency concerns create another layer of confusion to investors (Delmas et al., 2013). Moreover, there is still no standard for ESG metrics, which means that data are fragmented and inconsistent due to differences in data collection, incompatible data formats, and different levels of quality control. Recent studies have also uncovered other measurement issues including bias toward larger companies and a lack of predictive power.

6. References

Abhayawansa, S., & Tyagi, S. (2021). Sustainable investing: the black box of environmental, social, and governance (ESG) ratings. *The Journal of Wealth Management*, 24(1), 49-54.

Alareeni, B. A., & Hamdan, A. (2020). ESG impact on performance of US S&P 500-listed firms. *Corporate Governance: The International Journal of Business in Society*. Vol. 20 No. 7, pp. 1409-1428

Albuquerque, R., Koskinen, Y., Yang, S., & Zhang, C. (2020). Resiliency of environmental and social stocks: An analysis of the exogenous COVID-19 market crash. *The Review of Corporate Finance Studies*, 9(3), 593-621.

Alsaifi, K., Elnahass, M., & Salama, A. (2020). Carbon disclosure and financial performance: UK environmental policy. *Business Strategy and the Environment*, *29*(2), 711-726.

Amel-Zadeh, A., & Serafeim, G. (2018). Why and how investors use ESG information: Evidence from a global survey. *Financial Analysts Journal*, *74*(3), 87-103.

Amiraslani, H., Lins, K. V., Servaes, H., & Tamayo, A. (2022). Trust, social capital, and the bond market benefits of ESG performance. Forthcoming, *Review of Accounting Studies*. https://doi.org/10.1007/s11142-021-09646-0

Antoniuk, Y., & Leirvik, T. (2021). Climate transition risk and the impact on green bonds. *Journal of Risk and Financial Management*, 14(12), 597.

Apergis, N., & Apergis, E. (2022). The role of Covid-19 for Chinese stock returns: evidence from a GARCHX model. *Asia-Pacific Journal of Accounting & Economics*, *29*(5), 1175-1183.

Avetisyan, E., & Hockerts, K. (2017). The consolidation of the ESG rating industry as an enactment of institutional retrogression. *Business Strategy and the Environment*, 26(3), 316-330.

Baker, S. R., & Bloom, N. (2013). Does uncertainty reduce growth? Using disasters as natural experiments. Working paper (No. w19475). *National Bureau of Economic Research.*

Balatbat, M., Siew, R., & Carmichael, D. (2012). ESG scores and its influence on firm performance: Australian evidence. In *Australian School of Business School of Accounting, School of Accounting Seminar Series Semester* (Vol. 2, pp. 1-30). Australia: University of New South Wales.

Balvers, R., Du, D., & Zhao, X. (2017). Temperature shocks and the cost of equity capital: Implications for climate change perceptions. *Journal of Banking & Finance*, 77, 18-34.

Bannier, C. E., Bofinger, Y., & Rock, B. (2019). *Doing safe by doing good: ESG investing and corporate social responsibility in the US and Europe. Working paper* (No. 621). CFS Working Paper Series.

Bansal, R., Kiku, D., & Ochoa, M. (2016). *Price of long-run temperature shifts in capital markets. Working paper* (No. w22529). National Bureau of Economic Research.

Barnett, M. L., & Salomon, R. M. (2006). Beyond dichotomy: The curvilinear relationship between social responsibility and financial performance. *Strategic Management Journal*, 27(11), 1101-1122.

Barnett, M. L., & Salomon, R. M. (2012). Does it pay to be really good? Addressing the shape of the relationship between social and financial performance. *Strategic Management Journal*, 33(11), 1304-1320.

Bassen, A., & Kovács, A. M. (2020). Environmental, social and governance key performance indicators from a capital market perspective. In *Wirtschafts-und Unternehmensethik (pp. 809-820)*. Springer VS, Wiesbaden.

Battiston, S., Mandel, A., Monasterolo, I., Schütze, F., & Visentin, G. (2017). A climate stress-test of the financial system. *Nature Climate Change*, 7(4), 283-288.

Birindelli, G., & Chiappini, H. (2021). Climate change policies: Good news or bad news for firms in the European Union? *Corporate Social Responsibility and Environmental Management*, 28(2), 831-848.

Birindelli, G., Ferretti, P., Intonti, M., & Iannuzzi, A. P. (2015). On the drivers of corporate social responsibility in banks: Evidence from an ethical rating model. *Journal of Management & Governance*, 19(2), 303-340.

Boermans, M.A. and Galema, R. (2019) Are pension funds actively decarbonizing their portfolios? *Ecological Economics*, 161: 50–60.

Bolton, P., & Kacperczyk, M. (2021). Do investors care about carbon risk? *Journal of Financial Economics*, 142(2), 517-549.

Borghesi, R., Houston, J. F., & Naranjo, A. (2014). Corporate socially responsible investments: CEO altruism, reputation, and shareholder interests. *Journal of Corporate Finance*, 26, 164-181.

Borovkova, S., & Wu, Y. (2020). *ESG versus financial performance of large-cap firms: The case of EU, US, Australia, and south-East Asia*. Refinitiv White paper.

Bourdeau-Brien, M., & Kryzanowski, L. (2017). The impact of natural disasters on the stock returns and volatilities of local firms. *The Quarterly Review of Economics and Finance*, 63, 259-270.

Brammer S, Millington, A (2008). Does it pay to be different? An analysis of the relationship between corporate social and financial performance. *Strategic Management Journal,* 29(12), 1325-1343.

Branikas, I., Buchbinder, G., Ding, Y., & Li, N. (2020). *The response of local corporate sustainability to environmental disasters: Evidence from wildfires*. Available at SSRN 3640791.

Braun, A., Utz, S. and Xu, J. (2019) Are insurance balance sheets carbon-neutral? Harnessing asset pricing for climate change policy. *Geneva Papers on Risk and Insurance - Issues and Practice* 44: 549–568.

Breitenstein, M., Nguyen, D. K., & Walther, T. (2021). Environmental hazards and risk management in the financial sector: A systematic literature review. *Journal of Economic Surveys*, 35(2), 512-538

Brooks, C. (2008). Introductory Econometrics for Finance (2nd ed.). *Cambridge University Press*.

Buallay, A. (2019). Is sustainability reporting (ESG) associated with performance? Evidence from the European banking sector. *Management of Environmental Quality: An International Journal*, 30(1), 98–115. https://doi.org/10.1108/meq-12-2017-0149

Buchanan, B., Cao, C. X., & Chen, C. (2018). Corporate social responsibility, firm value, and influential institutional ownership. *Journal of Corporate Finance*, 52, 73-95.

Burke, M., Hsiang, S. M., & Miguel, E. (2015). Global non-linear effect of temperature on economic production. *Nature,* 527(7577), 235-239.

Campiglio, E., Dafermos, Y., Monnin, P., Ryan-Collins, J., Schotten, G., & Tanaka, M. (2018). Climate change challenges for central banks and financial regulators. *Nature climate change*, 8(6), 462-468.

Capasso, G., Gianfrate, G., & Spinelli, M. (2020). Climate change and credit risk. *Journal of Cleaner Production*, 266, 121634.

Chang, K., Shim, H., & Yi, T. D. (2019). Corporate social responsibility, media freedom, and firm value. *Finance Research Letters*, 30, 1-7.

Chen, T., Dong, H., & Lin, C. (2020). Institutional shareholders and corporate social responsibility. *Journal of Financial Economics*, 135(2), 483-504.

Cheng, B., I. Ioannou, and G. Serafeim. 2014. "Corporate Social Responsibility and Access to Finance." *Strategic Management Journal* 35 (1): 1–23.

Choi, D., Gao, Z., & Jiang, W. (2020). Attention to global warming. *The Review of Financial Studies*, 33(3), 1112-1145.

Climate Change Report. (2019). Carbon Disclosure Project (CDP). https://www.cdp.net/en/reports/archive?page=1&per_page=20&sort_by=last_post_revision_published_at&sort_dir=desc

Colacito, R., Hoffmann, B., & Phan, T. (2019). Temperature and growth: A panel analysis of the United States. *Journal of Money, Credit and Banking*, 51(2-3), 313-368.

Cornett, M. M., Erhemjamts, O., & Tehranian, H. (2016). Greed or good deeds: An examination of the relation between corporate social responsibility and the financial performance of US commercial banks around the financial crisis. *Journal of Banking & Finance*, 70, 137-159.

Delmas, M. A., Etzion, D., & Nairn-Birch, N. (2013). Triangulating environmental performance: What do corporate social responsibility ratings really capture? *Academy of Management Perspectives*, 27(3), 255-267.

Dhaliwal, D. S., Li, O. Z., Tsang, A., & Yang, Y. G. (2011). Voluntary nonfinancial disclosure and the cost of equity capital: The initiation of corporate social responsibility reporting. *The accounting review*, 86(1), 59-100.

Di Giuli, A., & Kostovetsky, L. (2014). Are red or blue companies more likely to go green? Politics and corporate social responsibility. *Journal of Financial Economics*, 111(1), 158-180.

Diaz-Rainey, I., Gehricke, S. A., Roberts, H., & Zhang, R. (2021). Trump vs. Paris: The impact of climate policy on US listed oil and gas firm returns and volatility. *International Review of Financial Analysis*, 76, 101746.

Dietz, S., Bowen, A., Dixon, C. and Gradwell, P. (2016) Climate value at risk of global financial assets. *Nature Climate Change* 6: 676–679.

Dimson, E., Marsh, P., & Staunton, M. (2020). Divergent ESG ratings. *The Journal of Portfolio Management*, 47(1), 75-87.

Donadelli, M., Jüppner, M., Paradiso, A., & Ghisletti, M. (2020). Tornado activity, house prices, and stock returns. *The North American Journal of Economics and Finance*, 52, 101162.

Duqi, A., McGowan, D., Onali, E., & Torluccio, G. (2021). Natural disasters and economic growth: The role of banking market structure. *Journal of Corporate Finance*, 71, 102101.

Dyck, A., Lins, K. V., Roth, L., & Wagner, H. F. (2019). Do institutional investors drive corporate social responsibility? International evidence. *Journal of Financial Economics*, 131(3), 693-714.

Edmans, A. (2011). Does the stock market fully value intangibles? Employee satisfaction and equity prices. *Journal of Financial Economics*, 101(3), 621-640.

Eliwa, Y., Aboud, A., & Saleh, A. (2019). ESG practices and the cost of debt: Evidence from EU countries. *Critical Perspectives on Accounting*, 102097.

Elsayed, K., & Paton, D. (2005). The impact of environmental performance on firm performance: static and dynamic panel data evidence. *Structural Change and Economic Dynamics*, 16(3), 395-412.

Fatemi, A., Glaum, M. & Kaiser, S. (2017) ESG performance and firm value: The moderating role of disclosure. *Global Finance Journal*, Forthcoming.

Ferrell, A., Liang, H., & Renneboog, L. (2016). Socially responsible firms. *Journal of Financial Economics*, 122(3), 585-606.

Fisher-Vanden, K., & Thorburn, K. S. (2011). Voluntary corporate environmental initiatives and shareholder wealth. *Journal of Environmental Economics and Management*, 62(3), 430–445. https://doi.org/10.1016/j.jeem.2011.04.003

Flammer, C. (2021). Corporate green bonds. *Journal of Financial Economics*, 142(2), 499-516.

Friede, G. (2019). Why don't we see more action? A metasynthesis of the investor impediments to integrate environmental, social, and governance factors. *Business Strategy and the Environment*, 28(6), 1260-1282.

Friede, G., Busch, T., & Bassen, A. (2015). ESG and financial performance: aggregated evidence from more than 2000 empirical studies. *Journal of Sustainable Finance & Investment*, 5(4), 210-233.

Gao, L., & Zhang, J. H. (2015). Firms' earnings smoothing, corporate social responsibility, and valuation. *Journal of Corporate Finance*, 32, 108-127.

Gillan, S. L., Koch, A., & Starks, L. T. (2021). Firms and social responsibility: A review of ESG and CSR research in corporate finance. *Journal of Corporate Finance*, 101889.

Global Risks Report, 17th Edition. (2022). *World Economic Forum*. https://wef.ch/risks22

Global Sustainable Investment Alliance (GSIA) (2020), *Global Sustainable Investment Review*.

Graff Zivin, J., & Neidell, M. (2014). Temperature and the allocation of time: Implications for climate change. *Journal of Labor Economics*, 32(1), 1-26.

Greene, W. (2017). *Econometric Analysis (8th ed.)*. Pearson.

Grewal, J., Hauptmann, C., & Serafeim, G. (2021). Material sustainability information and stock price informativeness. *Journal of Business Ethics*, 171(3), 513-544.

Grewal, J., Riedl, E. J., & Serafeim, G. (2019). Market reaction to mandatory nonfinancial disclosure. *Management Science*, 65(7), 3061-3084.

Gulev, S.K.; Thorne, P.W. ; Ahn, J.; Dentener, F.J.; Domingues, C.M. ; Gerland, S.; Gong, D.; Kaufman, D.S; Nnamchi, H.C.; Quaas, J.; Rivera, J.A.; Sathyendranath, S.; Smith, S.L.; Trewin, B.; von Schuckmann, K.; Vose, R.S.. 2021 Changing state of the climate system. In: Masson-Delmotte, V.; Zhai, P.; Pirani, A.; Connors, S.L.; Péan, C.; Berger, S.; Caud, N.; Chen, Y.; Goldfarb, L.; Gomis, M.I.; Huang, M.; Leitzell, K.; Lonnoy, E.; Matthews, J.B.R.; Maycock, T.K.; Waterfield, T.; Yelekçi, O.; Yu, R.; Zhou, B., (eds.) *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge*, United Kingdom and New York, NY, USA, Cambridge University Press, 287-422.

Han, J. J., Kim, H. J., & Yu, J. (2016). Empirical study on relationship between corporate social responsibility and financial performance in Korea. *Asian Journal of Sustainability and Social Responsibility,* 1(1), 61-76.

Hoepner, A. G., Majoch, A. A., & Zhou, X. Y. (2021). Does an asset owner's institutional setting influence its decision to sign the principles for responsible investment? *Journal of Business Ethics*, 168(2), 389-414.

Hong, H., Li, F. W., & Xu, J. (2019). Climate risks and market efficiency. *Journal of Econometrics*, 208(1), 265-281.

Hsiao, C. (2010). Analysis of Panel Data. *Cambridge University Press*.

Huang, Q., Li, Y., Lin, M., & McBrayer, G. A. (2022). Natural disasters, risk salience, and corporate ESG disclosure. *Journal of Corporate Finance*, 72, 102152.

Hsiang, S. M., & Jina, A. S. (2014). The causal effect of environmental catastrophe on long-run economic growth: Evidence from 6,700 cyclones (No. w20352). *National Bureau of Economic Research*.

Hvidkjær, S. (2017). ESG investing: a literature review. Report prepared for Dansif.

Hwang, C. Y., Titman, S., & Wang, Y. (2022). Investor tastes, corporate behavior, and stock returns: An analysis of corporate social responsibility. *Management Science*, 68(10), 7131-7152.

Ilhan, E., Krueger, P., Sautner, Z., & Starks, L. T. (2019). Institutional investors' views and preferences on climate risk disclosure. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3437178

In, S. Y., Park, K. Y., & Monk, A. (2017). Is "Being Green" Rewarded in the Market? An Empirical Investigation of Decarbonization Risk and Stock Returns. *International Association for Energy Economics (Singapore Issue)*, 46(48).

IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. *Cambridge University Press, Cambridge, UK and New York, NY, USA,* pp. 3-24, doi:10.1017/9781009157940.001.

Kaplanski, G., & Levy, H. (2010). Sentiment and stock prices: The case of aviation disasters. *Journal of Financial Economics*, 95(2), 174-201.

Khan, H., Metaxoglou, K., Knittel, C. R., & Papineau, M. (2019). Carbon emissions and business cycles. *Journal of Macroeconomics*, 60, 1-19.

Kim, E.-H. & Lyon, T. P. (2014) Greenwash vs. brownwash: Exaggeration and undue modesty in corporate sustainability disclosure. *Organization Science*, 26(3), 705-723.

Kling, G., Volz, U., Murinde, V., & Ayas, S. (2021). The impact of climate vulnerability on firms' cost of capital and access to finance. *World Development*, 137, 105131.

Koch, N., Grosjean, G., Fuss, S., & Edenhofer, O. (2016). Politics matters: Regulatory events as catalysts for price formation under cap-and-trade. *Journal of Environmental Economics and Management*, 78, 121-139.

Koerniadi, H., Krishnamurti, C., & Tourani-Rad, A. (2016). Natural Disasters—Blessings in disguise? *The Singapore Economic Review*, 61(01), 1640004.

Kotz, M., Wenz, L., & Levermann, A. (2021). Footprint of greenhouse forcing in daily temperature variability. *Proceedings of the National Academy of Sciences*, 118(32), e2103294118.
Krueger, P., Sautner, Z., & Starks, L. T. (2020). The importance of climate risks for institutional investors. *The Review of Financial Studies*, 33(3), 1067-1111.
Krüger, P. (2015). Corporate goodness and shareholder wealth. *Journal of Financial Economics*, 115(2), 304-329.
Kumar, A., Xin, W., & Zhang, C. (2019). Climate sensitivity and predictable returns. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.3331872
Lanfear, M. G., Lioui, A., & Siebert, M. G. (2019). Market anomalies and disaster risk: Evidence from extreme weather events. *Journal of Financial Markets*, 46, 100477.
Leiter, A. M., Oberhofer, H., & Raschky, P. A. (2009). Creative disasters? Flooding effects on capital, labour and productivity within European firms. *Environmental and Resource Economics*, 43(3), 333-350.
Lins, K. V., Servaes, H., & Tamayo, A. (2017). Social capital, trust, and firm performance: The value of corporate social responsibility during the financial crisis. the *Journal of Finance*, 72(4), 1785-1824.
Manes-Rossi, F., Nicolò, G., & Argento, D. (2020). Non-financial reporting formats in public sector organizations: a structured literature review. Journal of Public Budgeting, *Accounting & Financial Management.*
McWilliams, A., & Siegel, D. (2001). Corporate social responsibility: A theory of the firm perspective. *Academy of Management Review*, 26(1), 117-127.
Monasterolo, I., & De Angelis, L. (2020). Blind to carbon risk? An analysis of stock market reaction to the Paris Agreement. *Ecological Economics*, 170, 106571.
Nakamura, E., Steinsson, J., Barro, R., & Ursúa, J. (2013). Crises and recoveries in an empirical model of consumption disasters. *American Economic Journal: Macroeconomics*, 5(3), 35-74.
Nollet, J., Filis, G., & Mitrokostas, E. (2016). Corporate social responsibility and financial performance: A non-linear and disaggregated approach. *Economic Modelling*, 52, 400-407.
Nor, N. M., Bahari, N. A. S., Adnan, N. A., Kamal, S. M. Q. A. S., & Ali, I. M. (2016). The effects of environmental disclosure on financial performance in Malaysia. *Procedia Economics and Finance*, 35, 117-126.
Pasquini-Descomps, H. and Sahut, J. (2013), ESG Impact on a firm's performance in Switzerland, Researchgate.net, available at: www.researchgate.net/publication/248392697_ESG_Impact_on_a_Firm's_Performance_in_Switzerland/file/9c96051ded038229fe.pdf.
Polbennikov, S., Desclée, A., Dynkin, L., & Maitra, A. (2016). ESG ratings and performance of corporate bonds. *The Journal of Fixed Income*, 26(1), 21-41.
Qian, W., Suryani, A. W., & Xing, K. (2020). Does carbon performance matter to market returns during climate policy changes? Evidence from Australia. *Journal of Cleaner Production*, 259, 121040.
Radhi, D. S. M., & Sarea, A. (2019). Evaluating financial performance of Saudi listed firms: using statistical failure prediction models. *International Journal of Business Ethics and Governance*, 1-15.
Raimo, N., Caragnano, A., Zito, M., Vitolla, F., & Mariani, M. (2021). Extending the benefits of ESG disclosure: The effect on the cost of debt financing. *Corporate Social Responsibility and Environmental Management.*
Roberts, M.R., Whited, T.M., 2013. Endogeneity in empirical corporate finance. In: Constantinides, G., Harris, M., Stulz, R.M. (Eds.), *Handbook of the Economics of Finance*, vol. 2. Elsevier, Amsterdam, pp. 493–572.
Sahut, J. M., & Pasquini-Descomps, H. (2015). ESG impact on market performance of firms: International evidence. *Management International*, *19*(2), 40–63.

Sarkodie, S. A., Owusu, P. A., & Leirvik, T. (2020). Global effect of urban sprawl, industrialization, trade and economic development on carbon dioxide emissions. *Environmental Research Letters*, 15(3), 034049.

Schlenker, W., & Roberts, M. J. (2009). Nonlinear temperature effects indicate severe damages to US crop yields under climate change. *Proceedings of the National Academy of sciences*, 106(37), 15594-15598.

Seetharam, I. (2017, September). Environmental disasters and stock market performance. In Stanford University Working paper.

Seltzer, L. H., Starks, L., & Zhu, Q. (2022). Climate regulatory risk and corporate bonds. *Working paper* (No. w29994). National Bureau of Economic Research.

Serafeim, G., & Yoon, A. (2022). Which Corporate ESG News does the Market React to? *Financial Analysts Journal*, 78(1), 59-78.

Sharma, D., & Thukral, M. S. (2016). Do social, environmental and governance concerns reward value to firms? An investigation of BSE-500 listed firms. *Journal of Economics and Finance*, 3(2), 23-28.

Siddikee, M. N., & Rahman, M. M. (2017). Effect of catastrophic disaster in financial market contagion. *Cogent Economics & Finance*, 5(1), 1288772.

Statman, M., & Glushkov, D. (2009). Equity investments: Research sources; investment theory: Efficient market theory; Portfolio management: Equity strategies. *Financial Analysts Journal*, 65(4).

Steen, M., Moussawi, J. T., & Gjolberg, O. (2020). Is there a relationship between Morningstar's ESG ratings and mutual fund performance? *Journal of Sustainable Finance & Investment*, 10(4), 349-370.

Storelvmo, T., Leirvik, T., Lohmann, U., Phillips, P. C., & Wild, M. (2016). Disentangling greenhouse warming and aerosol cooling to reveal Earth's climate sensitivity. *Nature Geoscience*, 9(4), 286-289.

Taneja, S. S., Taneja, P. K., & Gupta, R. K. (2011). Researches in corporate social responsibility: A review of shifting focus, paradigms, and methodologies. *Journal of Business Ethics*, 101(3), 343-364.

Tang, D. Y., & Zhang, Y. (2020). Do shareholders benefit from green bonds? *Journal of Corporate Finance*, 61, 101427.

Tarmuji, I., Maelah, R., & Tarmuji, N. H. (2016). The impact of environmental, social and governance practices (ESG) on economic performance: Evidence from ESG score. *International Journal of Trade, Economics and Finance*, 7(3), 67.

Velte, P. (2017). Does ESG performance have an impact on financial performance? Evidence from Germany. *Journal of Global Responsibility*.

Wagner, M., & Schaltegger, S. (2004). The effect of corporate environmental strategy choice and environmental performance on competitiveness and economic performance: an empirical study of EU manufacturing. *European Management Journal*, 22(5), 557-572.

Walker, T. J., Walker, M. G., Thiengtham, D. N., & Pukthuanthong, K. (2014). The role of aviation laws and legal liability in aviation disasters: A financial market perspective. *International Review of Law and Economics*, 37, 51-65.

Wang, L., & Kutan, A. M. (2013). The impact of natural disasters on stock markets: Evidence from Japan and the US. *Comparative Economic Studies*, 55(4), 672-686.

Widyawati, L. (2020). A systematic literature review of socially responsible investment and environmental social governance metrics. *Business Strategy and the Environment*, 29(2), 619-637.

World Economic Forum, 2022. The Global Risks Report 2022, 17th Edition.

Worthington, A. C. (2008). The impact of natural events and disasters on the Australian stock market: A GARCH-M analysis of storms, floods, cyclones, earthquakes, and bushfires. *Global Business and Economics Review,* 10(1), 1.

Yuan, M., Leirvik, T., & Wild, M. (2021). Global trends in downward surface solar radiation from spatial interpolated ground observations during 1961–2019. *Journal of Climate*, 34(23), 9501-9521.

Tables:

Table 1:The NCEI & EM-DAT Natural Disasters Distribution (2009 – 2019)

Year	Total number of events	Total number of deaths	Total CPI-adjusted damage (billion $)
2009	6	23	13.44
2010	5	37	16.92
2011	6	603	49.89
2012	6	242	97.3
2013	6	39	11.7
2014	5	51	13.5
2015	5	111	11.6
2016	7	85	25.35
2017	10	226	225.9
2018	7	110	64.4
2019	9	32	33.3
Total	72	1559	563.3

The total number of events per year shows the number of severe hurricanes and tropical cyclones of the US between 2009 to 2019. The total number of deaths is the number of casualties resulting from these events. The total CPI-adjusted damage in billions of dollars is the aggregate damage per year resulting from events.
Data retrieved from: https://www.ncei.noaa.gov/access/billions/time-series and https://emdat.be/

Table 2: State-level Natural Event Distribution (2009 – 2019)

State	Number of events	Number of deaths	CPI-adjusted damage (billion $)
TX	16	191	185.2
CO	8	5	17.62
IL	7	44	13.93
FL	4	165	93.8
MO	4	184	15.65
NE	3	7	16.9
OH	3	15	9.66
AL	3	53	6.55
AR	2	35	4
GA	2	28	6
MA	2	31	7.8
MS	2	357	15.59
NC	2	102	39.9
NY	2	175	84.6
OK	2	6	6.5
SC	2	31	4.5
AZ	1	0	5.1
CA	1	5	1.8
IN	1	1	1.8
LA	1	3	1.5
PA	1	21	3.2
TN	1	32	3.1
VA	1	45	17.4
WV	1	23	1.2
Total	72	1559	563.3

The total number of events per year shows the number of severe hurricanes and tropical cyclones of the US between 2009 to 2019. The total number of deaths is the number of casualties resulting from these events. The total CPI-adjusted damage in billions of dollars is the aggregate damage per year resulting from events.
Data retrieved from: https://www.ncei.noaa.gov/access/billions/time-series and https://emdat.be/

Table 3: Market and Industry Distribution of Companies

Panel A: Market Distribution

Market	Number of Companies
NASDAQ	1252
NYSE	1165
Total	2417

Panel B: Industry Distribution

Industry	Number of Companies
Energy	118
Materials	113
Industrials	346
Consumer Discretionary	285
Consumer Staples	93
Health Care	427
Financials	442
Information Technology	293
Communication Services	79
Utilities	61
Real Estate	160
Total	2417

Panel A shows the distribution of companies with available ESG scores that are actively traded NASDAQ and NYSE. Panel B shows the distribution of active companies across industries based on GICS codes.

Table 4: Firm-Year Observations

Year	Number of Observations
2009	773
2010	537
2011	1548
2012	1024
2013	713
2014	1051
2015	2080
2016	2861
2017	3704
2018	4031
2019	4111
Total Number of Observations	22433

The first column is the year of the natural disasters in our sample, and the second column is the number of actively traded companies with available ESG scores and control variables.

Table 5: Event Study Results

Day Relative to Event	Mean AR (%)	Mean CAR (%)
-1	0.097	0.097
	(4.16) ***	(6.28) ***
0	-0.011	0.086
	(-0.95)	(4.12) ***
1	0.074	0.16
	(3.85) ***	(6.25) ***
2	-0.028	0.132
	(-4.66) ***	(4.57) ***
3	-0.064	0.068
	(-1.41)	(2.12) *
4	0.002	0.07
	(0.84) *	(1.97) *
5	-0.008	0.062
	(-0.75)	(1.63)
6	-0.076	-0.013
	(-3.25) **	(-0.33)
7	-0.113	-0.126
	(-8.1) ***	(-3.47) ***

The symbols $, *, **, and *** denote statistical significance at the 0.1, 0.05, 0.01 and 0.001 level, respectively. Column one presents the day (day t) relative to an event, where day 0 represents the starting day of the event listed in the NCEI and/or EM-DAT database (e.g., the day of a land fall for a hurricane). Column two presents the cross-sectional abnormal returns (AR) on day t. Column three is the cumulative abnormal returns (CARs) from day -1 to day t.

Table 6: Descriptive Statistics

Variable	Number of Observations	Mean	Std. Dev.	Min	Max	25th Percentile	50th Percentile	75th Percentile
CAR (%)	22433	-0.13	6.69	-91.39	97.5	-2.86	-0.12	2.62
ESG	22433	39.24	18.96	0.45	93.01	24.77	35.83	51.74
Market Cap (billion $)	22433	8.5	33.6	0.0002	1270.76	0.33	1.24	4.5
ROA (%)	22433	1.44	21.19	-983.69	318.75	0.81	3.41	7.44
Size	22433	8.24	1.88	0.08	14.82	7.054	8.23	9.46
Tobin's q	22433	1.98	2.65	0.31	288.44	1.11	1.47	2.17
Book-to-Market	22433	0.55	0.52	0.00004	12.15	0.25	0.44	0.72
Damage (billion $)	22433	6.86	18.78	1.1	148.8	1.5	2.1	4
Deaths	22433	20.22	47.12	0	321	2	4	23

CAR (%) is the cumulative abnormal return at the end of the event window and is the summation of abnormal return from day -1 to day 7. **ESG** score is the Reuters Refinitive net ESG score based on environmental, social, and governance score at the end of the previous quarter. **The market cap** is the net market value of the common outstanding shares of a company at the end of the previous quarter. **ROA (%)** is return on assets at the end of the previous quarter. **Size** is the natural logarithm of the total assets of a firm at the end of the previous quarter. **Tobin's q** is the total market value of a firm divided by its total assets at the end of the previous quarter. **Book-to-market** is a firm's common shareholders' equity book value divided by its market capital at the end of the previous quarter. **Damage** is the net CPI-adjusted dollar value of damages caused by a natural disaster. **Deaths** is the number of casualties of a natural disaster reported by the NCEI.
*All control variables are downloaded from Bloomberg and Compustat.

Table 7: Variable Correlations & Variance Inflation Factors (VIFs)

Panel A: Correlation Matrix

	CAR	ESG	ROA	Size	Tobin's q	Book-to-Market	Damage	Deaths
CAR	1							
ESG	-0.006 (0.3665)	1						
ROA	0.018*** (0.0000)	0.16*** (0.0000)	1					
Size	0.008 (0.213)	0.56*** (0.0000)	0.28*** (0.0000)	1				
Tobin's q	0.028*** (0.0000)	-0.034*** (0.0000)	-0.26*** (0.0000)	-0.25*** (0.0000)	1			
Book-to-Market	-0.078*** (0.0000)	-0.08*** (0.0000)	-0.03*** (0.0000)	0.16*** (0.0000)	-0.25*** (0.0000)	1		
Damage	0.024*** (0.0000)	-0.015* (0.021)	0.0069 (0.3008)	0.0051 (0.4456)	-0.0096 (0.1526)	0.0067 (0.3162)	1	
Deaths	0.0037 (0.5772)	0.039*** (0.0000)	0.0515*** (0.0000)	0.10*** (0.0000)	-0.018** (0.0082)	0.0082 (0.2189)	0.4181*** (0.0000)	1

The symbols $, *, **, and *** denote statistical significance at the 0.1, 0.05, 0.01 and 0.001 level, respectively. P-values are presented in parentheses. **CAR (%)** is the cumulative abnormal return at the end of the event window and is the summation of abnormal return from day -1 to day 7. **ESG** score is the Reuters Refinitive net ESG score based on environmental, social, and governance score at the end of the previous quarter. **ROA (%)** is return on assets at the end of the previous quarter. **Size** is the natural logarithm of the total assets of a firm at the end of the previous quarter. **Tobin's q** is the total market value of a firm divided by its total assets at the end of the previous quarter. **Book-to-market** is a firm's common shareholders' equity book value divided by its market capital at the end of the previous quarter. **Damage** is the net CPI-adjusted dollar value of damages caused by a natural disaster. **Deaths** is number of casualties of a natural disaster reported by the NCEI.

Panel B: VIF Matrix

Variable	Variance Coefficient	Uncentered VIF	Centered VIF
ESG	0.00004	32.1	1.14
Market Cap	0.03	940.9	2.38
ROA	0.00002	1.08	1.05
Size	0.044	1622.86	1.9
Tobin's q	0.0006	2.49	1.14
Book-to-Market	0.031	6.56	1.52
Damage	0.00007	1.39	1.22
Deaths	0.00001	1.51	1.25

Variance inflation is used to show the collinearity among our regressors. The literature suggests that for the centered VIF values above 1.7 suggest a serious collinearity problem and makes an estimation biased and inefficient. The uncentered VIF is another way of evaluating VIF where the intercept is also considered as an independent/explanatory variable. For both criteria, the higher the value is, the more serious the collinearity.

Table 8: Preliminary Examination of Cumulative Abnormal Return (CAR) & Volatility

Panel A: Mean Difference Tests of CARs (N=22433)

Subsample 1	Mean CAR	Subsample 2	Mean CAR	Tests of differences Mean (p-value)
Companies with a higher ESG score than the median	-0.1572	Companies with a lower ESG score than the median	-0.0937	0.4765
Companies with a higher ROA than the median	-0.0564	Companies with a lower ROA than the median	-0.1947	0.1210
Companies with a higher Size than the median	-0.0622	Companies with a lower Size than the median	-0.1889	0.1554
Companies with a higher Book-to-Market than the median	-0.4803	Companies with a lower Book-to-Market than the median	0.2293	(0.0000) ***
Companies with a higher Tobin's q than the median	0.1144	Companies with a lower Tobin's q than the median	-0.3655	(0.0000) ***
Companies affected by disasters above median deaths	0.0984	Companies affected by disasters below median deaths	-0.3313	(0.0000) ***
Companies affected by disasters above median damage	-0.3541	Companies affected by disasters below median damage	0.1086	(0.0000) ***

Panel B: Mean Difference Test of Variance (N=22433)

Subsample 1	Mean Variance	Subsample 2	Mean Variance	Tests of differences Mean (p-value)
Companies with a higher ESG score than the median	0.5237	Companies with a lower ESG score than the median	0.5807	(0.0000) ***
Companies with a higher ROA than the median	0.3959	Companies with a lower ROA than the median	0.7092	(0.0000) ***
Companies with a higher Size than the median	0.6069	Companies with a lower Size than the median	0.4981	(0.0000) ***
Companies with a higher Book-to-Market than the median	0.8656	Companies with a lower Book-to-Market than the median	0.2394	(0.0000) ***
Companies with a higher Tobin's q than the median	0.2767	Companies with a lower Tobin's q than the median	0.8284	(0.0000) ***

Companies affected by disasters above median deaths	0.5513	Companies affected by disasters below median deaths	0.4739	(0.0000) ***
Companies affected by disasters above median damage	0.5731	Companies affected by disasters below median damage	0.5077	(0.0000) ***

The symbols $, *, **, and *** denote statistical significance of the at the 0.1, 0.05, 0.01 and 0.001 level, respectively. P-values are presented in the right-most column. In Panel A (Panel B) second column shows the average CAR and return variance when independent variable is above the median, and the third column shows the average CAR and return variance when independent variable is below the median.

Table 9: Correlated Random Effects (RE) - Hausman Test

Panel A

	Chi-Sq. Statistic	Chi-Sq. d.f.
Cross-section random	59.991 (0.0000)	7

The Hausman specification test investigates the presence of random effect (RE) in the panel model. The Chi-squared test statistics is significant at the 1% level and suggests that there is no RE in the model; thus, the fixed effect (FE) setting is appropriate to estimate the model.

Table 10: CAR Fixed Effect (FE) Panel Regression Results – All Sectors

Dependent Variable: CAR				
	(1)	(2)	(3)	(4)
Variable	Coefficient	Coefficient	Coefficient	Coefficient
ESG	-0.0189 (0.001) ***	-0.0209 (0.0005) ***	-0.0203 (0.0008) ***	-0.022 (0.0003) ***
ROA		-0.0023 (0.5928)	-0.0024 (0.5741)	-0.0022 (0.6033)
Tobin's q		0.05149 (0.0319) *	0.0515 (0.0273) *	0.05066 (0.0347) *
Book-to-Market		-1.893 (0.0000) ***	-1.8924 (0.0000) ***	-1.8893 (0.0000) ***
Size		-0.3569 (0.0282) *	-0.3589 (0.0273) *	-0.3938 (0.0159) *
Damage			0.0065 (0.0059) **	0.00908 (0.0005) ***
Deaths				-0.0025 (0.018) *
Intercept	0.6157 (0.0073) ***	4.5834 (0.0004) ***	4.5316 (0.0004) ***	4.9185 (0.0002) ***
Number of Cross-sections	2433	2433	2433	2433
Number of Periods	66	66	66	66
Total Panel Observations	22433	22433	22433	22433
R-Squared	0.161	0.169	0.169	0.169

The symbols $, *, **, and *** denote statistical significance at the 0.1, 0.05, 0.01 and 0.001 level, respectively. P-values are presented in parentheses. Column one presents the panel regression results when ESG is the only independent variable in the model. Column two to four present regression results in which we add with company and natural disaster control variables. **CAR (%)** is the cumulative abnormal return at the end of the event window and is the summation of abnormal return from day -1 to day 7. **ESG** score is the Reuters Refinitive net ESG score based on environmental, social, and governance score at the end of the previous quarter. **ROA (%)** is return on assets at the end of the previous quarter. **Size** is the natural logarithm of the total assets of a firm at the end of the previous quarter. **Tobin's q** is the total market value of a firm divided by its total assets at the end of the previous quarter. **Book-to-Market** is a firm's common shareholders' equity book value divided by its market capital at the end of the previous quarter. **Damage** is the net CPI-adjusted dollar value of damages caused by a natural disaster. **Deaths** is number of casualties of a natural disaster reported by the NCEI.

Table 11: CAR Fixed Effect (FE) Panel Regression Results – Industrial Sectors

Dependent Variable: CAR			
	(1)	(2)	(3)
	Industrial	Consumer Discretionary	Consumer Staples
Variable	Coefficient	Coefficient	Coefficient
ESG	-0.037532	-0.06198	-0.03739
	(0.0046) **	(0.0008) ***	(0.0898)$^{\$}$
ROA	0.061975	0.006961	1.374628
	(0.0135) *	(0.7151)	(0.0908) $^{\$}$
Tobin's q	-0.03038	0.038718	0.038718
	(0.8967)	(0.8565)	(0.2597)
Book-to-Market			-0.05929
	-3.29673	-1.14622	(0.3921)
	(0.0000) ***	(0.0148) *	
Size	-0.44572	-0.84537	-1.09153
	(0.3)	(0.0484) *	(0.1522)
Damage	0.023831	-0.00885	0.00182
	(0.0000) ***	(0.2864)	(0.8566)
Deaths	-0.00632	-0.00013	0.006182
	(0.0039) **	(0.9639)	(0.0825) $^{\$}$
Intercept	6.822915	9.144592	-1.81775
	(0.0385) *	(0.007) **	(0.8406)
Number of Cross-sections	346	285	93
Number of Periods	66	66	66
Total Panel Observations	3729	2885	1083
R-Squared	0.175	0.138	0.166

The symbols $, *, **, and *** denote statistical significance at the 0.1, 0.05, 0.01 and 0.001 level, respectively. P-values are presented in parentheses. The table presents the results of the panel regression fixed model (FE) model for three major industries. The industry classification is based on the GICS system. Column one presents results for a subsample of firms in the 'Industrial' sector, column two presents result for 'Consumer Discretionary' sector and column three presents results for 'Consumer Staples' sector.

CAR (%) is the cumulative abnormal return at the end of the event window and is the summation of abnormal return from day -1 to day 7. **ESG** score is the Reuters Refinitive net ESG score based on environmental, social, and governance score at the end of the previous quarter. **ROA (%)** is return on assets at the end of the previous quarter. **Size** is the natural logarithm of the total assets of a firm at the end of the previous quarter. **Tobin's q** is the total market value of a firm divided by its total assets at the end of the previous quarter. **Book-to-Market** is a firm's common shareholders' equity book value divided by its market capital at the end of the previous quarter. **Damage** is the net CPI-adjusted dollar value of damages caused by a natural disaster. **Deaths** is the number of casualties of a natural disaster reported by the NCEI.

Table 12: CAR Fixed Effect (FE) Panel Regression Results – Primary Affected States

Dependent Variable: CAR

Variable	Coefficient
ESG	-0.029
	(0.111)
ROA	0.00133
	(0.888)
Tobin's q	0.3452
	(0.0725) $
Book-to-Market	-2.829
	(0.0000) ***
Size	-0.8226
	(0.0725) $
Damage	0.0109
	(0.0144) **
Deaths	-0.0097
	(0.0304) *
Intercept	8.712
	(0.0163) **
Number of Cross-sections	1355
Number of Periods	65
Total Panel Observations	4655
R-Squared	0.319

The symbols $, *, **, and *** denote statistical significance at the 0.1, 0.05, 0.01 and 0.001 level, respectively. P-values are presented in parentheses. Column one presents the results of the primary affected states. **CAR (%)** is the cumulative abnormal return at the end of the event window and is the summation of abnormal return from day -1 to day 7. **ESG** score is the Reuters Refinitive net ESG score based on environmental, social, and governance score at the end of the previous quarter. **ROA (%)** is return on assets at the end of the previous quarter. **Size** is the natural logarithm of the total assets of a firm at the end of the previous quarter. **Tobin's q** is the total market value of a firm divided by its total assets at the end of the previous quarter. **Book-to-Market** is a firm's common shareholders' equity book value divided by its market capital at the end of the previous quarter. **Damage** is the net CPI-adjusted dollar value of damages caused by a natural disaster. **Deaths** is number of casualties of a natural disaster reported by the NCEI.

Table 13: CAR Fixed Effect (FE) Panel Regression Results – All Sectors

	Dependent Variable: CAR			
	(1)	(2)	(3)	(4)
Variable	Coefficient	Coefficient	Coefficient	Coefficient
ESG	-0.0171 (0.054) $	-0.0232 (0.0148) *	-0.0223 (0.019) ***	-0.027 (0.0056) **
ROA		0.0028 (0.5741)	-0.0027 (0.5912)	0.0029 (0.5605)
Tobin's q		0.03443 (0.5353)	0.0349 (0.5295) *	0.03314 (0.5506)
Book-to-Market		-1.7606 (0.0000) ***	-1.7599 (0.0000) ***	-1.7612 (0.0000) ***
Size		-0.2849 (0.0883) $	-0.2867 (0.0862) $	-0.3097 (0.0642) $
Damage			0.0062 (0.0085) **	0.00879 (0.0007) ***
Deaths				-0.0025 (0.0174) *
Intercept	0.515308 (0.1172)	3.9978 (0.0025) **	3.9375 (0.0029) ***	4.3362 (0.0011) **
Number of Cross-sections	2345	2345	2345	2345
Number of Periods	66	66	66	66
Total Panel Observations	22120	22120	22120	22120
R-Squared	0.155	0.1613	0.1616	0.1618

The symbols $, *, **, and *** denote statistical significance at the 0.1, 0.05, 0.01 and 0.001 level, respectively. P-values are presented in parentheses. Column one presents the panel regression results when ESG is the only independent variable in the model. Columns two to four present regression results in which we add with company and natural disaster control variables. **CAR (%)** is the cumulative abnormal return at the end of the event window and is the summation of abnormal return from day -1 to day 7. **ESG** score is the Reuters Refinitive net ESG score based on environmental, social, and governance score at the end of the previous quarter. **ROA (%)** is return on assets at the end of the previous quarter. **Size** is the natural logarithm of the total assets of a firm at the end of the previous quarter. **Tobin's q** is the total market value of a firm divided by its total assets at the end of the previous quarter. **Book-to-Market** is a firm's common shareholders' equity book value divided by its market capital at the end of the previous quarter. **Damage** is the net CPI-adjusted dollar value of damages caused by a natural disaster. **Deaths** is number of casualties of a natural disaster reported by the NCEI.

Table 14: Volatility Fixed Effect (FE) Panel Regression Results – All Sectors

	Dependent Variable: Volatility			
	(1)	(2)	(3)	(4)
Variable	Coefficient	Coefficient	Coefficient	Coefficient
ESG	-0.1011 (0.0000) ***	-0.04764 (0.0003) ***	-0.0483 (0.0002) ***	-0.0551 (0.0000) ***
ROA		-0.0642 (0.0000) ***	-0.0641 (0.0000) ***	-0.0633 (0.0000) ***
Tobin's q		-0.09 (0.0837) $	-0.09 (0.0837) $	-0.093 (0.0727) $
Book-to-Market		6.8955 (0.0000) ***	6.8949 (0.0000) ***	6.9078 (0.0000) ***
Size		-2.7947 (0.0000) ***	-2.7925 (0.0000) ***	-2.9338 (0.0000) ****
Damage			0.007 (0.1684)	0.0034 (0.5403)
Deaths				-0.0102 (0.0000) ***
Intercept	9.2245 (0.0000) ***	26.6216 (0.0000) **	26.6779 (0.0000) ***	28.244 (0.0000) ***
Number of Cross-sections	2417	2417	2417	2417
Number of Periods	66	66	66	66
Total Panel Observations	22433	22433	22433	22433
R-Squared	0.2433	0.2659	0.2659	0.2666

The symbols $, *, **, and *** denote statistical significance at the 0.1, 0.05, 0.01 and 0.001 level, respectively. P-values are presented in parentheses. Column one presents the panel regression results when ESG is the only independent variable in the model. Columns two to four present regression results in which we add with company and natural disaster control variables. **Volatility (%)** is the variance of the return of the event window. **ESG** score is the Reuters Refinitive net ESG score based on environmental, social, and governance score at the end of the previous quarter. **ROA (%)** is return on assets at the end of the previous quarter. **Size** is the natural logarithm of the total assets of a firm at the end of the previous quarter. **Tobin's q** is the total market value of a firm divided by its total assets at the end of the previous quarter. **Book-to-Market** is a firm's common shareholders' equity book value divided by its market capital at the end of the previous quarter. **Damage** is the net CPI-adjusted dollar value of damages caused by a natural disaster. **Deaths** is number of casualties of a natural disaster reported by the NCEI.

Table 15: Volatility Fixed Effect (FE) Panel Regression Results – Primary Affected States & Industries

Panel A: Primary Affected States

Dependent Variable: Volatility	
Variable	Coefficient
ESG	-0.1003 (0.0137) *
ROA	-0.793 (0.0002) ***
Tobin's q	0.2238 (0.605)
Book-to-Market	8.6721 (0.0000) ***
Size	-4.1728 (0.0000) ***
Damage	0.0057 (0.5691)
Deaths	-0.0246 (0.0147) *
Intercept	38.6623

	(0.0000) ***
Number of Cross-sections	1355
Number of Periods	65
Total Panel Observations	4655
R-Squared	0.34

Panel B: Industries

Dependent Variable: Volatility						
	Industrials	Consumer Discretionary	Financials	Information Technology	Communication Services	Utilities
Variable	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
ESG	-0.0268	-0.0854	-0.1362	-0.0785	-0.099	-0.0261
	(0.0957) $	(0.001) **	(0.0000) ***	(0.0087) **	(0.0726) $	(0.0093) **
ROA	-1.4236	-0.1615	-0.1144	-0.1526	-0.2847	-0.0888
	(0.0089) **	(0.0000) ***	(0.0285) *	(0.0000) ***	(0.0000) ***	(0.0004) ***
Tobin's q	-0.2513	0.6522	0.3881	0.1549	-0.9165	0.0427
	(0.3772)	(0.0315) *	(0.2473)	(0.4887)	(0.1773)	(0.9276)
Book-to-Market	4.9683	4.1332	9.1638	-0.7825	4.1807	1.2948
	(0.0000) ***	(0.0000) ***	(0.0000) ***	(0.6184)	(0.0000) ***	(0.001) ***
Size	-1.42358	-0.096	-2.779	-0.498	-0.7939	-0.8566
	(0.0065) **	(0.8741)	(0.0003) ***	(0.4887)	(0.5243)	(0.0071) **
Damage	0.00336	0.0142	0.02483	0.0009	0.0134	-0.0017
	(0.6236)	(0.2255)	(0.0348) *	(0.95)	(0.5367)	(0.6659)
Deaths	-0.0042	-0.0083	-0.0199	0.0023	-0.0097	-0.0033
	(0.1138)	(0.0452) *	(0.0000) ***	(0.7333)	(0.2849)	(0.0133) *
Intercept	15.33344	7.1483	26.9655	12.03	14.636	10.51
	(0.0001) ***	(0.1365)	(0.0001) ***	(0.0233) *	(0.1654)	(0.001) ***
Number of Cross-sections	346	285	442	293	79	61
Number of Periods	66	66	66	66	66	66
Total Panel Observations	3727	2885	4079	1985	707	729
R-Squared	0.33	0.26	0.22	0.41	0.33	0.37

The symbols $, *, **, and *** denote statistical significance of the at the 0.1, 0.05, 0.01 and 0.001 levels, respectively. The p-values are presented in parentheses. **Panel A:** Column one presents the results of the primary affected states. **Panel B:** Columns one to six present results of major industries. **Volatility (%)** is the variance of the return of the event window. **ESG** score is the Reuters Refinitive net ESG score based on environmental, social, and governance score at the end of the previous quarter. **ROA (%)** is return on assets at the end of the previous quarter. **Size** is the natural logarithm of the total assets of a firm at the end of the previous quarter. **Tobin's q** is the total market value of a firm divided by its total assets at the end of the previous quarter. **Book-to-Market** is a firm's common shareholders' equity book value divided by its market capital at the end of the previous quarter. **Damage** is the net CPI-adjusted dollar value of damages caused by a natural disaster. **Deaths** is number of casualties of a natural disaster reported by the NCEI.