Climate Change Fear:
Natural Disasters and Investor Behavior

Franco Fiordelisi (corresponding author)

Essex Business School, University of Essex, Wivenhoe Park, Colchester CO4 3SQ, U.K.,
tel. +44 (0) 1206 872 260; email: franco.fiordelisi@essex.ac.uk

Giuseppe Galloppo

Department of Economics and Business, University of Viterbo La Tuscia, Via del Paradiso 47, 01100 Viterbo, Italy, email: galloppo@unitus.it

Viktoriia Paimanova

Department of Management, University of Rome Tor Vergata, Via Columbia 2, Rome, Italy, e-mail: viktoriia.paimanova@uniroma2.it

Abstract

Although an increasing number of papers analyze losses due to natural disasters, there is no evidence that climate change events have an impact on sustainable investment decisions. Our paper proves that natural disasters have a substantial influence on returns of Exchange-traded Funds (ETF). By using data on natural disasters, we show that investors react to natural disasters by investing in sustainable financial products. Our findings suggest that large-scale natural disasters significantly increase investors' preferences of sustainable ETFs. Finally, we also provide evidence that investors' sentiment towards sustainability macro theme has changed over time.

Keywords: Sustainable Investments, Climate Change, Natural Disasters, ETF.

JEL Classification: *G11***,** *G12, G18*

1. Introduction and Motivation

Climate change is a global challenge affecting all human and non-human habitants. As reported by the United Nations webpage "*Climate Change is the defining issue of our time and we are at a defining moment. From shifting weather patterns that threaten food production, to rising sea levels that increase the risk of catastrophic flooding, the impacts of climate change are global in scope and unprecedented in scale. Without drastic action today, adapting to these impacts in the future will be more difficult and costly*"[1]. Not surprisingly, a large number of initiatives have been recently developed both at the worldwide[2] and country[3] levels. Our paper measures natural disasters and its effect on investment decisions. We consider natural disasters as a part of climate change, that means, we assume that climate change cause natural disasters, not vice-versa, and, thus, climate change by means of natural disasters increases the attention of investors. Our paper considers the following types of natural disasters: drought, extreme temperature, flood, landslide, mass movement (dry), storm, volcanic activity, and wildfire[4]. Research on relationship between climate change and natural disasters is broadly examined by non-economic studies for a long time already (to name a few: Anderson and Bausch, 2006[5]; Dixon, et al., 2019; Fang et al., 2019; Lee et al. 2020; Van Aalst, 2006). All these studies explain the relationship between different natural disasters events and climate change. According to National Aeronautics and Space Administration (NASA) Earth Observatory[6] climate change will create conditions more favorable to the formation

[1] https://www.un.org/en/sections/issues-depth/climate-change (31 August 2019)

[2] E.g. The "United Nations Framework Convention on Climate Change", signed by 195 members and 180 new participants in Paris in 2015, deals with greenhouse-gas-emissions mitigation, adaptation, and financing. Also, the "Sustainable Development Goals (SDG)", signed in 2015 by 193 members of the United Nations and global civil society in 2015, identifies 17 goals related to the planet protection, peace and prosperity promotion and poverty decline to be achieved between 2015 and 2030.

[3] Among all, we remind the Presidential Climate Action Plan (2013) in the US aiming to reduce carbon dioxide emissions. In China, the Government established its Green Finance Taskforce in 2014: the task force recommendations were applied by Central Council in 2015 and reflected in Green Financial Guidelines in 2016. In the same year, China also turned into the largest issuer of green bonds and provided legal support to growing green products. Other governments (e.g. South Africa, Malaysia, China, EU, and Brazil) obliged large companies to disclose their sustainable business practices together with financial data. The number of companies disclosing their sustainability actions has increased from 30 in 1990 up to more than 7000 in 2014 worldwide (Khan et al., 2016). COP 26 hosted in Glasgow in 2021 finalized the elements of the Paris Agreement in 2015: commitment to support developing countries in dealing with consequences of climate change, adoption of the global methane pledge and finalization of the Paris rulebook.

[4] We consider that while the effect of climate change on drought, extreme temperature, flood, landslide, wildfire, for example, is obvious due to greenhouse effect in the atmosphere that boost temperatures and human activity, the relationship between climate change and natural disasters such as earthquakes is not fully scientifically proven. https://climate.nasa.gov/news/2926/can-climate-affect-earthquakes-or-are-the-connections-shaky/ .

[5] Fang et al., (2019) show that climate change and GDP have no positive impacts on the growth of natural capital. By contrast, natural disaster frequency contributes to the accumulation of natural capital in G20 countries, while an inverted U-shaped relationship between the growth of natural capital and the magnitude of natural disasters is observed. Dixon et al, 2019, in a survey experiment involving three different natural hazards find that emphasizing the role of climate change in these hazards produced unintended effects for climate change sceptics. Anderson and Bausch (2006) provide the clear influence of climate change on heatwaves and intense rainfall and the emerging evidence of hurricanes which are going to become more severe through the years. Van Aalst (2006) describes such catastrophic events as Hurricanes Katrina (2005) and Wilma (2005) and provides evidence that the intensity of tropical cyclones in the Atlantic has been increasing since 1995 and explain by a sea-level rise which results in much higher storm surge damage, and it incorporates some of the effects of global climate change. Lee et al. (2020) provide evidence that climate change on disaster events results in various disasters (earthquakes, typhoons, floods, and landscape hazards) and classify disaster events into natural disasters (24.5%), disasters associated with technology (64.5%) and those associated with security or violence (11.0%).

[6] https://earthobservatory.nasa.gov/features/RisingCost/rising_cost5.php

of severe thunderstorms and tornadoes, even though such effects are not detectable in observations today, there is evidence that tornadoes have become more frequent in recent years. In modern conditions of climate change and the probable increase of natural disasters due to its effects, it is getting more crucial for investors to both protect their portfolios from financial risks caused by catastrophic events and grab new opportunities resulting from new market conditions. Moreover, driven by the evolution of legislation related to the new European Union Climate Benchmarks, we are observing the creation of new UCITS instruments (e.g., Climate transition Mutual Funds) which are offered to both retail and institutional customers and targeted to a fair and green transition. The financial system plays an essential role in achieving Sustainable Development. The United Nations Environment established the "Inquiry into the Design of a Sustainable Financial System" in 2014 to contribute to the transition of the financial system to a green and inclusive one. This inquiry was followed by a wide number of policy regulators, financial institutions, and civil society from more than 20 countries around the world in 2018. Not surprisingly, there is an increasing interest in sustainable and responsible investing also driven by various initiatives, such as the Financial Stability Board's "Task Force on Climate-Related Financial Disclosures"[7] or the "Network of Central Banks and Supervisors for Greening the Financial System[8]. Almost all main stock exchanges have enhanced sustainability reporting to improve corporate transparency, risk management and engagement with stakeholders: as of 15 March 2018, there are 38 exchanges worldwide providing Environmental, Social, and Corporate governance (ESG) guidance (Sustainable Stock Exchanges Initiative under United Nations[9]).

No wonder, the number of studies investigating the effect of Sustainability issues on a very wide number of financial items is fast growing. The first group of papers literature deals with "Corporate Social Responsibility" with a focus on environmental consciousness (Di Giuli, & Kostovetsky, 2014; Tang & Zhang, 2020; Zerbib, 2019). The second group of papers use natural disasters and climate changes as an exogenous shock to test the reaction of various types of financial products, such as credit supply, real estate prices, and financial instruments. The third group of papers outlines how investment decisions are influenced by ESG or Socially Responsible Investing (SRI) items.

Our paper is at the intersection between the second and the third group of studies: specifically, we use worldwide natural disasters as an exogenous shock, and we measure the investors' reaction just after the shock by comparing ESG-oriented investments and other (normal) investments. Our paper provides a substantial contribution to both groups of papers. In comparison to papers investigating the relationship between ESG and investors' decisions, we propose a new focus based on the analysis of Exchange-traded Funds (ETF), i.e., investment funds that track an index, a commodity or bonds and are traded on stock exchanges. A common feature of all papers assessing the relationship between ESG items and investors' decision is their focus on mutual

[7] Task Force on Climate-Related Financial Disclosures[7] (TCFD), set up in 2015 by the Financial Stability Board, to develop voluntary, consistent climate-related financial risk disclosures for use by companies, banks, and investors in providing information to stakeholders.
[8] The Network of Central Banks and Supervisors for Greening the Financial System[8] was originally set up by eight central banks and supervisors at the end of 2017**.** As of October 15th, 2019, the network includes 46 members and 9 observers. Network for Greening the Financial System (NGFS), places central banks in a unique position to influence broader financial market behaviors and accelerate the transition to a more socially and environmentally sustainable economy and financial system, due to the fact that climate change is a key area of focus given the potential risks it poses to financial stability.
[9] https://sseinitiative.org/home-slider/sri-lankan-exchange-launches-sustainability-guidance/

funds and, especially, their ESG ratings. The ESG-rating assignment is a non-fully standardized process: an ESG rating reflects both the weighted average of the ESG values of single loadings of mutual funds, but it is also influenced by rating agencies' subjective evaluation policies (Escrig-Olmedo et al. 2019). As such, ESG ratings produced by different rating agencies are not comparable and their adoption may introduce arbitrary factors in empirical analysis. In our paper, we focus on ETF investments, rather than Mutual Funds, since ETFs enable us to have an objective assessment of ETFs related to sustainability themes (i.e., we define ESG-oriented ETFs using the following two complementary and objective criteria: (1) the ETF name contains either "ESG" or "SRI"; (2) self-declared sustainable-oriented ETF: that ETF asset manager declares itself when dealing with sustainability macro themes). There are also various factors making ETFs attractive for investors, in place of Mutual Funds. ETF allows better targeting for a thematic investment, as the ESG and the ESG-oriented investments. ETFs are highly trading flexibility instruments (allowing investors to enter and exit very quickly from an investment thematic strategy: Sherrill, et al. 2017). ETFs also have lower fees than mutual funds and ETFs might be preferred by investors with higher liquidity and trading needs and/or higher marginal taxes (Agapova, 2011). In our paper, we collect data on single natural disasters from a novel database of natural disaster events worldwide that provide us with different parameters (number of deaths, number of injuries, and value of damages) to measure the gravity of the disaster. Focusing on the last decade (January 2009-December 2018), we selected 848 natural disaster events from 147 countries: this enables us to investigate the reaction of worldwide investments using quite 1500 ETFs.

Our novel identification approach enables us to answer the following research questions: do worldwide investments react to natural disasters? We show that there is an increase in investment demand after the occurrence of natural disasters, signalling the need for additional sustainable investments. We also find that investment activity towards sustainable financial products is influenced by the asset class type (fixed income or equity). Moreover, we evaluate whether investment returns after natural disasters can differ across time, considering that the Climate Change topic has acquired increasing attention by the market sentiment, in particular after the occurrence of very popular international conferences such as the 2015 Paris COP 21. The basic assumption is that the sentiment on climate change changes over time according to the increase in the media attention and the interest in the international political agenda, over this topic.

Our main contribution is that we provide readers with empirical evidence of "whether" and "to what extent" investors change their investment attitudes after natural disasters. By analyzing a large dataset, including international natural disasters and a very extensive dataset of sustainable ETF, our empirical results indicate that investment demand increases significantly after natural disasters, suggesting the necessity of additional sustainability investments after climate shocks' occurrence. Considering the expectation that scientists have regarding the possible increase in frequency and intensity of natural disasters, a study investigating the investment activity in response to climate change events may help ensure the best use of anti-climate change measures, with particular reference to emerging market countries characterized by climate change events of a particular intensity.

The rest of this paper is organized as follows. In Section 2, we review past papers, and we formulate our research hypothesis. In Section 3, we describe our data and variables. Then, we illustrate our identification approach in Section 4., we present our results in section 5 and we report robustness checks in section 6. We conclude in Section 7.

2. Literature and hypotheses development

There is fast-growing literature investigating the effect of ESG issues on a very wide number of financial items. Although the heterogeneity of these studies, we group them into three main areas. The first branch of literature deals with "Corporate Social Responsibility" with a focus on environmental consciousness suggesting that the standard profit maximization model is evolving toward complex profit maximization strategies including constraints related to a minimal degree of satisfaction of the other stakeholders (e.g., Becchetti et al., 2015; Ferrell et al., 2016). The second group of papers uses natural disaster and climate changes phenomenon as an exogenous shock to the test the reaction of various type of financial products, such as credit supply (Berg and Schrader, 2012; Cortés and Strahan, 2017; Koetter et al. 2019), real estate prices (e.g. Bernstein et al., 2019) and the issuance of financial instruments (Painter, 2019). The third group of papers focus on the effect of ESG items on financial markets focusing on stock prices (Oestreich and Tsiakas, 2015; Tang and Zhang, 2018; Zerbib, 2019), weather derivatives market (Perez-Gonzalez and Yun, 2013; Purnanandam and Weagley, 2016), and investment decisions (Hartzmark and Sussman, 2019; Renneboog, et al., 2011; Trück, and Weron, 2016; Riedl and Smeets, 2017).

ESG in the form of green finance is called to support economic growth with less pressure on the environment and taking into account social and governance parameters (EU Commission). Modern definitions of Corporate Social Responsibility (CSR) include the sustainability part as well. Therefore, ESG deals very closely with CSR practices in the part of environment dimension, however, there are two different streams of literature dedicated to CSR and ESG as the whole units with their specific dimensions. According to Carroll's Pyramid of CSR (Carroll, 1979), the CSR activities are classified as economic, legal, ethical, and discretionary (philanthropic), where sustainability is only partially included as a part of legal responsibility. However, modern scholars also include an environmental responsibility dimension to Carroll's Pyramid of CSR (Lee et al., 2019; Weber, 2008 to name a few). World Business Council for Sustainable Development divides modern CSR into three main dimensions of sustainable development, such as environment, economy, and society. Therefore, we can relate environmental consciousness as an important part of CSR.

Regarding the first branch of literature dealing with climate finance, there is a large literature dealing with the effect of corporate social responsibility (related to environmental consciousness) on firm returns, cash flows, value, and investor behaviour.

A first group of papers focus on stock returns reaching mixed evidence: Di Giuli and Kostovetsky (2013) show that CSR rating improvements might lead to negative future stock returns and declines in ROA, Humphrey et al., (2012) do not find differences in terms of risk or return; Gao and Zhang, (2015) and Lins et al., (2017) conversely show that CSR increases earnings-return relationship, especially in time of financial crisis. Another group of papers show that the relationship between CSR and firm value is positive (Dutordoir et al., 2018; Ferrell et al., 2016). Adhikari (2016) underlines that the firm value is influenced by the financial analyst coverage while investors indicate a "strong negative" reaction to negative events, and a "weakly negative" reaction to positive events concerned with a firm's CSR (Krüger, 2015). Overall, investors evidence their selective preferences to the presence of environmental and social indicators (Arouri et al., 2019; Nofsinger et al., 2019).

A second group of papers is devoted to credit supply: Berg and Schrader (2012), Cortés and Strahan (2017) and Koetter et al. (2019) show that financially integrated banks reallocate funds toward markets with high credit demand and away from other markets ("connected markets") in which they lend, in response to local, exogenous shocks to credit demand stimulated by natural disasters. Berg and Schrader (2012) indicate that while credit demand increases due to volcanic activity, access to credit is restricted. There are also a few papers about the effect of the natural disaster on other items such as real estate prices (e.g., Bernstein et al., 2019[10]), and the issuance of financial instruments (Painter, 2019[11]). Weather and Natural disasters related research, assessing the negative impact between extreme events and stock return natural include Bourdeau-Brien and Kryzanowski (2017), Cao and Wei (2005) and Klomp (2017), Lanfear, et al., (2018). Other papers focus on the weather derivatives market (Perez-Gonzalez and Yun, 2013; Purnanandam and Weagley, 2016), where they reveal that derivatives experience great price declines during the financial crisis, and they significantly reduce the ability of firms to hedge weather risks.

A third branch of literature focuses on the effect of ESG on financial markets. Several papers focus on stock prices (Lanfear, et al., 2018; Oestreich and Tsiakas, 2015; Tang and Zhang, 2018; Zerbib, 2019) showing a positive effect on the market value, connected to a good performer in terms of ESG criteria. Finally, under this research stream, a group of papers investigates the influence of ESG and SRI issues on investment decisions (Hartzmark and Sussman, 2019; Renneboog, et al., 2008, 2011; Riedl and Smeets, 2017; Truck, and Deron, 2016;). All those papers focus on mutual funds and show that: a) investors in socially responsible investment (SRI) expect to earn lower returns rather than on conventional funds (Renneboog, et al., (2008) find that SRI funds globally underperform their domestic benchmarks but on average the risk-adjusted returns of SRI funds are not statistically different from the performance of conventional funds), and forgo financial performance for the benefit of their social preferences (Riedl and Smeets, 2017); b) SRI are less related to past fund returns than are conventional fund flows, but more sensitive to past positive returns than are conventional fund flows (Renneboog, et al., 2011); c) investors collectively put a positive value on sustainability (Hartzmark and Sussman, 2019), i.e. a "low sustainability" categorization of a fund results in net outflows, while a "high sustainability" categorization led to net inflows; d) companies' environmental and social performance increase when investors have strong understanding of importance of ESG (Dyck et al., 2019, Nofsinger et al. 2019).

Based on past papers, we posit various research hypotheses. Our first research question is the following:

H_1: *Investors increase investment in sustainable instruments after natural disasters.*

This question is based on the view that natural disasters are stark signs of climate change and investors' decision-making is oriented towards sustainable financial instruments based on their values and personal priorities to contribute to climate change mitigation. Indeed, investors show their selective preferences to the presence of environmental and social indicators (Arouri et al., 2019; Nofsinger et al., 2019). They put a positive value on sustainability. Hartzmark and Sussman, 2019, show that a "low sustainability" categorization of funds results in net outflows, while a "high sustainability" categorization led to net inflows.

[10] Bernstein et al., 2019 show that coastal properties exposed to projected sea level rise have a 7% lower selling price relative to observably equivalent unexposed properties equidistant from the beach
[11] Painter, 2019 proved that counties more likely to be affected by climate change pay more in underwriting fees and initial yields to issue long-term municipal bonds compared to counties unlikely to be affected by climate change.

Natural Disasters influence the investment targets of issuers of ESG-oriented ETFs because investment targets are represented in the form of companies 'stocks as a part of fund holdings. The pressure on buying the performance of such companies is seen in the increase in stock price and, hence, the rise of ETFs' Net Asset Value (NAV). This is consistent with the focus on the performance of ESG-oriented ETFs. Thus, we expect a statistically significant relationship between natural disasters and returns of sustainable investing instruments.

In the second step, we expect that investment returns after a natural disaster can differ over time, indeed the Climate Change topic has acquired an increasing concern in the political agenda and mass media. This might have influenced the formation of the so-called "collective consciousness". This leads us to the following hypothesis:

H2: The relationship between natural disasters and sustainable investing increased over time

Furthermore, we explore the differences between equity and bond investment. The difference in investors' behaviour between equity and bond has been largely explored by past papers. Investor sentiment changes induce investors to adjust their asset allocation decisions. When investors' sentiment-induced trading behaviour changes in response to the decline of financial market sentiments compared to the historical average, investors tend to switch from riskier to safer assets and move their investments from equity funds to bond funds when the sentiment gets worse (Da et al., 2015).

3. Data and Variables

Data have been collected from different sources. Data related to natural disasters are collected from the "Emergency Events Database" (EM-DAT)[12]: this contains core data on both the occurrence and the effects of worldwide mass disasters from 1900. The database is compiled from various sources, including UN agencies, non-governmental organizations, insurance companies, research institutes and press agencies. ETF returns data are collected from Thomson Reuters DataStream: we collect monthly total returns for ETFs traded worldwide traded (both dead and still alive, to avoid survivorship bias) between January 2009 and December 2018 period. Over the sample period (January 2009-December 2018), our sample includes 848 natural disaster events from 147 countries and 1224 ETFs from 187 financial companies.

< Insert Table 1 >

3.1 Measuring natural disaster

We consider the following natural disasters in our database: drought, extreme temperature, flood, landslide, mass movement (dry), storm (including hurricanes) and wildfire. We measure nature disaster events (848) that occurred in 147 countries (panels B and C of Table 1) by the meaning of total Damages (in thousands of Us dollars). Table 1 reports some descriptive statistics.

[12] EM-DAT is the "Emergency Events Database" (www.emdat.be). In 1988, the Centre for Research on the Epidemiology of Disasters of the Université Catholique de Louvain in Belgium launched the Emergency Events Database (EM-DAT) with the aims of rationalizing decision making for disaster preparedness and providing an objective base for vulnerability assessment and priority setting.

3.2 Measuring sustainability

The wealth management industry has developed over the last decade various financial products for investors wishing to invest in sustainable instruments. In 2018, more than one out of every four dollars under professional management was invested under ESG criteria 2018 (Connaker and Madsbjerg, 2019). Since 1976 (when Vanguard launched the first open-end index mutual fund), ETFs have constantly grown up over time reaching an asset value (of global ETFs) of 4.7 USD trillion in 2018 and representing one of the main financing sources for companies. ETFs can take one of the following organizational forms: trusts[13], mutual funds, and holders[14]. By focusing on ETFs, we can have a direct and safe method for identifying ESG-oriented investments. Rather than focusing on the ESG ratings (as Ferrell, et al., 2017; Hartzmark and Sussman, 2019; Riedl and Smeets, 2017) that are also influenced by rating agencies' subjective policy evaluations, we believe that the most straightforward approach for an investor to make a sustainability-related investment is through the purchase of a thematic ETF. Specifically, we define ESG-oriented ETFs using the following two complementary and objective criteria: (1) the ETF name contains either "ESG" or "SRI", given that these two specifications are the most commonly used to identify sustainable instruments; (2) self-declared sustainable-oriented ETF: that ETF asset manager declares itself when dealing with sustainability macro themes. Therefore, the sample construction was primarily based on self-declared "Sustainability oriented strategies"[15]. The name of an investment strategy is of paramount relevance in the wealth management industry. The SEC generally requires that any mutual fund or ETF with a name suggesting that it focuses on a particular type of investment must invest at least 80% of its assets in the type of investment suggested by its name." In the same fashion UK FCA, under the OEIC Regulation 15(9), sections 243(8) and 261D(10), require that "an authorized fund's name must not be undesirable or misleading"16. Secondly, we checked the asset allocation objectives of underlying investment strategies by referring to their fact sheets. To the best of our knowledge, it is the first time that academic literature addresses a similar mutual fund sample.

Our control sample is composed of all worldwide non-ESG-oriented ETFs with that same currency (British Pound, Canadian Dollar, Euro, Japanese Yen, Korean (South) Won, New Zealand Dollar, Swiss Franc, and US Dollar), same country-domicile (Canada, France, Ireland, Japan, Luxembourg, New Zealand, South Korea, Switzerland, and the United States), same fund-type (Bond and Equity) of ESG-oriented ETFs. Our final sample consists of 139 ESG-oriented ETFs, i.e. 84 ETFs containing ESG in the name, 40 containing SRI in the name and 15 self-declaring ESG-oriented ETFs (all Equity Type). Most of the ESG-oriented ETFs focusing focus on equity (126) and few on bonds (23). The control sample is composed of 1105 non-ESG-oriented ETFs, (209 focusing on bonds and 896 on equity). In terms of assets under management, our sample of ESG-oriented ETFs value about 12 billion US dollars and the control sample 1.7 Trillion US dollars (as of 01/10/2018): our sample represents almost 90% of the universe of worldwide ESG-oriented ETFs ($13.5 billion in assets under management at the end of August 2018[17]).

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[13] These are exchange-traded mutual fund offering a fixed (unmanaged) portfolio of securities with a definite life.

[14] ETFs holders have a direct ownership of the securities held by the ETF holder and the investor retains all rights such as voting rights.

[15] We check periodically the characteristics of the ETFs, according to their ESG-oriented investor scheme, with respect to our selection criteria, with particular reference to any change in the name of the underlying strategy.

[16] https://www.handbook.fca.org.uk/handbook/COLL/6/9.html

[17] Source of data: https://www.pionline.com/interactive/esg-etf-assets-surge-2019

3.3 Measuring ETFs Returns and ETF Characteristics

We measure ETF returns using the log rate of change of monthly ETF prices between January 2009 and December 2018 (collected from Thomson Reuters Eikon), as follows:

$$\text{ETF Ret}_{i,t+1} = \text{Ln}(\text{ETF}_{i,t+1} / \text{ETF}_{i,t}) \quad (2)$$

where $ETF_{i,t}$ is the *i-th* ETF price at month *t.* A positive ETF return (i.e. ETF price increase) shows an increase in prices of the ETF constituent stocks and bonds: once we observe an increase in the ETF return, this suggests that there is excess demand in the constituents' bonds and equity (thus increasing their prices). We considered the following ETF characteristics: *Age* - the seniority of the single ETF (measured in terms of months since inception), *Div_yeld* - Dividend Yield return, and *Size* - Fund asset size. Age and Dividend Yield are expected to act with a positive meaning over the return. ETF characteristics are taken from the Refinitiv.

4. Identification strategy

Our empirical approach to investigate whether ESG-oriented ETFs achieve different performance in comparison to other ETFs is based on the following model:

$$Y_{i,t} = \alpha + \beta_1 SUST_{i,t} + \beta_2 DAM_{j,t-1} + \beta_3 SUST_i\_DAM_{j,t-1} + \gamma X_{i,t-1} + A_i + B_t + \varepsilon_{i,t}, \quad (3)$$

where the dependent variable (Y) is the log monthly ETF return measured at month *t* for the fund *I*. Our main variable of interest is *SUST_DAM, i.e.* the interaction between *SUST (*a dummy variable related to sustainable instruments, takes a value of one for ESG-oriented ETF, or zero otherwise) and the lagged value of *DAM* (our indicator of the relative importance of disastrous events). There are several potential explanations for why ESG-oriented ETFs may obtain greater performance than other ETFs, including the fact that, in reaction to "climate change signals" in the form of extreme weather events we should expect a change in the investor sentiment, and it can play a role in allocating investments contributing to a more sustainable future. *SUST* is our classification variable capturing sustainable instruments (taking a value of 1 the ETF is associated with the sustainability umbrella, and 0 otherwise). $DAM_{j,t-1}$ stands for the disaster event intensity measured by the meaning of the total damages (in thousands of US dollars) that occurred during last month in the country *j*. $X_{i,t-1}$ stands for control variables and includes: $Size_{t-1}$ (Fund asset size) is a total market value of the ETF as observed at the end of month *t*; Age_{t-1} (ETF Age) is ETF seniority (number of months since inception); Div_yield_{t-1} is a Dividend Yield return. All dependent variables are one period lagged and are winsorized at 1 and 99 percentiles. In our main models, we include fund fixed effects (A) considering the asset management company and the country where ETFs are domiciled, and the month dummy variables (B). We consider robust standard errors clustered at the ETF level. Since one might claim that the total Unlike most of the academic literature in this area, (see among others, Marti-Ballester, 2019 and Soler-Domínguez et al., 2021) to address potential endogeneity problems, we perform 2SLS regression analyses using the total number of deaths and the total number of affected as instrumental variables for the damages.

To provide additional support for our choice of instruments, in each of the 2SLS regressions we perform the following three tests: (1) a Cragg and Donald (1993) instrument relevance test to confirm the relevance of the instrumental variables; (2) a Sargan (1958) over-identification test to examine the exogeneity of the instrumental variables; 3) a Stock and Yogo minimum eigenvalue statistics that is a test for under-identification. All the diagnostics reported at the bottom of all tables, satisfy the validity of the instruments. Our identification approaches present two unique and novel elements: firstly, we focus on ETF (that enable an objective identification of ESG investments), and secondly, we run a worldwide analysis both in terms of disasters, and investments.

5. Empirical Results

5.1 Baseline analysis: sustainability & natural disaster

First, we analyze the relationship between the performance of sustainability-related ETFs and our disaster Indicator (lagged by one period) to test our first hypothesis (H_1: *Investors increase investment in sustainable instruments after natural disasters because they believe that sustainable instruments have greater returns than other investments*). Table 2 shows the climate change effect on Sustainable Investment Decisions with the main dependent variable ETF Log Return. Our main variable of interest is *SUST_DAM*. Looking at *SUST_ DAM*, we are able to estimate the relationship between stock market reactions and ESG-oriented ETFs investing in countries experiencing severe disastrous events.

Focusing on the whole sample (Panel A), we find a positive and statistically significant relationship between our main independent variable *SUST_ DAM* and the ETF returns. Concerning the overall sample, we find (10% level) marginal evidence, when we consider the equity side of the relationship, we have a 5% level of statistical significance. Our evidence suggests that natural disasters influence investors' decisions toward sustainable instruments (*SUST_ DAM*), especially on the Equity side (Panel B). Looking at the magnitude of the effect, our results show a positive reaction, when a disaster event occurs, of 20bp. Overall, the results also show no particular predisposition towards financial instruments in the whole (Panel A) sample period (*SUST*). The *SUST* variable related to sustainable instruments takes a negative sign of 5% statistical significance only for equity. Furthermore, we observe an increase in market returns after natural disasters. *DAM*, is the log value of total damages which determines the relative importance of disastrous events that occurred shows a high level of statistical significance of 1% for all samples and both equity and bond asset classes. We estimate a positive reaction of 7bp mean reaction (8bp and 5bp for equity- and bond-ETFs respectively, Panel B). Despite their ostensible low impact, our estimates (monthly based) correspond to quite 1% (when we consider Bond ETF) and 1.5% (Equity ETF), in terms of yearly compound return.

We also include various control variables such as Age_{t-1} (the seniority of the single ETF, measured in terms of months since inception), Div_yeld_{t-1} (the Div Yield return), and $Size_{t-1}$ (fund asset size). All variables are taken with one month lag.

< Insert Table 2 >

5.2. The time evolution effect

In this section, we test whether the relationship between natural disasters and sustainable investing has increased over time. Specifically, we select two time periods pre and post Paris Agreement, i.e., 2013-2015, and 2016-2018. Following carious papers (among others, Diaz-Rainey et al., 2021; Kinley, 2019), we consider Paris Agreement as a kind of watershed in creating strong market sentiment concerning Climate and sustainable finance themes. The basic assumption is that the sentiment on climate change has been growing over time, so it is reasonable to assume that critical awareness has evolved over time and that the common thinking of a few years ago has profoundly changed in the light of the broad information campaign performed by different media over the years and also followed by an increase in interventions regarding the effects of climate change over time from both national governments and international organizations. The results are shown in Tables 3 and 4 for the time evolution of ETF reaction to the disaster from 2013 to 2015 and 2016 to 2018, respectively.

SUST_DAM is the variable of main interest capturing the market reaction to ESG-oriented ETFs after natural disasters. The interaction dummy *SUST_DAM* gets positive (significant at the 1% level) for bonds in the period 2013-2015 (Table 3). The picture is different in 2016-2018 (Table 4): we find a positive (at the 1% statistical level) for all samples and equities. It is now important to verify whether our basic assumption is confirmed, because all coefficients (excluding the bond asset class) turn out to be statistically significant (at the 10% or less) in the second period and, also, their magnitude increase. The different behaviour of the fixed income (bond) sector is likely to be attributed to the increase in competition in the offering of fixed income products in recent years. The increase in competition has made investments in sustainable instruments less attractive for the bond sector compared to other types of fixed-income investments available in financial markets. During the sample period while at the beginning we have the 7% of the sample composed of sustainability-oriented ETFs, at the end of the sample period the number of sustainability-oriented ETFs for the fixed income side is reduced by 5%. Moreover, there is a statistically significant difference between the two groups in favor of not sustainability-oriented investments (0.3% versus 1%, yearly based).

< Insert Tables 3 and 4 >

Looking at the change of the sign of coefficient estimates for *SUST* and *DAM*, we note a negative reaction (statistically significant at 10% level or less) in the period 2016-2018. The relative importance of disastrous events that occurred (*DAM*) brought positive statistically results at a 1% level for the period 2013-2015 for all our groups analyzed, but, interestingly, there is a negative statistically significant reaction at a 1% level for all sample and equity, however, positive for bonds in the period 2016-2018. We interpret this result by assuming that in the second period natural disasters lead to a particularly negative market sentiment that overcomes the positive expectations of investors connected to future reconstruction revenues. In our opinion, this is particularly important and worthy of further investigation in future research work.

6. Additional Test

We run some robustness checks by rerunning the basic model with a different measure of market reaction (Tables 5-7).

We also validate our main findings by changing our dependent variables. To be specific instead of return, we consider Turnover by Volume, representing the total number of constituent shares traded on a particular day. Similarly, to the rationale of the analysis that takes into consideration the reaction of the price, and therefore of the return, of the sustainable instruments, in the same fashion, the turnover by volume reacts to the increase in demand pressure by investors.

We use this new measure to run the basic model. In Table 5 we show the climate change effect on sustainable investment decisions and change in the market reaction variable – Turnover by Volume. Looking at the results, the main result, corresponding to the market reaction of Sustainable Investments (measured in terms of ETF) to extreme natural events is unchanged. We find positive (and statistically significant at the 1% level) estimates in terms of sustainable instruments variable, both for all samples and equity. Table 5 highlights a positive correspondence between extreme natural events and investor demand pressure concerning investments with sustainability macro themes. This is especially true for the Equity asset class. The relative importance of disastrous events shows a 5% level of positive statistically significant results for all samples and equity.

< Insert Table 5 >

Then, we control for climate change awareness and investigate the time evolution effect of ETF reaction to a natural disaster like in Tables 3 and 4 but changing our main dependent variable and previous results still hold.

< Insert Tables 6 and 7 >

7. Conclusion

How do international investors react to climate change? Surprisingly, there are no papers showing "whether" and "to what extent" investments change after natural disasters. Our paper is a first attempt to fill this gap in the literature by analyzing a rich dataset of worldwide natural disasters. Specifically, we use monthly data on return and trading volumes to examine the link between natural disasters and investments in Sustainability ETFs. We find that natural disasters have a statistically significant link with ETFs returns.

Our contribution is threefold. First, our paper focuses on ETFs instruments, that enable us to identify sustainable investments. We believe that this is the most direct way from the point of view of resource allocation mechanisms that trigger the occurrence of events related to climate change. Secondly, we use a large sample of natural disasters, both in terms of geographical coverage and type of disasters and losses measures. Lastly, for the first time, we investigate investment decisions addressed to sustainable investing in reaction to climate change extreme events.

Our main finding indicates that investments increase significantly after natural disasters, suggesting the necessity of additional sustainability investments after climate shocks' occurrence. As expected, we also show that investments in sustainable financial products are influenced by the asset class type (Fixed Income or Equity). Furthermore, we find that *ceteris paribus* investors have lower demand for ESG investments: on average, investors are not willing to invest *tout court* in ESG oriented instruments, rather do so when solicited by external events, such as natural disasters. This shows that, after a natural disaster, investors spontaneously activate a sort of social awareness that makes them deviate from their usual investment strategy.

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Table1: Descriptive statistics

This table reports the summary statistics for the whole sample. Panel A reports the summary statistics for the whole ETF sample. We disentangle ESG-oriented ETFs in two groups: (1) ETFs whose name contains either "ESG" or "SRI", given that these two specifications are the most commonly used to identify sustainable instruments; and (2) ETFs that self-declare being sustainable-oriented. Panel B provides the asset type breakdown (bond and equity, respectively). Panel C and D is the summary statistics for the Natural Disaster sample. The sample time range corresponds to January 2009 – December 2018 period. Age is the seniority of the single ETF (measured in terms of months since inception). Div_yeld_{t-1} stands for Dividend Yield return. All variables are taken with a one-month lag and are winsorized at 1 and 99 percentiles. Panel C reports the number of natural disasters analyzed in our empirical investigation. The natural disaster Database is based on EM-DAT. p < 0.10, ** p < 0.05, *** p < 0.01.

***Panel A**: ETF Sample – Descriptive Statistics*

	Auto Declared Sustainable Strategy				**ESG & SRI Strategy**			
	Mean	Max	Min	St. Dev	Mean	Max	Min	St. Dev
Returns	0.005	0.140	-0.154	0.058	0.001	0.140	-0.154	0.018
Dividend Yield	1.354	11.020	0.000	1.200	1.839	11.020	0.000	1.840
Age	90.214	116.000	2.000	41.877	34.337	116.000	0.000	33.754

***Panel B:** ETF Sample – Asset Type - Descriptive Statistics*

	Equity ETF (1)				**Bond ETF (2)**				**(1)-(2)**
	Mean	Max	Min	St. Dev	Mean	Max	Min	St. Dev	
Returns	0.006	0.139	-0.153	0.045	0.001	0.039	-0.020	0.007	0.005***
Dividend Yield	1.152	11.020	0.000	1.370	0.522	3.000	0.000	1.080	0.630***
Age	30.360	116.000	0.000	38.140	18.440	93.000	2.000	26.940	11.915***

***Panel C**: Natural Disaster Sample – Descriptive Statistics*

	Mean	Max	Min	St.Dev	p25	p75	p90
Total deaths	369	222570	1	7553	5	45	143
Total affected	1058330	134000000	1	6610290	3562	241734	1498408
Total damage ('000 US$)	1327812	210000000	2	8679864	20000	600000	2000000

***Panel D**: Natural Disaster Sample – Number of Events and Year of Occurrence*

Year	Number of Events	Total deaths	Total affected	Total damage (USD th)
2009	72	6122	93140958	30816621
2010	69	234722	190618784	106561220
2011	74	27619	156417664	338734766
2012	95	5141	70918287	54642271
2013	120	17629	76525314	100948787
2014	102	3647	63810290	56517314
2015	97	12061	22626002	47287771
2016	97	5412	166371463	102894918
2017	110	5877	71268207	309245094
2018	42	5501	17516849	18169810
Total	878	323731	929213818	1165818572

***Panel E**: Natural Disaster Sample – Number of Events by Type and Geographical Areas*

	Total deaths	Total affected	Total damage (USD th)
Africa			
Flood	1839	12920684	3595715
Landslide	1132	11932	58036
Storm	565	2045927	1186500
Wildfire	9	5500	420000
Asia			
Extreme temperature	2	4033472	281000
Flood	25349	563718762	224589993
Landslide	2473	407394	1687378
Mass movement (dry)	46	2	8000
Storm	17691	198500930	106418416
Volcanic activity	39	115160	186000
Wildfire	233	32259	2271000
Europe			
Flood	641	2879505	34515728
Storm	148	543789	10103875
Wildfire	142	10613	1025820
North America			
Flood	158	376518	30417000

Landslide	64	1516	870000
Storm	1257	86531196	243976000
Wildfire	94	51116	22497000
South America			
Extreme temperature	3	120000	500000
Flood	2827	8995016	12190716
Landslide	904	130080	967000
Storm	1744	15593221	107063252
Wildfire	24	19705	784000
Total	323731	929213818	1165818572

Table 2: The climate change effect on Sustainable Investment Decisions: Returns

The main dependent variable is ETF Log Return. The main independent variable is $SUST\_ DAM_{-1}$. The variable $SUST\_ DAM_{-1}$ is an interaction dummy between *SUST* and the lagged value of *DAM*. *SUST* variable is a dummy variable related to sustainable instruments (dummy takes a value of 1 if we consider ETF associated with sustainability umbrella, otherwise it equals 0). *DAM* captures the severity of natural disasters, and it is the log value of damages. We include the following control variables related to ETFs' characteristics: $Size_{t-1}$ stands for fund asset size; Age_{t-1} is the seniority of the single ETF (measured in terms of months since inception); Div_yeld_{t-1} means the Div Yield return. In columns 1 and 2, we estimate the model using OLS. In column 3, we perform 2SLS regression analyses using the total number of deaths and the total number of affected as instrumental variables for the damages (DAM_{t-1}). Fixed Effects are considered as follows: Asset Manager level, Country (domicile)*Month and ETF. In panel A, we use our entire sample: in columns (1) and (2), we estimate the model using OLS. In column (3), we perform 2SLS regression analyses using the total number of deaths and the total number of affected as instrumental variables for the damages (DAM_{t-1}). In panel B, we split our sample between ETF investing in equity and bonds: in columns (1) and (3), we estimate the model using OLS. In columns (2) and (4), we perform 2SLS regression analyses using the total number of deaths and the total number of affected as instrumental variables for the damages (DAM_{t-1}). Standard errors are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Panel A – All sample

	y=log returns (1)	*y=log returns* (2)	*y=log returns* (3)
SUST	-1.873***		
	(0.569)		
DAM_{-1}	-0.018**	-0.013*	-0.849***
	(0.008)	(0.008)	(0. 011)
$SUST\_ DAM_{-1}$	0.143***	0.143***	0.215***
	(0.039)	(0.038)	(0. 038)
$Size_{t-1}$	-0.161***	-0.736***	-0. 736***
	(0.023)	(0.044)	(0.045)
Age_{t-1}	0.004***		
	(0.001)		
Div_yeld_{t-1}	-0.031***	0.142***	0. 139***
	(0.012)	(0.015)	(0.018)
No. observations	74.294	74.294	74.294
Company-FE	Yes	No	No
Country*Month FE	Yes	Yes	Yes
ETF-FE	No	Yes	Yes
Estimation approach	OLS	OLS	IV-2SLS
Tests:			
Underidentification (p-value			0.000
Weak identification (p-valu			0.000
Overidentification (p-value)			0.000
			1st stage results
Total deaths			0.478***
			(0.000)
Total affected			0.315***
			(0.000)

Panel B – Equity & Bond

	y=log returns	*y=log returns*	*y=log returns*	*y=log returns*
	Equity (1)	Equity (2)	Bonds (3)	Bonds (4)
SUST				
DAM $_{-1}$	-0.021**	-1.868***	0.050***	-0.035
	(0.008)	(0.094)	(0.008)	(0.095)
SUST_ DAM $_{-1}$	0.153***	2.001***	0.011	0.095
	(0.040)	(0.092)	(0.026)	(0.096)
$Size_{t-1}$	-0.776***	-0.753***	-0.344***	-0.352***
	(0.049)	(0.049)	(0.051)	(0.056)
Age_{t-1}				
Div_yeld_{t-1}	0.154***	0.088***	0.021	0.018
	(0.017)	(0.019)	(0.017)	(0.017)
No. observations	66.254	66.254	8.040	8.040
Company-FE	NO	NO	NO	NO
Domicile*Month FE	Yes	Yes	Yes	Yes
ETF-FE	Yes	Yes	Yes	Yes
Estimation approach	OLS	IV-2SLS	OLS	IV-2SLS
Tests:				
Underidentification (p-value)				0.000
Weak identification (p-value)				0.000
Overidentification (p-value)				0.004
				1st stage results
Total deaths				0.480***
				(0.000)
Total affected				0.311***
				(0.000)

Table 3: Climate Change Awareness: the time evolution of ETFs reaction to disasters. All Sample PRE-Paris Agreement (2013-2015)

The main dependent variable is ETF Log Return. The main independent variable is $SUST\_ DAM_{-1}$. The variable $SUST\_ DAM_{-1}$ is an interaction dummy between *SUST* and the lagged value of DAM_{t-1}. *SUST* variable is a dummy variable related to sustainable instruments (dummy takes a value of 1 if we consider ETF associated with sustainability umbrella, otherwise it equals 0). DAM_{t-1} determines the relative importance of disastrous events that occurred during the previous month. This disaster metric is linked to damages in thousands of dollars. We include the following control variables related to ETFs' characteristics: $Size_{t-1}$ stands for fund asset size; Age_{t-1} is the seniority of the single ETF (measured in terms of months since inception); Div_yeld_{t-1} means the Div Yield return. Fixed Effects are considered as follows: Asset Manager level, Country (domicile)*Month and ETF. In columns (1) and (2), we estimate the model using OLS. In column (3), we perform 2SLS regression analyses using the total number of deaths and the total number of affected as instrumental variables for the damages (DAM_{t-1}). Standard errors are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	y=log returns (1)	*y=log returns* (2)	*y=log returns* (3)
SUST	0.724		
	(2.580)		
DAM_{-1}	0.257***	0.247***	0.345***
	(0.022)	(0.021)	(0.035)
$SUST\_ DAM_{-1}$	-0.033	-0.045	-0.143
	(0.172)	(0.172)	(0.178)
$Size_{t-1}$	-0.306***	-2.389***	-2.377***
	(0.051)	(0.156)	(0.157)
Age_{t-1}	0.013***		
	(0.002)		
Div_yeld_{t-1}	-0.183***	0.011	0.010
	(0.026)	(0.050)	(0.050)
No. observations	22.490	22.490	22.490
Company-FE	Yes	NO	NO
Domicile*Month FE	Yes	Yes	Yes
ETF-FE	No	Yes	Yes
Estimation approach	OLS	OLS	IV-2SLS
Tests:			
Underidentification (p-value			0.000
Weak identification (p-valu			0.000
Overidentification (p-value)			0.000
			1st stage results
Total deaths			0.529***
			(0.004)
Total affected			0.327***
			(0.002)

Table 4: Climate Change Awareness: the time evolution of ETFs reaction to disasters. All Sample POST-Paris Agreement (2016-2018)

The main dependent variable is ETF Log Return. The main independent variable is $SUST\_DAM_{-1}$. The variable $SUST\_DAM_{-1}$ is an interaction dummy between *SUST* and the lagged value of DAM_{t-1}. *SUST* variable is a dummy variable related to sustainable instruments (dummy takes a value of 1 if we consider ETF associated with sustainability umbrella, otherwise it equals 0). DAM_{t-1} determines the relative importance of disastrous events that occurred during the previous month. This disaster metric is linked to damages in thousands of dollars. We include the following control variables related to ETFs' characteristics: $Size_{t-1}$ stands for fund asset size; Age_{t-1} is the seniority of the single ETF (measured in terms of months since inception); Div_yeld_{t-1} means the Div Yield return. Fixed Effects are considered as follows: Asset Manager level, Country (domicile)*Month and ETF, In columns (1) and (2), we estimate the model using OLS. In column (3), we perform 2SLS regression analyses using the total number of deaths and the total number of affected as instrumental variables for the damages (DAM_{t-1}). Standard errors are reported in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$..

	y=log returns (1)	*y=log returns* (2)	*y=log returns* (3)
SUST	-1.167**		
	(0.505)		
DAM_{-1}	0.287***	-0.149***	0.280***
	(0.009)	(0.015)	(0.008)
$SUST\_DAM_{-1}$	0.101***	0.525***	0.100***
	(0.034)	(0.037)	(0.034)
$Size_{t-1}$	-0.065***	-1.106***	-0.817***
	(0.021)	(0.093)	(0.084)
Age_{t-1}	0.002***		
	(0.001)		
Div_yeld_{t-1}	-0.045***	0.099***	0.102***
	(0.009)	(0.025)	(0.024)
No. observations	33.356	33.356	33.356
Company-FE	Yes	NO	NO
Domicile*Month FE	Yes	Yes	Yes
ETF-FE	No	Yes	Yes
Estimation approach	OLS	OLS	IV-2SLS
Tests:			
Underidentification (p-value			0.000
Weak identification (p-value			0.000
Overidentification (p-value)			0.000
			1st stage results
Total deaths			0.329***
			(0.005)
Total affected			0.267***
			(0.004)

Table 5: The climate change effect on Sustainable Investment Decisions – Change in Market reaction variable – Trading Volume

The main dependent variable is ETF Trading Volume (*TR_Vol)*. The main independent variable is $SUST\_ DAM_{-1}$. The variable $SUST\_ DAM_{-1}$ is an interaction dummy between *SUST* and the lagged value of DAM_{t-1}. *SUST* variable is a dummy variable related to sustainable instruments (dummy takes a value of 1 if we consider ETF associated with sustainability umbrella, otherwise it equals 0). DAM_{t-1} determines the relative importance of disastrous events that occurred during the previous month. This disaster metric is linked to damages in thousands of dollars. We include the following control variables related to ETFs' characteristics: $Size_{t-1}$ stands for fund asset size; Age_{t-1} is the seniority of the single ETF (measured in terms of months since inception); Div_yeld_{t-1} means the Div Yield return. Fixed Effects are considered as follows: Asset Manager level, Country (domicile)*Month and ETF. In panel A, we use our entire sample: in columns (1) and (2), we estimate the model using OLS. In column (3), we perform 2SLS regression analyses using the total number of deaths and the total number of affected as instrumental variables for the damages (DAM_{t-1}). In panel B, we split our sample between ETF investing in equity and bonds: in columns (1) and (3), we estimate the model using OLS. In columns (2) and (4), we perform 2SLS regression analyses using the total number of deaths and the total number of affected as instrumental variables for the damages (DAM_{t-1}). Standard errors are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Panel A – All sample

	y=TR_Vol (1)	*y= TR_Vol* (2)	*y= TR_Vol* (3)
SUST	-1.262***		
	(0.449)		
DAM_{-1}	0.003	0.006	-0.115*
	(0.005)	(0.005)	(0.060)
$SUST\_ DAM_{-1}$	0.089***	0.090***	0.211***
	(0.032)	(0.031)	(0.067)
$Size_{t-1}$	-0.038*	-0.151***	-0.159***
	(0.022)	(0.029)	(0.029)
Age_{t-1}	-0.000		
	(0.001)		
Div_yeld_{t-1}	-0.001	0.008	0.005
	(0.007)	(0.007)	(0.007)
No. observations	42.801	42.801	42.801
Company-FE	Yes	NO	NO
Domicile*Month FE	Yes	Yes	Yes
ETF-FE	No	Yes	Yes
Estimation approach	OLS	OLS	IV-2SLS
Tests:			
Underidentification (p-value			0.000
Weak identification (p-valu			0.000
Overidentification (p-value)			0.942
			1st stage results
Total deaths			0.421***
			(0.013)
Total affected			0.369***
			(0. 011)

Panel B – Equity & Bond

	y=TR_Vol	*y= TR_Vol*	*y= TR_Vol*	*y=TR_Vol*
	Equity (1)	*Equity* (2)	*Bond* (3)	*Bond* (4)
SUST				
DAM_{-1}	0.007	-0.112*	-0.003	-0.146
	(0.005)	(0.064)	(0.022)	(0.095)
$SUST\_DAM_{-1}$	0.077**	0.196***	0.305**	0.446***
	(0.030)	(0.069)	(0.127)	(0.155)
$Size_{t-1}$	-0.155***	-0.161***	-0.099	-0.130
	(0.029)	(0.030)	(0.125)	(0.129)
Age_{t-1}				
Div_yeld_{t-1}	0.010	0.007	-0.019	-0.026
	(0.007)	(0.007)	(0.023)	(0.023)
No. observations	39.000	39.000	3.801	3.801
Company-FE	NO	NO	NO	NO
Domicile*Month FE	Yes	Yes	Yes	Yes
ETF-FE	Yes	Yes	Yes	Yes
Estimation approach	OLS	IV-SLS	OLS	IV-SLS
Tests:				
Underidentification (p-value)		0.000		0.000
Weak identification (p-value)		0.000		0.000
Overidentification (p-value		0.775		0.886
		1st stage results		1st stage results
Total deaths		0.550***		0.469***
		(0.051)		(0.054)
Total affected		0.402***		0.315***
		(0.033)		(0.045)

Table 6: Climate Change Awareness: the time evolution of ETFs reaction to disasters

All Sample PRE-Paris Agreement (2013-2015)

The main dependent variable is ETF Trading Volume (*TR_Vol)*. The main independent variable is $SUST\_DAM_{-1}$. The variable $SUST\_DAM_{-1}$ is an interaction dummy between *SUST* and the lagged value of DAM_{t-1}. *SUST* variable is a dummy variable related to sustainable instruments (dummy takes a value of 1 if we consider ETF associated with sustainability umbrella, otherwise it equals 0). DAM_{t-1} determines the relative importance of disastrous events that occurred during the previous month. This disaster metric is linked to damages in thousands of dollars. We include the following control variables related to ETFs' characteristics: $Size_{t-1}$ stands for fund asset size; Age_{t-1} is the seniority of the single ETF (measured in terms of months since inception); Div_yeld_{t-1} means the Div Yield return. Fixed Effects are considered as follows: Asset Manager level, Country (domicile)*Month and ETF. In columns (1) and (2), we estimate the model using OLS. In column (3), we perform 2SLS regression analyses using the total number of deaths and the total number of affected as instrumental variables for the damages (DAM_{t-1}). $^{*}p<0.10$, $^{**}p<0.05$, $^{***}p<0.01$.

	y=TR_Vol (1)	*y= TR_Vol* (2)	*y= TR_Vol* (3)
SUST	-0.725		
	(1.261)		
DAM_{-1}	-0.014	-0.013	0.009
	(0.012)	(0.012)	(0.021)
$SUST\_DAM_{-1}$	0.051	0.039	0.017
	(0.087)	(0.084)	(0.088)
$Size_{t-1}$	-0.038	-0.089	-0.087
	(0.032)	(0.058)	(0.058)
Age_{t-1}	0.001		
	(0.001)		
Div_yeld_{t-1}	0.001	0.001	0.000
	(0.010)	(0.010)	(0.010)
No. observations	12.478	12.478	12.478
Company-FE	Yes	NO	NO
Domicile*Month FE	Yes	Yes	Yes
ETF-FE	No	Yes	Yes
Estimation approach	OLS	OLS	IV-SLS
Tests:			
Underidentification (p-value			0.000
Weak identification (p-valu			0.000
Overidentification (p-value)			0.013
			1st stage results
Total deaths			0.515***
			(0.006)
Total affected			0.334***
			(0.003)

Table 7: Climate Change Awareness: the time evolution of ETFs reaction to disasters

All Sample POST-Paris Agreement (2016-2018)

The main dependent variable is ETF Trading Volume (*TR_Vol)*. The main independent variable is *SUST_ DAM* $_{-1}$. The variable *SUST_ DAM* $_{-1}$ is an interaction dummy between *SUST* and the lagged value of *DAM* $_{t-1}$. *SUST* variable is a dummy variable related to sustainable instruments (dummy takes a value of 1 if we consider ETF associated with sustainability umbrella, otherwise it equals 0). *DAM* $_{t-1}$ determines the relative importance of disastrous events that occurred during the previous month. This disaster metric is linked to damages in thousands of dollars. We include the following control variables related to ETFs' characteristics: *Size* $_{t-1}$ stands for fund asset size; *Age* $_{t-1}$ is the seniority of the single ETF (measured in terms of months since inception); *Div_yeld* $_{t-1}$ means the Div Yield return. Fixed Effects are considered as follows: Asset Manager level, Country (domicile)*Month and ETF. In columns (1) and (2), we estimate the model using OLS. In column 3, we perform 2SLS regression analyses using the total number of deaths and the total number of affected as instrumental variables for the damages (*DAM* $_{t-1}$). Standard errors are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	y=TR_Vol (1)	*y= TR_Vol* (2)	*y= TR_Vol* (3)
SUST	-1.996***		
	(0.615)		
DAM $_{-1}$	0.028***	0.030***	0.024*
	(0.007)	(0.006)	(0.013)
SUST_ DAM $_{-1}$	0.143***	0.142***	0.148***
	(0.042)	(0.039)	(0.039)
Size $_{t-1}$	-0.031	-0.283***	-0.288***
	(0.029)	(0.073)	(0.074)
Age $_{t-1}$	-0.000		
	(0.001)		
Div_yeld $_{t-1}$	-0.020**	0.000	0.000
	(0.009)	(0.011)	(0.011)
No. observations	21.741	21.741	21.741
Company-FE	Yes	NO	NO
Domicile*Month FE	Yes	Yes	Yes
ETF-FE	No	Yes	Yes
Estimation approach	OLS	OLS	IV-SLS
Tests:			
Underidentification (p-valu			0.000
Weak identification (p-valu			0.000
Overidentification (p-value)			0.000
			1st stage results
Total deaths			0.313***
			(0.011)
Total affected			0.255***
			(0.009)

ANNEX

Table A1. Variable description

This table defines the variables used in the paper and the sources of data.

Variables	Symbol	Definition and calculation method	Exp. Sign	Source
Dependent Variables:				
ETF return	*log returns*	The log difference in price between two consecutive months for a given ETF.	+	Thomson Reuters Data
Trading Volume	*TR_Vol*	Total monthly trading volumes for a given ETF	+	Thomson Reuters Data
Independent Variables:				
Sustainable Investments	$SUST_{t-1}$	A dummy variable taking the value of 1 if an ETF is associated with sustainability themes, and 0 otherwise.	+/-	Authors computation on Thomson Reuters Data
Natural disasters impact on Sustainable Investments	$SUST\_DAM_{t-1}$	The interaction between *SUST* and the lagged value of *DAM*.	+/-	Authors computation on Thomson Reuters Data & EM-DAT database
Damages (Disaster Intensity)	DAM_{t-1}	*DAM* capture the severity of disastrous events that occurred during the previous month. This disaster metrics is represented by Logarithm of total damages in thousands of dollars.	+/-	Authors computation on EM-DAT database
Control Variables:				
Fund Asset Size	$Size_{t-1}$	Total market value of the ETF as observed at the end of month *t*.	-	Thomson Reuters Data
ETF Age	Age_{t-1}	ETF seniority (number of months since inception)	+	Thomson Reuters Data
Div Yield return	Div_yield_{t-1}	Dividend Yield return		Thomson Reuters Data