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Does climate change affect the trading volume of sustainable funds?

Analysis through the trading volume of ETFs meeting the criteria of Articles 8 or 9 of the SFDR

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Abstract

This thesis examines a question related to sustainable finance. We will conduct an analysis of trading volume to highlight potential effects linking climate change to the traded volume of ETFs that meet the criteria of Articles 8 or 9 of the SFDR. This study is notably inspired by the works of Hartzmark & Sussman (2019) and Leclercq (2023).

The study will be conducted on a sample comprising European ETFs that adhere to the criteria outlined in Articles 8 and 9 of the Sustainable Finance Disclosure Regulation (SFDR). The study period will cover from November 2018 to December 2022. Different regression analyses will be applied to our panel data. Initially, we will conduct regressions where each climate change indicator is taken separately, in order to observe the individual impact of each indicator on the trading volume of our sustainable ETFs. Subsequently, a final regression will be performed, incorporating all climate change indicators simultaneously to account for potential interactions between them.

Our findings reveal that as climate-related natural disasters in Europe, represented by the number of flash floods and wildfires, increase, the trading volume of ETFs meeting the criteria of articles 8 and 9 of the SFDR also increases. Furthermore, in our comprehensive regression, we observe that a decrease in greenhouse gas emissions in Europe leads to an increase in the trading volume of sustainable ETFs. Surprisingly, the rise in temperature anomalies in Europe has a negative impact on the traded volume of our sample of sustainable ETFs. Expanding our scope beyond Europe and analyzing sea ice extent anomalies around the poles, we observe that the greater these anomalies become, the more the trading volume of sustainable ETFs increases. However, we emphasize the importance of interpreting these results with caution, as other variables could potentially explain the fluctuations in the traded volume of ETFs meeting the criteria of Articles 8 and 9 of the SFDR.

Few studies have delved into climate change as an explanatory factor for the traded volume of ETFs meeting the criteria of Articles 8 and 9 of the SFDR. Hence, this study holds significance in venturing to explore how climate change, manifested through various indicators, influences investment decisions in favor of sustainable funds.

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Introduction

As part of my final year of studies at UCLouvain, I embarked on a research project that is particularly close to my heart. This project focuses on sustainable finance, a financial theme that I had the opportunity to discover during my academic journey and that I decided to delve into through my research. Indeed, being environmentally conscious, I believe that sustainable finance is the finance of the future, given the threats that weigh on our planet.

The aim of this thesis is to highlight potential relationships linking climate change, measured by various indicators, to the traded volume of sustainable ETFs. The study will be conducted on a sample comprising ETFs that meet the criteria outlined in Articles 8 and 9 of the Sustainable Finance Disclosure Regulation (SFDR). We have chosen Europe as the geographical area of interest for this research, as SFDR is a European regulation and is thus more likely to impact European investors. The study period covers from November 2018 to December 2022. As each ETF contains all observations for each variable over the entire period, we consider our panel data to be balanced.

When I thought of this topic, to the best of my knowledge, there were no authors who had yet delved into the impact of climate change on the traded volume of sustainable funds. However, Hartzmark & Sussman (2019) had examined whether investors showed interest in sustainable fund ratings through an analysis of financial flows. Leclercq (2023) had also conducted an analysis of financial flows to highlight the link between investor sentiment and investment flows into European equity funds. We drew inspiration from his methodology to carry out our analysis, with the exception that, instead of analyzing financial flows, we examined the traded volume of our sample of ETFs, similar to what was done by Chen, Hond & Stein (2001).

We will attempt to address the following research question: “Does climate change affect the traded volume of sustainable ETFs?”

This dissertation will begin with a literature review, organized into distinct sections. Initially, we will explore the issue of climate change, with a specific focus on European awareness of this concern. Following that, we will delve into the fundamental principles of sustainable finance, highlighting the primary aspects of European regulatory efforts in this field (Sustainable Finance Disclosure Regulation). Additionally, we will closely examine the attributes of Exchange Traded Funds (ETFs) to enhance our comprehension. Lastly, we will

investigate how sustainable finance is integrated into ETFs and examine its implications, both within the European context and on a broader scale.

Once this theoretical groundwork is laid, we will be prepared to formulate our research hypotheses in anticipation of our analysis. Following an in-depth description of our data, we will introduce the methodology we have chosen. Subsequently, we will move forward to analyze and interpret the outcomes of the conducted analysis. This phase will involve assessing the impact of climate change on the traded volume of ETFs that adhere to the criteria outlined in Articles 8 and 9 of the SFDR. At this point, we will be ready to examine our hypotheses critically and to conduct tests to validate them.

Lastly, we will draw our conclusions and pay special attention to the limitations of this study. We will also explore potential avenues for future research that could enhance its overall contribution.

I. Literature review

The aim of this literature review is to establish a comprehensive conceptual framework for the key themes addressed in this study, namely climate change, the sentiment of European investors regarding this pressing matter, and the European regulatory measures implemented to mitigate the effects of climate change. Additionally, we will closely examine the attributes of Exchange Traded Funds (ETFs) to enhance our comprehension and we will investigate how sustainable finance is integrated into ETFs.

1. Climate change

The latest report from the Intergovernmental Panel on Climate Change (IPCC) was released in March 2023. The findings are alarming: scientists predict global warming exceeding 2 degrees Celsius if greenhouse gas emissions are not reduced (Réseau Action Climat, 2023). The industries with the highest greenhouse gas emissions are transport, manufacturing, agriculture, and energy production (Afzal, Rasoulinezhad & Malik, 2022). Those emissions cause rapid climate change, which in turn leads to natural disasters and resource depletion (Afzal, Rasoulinezhad & Malik, 2022). Some changes will be irreversible: sea-level rise, melting glaciers and permafrost, warming and acidification of oceans, as well as a decrease in CO2 absorption by forests and oceans (Réseau Action Climat, 2023). Water is also an underestimated risk. According to United Nations statistics, 80% of wastewater is released into the environment without being treated or reused. Additionally, one-fourth of climate-related disasters are water-related (Scott, 2023).

Climate change is already manifesting in various ways across Europe, with impacts differing by region (European Parliament, 2022). Loss of biodiversity, forest fires, flash floods, reduced crop yields, and rising temperatures represent some examples of the consequences of climate change affecting Europe. According to a report by the World Meteorological Organization (WMO), Europe experiences more than twice the global average of climate change. The IPCC also identifies Europe as the continent most affected by global warming. Over the period from 1991 to 2021, temperatures in Europe have risen significantly, with average warming of approximately +0.5°C per decade (UN France, 2022). Since March 2013, temperatures in Europe have continued to increase compared to the average from 1923 to 2023, without recording temperatures lower than this average, according to temperature anomalies from January 1973 to April 2023 (Appendix 1, NOAA National Centers for Environmental Information, 2023).

In terms of greenhouse gas emissions, the European Union (EU) ranks as the fourth-largest emitter globally in 2019, following China, the US, and India. The energy sector accounted for 77.01% of the EU's greenhouse gas emissions in 2019, followed by agriculture (10.55%), industry (9.10%), and waste (3.32%) (European Parliament, 2022).
Nevertheless, several European countries are successfully implementing measures to mitigate their impact on the climate. Within the European Union, greenhouse gas emissions have already decreased by 31% between 1990 and 2020, with the target being a net reduction of 55% by 2030 (UN France, 2022). Furthermore, following the war in Ukraine, Europe is quickly moving away from its dependence on Russian fossil fuels and increasing its renewable energy capacity. European companies have had no choice but to reduce their carbon emissions since energy prices have continued to rise. Europe is entering an era of decarbonization (Scott, 2023).

As a global initiative, the United Nations has emphasized the importance of developing green energies and reducing pollution by implementing Sustainable Development Goals (Yoshino, Taghizadeh-Hesary & Otsuka, 2021). "The 2030 Agenda of the United Nations is the major multilateral effort to overcome the greatest global sustainability challenges. The agenda defines 17 Sustainable Development Goals (SDGs) to be achieved by all countries until 2030." (de Oliveira, et al., 2020).

However, with the current functioning of the SDGs, the planet's temperature is expected to increase by 4-6°C above pre-industrial levels, which is well above the maximum level of 2°C to which governments agreed during the Paris Agreement. Indeed, the investment rate in SDGs is low: the recession has forced investors to consider the risk-return of their investment, which has made sustainable alternatives less attractive (Yoshino, Taghizadeh-Hesary & Otsuka, 2021). Therefore, achieving the SDGs will have to involve more government support. Institutional investors also have a crucial role to play given their size, as they can allocate their capital towards more sustainable investments (Yoshino, Taghizadeh-Hesary & Otsuka, 2021).

2. Investors' attention to environmental-related topics

The social lockdowns imposed by countries due to Covid-19 reduced NO2 and CO2 emissions by over 40% globally, allowing nature to regenerate (Paital, 2020). People's attitudes towards nature during the lockdown period changed; they maintained their gardens and public awareness levels increased, as measured by online search behavior. Indeed, there has been a rapid increase in the search for nature-related topics during the COVID-19 crisis (Rousseau & Deschacht, 2020). The graph in Appendix 2 illustrates a notable trend that emerged in the wake

of the Covid-19 pandemic: people's interest in nature-related topics has increased at a high rate. This shift in focus represents a crucial initial step towards a greater concern for environmental protection.

As far as investors' attention is concerned, they tend to overreact to news, which can increase volatility (Mbanga, Darrat, & Park, 2019). In addition, they tend to process more market-wide information than firm-specific information due to limited attention, which is a concept in behavioral finance that suggests investors are limited in time and energy, making it difficult for them to understand real-time market information (Mbanga, Darrat, & Park, 2019). Furthermore, a study by Leclercq (2023) shows that "when investor sentiment rises, fund flows increase".

Sustainable finance research is developing quickly due to growing concerns about climate change. Eco-friendly and socially responsible investors want to invest in green energy sectors (Dutta et al., 2023). In addition, climate events or periods of high climate risks could trigger investors to adjust their portfolios and allocate more to environmentally focused funds (Marshall, et al., 2021). Overall, climate disasters and media coverage can contribute to green investments, and "the correlation between climate disasters and green fund inflows is stronger when the climate disaster inflicts greater asset damage, and more Google searches for socially responsible investing" (Marshall, et al., 2021).

3. Environment, social and governance principles

According to de Oliveira, et al. (2020), stock exchanges, regulators, and companies promote sustainable investment practices through sustainability indices that act as a barometer of a company's performance based on environmental, social, and governance (ESG) criteria.

The environmental aspect relates to issues such as pollution, waste, management of natural resources, and climate change effects and risks (Strignert & Malm, 2021). Yoshino, Taghizadeh-Hesary, and Otsuka (2021) define the social pillar as including aspects "related to gender policies, human rights protection, labor standards, workplace and product safety, public health, and income distribution, which all affect employee satisfaction". In resume, it deals with how a company acts toward its stakeholders, with reciprocity (Strignert & Malm, 2021). "At last, the governance pillar is related to aspects such as the independence of the board of directors, shareholders' rights, managers' remuneration, control procedures and anti-competitive practices, as well as the respect of the law" (Yoshino, Taghizadeh-Hesary & Otsuka, 2021). According to Strignert and Malm (2021), the purpose of corporate governance

commitments is to reduce the discrepancies that exist between the information and control available to the management and shareholders.

Taliento, Favino, and Netti (2019) note that the assessment of ESG factors enhances the identification of risks and opportunities for companies. ESG performance can be interpreted as a quality metric for management, representing "the company's ability to face long-term trends while having a competitive edge" (Taliento, Favino & Netti, 2019). In the past two decades, ESG issues have gained increasing significance globally, which revealed their influence on the financial viability of several firms as well as their profitability (Taliento, Favino & Netti, 2019).

Furthermore, it is worth noting that the relationship between development and environmental welfare can be illustrated by the U-shaped EKC curve. This curve explains that initially, countries may be too impoverished to prioritize environmental concerns because of the cost of implementing sustainable rules. As countries achieve some level of stability, issues such as natural resource conservation and water waste become a matter of interest. As the country develops further, the rate of environmental degradation slows down. Additionally, the implementation of frameworks assists countries in carrying out green initiatives. Consequently, environmental degradation and institutional quality are closely intertwined (Afzal, Rasoulinezhad & Malik, 2022).

Large companies are encouraged to report their non-financial information through sustainable reports that involve key performance indicators to highlight their engagement towards environmental and social responsibilities (Taliento, Favino & Netti, 2021). Thus, companies play an active role in promoting a sustainable economy, particularly in mitigating the impact of climate change (Balp & Strampelli, 2022).

The Stakeholder Theory emphasizes that companies must consider the interests of all parties involved in business activities to create sustainable value over time (Taliento, Favino & Netti, 2021). This theory supports the notion of competitive advantage, where ESG commitments represent those. On the other hand, Corporate Social Responsibility (CSR) defines a company's responsibilities toward communities, taking into account the economic, social, and environmental consequences of its work (Taliento, Favino & Netti, 2021). Long-term planning is necessary, as the effect of CSR on Corporate Financial Performance may be negative in the short term, but sustainability indicators can support enhanced financial performance in the long

run. In other words, performing ESG engagement leads to a greater economic-financial return and facilitates the creation of value (Taliento, Favino & Netti, 2019).

4. ESG strategies and ratings

The integration of ESG factors into financial analysis refers to the systematic and explicit inclusion of environmental, social, and governance factors (D'Hondt, 2022). Investors interested in investing in ESG can choose different strategies. “Negative or exclusionary screening means the exclusion of unacceptable or controversial sectors or companies whose activities may harm the environment or society” (Taliento, Favino & Netti, 2019). “Positive or best-in-class screening is linked to the selection of the best ESG-performing companies within a specific business sector” (Favino, Taliento & Netti, 2019). In Europe, the development of best-in-class socially responsible investment is a growing strategy since 2005 (Appendix 3). Shareholders' exercise of their rights to influence corporate behavior through engagement with corporate management is known as corporate engagement and stock activism (Taliento, Favino & Netti, 2019). Finally, norm-based screening involves investing only in stocks that meet ethical business practice thresholds, while impact or community investing targets investments that solve social or environmental issues (Taliento, Favino & Netti, 2019; D'Hondt, 2022).

As for the scoring of ESG investments, rating agencies have developed their assessment methodology to evaluate ESG involvement, with different approaches. “ISS-Oekom and Bloomberg leverage direct contact with the company, while Thomson Reuters also considers stock market registrations” (Nikolov, 2022). Robeco SAM invites the world's largest listed companies to participate in a questionnaire that assesses missing information while MSCI and FTSE Russell assess 37 to 300 ESG criteria. The MSCI ESG ratings range from CCC to AAA, reflecting the issuer's performance (Strignert & Malm, 2021). Refinitiv's ESG scores measure a company's relative ESG performance, commitment, and effectiveness based on company-reported data, covering themes such as emissions, human rights, and shareholders' interests (Appendix 4).

The objective of ESG-scoring methodologies is to overcome the market capitalization bias that impacts large companies. The issue with ESG rating agencies is that they have their own interpretation of materiality, leading to varying weighting procedures and low correlation among scores assigned by different providers to the same companies. In addition, the multiplication of ESG rating providers may create confusion and greenwashing, posing a threat to the industry's transition toward carbon neutrality (Born, et al., 2021). Therefore, asset

managers and investors face the challenge of collecting consistent and qualitative data in order to achieve a specific ESG objective, with a lack of standards making it difficult to compare ESG characteristics of companies. As a result, standardization of ESG accounting procedures is necessary to meet investors' demand for transparency and data on risks and sustainable opportunities (BlackRock, 2023). A robust dataset of sustainability data points with regular quality checks is needed, with multiple features used for each data point to ensure plausibility in the broader context of the company's history, peers, and sector (Davison, McNelly, North & Mellon, 2023).

5. Europe, the leader in the ESG transition

Europe is the world's third-largest economy, and according to the International Monetary Fund, the Eurozone's growth is projected to bottom out at 0.7% this year before improving to 1.6% in 2024 (Business Insider, 2023). European governments, communities, and businesses are increasingly focused on sustainable development, prioritizing green initiatives and responsible investments. The Sustainable Finance Disclosures Regulation (SFDR) is a key catalyst for sustainable investment in Europe, and it is expected to help the continent achieve carbon neutrality by 2050 (BlackRock, 2023).

The European sustainability index (ESI) is unique in that it is not affected by the US Volatility (VIX) and Skewness indices (SKEW). Therefore, it represents a valuable hedging instrument for investors and asset managers that offsets the effects of economic policy uncertainty (de Oliveira et al., 2020). ESI represents the largest European sustainability leaders. Those companies are recognized as the top performers in Europe when it comes to environmental, social, and governance criteria, ensuring a robust framework for sustainable investment opportunities.

5.1 *European sentiment towards the Environment*

As explained before, the COVID-19 pandemic has heightened awareness of sustainability, with over 80% of people saying that sustainability is more top of mind now than before the pandemic. There has been a 30% year-over-year increase in searches containing the word "environment" and a 70% YOY increase in Google Image Searches containing "environment" from April to June 2021 (Zmuda, 2021).

More than 75% of Europeans acknowledge that environmental concerns have a direct impact on their daily lives and health, leading them to express their desire to take more action to protect

the environment (European Commission, 2020). Consumer sentiment in Europe is also strongly oriented towards ecology and sustainability, with increased demand for sustainable initiatives. Indeed,, Europe is currently the leading region for electric car sales (BlackRock, 2023).

According to a survey by the European Parliament, the majority of young people see climate change as the main global challenge for the future of Europe. 91% of 15-24 year-olds think that tackling climate change can help improve their health and well-being (Mayran, 2023). Moreover, six out of ten Belgians agree that the European Union and Belgium must reduce greenhouse gas emissions by 55% by 2030 in order to become carbon neutral by 2050. However, a low percentage of Belgians are satisfied with the actions taken by their government to fight climate change (Klimaat, 2022).

5.2 *Is this feeling reflected in the way they invest?*

Asset managers are expanding their offerings of green products, to meet the rising demand for ESG investments. Institutional investors in Europe account for more than 20% of ESG allocations, and regulatory pressure is increasing on asset managers to integrate climate considerations into investment strategies and decisions (Balp & Strampelli, 2022). In addition, impact investing and ESG integration are expected to see the greatest increase in allocations over the next five years, while thematic strategies focused on water scarcity or green energy are gaining popularity.

Europe leads in the allocation of sustainable strategies because investors aim to achieve their financial objectives while having a positive impact. Since today's decisions have long-term consequences on performance, investors need to assess companies that create long-term value. “Companies are motivated to make a positive contribution and, therefore, tend to make their business models more sustainable” (Wu, 2023).

5.3 *The problem of European Greenwashing*

Greenwashing occurs when an organization focuses its resources on promoting its environmental friendliness through means such as advertising, rather than minimizing its negative impact on the environment. Companies use greenwashing to appear socially and environmentally responsible (Mayran, 2023).

ESG policy greenwashing happens when a company declares its commitment to a sustainable strategy that does not align with what the company actually implements. Companies use strategies such as claiming that one approach is better for the environment than another or

pretending to have long-term green goals without using sufficient means to actually achieve them. In 2021, the European Commission reported that 42% of environmental claims made by organizations were misleading, and the lack of follow-through on these claims was criticized (Mayran, 2023).

In addition, as mentioned above, the lack of transparency and standards in the allocation of ESG scores by data providers to companies further encourages greenwashing. In 2022, the European Securities and Markets Authority (ESMA) pointed out the need to find a solution to gain a better understanding of the ESG rating markets in the EU.

6. Solution against European greenwashing: implementation of policies

European Commission is implementing several initiatives to fight against global warming including the Green Deal, which aims to reduce carbon emissions by 55% by 2030 and achieve carbon neutrality in Europe by 2050. This plan involves concrete actions, such as directing private investments and financial flows into green sectors (Mayran, 2023).

In order to implement sustainable initiatives, funds are needed. The European Union's €750 billion post-Covid-19 recovery plan raises questions about the implementation of a truly green financial strategy. Furthermore, the transparency and independence of European institutions have been criticized and the use of the European Ecolabel has been questioned. Recently, Greenpeace has criticized the expansion of the European Ecolabel to cover activities of industrial groups in fossil fuel and nuclear energy (Mayran, 2023).

To address these issues, the European Securities and Markets Authority (ESMA) proposed guidelines on the use of funds' names related to ESG and sustainability, including "a quantitative threshold of 80% of investments for environmental or social characteristics" (Delabye, 2023). In addition, it should be required to specify a clear formulation of greenwashing and to identify gaps in the current regulatory framework before implementing a new one (Delabye, 2023).

6.1 *Sustainable Finance Disclosure Regulation*

The Sustainable Finance Disclosure Regulation (SFDR) has been introduced to clarify institutions' responsibilities and increase transparency about how they integrate sustainability factors into their investment decisions (Balp & Strampelli, 2022).

It represents the first step towards the European Sustainable Finance Action Plan, which aims to redirect capital flows towards a more sustainable economy, integrate climate as a risk, and promote transparency as well as long-term commitments (Zhang et al., 2022). This regulation was introduced by the High-Level Expert Group on Sustainable Finance in 2019 and applies since March 2021 across the 27 nations of the EU, as well as entities that provide their services in EU territory. Its main goal is to achieve the climate neutrality objective of the European Green Deal by 2050 (Impact Institute, n.d.).

SFDR requires companies to report on 18 mandatory Principles of the Adverse Impact Statement (PAIS) and other voluntary areas following a strict format. Those PAIS have the objective of making the different financial market participants speak the same language about sustainability (Zhang, et al.,). Compliance with detailed rules, called Regulatory Technical Standards (RTS), is also required. (Allianz, n.d.).

i. Articles 6, 8 and 9

SFDR has split the European fund universe into three categories: article 6, article 8 and article 9. “Conventional article 6 funds are funds without stated sustainability or ESG ambition” (Becker et al., 2022). Article 6 aims to achieve transparency regarding how sustainability risks are incorporated into investment decisions and financial advice, as well as to ensure adequate disclosure of this information to investors and clients (EUR Lex, 2019).

“Article 8, the light green funds, promote environmental or social characteristics or a combination of those” (Becker et al., 2022). The information disclosed should encompass comprehensive explanations of how the environmental or social characteristics are fulfilled within the financial product. Additionally, if an index is employed as a reference benchmark, the disclosure should address whether it aligns with the aforementioned characteristics and provide insights into the methodology used for its calculation. (EUR Lex, 2019).

“Article 9, the dark green funds, promote environmental and social impact” (Becker, et al., 2022). In other words, those funds have sustainable investment as an objective. When financial products are specifically geared towards reducing carbon emissions, the information disclosed should incorporate the objective of achieving low carbon emission exposure in accordance with the long-term global warming objectives outlined in the Paris Agreement. In situations where there is a lack of available EU Climate Transition Benchmark or EU Paris-aligned Benchmark, a comprehensive explanation should be provided to elucidate how the ongoing efforts to

decrease carbon emissions align with the long-term global warming goals of the Paris Agreement. Additionally, financial market participants must specify the location of the methodology employed for calculating the designated indices and benchmarks in the disclosed information (EUR Lex, 2019).

There is currently strong evidence that retail investors shift their money toward Article 8 and 9 funds. But, there are some criticisms of the classification of Article 8 funds: investors and asset managers are calling for a truly unified technical standard (Zhang, et al. 2022).

However, starting from April 2023, a pre-contractual disclosure template has been introduced for financial products categorized under Article 8 and 9. This template enables financial market participants to have a better understanding of the statements that funds must adhere to in order to define themselves as Article 8 or 9 (EBA, ESMA, EIOPA, Joint Committee of the European Supervisory Authorities, 2023).

To prevent market participants from engaging in greenwashing, European Commission provides a taxonomy of the activities that appear sustainable regarding climate change issues. The European taxonomy aims to enhance investor confidence and awareness of the environmental impact of financial products. Institutional investors selling financial products marketed as environmentally sustainable must disclose “how and to what extent these products are invested in environmentally sustainable activities as per taxonomy” (Balp & Strampelli, 2022).

ii. European CTB and PAB benchmarks

The Commission's Action Plan on Financing Sustainable Growth has led to the emergence of two investment benchmark metrics. The European Climate Transition Benchmark (EU CTB) allows for greater diversification and meet the needs of institutional investors in their core allocation while the EU Paris-aligned Benchmark (EU PAB) involves more constraints (Appendix 5).

A benchmark labeled PAB means that selected assets must align with the long-term global warming target of the Paris Climate Agreement. The objectives of these benchmarks are related to "greenhouse gas emissions reduction and the transition to a low-carbon economy" (EU technical expert group on sustainable finance, 2018).

These benchmarks are developed to allow investors to choose the most suitable benchmark for their investment strategies, as they are standardized ESG disclosures. The main objective is to increase the share of investments in climate-related projects, while also ensuring that market participants can easily comply with their transparency duties.

iii. Principal adverse impacts & Regulated Technical Standards

The SFDR requires financial market participants (FMP) to disclose Principal Adverse Impacts (PAIs) which is a list of mandatory sustainability factors to be considered in investment decisions. FMPs with over 500 employees must disclose PAIs, while others must explain why they do not.

Regulated Technical Standards (RTS) specify the content, methodology, and presentation of mandatory sustainability information, including adverse sustainability impacts and environmental or social features. "These standards should consider the various financial product types, their characteristics, and ensure that the disclosures are accurate, fair, clear, not misleading, and presented in a simple and concise manner" (EUR Lex, 2019). The goal is to minimize negative impacts on society and the environment that may affect investments. Disclosures related to fossil gas and nuclear activities have also been recently added to the RTS (Impact Institute, n.d.; Delabye, 2023).

iv. The Future of SFDR

Global ESG assets are expected to reach 50 trillion by 2025, highlighting the growing demand for sustainable investment products worldwide. Considering the increasing number of assets under management including ESG factors in the coming years, it is important to have reliable information regarding ESG, including a transparent ESG rating that assesses ESG risks, opportunities, and impacts (Baroness, 2023). The European Sustainable Finance Disclosure Regulation (SFDR) is a key policy designed to promote transparency and prevent greenwashing in the industry (Davison et al., 2023).

Under SFDR, products must be classified correctly based on their sustainability objectives. Article 6 products are those that do not follow sustainable investment objectives or promote environmental/social characteristics, while Article 8 promotes these characteristics and Article 9 targets sustainable investments as an objective. However, there is a lack of precision in

defining sustainable investments, as evidenced by the reclassification of 41 funds from Article 9 to Article 8 in Q3 2022 (Davison, McNelly, North, & Mellon, 2023).

While the principal provisions of SFDR have been in effect since March 2021, Regulatory Technical Standards (RTS) have only become applicable since January 2023. These standards define the content, methodology, and presentation of sustainability information that financial market participants (FMP) must disclose under SFDR.

The European Taxonomy regulation establishes a broad framework to provide a common language for identifying environmentally sustainable economic activities.
The ultimate goal of SFDR and the European Taxonomy is to redirect capital flows toward sustainable activities (Davison et al., 2023).

6.2 *MiFID*

Markets in Financial Instruments Directive (MiFID) is a European directive that governs investment products and services, with the aim of protecting investors and ensuring the integrity of financial markets, while promoting equity, transparency, and efficiency (FSMA, 2023).
MiFID requires distributors, issuers, and asset managers to disclose sustainability preferences and conduct a suitability test with clients. This involves determining the percentage of taxonomy-aligned and sustainable investments desired, as well as information on mitigating negative impacts (Allianz, n.d.). With increasing demand from investors for sustainable strategies, asset managers are expected to launch additional sustainable products and rename existing conventional products (Bioy, 2023).

7. Focus on Exchange-Traded Funds

Now that we have gained a deeper understanding of the issues related to climate change and the European policies implemented to mitigate these risks, let us delve into a specific type of financial instrument that will play a central role in this thesis : Exchange-Traded Funds (ETFs).

7.1 *What is an Exchange-Traded Fund?*

Exchange-Traded Funds (ETFs) are investment funds traded on stock exchanges, offering exposure to a variety of asset classes such as Equity, Fixed-income (bond), Commodity, Mixed-asset, and other alternative ETFs (Marszk & Lechman, 2019; Tsalikis, 2020). ETFs combine the investment characteristics of mutual funds with the features of stocks (Tsalikis, 2020).

Factors such as the development of financial markets, technological advancements, and government actions have influenced the growth of ETFs, which offer exposure to a plethora of asset classes (Tsalikis, 2020). The emergence of specialized ETFs since 2012 has enabled investors to trade sectors (precious metal, currencies, …) and themes that were once costly and difficult to access, making hard-to-reach asset classes accessible to small and retail investors (Tsalikis, 2020 ; Ben-David et al., 2021).

Today, ETFs are the most popular passive investment vehicles for both retail and professional investors. There are many issuers of ETFs, including Amundi, BNP Paribas, Invesco, iShares, Van Eck, Vanguard, JP Morgan, … (Tsalikis, 2020).

7.2 *Advantages of ETFs*

ETFs have gained tremendous popularity due to several advantages they offer to investors. One of the most compelling reasons is their low costs, as ETFs provide access to different asset classes in a single fund, resulting in lower transaction costs (XETRA, 2023). In addition, passive ETFs that track an index can have lower annual management fees than actively managed funds.

Diversification is another advantage, with ETFs providing the ability to invest across various sectors and geographies, helping investors to reduce idiosyncratic risk (Tsalikis, 2020).
Furthermore, ETFs are transparent and disclose their holdings daily, allowing investors to easily understand the composition and construction methodology of the funds (Eckett, 2022).
Lastly, ETFs have great liquidity due to their equity-like features and being traded on stock exchanges, allowing investors to buy or sell them throughout the day (Marszk & Lechman, 2019).

7.3 *The proliferation of European ETFs*

Over the past eight years, European investors have been increasingly allocating their investments to ETFs, as evidence from the data provided in Appendix 6. Indeed, Appendix 7 shows that more than half of the surveyed investors invest in ETFs (Zhang et al., 2022). In terms of asset classes, equity and fixed-income ETFs are the preferred asset classes for ETFs users in Europe (Zhang et al., 2022 ; Appendix 8).

The proliferation of ETFs in Europe can be attributed to three main reasons. Firstly, the market fragmentation makes it difficult for investors to access specific markets and ETFs can provide a solution to this problem. Secondly, the presence of institutional investors is significant, and

they have been quick to adopt ETFs as part of their investment strategy. Lastly, the ability to offer ETFs in different share classes and currencies has made them more accessible to a wider range of investors (Ricci, 2019).

Overall, ETFs have gained popularity due to their lower costs, diversification benefits, transparency, and liquidity, making them viable investment options for both short-term and long-term strategies (Tsalikis, 2020).

8. ESG trend in Europe : ESG ETFs

The population of ESG ETFs in Europe has grown between 2016 and 2021. Since the coronavirus, European investors have increasingly turned to ESG funds (Appendix 9). During the period of 2020 and 2021, ESG ETFs accounted for 81% of the new ETF launches in Europe. This trend is further reinforced by the fact that about 67% of European investors have predominantly used ESG ETFs since 2020 to expand their investment portfolio in sustainable responsible investing (Le Sourd & Safaee, 2021; Appendix 10). As of the end of December, European sustainable fund assets were at $2.1 billion (Bioy, 2023).

As explained before, “all UCITS ETFs are required to be identified by their provider as one of three SFDR categories, namely, Article 6, Article 8, and Article 9” (Zhang et al., 2022). According to a survey conducted by Trackinsight, 26% of European ETFs are currently classified as ESG (Appendix 11). On the other hand, recent data shows that in the past two years, light green funds have attracted more investment than non-ESG funds (Appendix 12), indicating a significant shift towards environmentally-friendly investments.

ESG investment remains the primary trend in Europe, with ESG ETFs making up 60% of all UCITS ETF inflows as of October 31st, according to Bloomberg (Eckett, 2022). Investors' top priority is addressing climate change in their portfolios and aligning with their values. In a survey by JP Morgan Asset Management, over a quarter of respondents saw potentially improved risk-adjusted returns as a motivator for ESG investment, and more than 50% planned to increase their ESG allocations. However, over 50% of ETF investors do not believe that 2023 will be the year of sustainable investing given the energy crisis and the current economic instability (Malcolm, 2022).

In terms of issuers, iShares remains the market leader, with BlackRock launching 72% of its funds under Article 8 or Article 9 (Boyde, 2023). Vanguard has minimized its exposure to ESG

ETFs due to underperformance in 2022. This underperformance can be easily explained by the fact that in 2022, the fossil sector, which is excluded from ESG investment, was the best-performing sector (BFM Business & Husson-Traore, 2023).

8.1 *Risk-adjusted return of ESG ETFs*

In general, ESG Global ETFs have been found to outperform traditional global ETFs in terms of risk-adjusted return, as measured by Jensen's alpha, Sharpe and Treynor ratios (Baklaci, Zhang & Cheng, 2020). This suggests that investors can lower the overall risk of their portfolios by diversifying them with ESG ETFs.

One recent study by Rompotis (2022) analyzed 49 UK ESG ETFs from 2007 to 2020 and found that they outperformed the UK market (FTSE 100 Index) based on various metrics, including CAPM and the FAMA and French five-factor model. Another study highlights that green portfolios showed better performance over time, with ESG ETFs and SDG value-weighted portfolios outperforming the global market from 2018 to 2021 (Henriques, 2022).

Nevertheless, during times of crisis, the performance of ESG ETFs is more uncertain, with some studies showing that they outperform conventional funds and others studies showing the opposite. For example, Kanuri (2020) found that ESG portfolios outperformed in some periods but underperformed in others, while a study during the COVID-19 crisis found that 24 out of 26 ESG-tilted index funds beat similar conventional funds (Folger-Laronde, et al., 2022). In addition, Raho suggests that “socially responsible outperformance is more likely to appear during recessions and bear markets” (Raho, 2021). This means that investors no longer need to sacrifice returns for sustainable investments during market turmoil (Belloni et al., 2020). Therefore firms with higher ESG ratings have been found to have lower downside risk and to be more resilient during turbulent times, such as the COVID-19 pandemic (Broadstock, Chan, Cheng & Wang, 2021). This may be due to the fact that sustainable investments can increase diversification and lower downside risk.

In addition, as ESG regulations become more prevalent in Europe, it is expected that European companies will improve their ESG scores, which could lead to ESG portfolios naturally outperforming benchmarks (Fish, Kim, & Venkatraman, 2019).

In conclusion, while the performance of ESG investments during crisis periods is less certain, the long-term performance of ESG ETFs is either better or similar to conventional funds, according to a panel of authors. Despite a challenging year for ESG investments in 2022, with

the fossil fuel sector outperforming, the continued flow of ESG ETFs suggests a structural shift in investor behavior toward companies that have a positive impact on the environment and society, rather than just focusing on financial returns (Englundh, Garcia-Zarate, 2023).

9. Conclusion

This literature review has enabled us to gain insight into the awareness of climate change among Europeans. Additionally, we have understood that the Sustainable Finance Disclosure Regulation (SFDR) represents a European regulatory initiative designed to assist investors seeking to align their investments with Environmental, Social, and Governance (ESG) considerations. Indeed, this regulatory framework aims to standardize criteria pertaining to how companies or funds integrate their environmental and social impacts into the broader societal context.

Furthermore, our analysis reveals that sustainable investments are gaining popularity year after year, especially among European investors. Exchange-Traded Funds (ETFs) have emerged as the prevailing avenue for both individual and institutional investors to incorporate sustainability into their portfolios.

II. Hypotheses

The IPCC report is alarming: the Earth is warming, leading to biodiversity loss, water scarcity, and an increase in climate-related natural disasters. Individual actions are important, but the actions of corporations hold even greater significance, as their impact on climate change is stronger.

In Europe, the SFDR was created, among other initiatives, to compel financial market participants to take concrete actions to fight against climate change. This regulation is reshaping the future of ESG investing. Indeed, all participants in the financial markets must comply with a comprehensive set of regulations.

According to numerous recent studies, including Raho (2022), it has been shown that ETFs incorporating environmental, social, and governance (ESG) criteria outperform conventional ETFs. These research findings highlight several advantages of sustainable ETFs over their traditional benchmark such as lower downside risk and a better portfolio diversification.

Furthermore, in Europe, environmental regulations are constantly evolving and becoming more stringent. Companies that adapt to the energy transition are less likely to be penalized by these regulations and can therefore gain a competitive advantage. In this context, it is not surprising to observe a trend of ESG portfolios outperforming their non-ESG benchmarks in the coming years (Fish, Kim, & Venkatraman, 2019).

While there have been numerous inquiries into the outperformance of ESG ETFs relative to their non-ESG benchmarks, there is currently a dearth of studies, to the best of our knowledge, that ascertain whether indicators of climate change have any discernible impact on the trading volume of sustainable ETFs. The aim of this thesis is to study the extent to which indicators of climate change in Europe influence the trading volume of sustainable ETFs.

We are therefore seeking to test the following hypotheses:

- Hypothesis 1: The occurrence of natural disasters such as wildfires, flash floods and windstorms observed in Europe over the last four years are increasing the volume traded in ESG ETFs.

For this hypothesis, we aim to examine the relationship between the occurrence of climatic incidents, measured by multiple indicators, and the trading volume of Article 8 and 9 ETFs in our sample.

Existing literature highlights a growing concern among European investors regarding climate change, leading to a significant emphasis on investing with a positive impact. Indeed, impact investing, which can be reflected in Article 9 funds, and ESG integration strategies are expected to experience the highest increase in allocations over the next five years (Balp & Strampelli, 2022).

Furthermore, as explained earlier, climate-related events or periods of high climate risks could prompt investors to adjust their portfolios and allocate more resources to environmentally focused funds. This relationship is further supported by empirical evidence showing a positive correlation between climate disasters and inflows into green funds (Marshall et al., 2021).

Considering investors' inclination to overreact to news and information (Mbanga, Darrat & Park, 2019), our study will specifically focus on climate disasters that affect Europe. This approach is motivated by the assumption that European investors are likely to be more directly impacted by events occurring in their geographic proximity.

- Hypothesis 2 : The decline in greenhouse gas emissions within European Union over the last four years has a positive impact on the volume traded of Article 8 and 9 ETFs.

For this hypothesis, we aim to examine the potential relationship between the traded volume of Article 8 and 9 ETFs and the decline in greenhouse gas emissions in the European Union over the last four years. Indeed, as greenhouse gas emissions are the primary driver of global climate change (Afzal, Rasoulinezhad & Malik, 2022), we wanted to incorporate this indicator into our analysis.

According to the European Parliament, the European Union was ranked as the fourth-largest global emitter of greenhouse gases in 2019. However, in line with the objective of reducing net emissions by 55% by 2030, several European countries have already implemented measures to mitigate their emissions (UN France, 2022). Additionally, Europe has been diversifying its energy sources and reducing reliance on Russian fossil fuels following the Ukraine conflict. Consequently, European companies have faced pressure to reduce carbon emissions while simultaneously increasing their renewable energy capacity (Scott, 2023).

Considering that emissions serve as important indicators for assessing a company's exposure to climate risks, when GHG emissions decline, we expect to observe a potential increase in the traded volume of ETFs meeting the criteria outlined in Articles 8 and 9 of the SFDR.

III. Data

1. Sample of ETFs

Our study relies on a sample of forty exchange-traded funds (ETFs) that fulfill the criteria stipulated in Articles 8 and 9 of the Sustainable Finance Disclosure Regulation (SFDR). As previously discussed, European investors have increasingly allocated their investments to ETFs over the past eight years, as evidenced by the data presented in Appendix 6 .The expansion of the ETF market can be attributed to factors such as market fragmentation, hindering access to specific markets; the growth of investment strategies employing ETFs; and the diversification benefits offered by ETFs, which allow investments across various asset classes (Ricci, 2019; Tsalikis, 2020).

Regarding the sustainability aspect, we have already highlighted the escalating appeal towards sustainable funds within the European context, as evidenced in Appendix 10 have opted to reference Articles 8 and 9 of the SFDR due to its status as a European regulation likely to impact European investors. Moreover, our choice is informed by the literature's acknowledgment of the limited transparency surrounding the ratings assigned to ESG-classified investments by different rating agencies. As a reminder, various rating agencies do not consistently assign identical ESG ratings to the same company (Born, et al., 2021). Given that Articles 8, referred to as "light green" funds, promote environmental or social characteristics, or a combination thereof, while Article 9 pertains to "dark green" funds having environmental and social impact as an objective, regulatory frameworks inherently provide greater standardized objective criteria and transparency than the ratings issued by individual rating agencies.

To summarize, our focus on ETFs falling under Articles 8 and 9 of the SFDR stems from concerns related to transparency and the adoption of standardized norms, which surpass the ESG standards established by rating agencies such as Morningstar, Sustainalytics, and others.

1.1 *Article 8 et 9 ETFs under SFDR*

All ESG ETFs in our sample have been carefully selected after the publication of the review of SFDR Delegated Regulation regarding PAI and financial product disclosures in April 2023, to ensure their accurate classification as Article 8 or 9.

This publication includes a principal adverse impacts statement template, provided in the first annex of the document, which offers definitions of key terms pertaining to the activities of

financial market participants. Additionally, it provides specific formulas to assess indicators such as greenhouse gas emissions, exposure to fossil fuel-related companies, … The relevant information can be found in pages 102 to 124 of the SFDR Delegated Regulation regarding PAI and financial product disclosures document (EBA, ESMA, EIOPA, Joint Committee of the European Supervisory Authorities, 2023).

An example of a climate and environment-related indicator is biodiversity indicator, which involves the assessment of activities negatively impacting biodiversity-sensitive areas. This particular indicator is derived by quantifying the percentage of investments allocated to investee companies that operate or have sites situated in close proximity to biodiversity-sensitive areas. These companies' activities are assessed for their negative impact on these areas. Furthermore, investee companies are required to disclose their past actions, planned actions, and set targets for the upcoming reference period (EBA, ESMA, EIOPA, Joint Committee of the European Supervisory Authorities, 2023).

In addition, each asset management company (BNP, Amundi, Blackrock, …) responsible for providing the selected ETFs in our sample has duly completed the pre-contractual disclosure template for financial products. This template serves the purpose of determining whether an ETF aligns with Article 8 or Article 9. Specifically, it aims to ascertain if the ETF invests in companies exhibiting some sustainability characteristics but lacks sustainable investment as its primary objective (for Article 8 ETFs) or if the ETF invests in companies with sustainable investment as their primary objective (for Article 9 ETFs) (EBA, ESMA, EIOPA, Joint Committee of the European Supervisory Authorities, 2023).

1.2 *Description of the sample*

The data regarding Article 8 and 9 ETFs were retrieved from Bloomberg using the EQS (equity screening) filter. Within the filtering options, the "asset class is active" criterion was selected, and Bloomberg's configuration was adjusted to identify ETFs that comply with Articles 8 and 9 of the SFDR. Subsequently, a manual verification process was undertaken to ascertain the possession of a Key Information Document for each fund, thus confirming its classification as either Article 8 or Article 9 under the SFDR. Additionally, we applied a geographic filter to ensure that each ETF was issued in Europe. This comprehensive procedure yielded a total of 136 ETFs.

Considering the recent implementation of the SFDR regulation, we refrained from imposing a fund inception date requirement. Subsequently, we excluded funds with undisclosed trading volume to mitigate potential issues in future variable calculations. To attain a comprehensive dataset, we gathered information spanning from November 2018 to December 2022. By focusing on traded volumes of ETFs from November 2018, we ensure the comparability of data within the same temporal framework, taking into account the recent implementation of the SFDR regulation. Subsequently, employing a random selection method, we chose forty ETFs to ensure a well-balanced representation.

In order to test our hypotheses, we needed the non-ESG benchmarks associated with the ETFs in our sample. The Key Information Documents of each Article 8 and 9 ETF in our sample provided information about their respective non-ESG benchmark. As a result, we collected the relevant data pertaining to eleven non-ESG ETFs.

2. Indicators of climate change

In this section, we will provide a concise explanation of the climate change indicators that will be utilized in accordance with our research scope.

2.1 *Temperature anomalies*

Temperature change plays a fundamental role in understanding the phenomenon of climate change, and it is considered as a prominent signal in this context. According to the World Meteorological Organization (WMO), Europe's climate is currently undergoing a warming trend that surpasses the global average by more than twofold (UN France, 2022). This trend is part of the larger global temperature increase, which is projected to rise by 4-6°C above pre-industrial levels. This significantly exceeds the maximum threshold of 2°C, which the member countries of the United Nations Framework Convention on Climate Change (UNFCCC) committed to during the Paris Agreement (Yoshino, Taghizadeh-Hesary & Otsuka, 2021). Consequently, temperature anomalies serve as a fundamental indicator for assessing the existence and magnitude of climate change.

In our analysis, we will refer to a database from the National Centers for Environmental Information, that provides monthly temperature anomalies from 2018 to 2022 in Europe compared with average temperatures in Europe from 1991 to 2020. As we can see from Appendix 13, since November 2018, Europe has only experienced temperatures above its 1991-2020 benchmark, except for April and May 2021.

2.2 *Sea ice extent anomalies*

Sea ice, which refers to frozen seawater on the ocean surface, displays distinct characteristics in the Arctic and Antarctic regions. “During late winter, the Arctic sea ice covers an average area of approximately 15.5 million square kilometers, while the Antarctic sea ice covers around 18.5 million square kilometers” (National Snow and Ice Data Center, n.d.). It is worth noting that since 2002, the Arctic sea ice minimum extent has consistently remained below 6.5 million square kilometers.

The sea ice extent in the Arctic and Antarctic regions exhibits contrasting features. The Antarctic maximum sea ice pattern appears approximately symmetric around the pole, forming a circular shape surrounding Antarctica. In contrast, the Arctic sea ice is asymmetric, with ice extending to significantly lower latitudes at certain longitudes than at others (Appendix 14). These differences in sea ice extent can be attributed to the influence of ocean currents and winds (National Snow and Ice Data Center, n.d.).

Scientific measurements indicate a remarkable decline in Arctic sea ice over the past three decades. This significant trend serves as a prominent indicator of climate change in polar regions and may be linked to the effects of global warming. Although sea ice is primarily found in polar regions, its impact extends to the global climate. Indeed, Arctic sea ice, with its high reflectivity, limits the absorption of solar energy, contributing to cooler temperatures in the region. However, the retreat of sea ice throughout the year results in darker open ocean areas that absorb more solar energy, leading to increased temperatures and initiating a cycle of further melting and warming. Even minor temperature rises can have a magnified effect over time, rendering polar regions the most vulnerable areas to climate change on Earth (National Snow and Ice Data Center, n.d.).

For our research study, we will utilize monthly sea ice extent anomalies data from November 2018 to December 2022 for both hemispheres. These data were collected from the Snow and Ice Data Center, ensuring a reliable and credible foundation for our analysis (National Snow and Ice Data Center, n.d.). It is worth emphasizing that between November 2018 and December 2022, there has been a consistent reduction in sea ice extent. Consequently, all sea ice extent anomalies during our timeframe exhibits negative values.

2.3 *Natural disasters*

In the European region, there has been a notable increase in the occurrence of natural disasters, particularly storms and floods, over the past four years, as indicated in Appendix 15. Among the various types of natural disasters experienced between November 2018 and December 2022, meteorological events such as storms and extreme temperatures accounted for approximately 50% of the occurrences, followed by hydrological disasters like floods (Appendix 16).

The literature highlighted that climate events or periods with high climate risks can influence investors' decisions, prompting them to adjust their portfolios and allocate more resources to environmentally focused funds. In simpler terms, climate-related disasters and media coverage surrounding them can contribute to an increase in green investments (Marshall et al., 2021). Considering the potential impact of natural disasters on European investors, we have chosen to focus exclusively on the natural disasters that occurred in Europe.

Therefore, to construct our dataset on natural disasters, we will rely the Centre for Research on the Epidemiology of Disasters, which maintains a record of the type and frequency of natural disasters occurring in Europe from 2018 to 2022.

i. Flash floods

As previously discussed, hydrological disasters, particularly floods, rank as the second most prevalent type of disasters encountered in Europe since November 2018. The climate change is going to increase the risk of flooding in many regions across Europe. In the year 2020, data from the Joint Research Centre (JRC) revealed that approximately 172,000 individuals in Europe (EU-27 + UK) faced exposure to river flooding annually and 100,000 individuals were exposed to coastal flooding. Furthermore, around one-tenth of Europe's urban population currently resides in areas that are potentially at risk of flooding (EEA, 2020; Climate Adapt, n.d.).

Therefore, floods represent coherent natural disasters to be considered as an indicator of climate change for our analysis. We will refer to the number of flash floods recorded by the European Flood Awareness System (EFAS) based on ERIC each month between November 2018 and December 2022.

The European Flood Awareness System (EFAS) operates as part of the Copernicus Emergency Management Service (CEMS) and is "specifically designed to support preparatory measures for flood events across Europe, particularly in large trans-national river basins" (EFAS, n.d.).

ii. Forest fires

Frequent and extensive forest fires have significant adverse impacts on various environmental aspects, including air and water quality, biodiversity, soil health, and landscape aesthetics. Moreover, they pose a notable threat to climate change mitigation efforts as they release substantial amounts of greenhouse gases into the atmosphere. The escalating intensity of wildfires and the resulting smoke also increasingly endanger human lives, property, and energy infrastructure across Europe (European Environment Agency, 2021).

The impact of climate change is evident in the heightened risk of forest fires throughout Europe. Unprecedented droughts and heatwaves have caused forest fires to affect regions in central and northern Europe that were historically less prone to such incidents. Furthermore, climate projections indicate an expansion of fire-prone areas and longer fire seasons across most European regions (European Environment Agency, 2021). Hence, considering forest fires as a relevant indicator of climate change is well-justified.

To effectively monitor trends in forest fires, the European Forest Fire Information System (EFFIS), under the management of the Joint Research Centre (JRC), provides data on the number of fires and the extent of burnt areas. For the purpose of this thesis, we will collect data from the EFFIS website, specifically focusing on the monthly records of forest fires in Europe from November 2018 to December 2022.

iii. Windstorms

Storms have emerged as the most financially burdensome climate-related natural hazard, considering insured losses, particularly impacting north-western Europe, especially coastal regions. These storm events typically manifest during the winter months spanning from October to March, and they have the capability to affect multiple countries simultaneously. Recent data reveals the significant economic toll of European windstorms, with the insurance industry facing a substantial cost of €3.7 billion EURs in February 2022 alone. Notably, cumulative losses over the past four decades (1980-2020) have reached a staggering total of €487 billion EURs (Willis & Leckebush, 2023).

Various model-based studies concerning the future implications of increased greenhouse gas concentrations demonstrate a direct association with heightened temperature gradients in the upper troposphere. Consequently, the potential for more intense European windstorms in the future becomes a valid concern (Willis & Leckebush, 2023).

For the purpose of our research, we intend to obtain monthly data pertaining to the occurrence of windstorms affecting Europe between November 2018 and December 2022. These data were sourced from Wikipedia, where we can confidently rely on the information, as multiple referenced authors have contributed to the construction and validation of the data presented on the Wikipedia page.

3. Greenhouse gas emissions in Europe

We have dedicated a specific section to the independent variable of greenhouse gas emissions, given their prominent role as the primary driver of global climate change (Afzal, Rasoulinezhad & Malik, 2022). Greenhouse gases (GHGs) encompass carbon dioxide (CO2), nitrous oxide (N2O), methane (CH4), and fluorinated gases (hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF6), and nitrogen trifluoride (NF3)). As highlighted in our literature review, these emissions have been linked to rapid climate changes, leading to a heightened occurrence of natural disasters and the melting of sea ice (Afzal, Rasoulinezhad & Malik, 2022).

In 2019, the European Union (EU) ranked as the fourth-largest emitter globally, trailing behind China, the US, and India (European Parliament, 2022). Without drastic cuts in global greenhouse gas emissions, even the 2°C limit will already be exceeded before 2050.

Nevertheless, noteworthy progress has been made within the European Union, as greenhouse gas emissions witnessed a significant decline of 31% between 1990 and 2020. Moreover, recent data shows a 4% reduction in emissions when comparing the last quarter of 2021 to the last quarter of 2022. Among the EU countries, Slovenia demonstrated the most substantial reduction of GHG emissions at -15.9%, followed by the Netherlands (-9.9%) and Slovakia (-6.9%). Detailed country-level emissions data can be found in Appendix 17.

To assess the quarterly greenhouse gas emissions, we utilized an Eurostat database covering the period from the last quarter of 2018 to the last quarter of 2022. This extensive dataset encompasses emissions from diverse economic activities, such as manufacturing, agriculture, waste, and includes household emissions.

4. European opinions

In addition to climate change-related indicators and greenhouse gas emissions, our research incorporates a comprehensive analysis by considering broader indicators. This inclusion is crucial to ensure a robust evaluation of the study outcomes.

4.1 *Indicator of Economic Sentiment*

The Economic Sentiment Indicator (ESI) is a composite metric developed by the Directorate General for Economic and Financial Affairs (DG ECFIN) of the European Commission. Its primary purpose is to assess and monitor GDP growth across Member states, as well as at the EU and euro area levels (Eurostat, 2023).

Comprising a weighted average, the ESI incorporates data obtained from surveys directed at firms in five key sectors covered by the EU Business and Consumer Surveys, along with inputs from consumers. The five sectors considered in the ESI are industry (40%), services (30%), consumers (20%), retail (5%), and construction (5%). The aggregated results for the EU and euro area are calculated based on national outcomes, and seasonal adjustments are applied to ensure accuracy and comparability over time (Eurostat, 2023).

To facilitate interpretation, the ESI is standardized to have a long-term average of 100 and a standard deviation of 10. Consequently, ESI values exceeding 100 indicate above-average economic sentiment, while values below 100 suggest below-average sentiment (Eurostat, 2023).

For our study, we have collected the monthly ESI scores covering the period from November 2018 to December 2022, and these data points have been sourced from Eurostat.

4.2 *Sentix indicator of Investor Sentiment*

The Sentix Indicator is produced by Sentix GmbH, which is a research firm specializing in behavioral finance and market sentiment analysis.

To construct this indicator, a survey is administered to a sample of 2,800 investors. This survey gauges the sentiment and emotional disposition of individual investors in the financial markets, shedding light on how retail investors, perceive and assess both the present and future market conditions. Respondents are solicited to articulate their sentiment using a numerical scale,

which typically ranges from strongly bullish (100) to strongly bearish (-100), incorporating a neutral option (0) within this range (Sentix GmbH, n.d.).

It is imperative to highlight the influence of emotions and behavioral biases on retail investors, as elucidated in the literature review. Consequently, the insights derived from this survey play a pivotal role in understanding of potential fluctuations in retail investor sentiment, which can substantially impact market trends and investment decision-making (Sentix GmbH, n.d.).

The collected data pertaining to this indicator were sourced from Refinitiv on a monthly basis from November 2018 to December 2022, with a specific focus on investor sentiment within the Eurozone.

4.3 *Consumer Confidence Index of OECD*

The consumer confidence indicator (CCI) assesses households' future consumption and saving patterns, drawing insights from their responses regarding their expected financial situation, general economic sentiment, unemployment outlook, and savings capability (OECD, 2023).

When the indicator surpasses 100, it means a heightened consumer confidence in the future economic landscape, leading individuals to be less inclined to save and more inclined to increase expenditures on significant purchases within the upcoming 12 months. Conversely, values below 100 indicate a pessimistic outlook on the future economic developments, potentially leading to a greater propensity to save and reduce consumption (OECD, 2023).

To conduct our study, we collected monthly data on the consumer confidence index from November 2018 to December 2022, specifically focusing on the Europe-27 region. The data were sourced from the official website of the OECD.

5. Transformations

In order to ensure the robustness of the results, the continuous variables were winsorized at the 1st and 99th percentiles. This technique, adopted from Leclercq's (2023) thesis, aims to mitigate the influence of extreme values on the statistical analysis, which could introduce biases in the linear regression results. In other words, values below the 1st percentile were replaced with the 1st percentile value, while values above the 99th percentile were replaced with the 99th percentile value.

As for the traded volume of ESG and non-ESG ETFs, we opted to apply a logarithmic transformation to these data, following the approach used by several authors, notably Ajinkya, Atiase, & Gift (1991) and Cready & Ramanan (1991). Taking the logarithm can reduce the impact of extreme values, thereby allowing the model to better conform to the remaining data. We will, of course, ensure proper interpretation of the coefficients obtained.

6. Descriptive statistics

Appendix 18 presents the summarized statistics of our sample covering the period from November 2018 to December 2022.

The results reveal that the traded volume of the representative average sample of non-ESG ETFs is higher than the traded volume of the representative average sample of ETFs falling under SFDR Article 8 and 9. Regarding monthly returns, the representative average ETF of SFDR article 8 and 9 ETFs exhibited a return of 0.7%, while the representative average non-ESG ETF achieved a slightly higher return of 0.9%.

It is important to note the elevated standard deviations in the traded volume of both ESG and non-ESG ETF samples, indicating significant volatility in this variable. However, this high standard deviation can be attributed to instances where the traded volume registered as zero for certain months. For instance, taking the ETF “IndexIQ Factors Sustainable Europe Equity UCITS”, meeting SFDR Article 8 criteria, recorded zero trading volume in November 2018, followed by a notable trading volume of 24,062 the subsequent month. Similarly, the same pattern is observed for non-ESG ETFs, such as the 'Xtrackers MSCI Europe Small Cap UCITS,' which serves as the non-ESG benchmark for the 'BNP Paribas Easy MSCI Europe Small Caps S-SRI PAB 5% Capped' ETF. In May 2019, this ETF recorded a traded volume of 1,129,164, while in the subsequent month, the traded volume decreased to 344,712.

Those statistics underscore the importance of considering such fluctuations in trading volume to gain a comprehensive understanding of the dynamics of ESG and non-ESG ETFs.

IV. Methodology

In this thesis, we conduct an analysis of traded volume to investigate whether a relationship exists between climate change, measured through various indicators, and the traded volume of Exchange-traded funds (ETFs) that meet the criteria of Articles 8 and 9 of the SFDR (Sustainable Finance Disclosure Regulation). We will perform panel data regressions using the RStudio software. Our panel data is balanced, as each ETF contains all observations for each variable over the entire period.

We will therefore seek to explain a dependent variable, "Traded volume of ETFs complying with Articles 8 and 9 of the SFDR", measured for each ETF i at each month t from November 2018 to December 2022, using a set of explanatory variables. This set of explanatory variables consists of climate change indicators as well as a set of control variables, which we detail below.

The regression will be repeated for each selected climate change indicator, described in the chapter on data (**Indicators of climate change**) of this study. This will allow us to distinguish the explanatory power of these different measures on the dependent variable, "Traded volume of ETFs complying with Articles 8 and 9 of the SFDR".

Our regression model, which was inspired by the work of Leclercq (2023), is as follows:

$$Tradedvolume_{i,t} = a_0 + \beta_1 Indicator\_CC_{t-1} + \theta X_{i,t-1} + \varepsilon_{i,t}$$

Where $Tradedvolume_{i,t}$ is our dependent variable for ETF i in month t, $Indicator\_CC_{t-1}$ represents our indicator of climate change in month t-1. Indicator_CC is lagged by one month as we consider that investors react to information related to past data (Leclercq, 2023). We also include a control matrix X, which contains variables that may influence the traded volume of ETFs complying with Articles 8 and 9 of the SFDR.

1. Control matrix

We introduce several control variables into our model, as done in Leclercq's thesis (2023), to ensure that our dependent variable, "Traded Volume", is adequately explained by our primary explanatory variable "Indicators of climate change" and is not biased by other determinants.

As emphasized by Shefrin and Statman (1985), Lakonishok and Smidt (1986), Odean (1998), and Chen, Hong & Stein (2001), trading volume is correlated with past returns. As

demonstrated in our literature review, as companies improve their ESG scores, sustainable ETFs exhibit increasingly better performance than their non-ESG benchmarks (Fish, Kim & Venkatraman). Therefore, performance could potentially serve as a driver for the traded volume of ESG ETFs. However, we aim to ensure that it is the climate change indicators that drive the traded volume of ETFs complying with Articles 8 and 9 of the SFDR, and not past performance. Hence, we include the monthly returns of ETFs complying with Articles 8 and 9 of the SFDR as a control variable. Furthermore, given the correlation between trading volume and past returns, we lag this variable by one month.

We also incorporate the monthly traded volumes of non-ESG benchmarks for our ETFs complying with Articles 8 and 9 of the SFDR into our control matrix. We make this assumption based on the notion that investors may turn to sustainable equivalents of non-sustainable ETFs as they seek to incorporate a sustainability constraint into their portfolios. This assumption aligns with the findings of the literature review, which emphasizes that investors prioritize addressing climate change and aligning their investments with their values. In a survey conducted by JP Morgan Asset Management, it was revealed that over 50% of ETF users plan to increase their ESG allocations (Malcolm, 2022).

For the same reason mentioned earlier, we also include the monthly returns of non-ESG ETFs in our control matrix. We anticipate a correlation between the monthly returns of ETFs complying with Articles 8 and 9 and the returns of their non-ESG benchmarks. We will assess this relationship during our study using a correlation matrix, and if it appears that these two variables are correlated, we will eliminate the variable with the higher variance inflation factor (VIF). As a reminder, the VIF is a statistical measure used to detect multicollinearity among explanatory variables in regression analysis.

We have also included indicators reflecting the sentiment of European investors (**European opinions**) in our analysis. This addition aligns with the findings of Leclercq's thesis (2023), which establishes a positive relationship between European investor sentiment and fund flows. Once again, since traded volumes result from decisions made by investors based on past information, we lag these variables by one month.

Finally, we introduce ETF-level fixed effects to our model. By doing so, we account for potential idiosyncratic effects specific to each ETF, as highlighted by Leclercq (2023). This

approach ensures that any unique characteristics or variations among ETFs are appropriately considered in the analysis.

Therefore, we will also test this model:

$$Tradedvolume_{i,t} = a_0 + \beta_1 IndicatorCC_{t-1} + \theta X_{i,t-1} + p_{i,t} + \varepsilon_{i,t}$$

Where $p_{i,t}$ represents the fund-level fixed effects.

This general manipulation allows us to test our hypothesis 1 described in the section **Hypotheses**: The occurrence of natural disasters such as wildfires, flashing floods and windstorms observed in Europe over the last four years are increasing the variations in the volume traded in ESG ETFs.

2. Comprehensive regression

During our initial regressions, each climate change indicator will be examined separately. This approach will allow us to observe the individual impact of each indicator on the traded volume of our sustainable ETFs.

In our literature review, we observed that certain climate change indicators are interconnected. For instance, greenhouse gas emissions have a direct impact on sea ice extent, as well as on the number of natural disasters (Afzal, Rasoulinezhad & Malik, 2022). Recognizing that our previous model did not consider potential interactions among the indicators, this could result in partial and incomplete conclusions. Therefore, to examine our second hypothesis, we will utilize the following model:

$$Tradedvolume_{i,t} = a_0 + \beta_1 Indicators\_CC1_{t-1} + \beta_2 Indicators\_CC2_{t-1} + \beta_3 Indicators\_CC3_{t-1} + \beta_4 Indicators\_CC4_{t-1} + B_5 Indicators\_CC5_{t-1} + \beta_6 Indicators\_CC6_{t-1} + \beta_7 Indicators\_CC7_{t-1} + \theta X_{i,t-1} + p_{i,t} + \varepsilon_{i,t}.$$

In this model, we will consider the combined influence that climate change indicators may have on our dependent variable, “traded volume of ETFs meeting the criteria of Articles 8 and 9 of the SFDR”. This approach will enable us to address hypothesis 2 : The decline in greenhouse gas emissions within European Union over the last four years has a positive impact on the volume traded of Article 8 and 9 ETFs.

V. Results

In this chapter, we will undertake an analysis of the outcomes derived from the diverse models detailed in the preceding section. The tables displaying the results will be provided in appendices, showcasing the coefficients of the explanatory variables alongside their respective standard errors and p-values, encompassing both the conventional regression and the fixed-effects regression. The intercepts are not featured in our tables.

The table below summarizes the coding of each variable, facilitating the comprehension of the results. For the sake of clarity, we have included "greenhouse gas emissions" in the climate change indicators table. We wish to emphasize that greenhouse gas emissions are not a climate change indicator per se, but rather one of the contributing factors to climate change, as outlined in earlier chapters.

Variables	**Abbreviations**
Indicators of climate change	
Greenhouse gas emissions (million tons)	IndicatorsCC1
Sea ice extent anomalies (Mkm^2)	IndicatorsCC2
Temperature anomalies (°C)	IndicatorsCC3
Number of natural disasters	IndicatorsCC4
Number of wildfires	IndicatorsCC5
Number of flash floods	IndicatorsCC6
Number of windstorms	IndicatorsCC7
Control matrix	
Traded volume of benchmark non ESG ETFs	X11
Monthly return of ESG ETFs	X12
Monthly return of benchmark non ESG ETFs	X13
Consumer confidence index	X21
Investor sentiment indicator	X22
Economic sentiment indicator	X23

Prior to conducting our regressions, we constructed a correlation matrix to mitigate the risk of multicollinearity in our regression models, which could distort the results of our analysis. The presence of correlation between certain independent variables can be observed in Appendix 19. Therefore, we have opted to exclude variables X13 and X23 from our model.

For each regression, we also calculated the Variance Inflation Factor (VIF) to address the potential issue of multicollinearity. We established a threshold of 2.5 for the VIF, following the approach of Johnston, Jones & Manley (2018). As variable X22 consistently surpassed this threshold of 2.5, we have also excluded it from the model.

To provide a concise overview, we have excluded three independent variables, namely X13, X22, and X23, which held the potential to introduce multicollinearity into the model. As a result, our control matrix is now focused on the variables X11, X12, and X21.

1. Initial regressions

These initial regressions will enable us to ascertain whether a relationship exists between the various climate change indicators, with each indicator being examined individually, and the traded volume of ETFs meeting the criteria of Articles 8 and 9 of the SFDR. The outcomes of these regressions can be found in Appendix 20. As observed, concerning the climate change indicators, the results vary depending on the model (with or without fixed effects).

Only the coefficients of the variables « number of climate-related natural disasters » and « number of windstorms » consistently fail to attain significance, regardless of the model employed. This suggests that the number of climate-related natural disasters and the frequency of windstorms do not exert a significant impact on the traded volume of ETFs complying with Articles 8 and 9 of the SFDR. We assume that this could be attributed to the insufficient specificity or targeting of these variables to capture potential effects on the traded volume of sustainable ETFs. More precise indicators might yield a more robust relationship with the traded volume of sustainable ETFs. This is a proposition we intend to investigate, particularly by examining the significance of coefficients associated with variables “number of wildfires” or “number of flash floods”.

It emerges that in the fixed-effects model, the coefficient for “number of wildfires” is significant at the 5% level. As for the coefficient of the “number of flash floods”, it is significant at the 5% level in the classical model and at the 0.1% level in the fixed-effects model. Furthermore, when we examine the sign of these coefficients, we observe that an increase in the number of wildfires or flash floods leads to an increase in the traded volume of ETFs meeting the criteria of Articles 8 and 9 of the SFDR. We assume that as the occurrence of these types of climate-related natural disasters in Europe escalates, it triggers alarm among climate-conscious investors. Consequently, it generates interest in green investments, which is manifested here by an augmented traded volume of ETFs adhering to the criteria of Articles 8 and 9 of the SFDR. This corroborates the assertions made by Marshall et al. (2021), indicating that climate disasters and media coverage can contribute to green investments, and that “the correlation between climate disasters and green fund inflows is stronger when the climate disaster inflicts greater asset damage”, as is often the case with wildfires or flash floods. This partially confirms our first

hypothesis, “The occurrence of natural disasters such as wildfires, flash floods, and windstorms observed in Europe over the last four years are increasing the volume traded in ESG ETFs”, with the number of windstorms in Europe not significantly impacting the traded volume of ESG ETFs.

If we turn our attention to the remaining climate change indicators under analysis, we notice that the coefficient for “sea ice extent anomalies” is significant at the 0.1% level regardless of the model (fixed-effects or classic model). This means that sea ice extent anomalies have a noteworthy impact on the traded volume of ETFs adhering to the criteria of articles 8 and 9 of the SFDR. Moreover, an increase in sea ice extent anomalies around the poles leads to an augmentation in the traded volume of sustainable ETFs. Once again, we observe a logical direction of this relationship. As emphasized in our literature review, scientific measurements indicate a huge decline in Arctic sea ice over the past three decades (National Snow and Ice Data Center, N.D.). Consequently, when sea ice extent decreases around the poles, it yields a positive impact on the traded volume of ETFs complying with Article 8 and 9 of the SFDR.

Finally, the coefficient associated with temperature anomalies in Europe is significant at the 10% level in the classical model and at the 1% level in the fixed-effects model. An increase in temperature anomalies leads to a decrease in the traded volume of ESG ETFs. The sign of this coefficient is surprising, as we initially anticipated a positive relationship between these two variables. Given that temperature change is regarded as a prominent indicator in the context of climate change (UN France, 2022), we expected that European investors, aware of temperature fluctuations in Europe, would engage in greater trading of ETFs meeting the criteria of articles 8 and 9 of the SFDR.

Turning our attention to our control variables, Appendix 20 reveals that the traded volume of non-ESG ETFs significantly and positively influences our dependent variable, namely, the traded volume of ETFs meeting the criteria of articles 8 and 9 of the SFDR. This means that an increase in the traded volume of non-ESG ETFs leads to an increase in the traded volume of sustainable ETFs. This finding affirms our assumption that investors may opt for sustainable alternatives to non-sustainable ETFs as they endeavor to integrate a sustainability criterion into their portfolios.

Let us shift our focus to the magnitude of the effects of the various climate change indicators on the traded volume of sustainable ETFs. Below, we will examine the absolute impact of a

one-standard-deviation change in the climate change measurement on the traded volume of ETFs meeting the criteria of Articles 8 and 9 of the SFDR. We have retained only those variables with significant coefficients.

Table 1 : Change in the dependent variable (Traded volume of Article 8 & 9 ETFs) following a one-standard-deviation change in the independent variable (Climate change indicator)

Explained variable									
Traded volume of Article 8 & 9 ETFs (%)									
		Indicators_CC2		Indicators_CC3		Indicators_CC5		Indicators_CC6	
Explanatory variables	***Indicator of climate change (t-1)***	0.3535	0.3713	-0.1145	-0.1134	0.0002	0.0004	0.0007	0.0009
	P-value	0.0002	0.0000	0.0891	0.0021	0.5144	0.0370	0.0313	0.0000
	Standard deviation	0.56208805	0.56208805	0.811635	0.81164	165.2068	165.2068	158.4344	158.4344
	Variation Traded volume of Article 8 & 9 ETFs (t) (%)	0.19867114	0.2087151	-0.09292	-0.092	/	0.061882	0.116174	0.141428

The anomalies in sea ice extent, the number of flash floods, and the number of wildfires exhibit a more pronounced impact than any other climate change-related variables on the traded volume of sustainable ETFs.

We will proceed iteratively to elucidate why it is logical for anomalies in sea ice extent and these types of natural disasters in Europe to exert stronger impact than any other climate change-related variables on the traded volume of sustainable ETFs. When delving into the definition of an Article 8 or 9 of the SFDR fund, the companies composing such funds must fulfill a Principal Adverse Impacts (PAI) statement, as expounded upon in our literature review. One of the principal adverse impacts pertains to the mitigation of greenhouse gas emissions. As these emissions have been correlated with rapid climate shifts, they contribute to an increased incidence of natural disasters and the melting of sea ice (Afzal, Rasoulinezhad & Malik, 2022). By curtailing their greenhouse gas emissions in response to the mitigation of PAI, the companies constituting the ETFs complying with the criteria of articles 8 and 9 of the SFDR make a positive contribution to increasing sea ice extent and diminishing natural catastrophes. Thus, it is logical for anomalies in sea ice extent and natural disasters such as flash floods and

wildfires to wield stronger impact than other climate change-related variables on the traded volume of sustainable ETFs.

In our regressions, each climate change indicator was examined individually, allowing us to observe how each one individually affects the traded volume of sustainable ETFs. However, as detailed in the **Methodology** section, this approach does not account for potential interactions among climate change indicators, which could lead to partial and incomplete conclusions. Moreover, we had identified a relationship among flash floods, wildfires, sea ice extent anomalies, GHG emissions, and the traded volume of our sample of sustainable ETFs. In the upcoming chapter, we will therefore conduct a comprehensive regression because our dependent variable, “traded volume of ETFs meeting the criteria of articles 8 and 9 of the SFDR” can be influenced by multiple factors simultaneously, including GHG emissions, sea ice extent anomalies, temperature anomalies, and natural disasters such as windstorms, wildfires, and flash floods. This approach will yield a more holistic comprehension of the phenomenon being investigated.

Before conducting our "comprehensive" regression, it is important to note that in our case, a fixed-effects model is far more relevant than a classical model. Firstly, our ETFs that meet the criteria of articles 8 and 9 of the SFDR are issued by various asset management firms (BNP Paribas Asset Management, BlackRock, Amundi, WisdomTree, etc.). Moreover, the sustainable ETFs comprising our sample do not all invest in the same sector or the same companies.

For instance, the top 6 holdings of the iShares MSCI Europe SRI UCITS ETF are ASML HOLDING NV ORD (4.70%), L'OREAL SA ORD (4.61%), NOVO NORDISK A/S ORD (4.35%), SCHNEIDER ELECTRIC SE ORD (4.18%), ZURICH INSURANCE GROUP AG ORD (3.04%), and HERMES INTERNATIONAL SCA ORD (2.93%). On the other hand, the top 6 holdings of another ETF, the BNP Paribas Easy ESG Quality Europe, which is also included in our sample, are as follows: NOVO NORDISK A/S ORD (4.07%), ASML HOLDING NV ORD (3.85%), NOVARTIS AG ORD (3.39%), ROCHE HOLDING AG (3.34%), ASTRAZENECA PLC ORD (3.22%), LVMH MOET HENNESSY LOUIS VUITTON SE ORD (2.57%). While both of these ETFs include Novo Nordisk and ASML, their other positions encompass companies from different sectors. Therefore, these funds will be affected by contrasting fluctuations, which will naturally impact the traded volume of the ETFs.

A fixed-effects model addresses this issue of heterogeneity within the funds by introducing indicator variables for each ETF. This approach allows us to control for and isolate the specific variations inherent to each ETF. Hence, in our forthcoming regressions, we will consistently work with a fixed-effects model.

2. Comprehensive regression

The model that we will use for this regression is as follows:

$$Tradedvolume_{i,t} = a_0 + \beta_1 Indicators\_CC1_{t-1} + \beta_2 Indicators\_CC2_{t-1} + \beta_3 Indicators\_CC3_{t-1} + \beta_4 Indicators\_CC4_{t-1} + B_5\, Indicators\_CC5_{t-1} + \beta_6 Indicators\_CC6_{t-1} + \beta_7 Indicators\_CC7_{t-1} + \theta X_{i,t-1} + p_{i,t} + \varepsilon_{i,t}.$$

In this model, we take into account the combined influence of climate change indicators on our dependent variable “traded volume of ETFs meeting the criteria of Articles 8 and 9 of the SFDR”. We have included variable 1 considering the identified link between greenhouse gas emissions, certain natural disasters, and sea ice extent anomalies. Furthermore, as highlighted numerous times in our literature review, we have indicated its prominent role as the primary driver of global climate change.

Lastly, our model incorporates fixed-effects. As justified at the end of the previous chapter, the fixed-effects model enables the control of specific variations inherent to each ETF.

Table 2 : Fixed-effects regression

	Estimate	Std. Error	P-value
Indicators_CC1	-0.00324912	0.00159645	0.0419642
Indicators_CC2	0.26535844	0.05549355	1.87E-06
Indicators_CC3	-0.12533592	0.04013032	0.0018151
Indicators_CC4	-0.00395432	0.00632126	0.5316776
Indicators_CC5	0.00071106	0.00018993	0.0001865
Indicators_CC6	0.00110383	0.00020974	1.58E-07
Indicators_CC7	-0.0103863	0.02030094	0.6089771
X11	0.03082433	0.01646878	0.0614002
X12	0.04178808	0.68220903	0.9511632
X2	-0.01881591	0.01367302	0.1689382

Let us begin by discussing the lack of significance of certain variables' coefficients. The coefficients of the variables Indicators_CC4, Indicators_CC7, X12, and X2 are never significant. Regarding Indicators_CC4 and Indicators_CC7, we can reach the same conclusion

as before: the number of natural disasters and the number of windstorms have no significant impact on the trading volume of ETFs that adhere to Articles 8 and 9 of the SFDR. We deduced that this is likely explained by the fact that these variables are not sufficiently specific to capture potential effects on the trading volume of sustainable ETFs.

We do not find it surprising that the coefficient of X12 is not statistically significant. The monthly returns of sustainable ETFs do not rank as the primary driving factor motivating investors to trade ESG ETFs. Individuals who invest in sustainable ETFs place greater emphasis on the environmental and societal impact of the constituent companies within the ETF, rather than the short-term financial return of these ETFs, which could potentially be negative. This aligns with existing literature, as evidenced by the ongoing inflow into ESG ETFs, signifying a fundamental shift in investor behavior towards companies that contribute positively to the environment and society. This shift transcends the narrow focus on mere financial gains (Englundh, Garcia-Zarate, 2023).

Lastly, the coefficient of variable X2 demonstrates limited statistical significance (at a level of 16.89%). The fact that the coefficient for this variable appears negative contradicts the findings of the study conducted by Leclercq (2023), but it aligns with the assertions put forth by Garel et al. (2022). In our context, when sentiment increases (as represented by the consumer confidence index), the traded volume of sustainable ETFs decreases.

The variables that exhibit a significant impact on the traded volume of ETFs meeting the criteria outlined in Articles 8 and 9 of the SFDR remain the same as our previous findings. Therefore, the coefficients of variables 2, 5, and 6 are significant at the 0.1% level. The positive sign associated with each coefficient indicates that an increase in anomalies of sea ice extent, the number of wildfires in Europe, and/or the number of flash floods in Europe leads to an increase in the traded volume of ETFs adhering to the criteria of Articles 8 and 9 of the SFDR. Moreover, the coefficient of variable 3 is significant at the 1% level, and its negative sign suggests that a rise in temperature anomalies contributes to a decrease in the traded volume of ETFs falling under the purview of Articles 8 and 9 of the SFDR. This reaffirms the observations gleaned from our initial linear regressions.

However, the coefficient of variable X11 exhibits reduced significance compared to our previous regressions. We assume that the diminishing significance of the variable “traded volume of non-ESG ETFs” is linked to the inclusion of additional variables in our regression.

As our objective revolves around investigating the influence of climate change indicators on the traded volume of sustainable ETFs, the incorporation of those indicators bolsters the model's relevance, consequently attenuating the significance of the traded volume of non-ESG ETFs. Furthermore, the direction of the relationship between variable X11 and our dependent variable remains consistent with what was observed in our prior regressions.

Lastly, we observe that the coefficient of our new variable "greenhouse gas emissions" is significant at a 5% level. The negative sign of the coefficient indicates an inverse relationship between greenhouse gas emissions in Europe and the traded volume of ETFs adhering to the criteria of Articles 8 and 9 of the SFDR. In other words, when greenhouse gas emissions decrease, the traded volume of ETFs meeting the criteria of Articles 8 and 9 of the SFDR increases. This finding validates our hypothesis 2: “The decline in greenhouse gas emissions within the European Union over the last four years has a positive impact on the volume exchanged of Articles 8 and 9 ETFs.” This relationship aligns logically with our understanding. If the greenhouse gas emissions of the companies comprising our ETFs adhering to the criteria of Articles 8 and 9 of the SFDR decrease, it is logical that environmentally-conscious investors would engage in increased trading of sustainable ETFs. This directly ties into the definition of funds meeting the criteria of Articles 8 and/or 9 of the SFDR. As explained earlier, one of the initial ESG commitments a company forming part of such ETFs must undertake is to outline its plans for reducing greenhouse gas emissions.

Before delving into the interpretation of the magnitude of the coefficients of the significant variables, we opt to conduct a final fixed-effects regression. Given the presence of non-significant variables in the current model, we choose to remove them. Our approach is guided by the econometrics teachings of Professor Petitjean and draws on the methodology outlined by Thompson (1978). This refinement aligns with the principle that a more focused and streamlined model is better equipped to offer accurate predictions and insights.

Table 3 : Fixed-effects regression without non-significant variables

	Estimate	Std. Error	P-value
Indicators_CC1	-0.00185	0.00052	0.0004255
Indicators_CC2	0.10685	0.02323	4.50E-06
Indicators_CC3	-0.05602	0.01621	5.62E-04
Indicators_CC5	0.00033	0.00008	5.45E-05
Indicators_CC6	0.00048	0.00009	4.18E-08
X11	0.01260	0.00698	0.0712255

We observe that the coefficients of the "climate change indicators" variable remain significant at the 0.1% level in our fixed-effects regression. Our findings underscore that climate change, as represented by indicators 2, 3, 5, and 6, exerts a statistically significant impact on our dependent variable: the traded volume of ETFs adhering to the criteria of Articles 8 and 9 of the SFDR. Moreover, the coefficient associated with variable X11 retains its significance at the 10% level. The signs of the coefficients remain consistent with those observed in the previous regressions, thus preserving the interpretations concerning the direction of these relationships.

In order to analyze the magnitude of the effects of climate change on our dependent variable, we are focusing on the absolute impact of a one-standard-deviation variation in climate change measurement on the dependent variable "Traded volume of Article 8 & 9 ETFs."

Before interpreting the results, it is pertinent to recall that our dependent variable is expressed in logarithmic form, similar to the approach adopted by Ajinkya, Atiase, & Gift (1991) and Cready & Ramanan (1991). As a result, a one-standard deviation variation in the independent variable corresponds to a percentage change of $\delta*(\beta*100)$ in the dependent variable.

Table 4 : Variation in the dependent variable (traded volume of ETFs meeting the criteria of articles 8 and 9 of the SFDR) following a variation of a one standard deviation in the independent variable (climate change)

		Explained variable				
		Traded volume of Article 8 & 9 ETFs (t)				
		Indicators_CC1	Indicators_CC2	Indicators_CC3	Indicators_CC5	Indicators_CC6
Explanatory variables	***Indicator of climate change (t-1)***	-0.0019	0.1069	-0.0560	0.0003	0.0005
	P-value	0.0004	0.0000	0.0006	0.0001	0.0000
	Standard deviation	26.2014	0.5621	0.8116	165.2068	158.4344
	Variation Traded volume of Article 8 & 9 ETFs (t)	-0.0485	0.0601	-0.0455	0.0539	0.0764

We observe that a one-standard-deviation increase in a climate change measure leads to a subsequent variation ranging from -4.55% to 7.64% in the dependent variable. For instance, a one-standard-deviation increase in the number of flash floods results in a 7.64% increase in the

traded volume of ETFs conforming to the criteria of Articles 8 and 9. A similar positive relationship is evident for a one-standard-deviation rise in the number of wildfires and anomalies in polar sea ice extent. Conversely, a one-standard-deviation increase in anomalies of temperature in Europe corresponds to a 4.55% decrease in the traded volume of ETFs adhering to the criteria of Articles 8 and 9 of the SFDR. As mentioned earlier, this particular relationship appears perplexing, and existing literature does not provide a clear justification for it. Lastly, a one-standard-deviation rise in greenhouse gas emissions in Europe results in a 4.85% decrease in the traded volume of sustainable ETFs.

These percentage variations shed light on the magnitude of the impact of climate change indicators on the trading volume of ETFs adhering to the specified sustainability criteria.

3. Conclusion

We shall now provide a comprehensive summary of this chapter by revisiting our hypotheses. Firstly, our investigation reveals that climate-induced natural disasters, such as flash floods and wildfires, exert a noteworthy and positively significant influence on the traded volume of ETFs adhering to the criteria stipulated in Articles 8 and 9 of the SFDR. This aligns with the assertions made by Marshall et al. (2021), who suggest that climate disasters and media coverage can contribute to green investments, with a stronger correlation between climate disasters and inflows into green funds when the disaster inflicts greater asset damage, as often seen in cases of wildfires or flash floods. Our empirical analysis partially corroborates our first hypothesis: “The occurrence of natural disasters such as wildfires, flash floods, and windstorms observed in Europe over the last 5 years is increasing the volume traded in ESG ETFs” with windstorms in Europe not significantly impacting the traded volume of ESG ETFs.

Secondly, considering that greenhouse gas emissions are a major driver of climate change, we deemed it relevant to conduct an analysis of this variable. It emerges that such emissions have a significant and negative impact on the traded volume of ETFs adhering to the criteria of Articles 8 and 9 of the SFDR. As explained previously, this implies that as greenhouse gas emissions in Europe decrease, the traded volume of ETFs meeting the criteria of Articles 8 and 9 of the SFDR increases. This finding further confirms our second hypothesis: “The decline in greenhouse gas emissions within the European Union over the last five years has a positive impact on the traded volume of Article 8 and 9 ETFs.”

Lastly, providing a definite answer to our research question is challenging due to the nuanced nature of the relationships. The observed connections between the aforementioned indicators lead us to believe that climate change has a significant impact on the traded volume of sustainable ETFs. Additionally, the fact that increased anomalies in polar sea ice extent correspond to an increase in the traded volume of ETFs adhering to Articles 8 and 9 lends further support to this notion.

Conversely, let us recall that the significant and negative relationship we highlighted between anomalies in temperature in Europe and the traded volume of sustainable ETFs lacks an evident justification. Furthermore, it is worth noting that our model omits variables that could also explain variations in the traded volume of these sustainable ETFs, given that the R-squared value of our model is 15%.

VI. Limits

It is important to highlight the various limitations associated with our study. This acknowledgment allows for a critical examination of our findings, while also providing potential avenues for improvement to be considered in the future.

Towards the conclusion of the preceding chapter, we highlighted the absence of certain explanatory variables pertaining to the fluctuations in the traded volume of ETFs adhering to Articles 8 and 9 of the SFDR. It would have been pertinent to procure data specific to European policies. Given the foundational alignment of our ETFs with the Sustainable Finance Disclosure Regulation (SFDR), our pursuit of datasets encompassing investor sentiment towards these European policies would have added significant depth. In addition, our efforts to obtain climate-related data also encountered challenges. Despite our engagement with a representative from the European Environment Agency, we encountered limitations in accessing additional climate change data pertinent to Europe, such as monthly precipitation records or European glacier-related information. The same holds true for natural disasters. As of our current knowledge, these variables either do not yet exist or were not available for the geographical scope and temporal horizon covered by our study.

Another limitation is the temporal scope of our study. In comparison to other financial studies, a period of four years may appear relatively short for analyzing the evolution of traded volume of financial flows. However, the European Commission introduced its Sustainable Finance Action Plan in 2018, and the SFDR Regulation was only established in 2019. Consequently, we were constrained to confine our analysis to data available from this timeframe.

In continuation of the aforementioned limitation, we have constructed a sample comprising ETFs that adhere to the criteria outlined in Articles 8 and 9 of the SFDR. Consequently, all our ETFs are domiciled in Europe (or the UK). Within this sample, we seek to investigate whether a relationship exists between climate change, as measured by specific indicators focusing on Europe, and the traded volume of these ETFs. "However, it is important to bear in mind that a fund domiciled in Europe can be open to investors from other continents since it can be marketed in regions beyond Europe" (Leclercq, 2023). As a result, a discrepancy might arise between the geographical scope of our climate change measurement and the actual origin of the traded volume of ETFs conforming to the criteria of Articles 8 and 9 of the SFDR. Nevertheless,

we consider this limitation to be substantive, given that our ETFs adhere to criteria set by the European SFDR regulation, which is likely to attract the attention of European investors.

Within our model, we have incorporated control variables to account for key influences that may impact the traded volumes of our ETFs sample. These include the monthly returns of sustainable ETFs, the monthly returns, and traded volume of non-ESG benchmarks corresponding to our sustainable ETFs, as well as metrics pertaining to European investor sentiment. Unfortunately, due to considerable correlations or lack of statistical significance, certain variables had to be excluded, as previously explained. It is worth noting that certain studies encompass a broader range of explanatory variables within their control panel, including aspects like fund management team characteristics, fund turnover rates, and fund expenses (Bazley et al., 2021). Once again, accessing such data was challenging and, in some cases, these data points were simply unavailable.

VII. Discussions

Throughout the course of our investigation, we have identified several emerging research possibilities associated with the field of study we have examined. This section will be dedicated to the discussion of these potential directions.

In our study, we considered the trading volume of non-ESG benchmark ETFs as a control variable. Conducting an investigation across a spectrum of ETFs (both ESG and non-ESG) and assessing whether climate change indicators influence the trading volume of both ESG and non-ESG ETF could provide a compelling avenue for investigation. This would help determine whether climate change metrics exclusively impact ESG funds or if they also exert an effect on non-ESG funds.

To ensure the robustness of the forthcoming study, it is imperative that the dataset encompassing climate change indicators is sufficiently expanded. This expansion is crucial to avoid drawing conclusions based on an inadequate data pool. Concerning the climate change indicators pertinent to this new study, it would be pertinent to extend the focus beyond the confines of Europe thereby encompassing a broader regional scope. Indeed, investors aware of climate change concerns exhibit a global perspective that extends beyond indicators singularly oriented toward the European context. As an illustrative example, the attention could be directed towards phenomena such as tsunamis – a highly publicized climatic natural disasters – which could potentially impact investors on a global scale.

Subsequently, considering the emergence of the SFDR regulation in 2019, we believe we must wait longer to discern the gradual influence of this regulatory framework on fund management firms. Indeed, the proportion of investors seeking to increase the sustainability aspect of their portfolios does so primarily through the medium of ETFs, as discerned from our literature review. However, this commitment to sustainability is mediated by the ESG ratings ascribed by fund rating agencies. Our investigation revealed a lack of transparency in these agencies' rating methodology and a notable inconsistency in the ESG ratings assigned to same companies or funds across different rating entities.

Given the prevailing climate urgency, the heightened public awareness regarding climate change, and the escalating corporate responsibility to integrate climate risk, investigations pertaining to this domain are poised to proliferate progressively year after year.

General conclusion

This dissertation has facilitated a deepening of our understanding regarding sustainable finance. We conducted an analysis of trading volumes to elucidate potential relationships linking climate change to the trading volume of ETFs meeting the criteria outlined in Articles 8 and 9 of the SFDR. Though this analysis, we attempted to address the following research question: "Does climate change affect the traded volume of sustainable ETFs?"

The initial segment of this study encompassed a literature review. To begin, we delved into the issue of climate change, with a specific focus on gauging the awareness among Europeans regarding this concern. Subsequently, we initiated an in-depth examination into the foundations of sustainable finance, elucidating the fundamental tenets of the Sustainable Finance Disclosure Regulation. Furthermore, we conducted an investigation into the characteristics of Exchange Traded Funds (ETFs) to enhance our comprehension. We concluded this section by elucidating how the principles of sustainable finance are applied to ETFs, both within the European context and in a broader setting.

Subsequently, we proceeded with our empirical investigation. Our research hypotheses were formulated based on the findings from our literature review and the data we collected. After that, we delved into the methodology by which we intended to assess the existence of a relationship between climate change, and the trading volume of ETFs meeting the criteria outlined in Articles 8 and 9 of the SFDR.

As a reminder, no prior researchers had explored the influence of climate change on the flows of sustainable funds. However, Hartzmark and Sussman (2019) had explored whether investors showed interest in fund ratings through an analysis of financial flows. Our methodology drew inspiration from Leclercq (2023), who conducted an analysis of financial flows to investigate the relationship between investor sentiment and investment flows into European equity funds. Nevertheless, rather than analyzing financial flows, we examined the traded volume of our sample of ETFs meeting the criteria outlined in Articles 8 and 9 of the SFDR, akin to the approach taken by Chen, Hond, and Stein (2001). Our geographical scope of interest is Europe, and we consider a period stretching from November 2018 to December 2022.

Consequently, we conducted various regressions on our panel data, incorporating a control matrix. In our initial regressions, each climate change indicator was examined individually to ascertain the distinct impact of each indicator on the trading volume of sustainable ETFs.

Subsequently, we performed a final regression that encompassed all climate change indicators simultaneously, in order to account for potential interactions between these indicators and the volume traded of our sample of ETFs.

The subsequent chapter was devoted to the presentation and interpretation of our findings. We were able to partially confirm our initial hypothesis, which assumed that the occurrence of natural disasters such as wildfires, flash floods, and windstorms observed in Europe over the last five years contributes to an increase in the trading volume of ESG ETFs. As the number of windstorms did not exhibit a significant impact on our dependent variable, we were unable to draw conclusions regarding this particular indicator. Nevertheless, we demonstrated that an increase in the occurrences of flash floods and wildfires correlates with a rise in the trading volume of ETFs meeting the criteria outlined in Articles 8 and 9 of the SFDR. This finding aligns with the research conducted by Marshall et al. (2021).

Through the analysis of the last two climate change indicators, we discovered that as the extent of sea ice diminishes, the trading volume of our sustainable ETFs increases. However, the direction of the relationship between temperature anomalies and climate change raised questions, as an increase in temperature anomalies corresponded to a decrease in the trading volume of sustainable ETFs.

Through our final regression analysis, we aimed to investigate whether greenhouse gas emissions, given their significant role as the primary catalyst of global climate change, exerted an influence on the trading volume of sustainable ETFs. We were able to address this question by confirming our second hypothesis, which assumed that the decrease in greenhouse gas emissions within the European Union over the last four years positively affects the trading volume of Article 8 and 9 ETFs.

Finally, providing an unequivocal answer to our research question presents challenges, as the situation is nuanced and not simply binary. Indeed, the interplay between climate change-related natural disasters, sea ice extent anomalies, and the trading volume of ETFs meeting the criteria outlined in Articles 8 and 9 prompts us to consider that climate change wields a noteworthy and positive influence on the trading volume of sustainable ETFs. On the other hand, it is pertinent to emphasize that the significant negative correlation we observed between temperature anomalies in Europe and the trading volume of sustainable ETFs lacks definitive substantiation or supporting literature. Moreover, it is crucial to acknowledge that our model

does not encompass all variables that could potentially elucidate variations in the trading volume of these sustainable ETFs. This omission gains significance in light of our model's modest coefficient of determination (R-squared) at 15%, underscoring a limitation in our study.

The final sections of this thesis are indeed devoted to the exploration of its limitations and the initiation of academic discussions. These segments are intended to encourage readers to engage in a critical analysis of the findings and to contemplate avenues for enhancement or future research.

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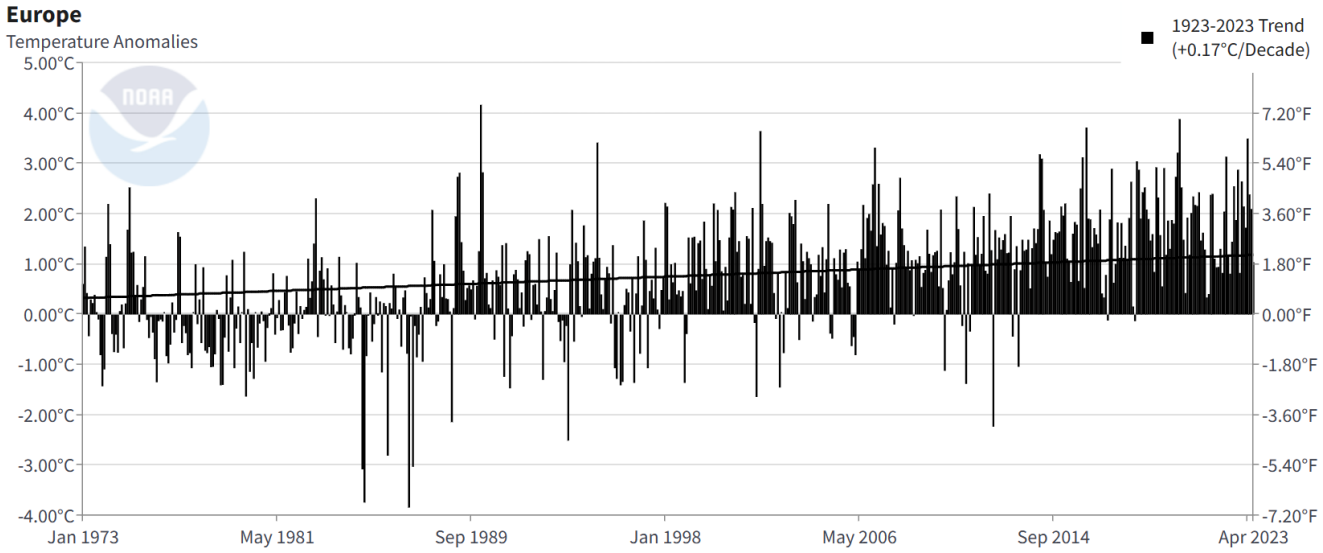
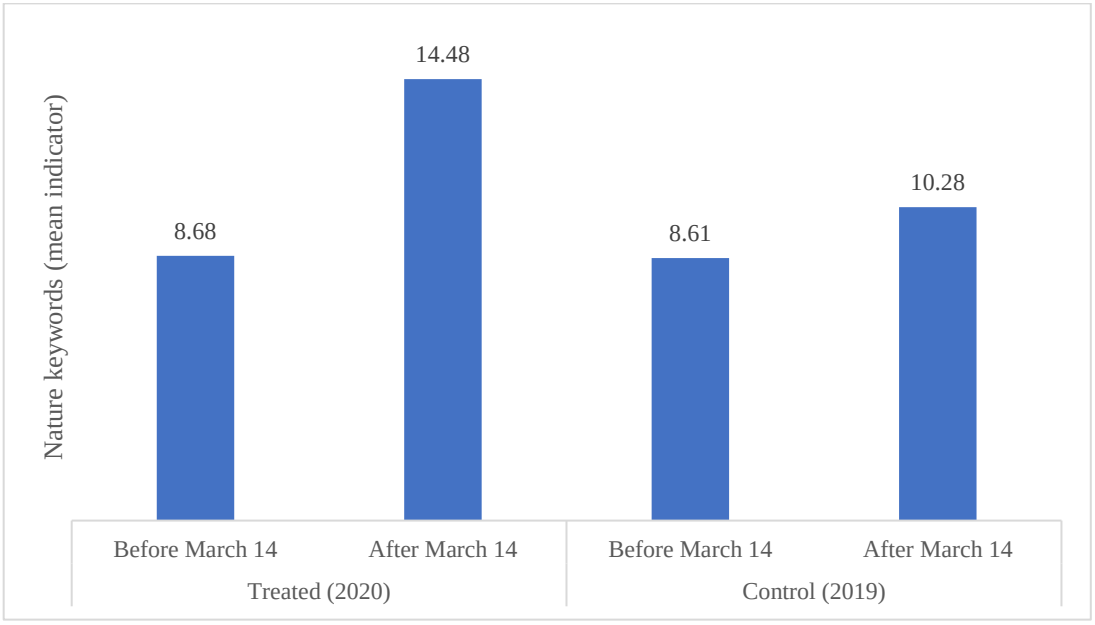
Appendices

Appendix 1 : Temperature anomalies in Europe



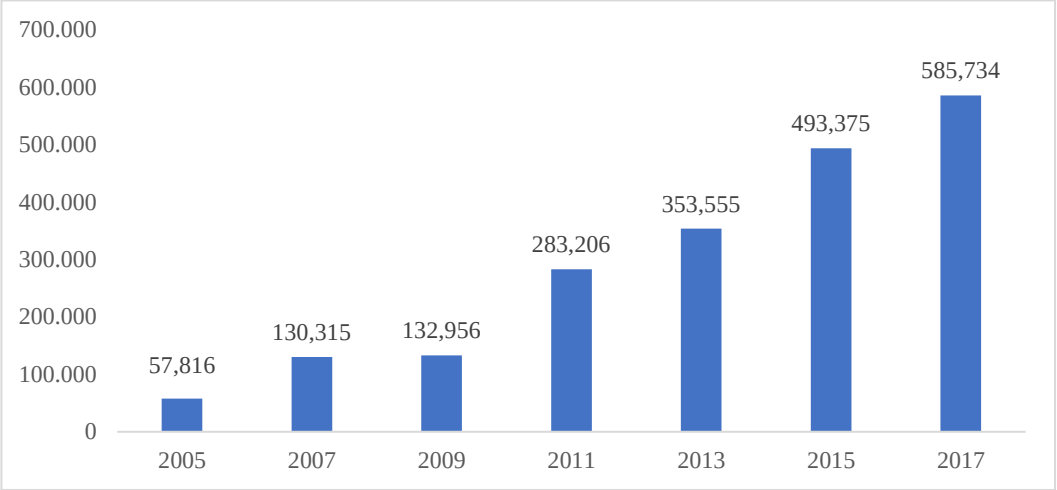
NOAA National Centers for Environmental information, 2023

Appendix 2 : Evolution in people's interest in environment-related topics



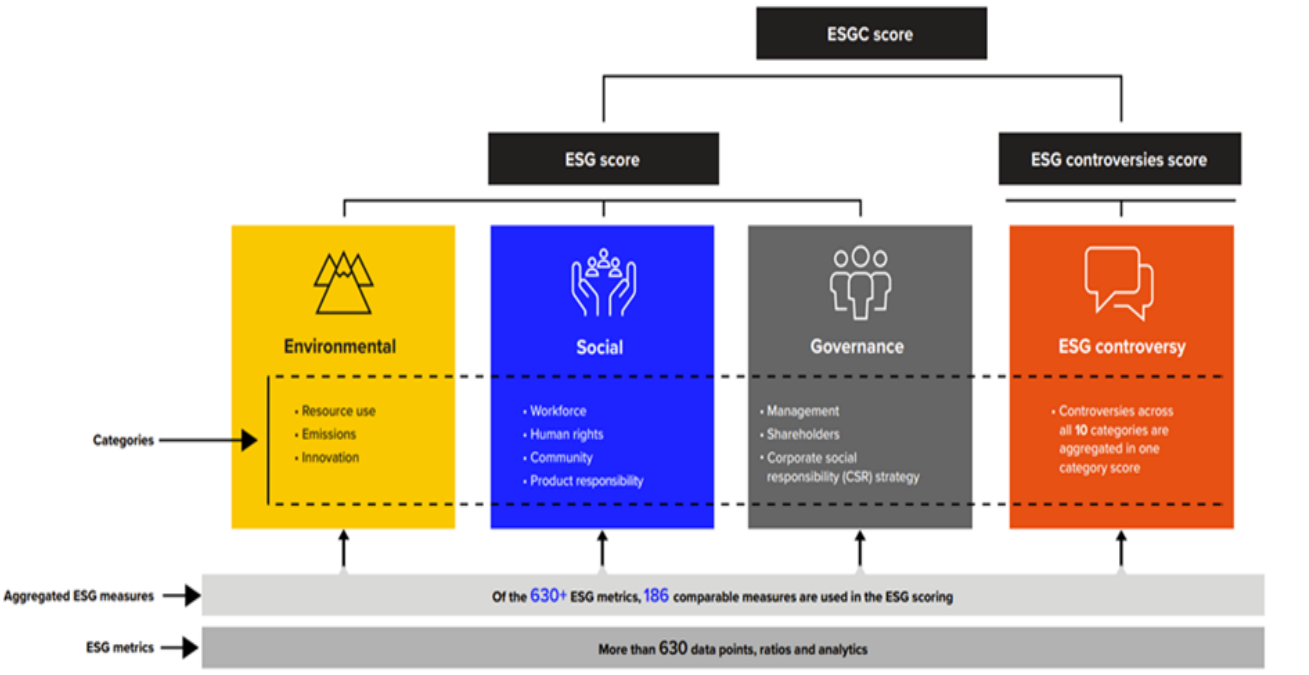
Rousseau & Deschacht, 2020

Appendix 3 : Evolution of best-in-class socially responsible investing in Europe



Eurosif, 2018

Appendix 4: Environmental, social and governance scores from Refinitiv



Refinitiv, 2023

Appendix 5 : Minimum technical standards for EU CTBs and EU PABs

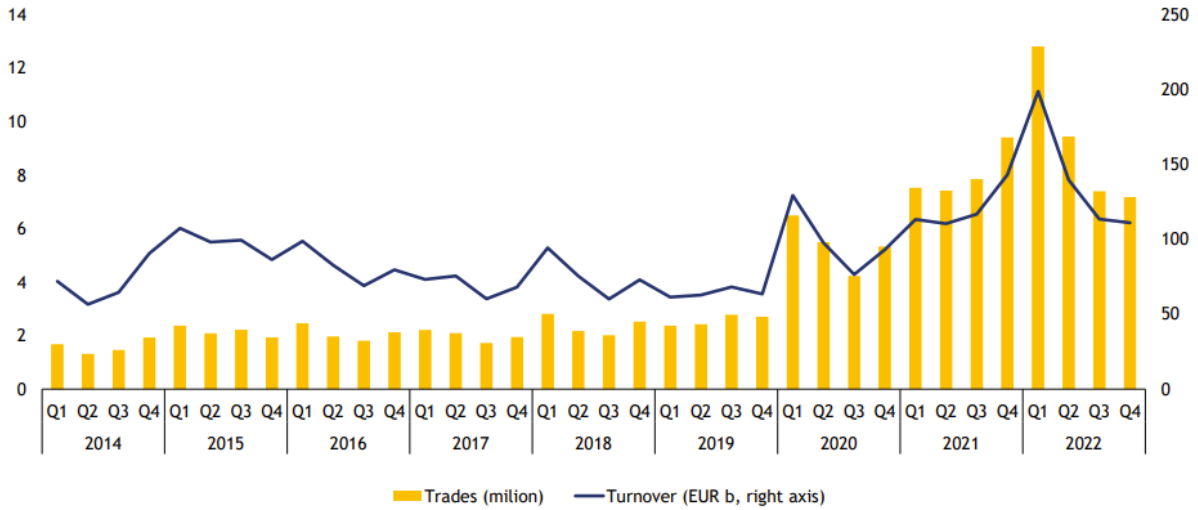
5.10 SUMMARY OF TECHNICAL STANDARDS

The following table summarizes all minimum technical standards for EU CTBs and EU PABs:

Minimum standards	EU CTB	EU PAB
Risk oriented minimum standards:		
Minimum Scope 1+2(+3)[43] carbon intensity reduction compared to investable universe	30%	50%
Scope 3 phase-in	2-4 years	2-4 years
Do no significant harm principle	Yes	Yes
Opportunity oriented minimum standards:		
Minimum green share / brown share ratio compared to investable universe	At least equivalent	Significantly larger (factor 4)
Exposure constraints	Minimum exposure to sectors highly exposed to climate change issues is at least equal to market benchmark value	
Year-on-year self-decarbonization of the benchmark	At least 7%: in line with or beyond the decarbonization trajectory from the IPCC's 1.5°C scenario (with no or limited overshoot)	
Disqualification from label if 2 consecutive years of misalignments with trajectory	Immediate	Immediate

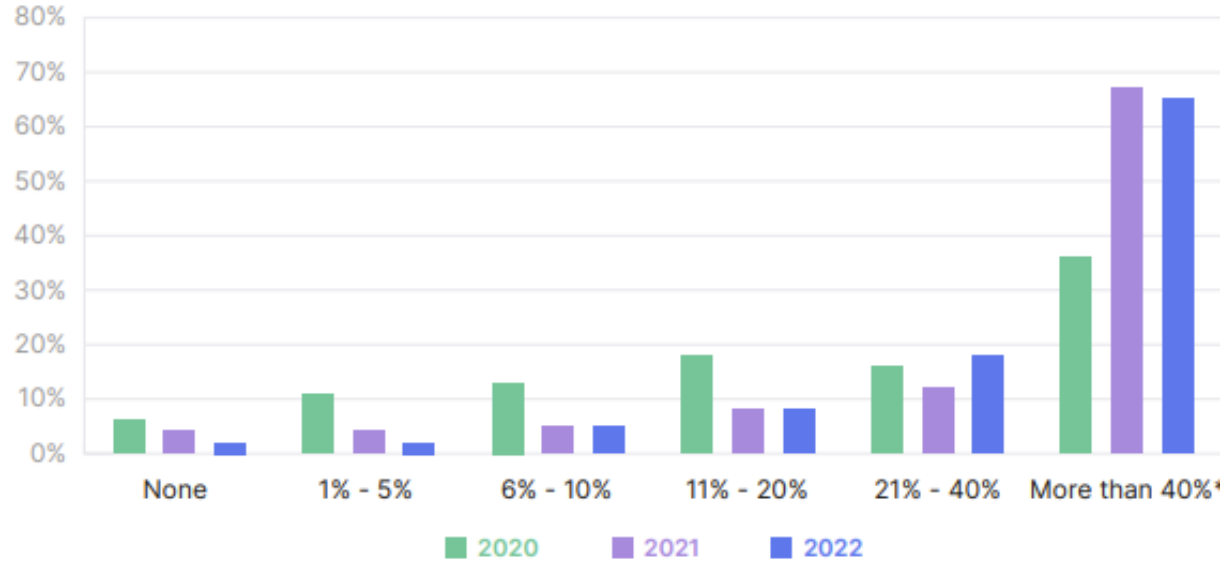
EU technical expert group on sustainable finance, 2018

Appendix 6 : Global flow of European ETFs



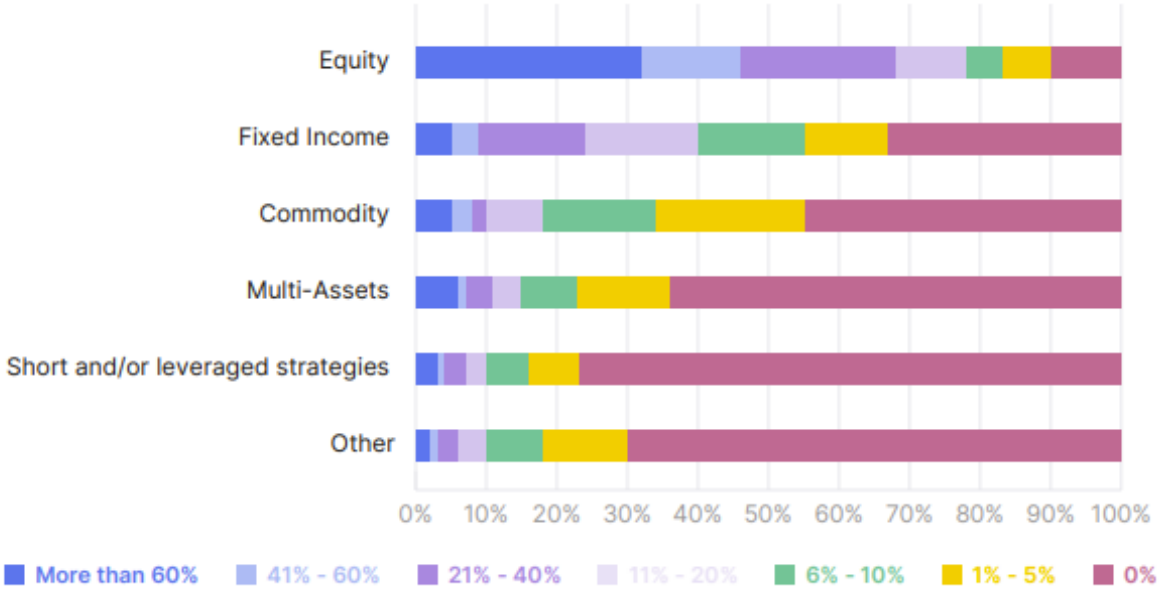
FESE, 2023

Appendix 7 : Percentage of portfolios invested in ETFs



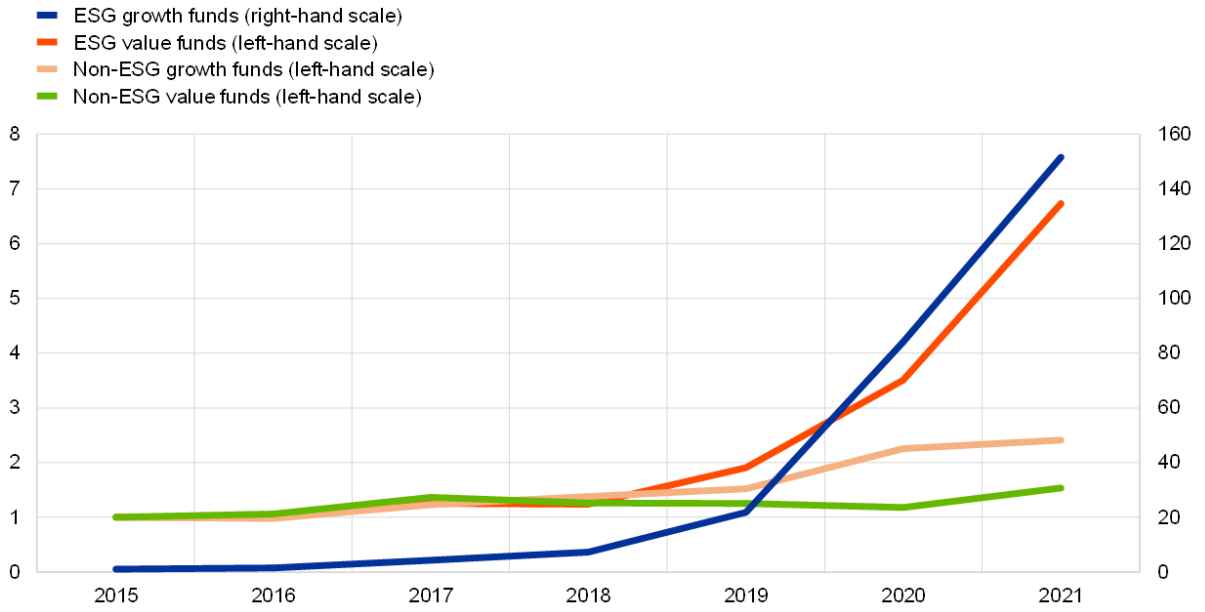
Zhang et al., 2022

Appendix 8 : Percentage of portfolios allocated to asset classes using ETFs



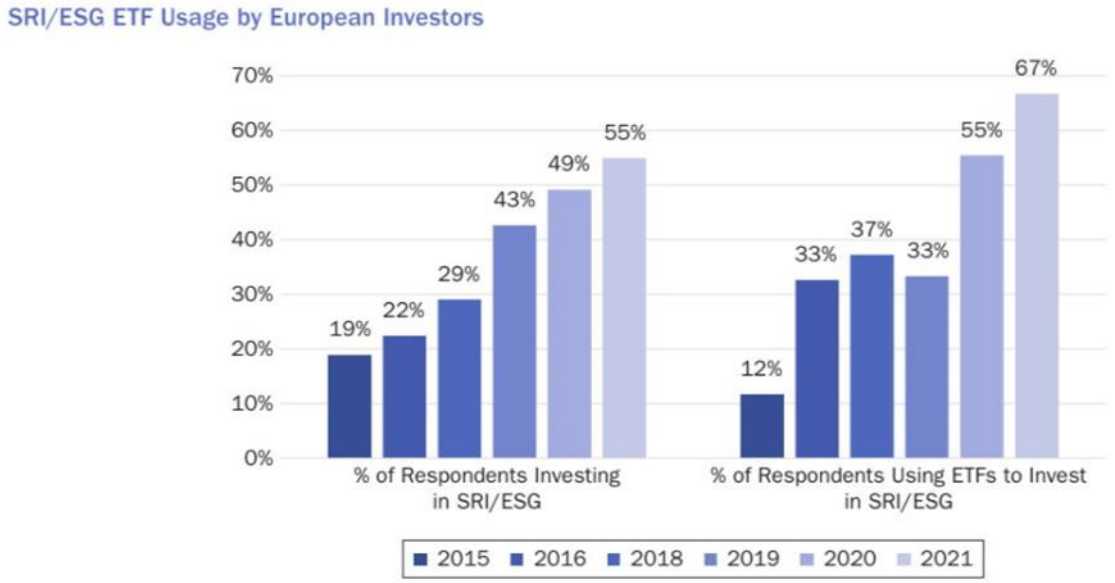
Zhang et al., 2022

Appendix 9 : Rapid growth in ESG funds



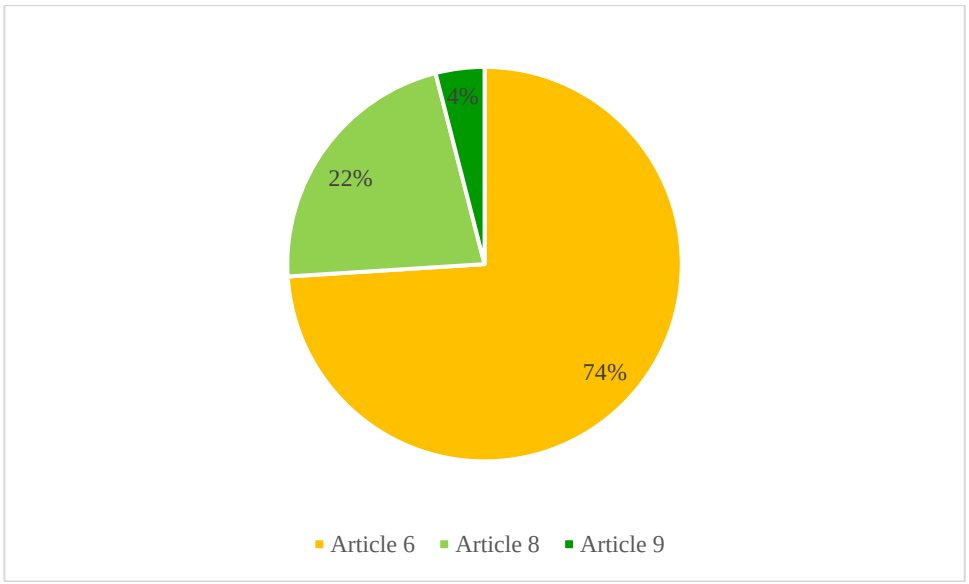
EFPR and ECB calculations, Born et al., 2021

Appendix 10 : SRI/ESG usage by European investors



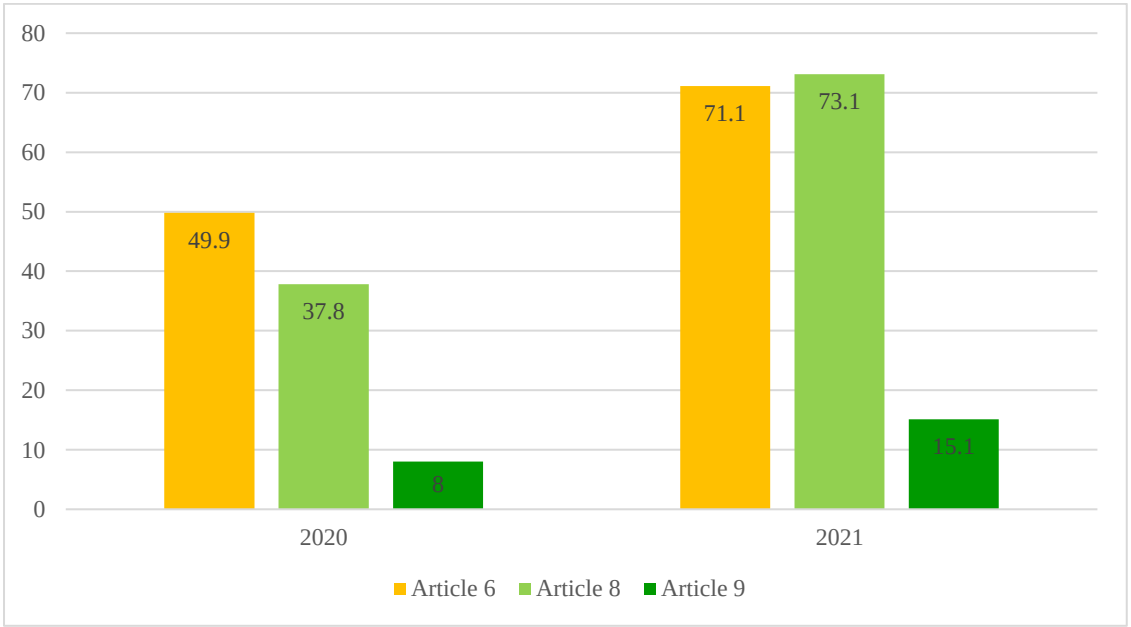
Le Sourd & Safaee, 2021

Appendix 11: Breakdown of SFDR Article 6, 8 and 9 ETFs per ISIN



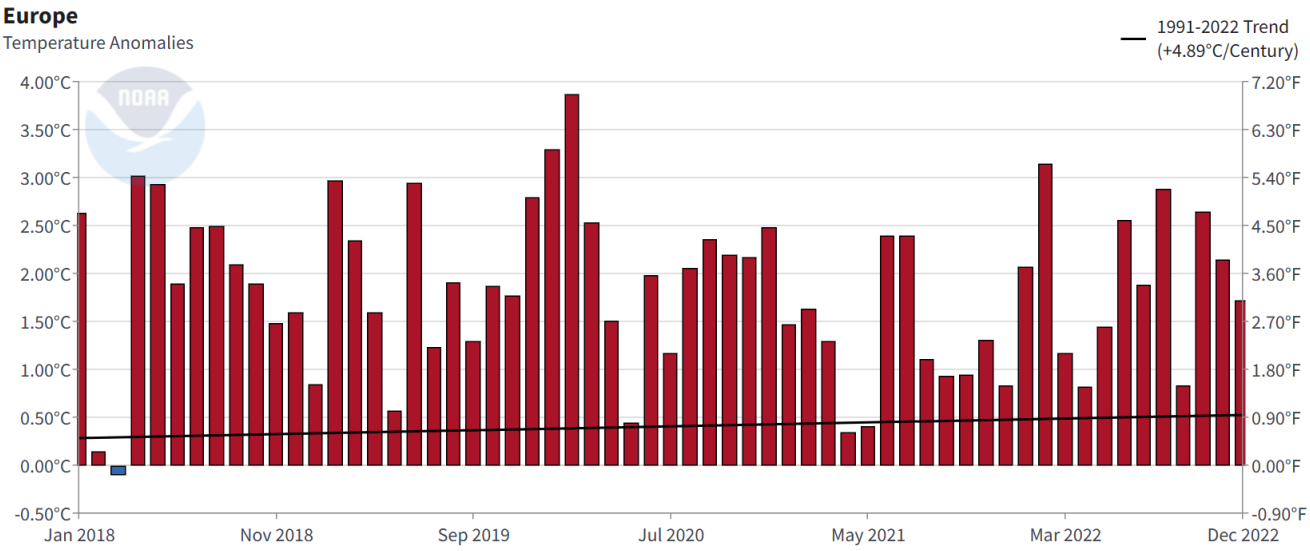
Zhang et al., 2022

Appendix 12 : Flows in Article 6, 8 and 9 ETFS in B€



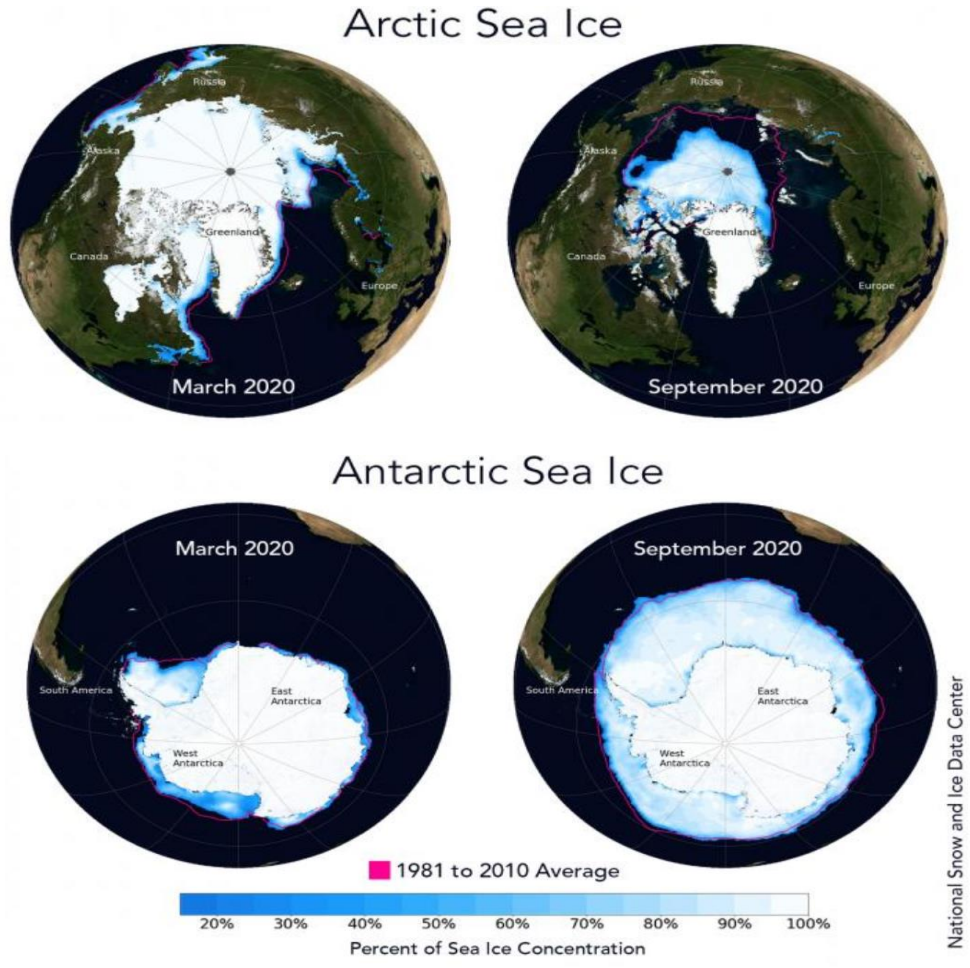
Zhang et al., 2022

Appendix 13 : Temperatures anomalies in Europe from January 2018 to December 2022 compared to 1991-2020 trend



NOAA National Centers for Environmental information, 2023

Appendix 14 : Sea ice concentration of Arctica and Antarctica



National Snow and Ice Data Center, 2023

Appendix 15 : Number of natural disasters in Europe from 2018 to 2022

	Number of disaster type per year
2018	**2**
Extreme temperature	1
Volcanic activity	1
2019	**57**
Earthquake	4
Extreme temperature	14
Flood	17
Landslide	1
Storm	20
Wildfire	1
2020	**43**
Earthquake	3
Extreme temperature	4
Flood	15
Landslide	2
Storm	17
Wildfire	2
2021	**54**
Earthquake	2
Extreme temperature	1
Flood	28
Landslide	2
Storm	15
Volcanic activity	1
Wildfire	5
2022	**43**
Drought	4
Earthquake	1
Extreme temperature	5
Flood	4
Glacial lake outburst	1
Landslide	1
Storm	23
Wildfire	4
Total	**199**

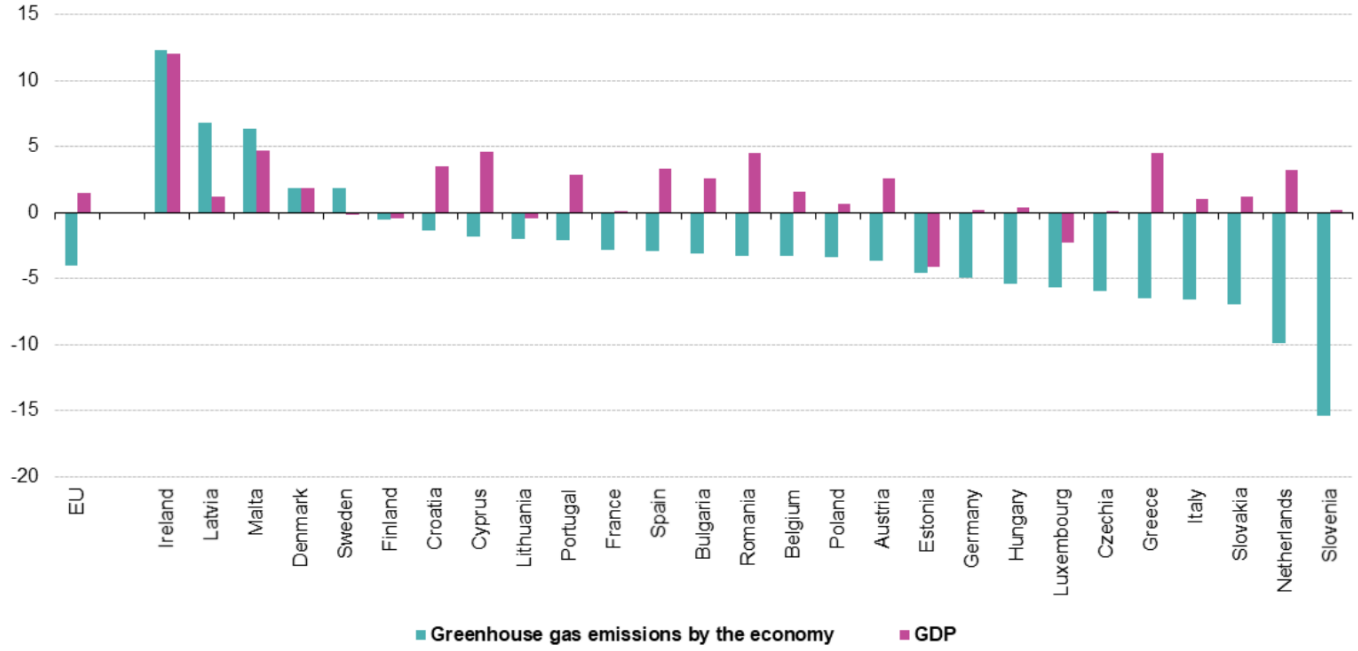
International Disaster Database, Centre for Research on the Epidemiology of Disasters, 2023

Appendix 16 : Types of natural disasters in Europe from 2018 to 2022

	Number of disaster type
Climatological	**17**
Drought	4
Glacial lake outburst	1
Wildfire	12
Geophysical	**12**
Earthquake	10
Volcanic activity	2
Hydrological	**70**
Flood	64
Landslide	6
Meteorological	**100**
Extreme temperature	25
Storm	75
Total	**199**

The International Disaster Database, Centre for Research on the Epidemiology of Disasters, 2023

Appendix 17: Growth rates of greenhouse gas emissions by the economy and GDP, Q4 2022 (% change compared with the same quarter of the previous year)



Eurostat, 2023

Descriptive statistics from November 2018 to December 2022								
Variables	**# Observations**	**Mean**	**Standard deviation**	**Minimum**	**0.25**	**Median**	**0.75**	**Maximum**
Volume exchanged article 8 and 9 ETF	2000	295.342,74	711.532,31	0,000	8.772,25	42.561,50	272.759,25	7.792.387,00
Monthly return article 8 and 9 ETF (%)	2000	0,007	0,0534	-0,239	-0,027	0,013	0,040	0,229
Volume exchanged benchmark non-ESG ETF	550	2.621.537,28	3.791.166,85	0,000	1.020.322,00	2.338.036,00	3.215.918,00	66.314.500,00
Monthly return non-ESG ETF (%)	550	0,009	0,057	-0,238	-0,030	0,016	0,050	0,252
Temperature anomalies (°C)	50	1,793	0,812	0,350	1,170	1,745	2,390	3,870
Sea ice extent anomalies (Mkm^2)	50	-1,221	0,562	-2,200	-1,670	-1,295	-0,780	0,030
Number of natural disasters	50	4,420	4,880	0,000	1,000	3,000	6,000	28,000
Flash flood notifications	50	162,040	158,434	4,000	58,000	104,500	212,000	793,000
Number of fires	50	154,080	165,207	3,000	32,000	86,000	261,000	851,000
Windstorm number	50	1,960	1,908	0,000	0,000	2,000	3,000	8,000
Economic sentiment	50	100,918	12,007	58,700	95,600	102,700	107,200	117,800
Investor sentiment	50	-4,450	18,136	-42,900	-17,100	-3,500	8,800	29,800
Consumer Confidence Index	50	99,120	2,594	93,700	97,400	99,850	101,500	101,900
GHG emissions (million tonnes)	50	304,093	26,201	245,333	284,333	312,667	321,667	350,333

	ReturnESG	VolnonESG	ReturnnonESG	GHG emissions (million tonnes)	Number of natural disasters	Temperature anomalies (°C)	Economic sentiment
ReturnESG	1						
VolnonESG	0,03754287	1					
ReturnnonESG	0,94487178	0,012565256	1				
GHG emissions (million tonnes)	0,02452932	0,016215353	0,011640633	1			
Number of natural disasters	-0,2765966	-0,028954257	-0,28757958	-0,147357368	1		
Temperature anomalies (°C)	-0,2342384	-0,012549473	-0,269585014	0,230418238	0,176658528	1	
Economic sentiment	-0,1829119	-0,02560777	-0,201398592	0,550572185	0,202515339	0,03006866	1
Investor sentiment	-0,1266869	0,026618194	-0,162816787	0,314929924	0,138218499	-0,06078733	0,795188476
Sea ice extent anomalies (Mkm^2)	-0,1785914	0,109180639	-0,198638471	-0,168828347	0,020359765	0,027701509	0,072150984
Number of fires	-0,168269	0,059116227	-0,184739175	-0,028899728	-0,031984127	0,19177445	0,096289743
Flash flood notifications	0,16011733	0,047662571	0,162808946	0,200484736	-0,078102316	0,091804007	-0,185796591
Number of windstorms	-0,1734019	-0,048124306	-0,149574388	0,48841105	-0,099201731	0,35220647	0,126074683
Consumer confidence index	-0,0604728	0,051549423	-0,096222117	0,366864279	0,047706253	-0,04363854	0,508429838

	Investor sentiment	Sea ice extent anomalies (Mkm^2)	Number of fires	Flash flood notifications	Windstorm number	Consumer confidence index
ReturnESG						
VolnonESG						
ReturnnonESG						
GHG emissions (million tonnes)						
Number of natural disasters						
Temperature anomalies (°C)						
Economic sentiment						
Investor sentiment	1					
Sea ice extent anomalies (Mkm^2)	0,314466096	1				
Number of fires	0,028686788	0,063745332	1			
Flash flood notifications	0,072306157	0,193723432	-0,267550483	1		
Number of windstorms	-0,033887534	-0,024293496	-0,03706375	0,283590303	1	
Consumer confidence index	0,734049545	0,11058823	-0,092396525	0,108015984	-0,156309013	1

Appendix 20 : Results of regressions (Pooled OLS and fixed-effects regressions)

		Explained variable											
		Traded volume of Article 8 & 9 ETFs											
		Indicators_CC2		Indicators_CC3		Indicators_CC4		Indicators_CC5		Indicators_CC6		Indicators_CC7	
Explanatory variables	***Indicator of climate change (t-1)***	0,3535	0,3713	-0,1145	-0,1134	-0,0154	-0,0093	0,0002	0,0004	0,0007	0,0009	-0,0137	-0,0239
	Std. Error	0,0957	0,0520	0,0673	0,0368	0,0112	0,0062	0,0003	0,0002	0,0003	0,0002	0,0281	0,0155
	P-value	0,0002	0,0000	0,0891	0,0021	0,1710	0,1342	0,5144	0,0370	0,0313	0,0000	0,6269	0,1214
	Traded volume of non-ESG ETFs	0,1668	0,0568	0,1702	0,0646	0,1727	0,0678	0,1689	0,0597	0,1671	0,0563	0,1695	0,0622
	Std. Error	0,0191	0,0155	0,0191	0,0156	0,0192	0,0158	0,0192	0,0158	0,0192	0,0156	0,0192	0,0157
	P-value	< 2.2e-16	0,0002	< 2,2e-16	0,0000	< 2,2e-16	0,0000	< 2,2e-16	0,0002	< 2,2e-16	0,0003	< 2,2e-16	0,0759
	Monthly return of Article 8 & 9 ETFs	0,1860	0,7723	-0,7700	-0,2358	-0,8426	-0,1475	-0,2687	0,3806	-0,8399	-0,3789	-0,4635	0,0299
	Std. Error	1,1325	0,6196	1,1447	0,6307	11,6936	0,6474	1,1437	0,6319	1,1419	0,6264	1,1318	0,6238
	P-value	0,8696	0,2128	0,5012	0,7085	0,4713	0,8198	0,8143	0,5470	0,4621	0,5453	0,6822	0,9618
	Consumer confidence index	-0,0181	-0,0256	-0,0120	-0,0190	-0,0088	-0,0161	-0,0086	-0,0147	-0,0153	-0,0236	-0,0116	-0,0198
	Std. Error	0,0205	0,0112	0,0205	0,0112	0,0205	0,0112	0,0206	0,0113	0,0206	0,0112	0,0207	0,0114
	P-value	0,3772	0,0216	0,5563	0,0913	0,6654	0,1512	0,6745	0,1927	0,4578	0,0361	0,5760	0,0818
	Observation	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
	R squared	0,045186	0,035695	0,04005	0,015359	0,039561	0,011726	0,038863	0,01279	0,040889	0,022069	0,038772	0,011805
	Fixed effects	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes

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