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Chair of Econometric Theory

THE ESG PREMIUM: A FACTOR ANALYSIS

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Abstract

In 2004, the concept of Sustainable and Responsible Investing (SRI) was first introduced to a broader audience. It is defined as an investment practice that incorporates ESG metrics into the investment decision-making process. However, people question whether these new investments practices are profitable. The aim of the following research is to find whether there exists a market anomaly related to ESG investing. For this purpose, an anti-ESG factor is constructed and an extended version of the Carhart model is developed. Findings highlight that there exists a market inefficiency linked to ESG investing and this is represented by the anti-ESG premium. Moreover, anti-ESG portfolios tend to outperform some equities sectors during periods of market downturns. Further research could try to investigate what has been the impact of the Great Financial Crisis, Covid-19 Pandemic and Russian invasion of Ukraine on the proposed investment strategy.

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Abbreviations and Nomenclature

ACF - Autocorrelation Function

ADF - Augmented Dickey–Fuller test

aESG - anti-ESG portfolio

AO- Assets' owners

AuM - Assets under Management

CD - Consumer Discretionary

C.Services - Communication Services

CS- Consumer Staples

CSRD - Corporate Sustainability Reporting Directive

E - Energy

ESG - Environmental, Social and Governance

F - Financials

F-Stat - F-statistic ESGC - ESG Combined Score

GICS - Global Industry Classification Standard

HC - Health Care

HML- High minus Low Factor

I - Industrials

IT - Information Technology

JB - Jarque-Berra test

M - Materials MKT - Market Factor

NFDR - Non-Financial Reporting Directive

PRI - Principles for Responsible Investments

RE - Real Estate

SRI - Sustainable and Responsible Investing

SFDR- Sustainable Finance Disclosure Directive

SMB - Small minus Big Factor

U - Utilities

UMD - Momentum Factor

UNPRI - United Nations Principles for Responsible Investments

Chapter 1

Introduction

In 2004, the concept of Sustainable and Responsible Investing (SRI) was first introduced to a broader audience in a report, sponsored by the United Nations (UN), whose title was 'Who Cares Wins'. The report was part of a UN project, where a coalition of financial institutions attempted to find a set of general guidelines on how to efficiently incorporate ESG (Environmental, Social and Governance) challenges in asset management (The Global Compact 2004). Since then, due to investors' increasing awareness and research for green investing, Assets under Management (AuM) and fund flow in socially responsible investments have grown exponentially, especially during the COVID-19 pandemic. According to a report released by The Global Sustainable Investment Alliance (2020), global sustainable investments in 2020 were $35.3 trillion, resulting in a 15% increase in the period 2018-2020 and a 55% increase in the period 2016-2020. In 2020, 35.9% of total AuM was in sustainable investments. At the same time, Morningstar highlights that 46% of the total world AuM in sustainable investments are from Europe, with Luxembourg being the leading country.

However, there are many obstacles when incorporating ESG factors in the investment decision-making process. Among them, there is the lack of common parameters for ESG valuation, the difficulty of having reliable and high-quality data, and the belief that ESG investing implies a reduction of the permissible investment universe, thus leading to sub-optimal portfolios. The absence of common parameters means that investors use different metrics to incorporate and measure ESG factors. As a matter of fact, Kotsantonis and Serafeim (2019) analyse fifty companies listed in Fortune 500 and highlight that these firms use more than twenty different ways to report data about the safety of their employee, in particular, they use different units of measure and terminology. Unfortunately, these divergences in data reporting exist for any ESG factor, interfering with the comparability of firms' ESG performances and leaving room for arbitrage opportunities. It follows that finding reliable ESG data is a difficult task, even though the increasing technology improves data transparency and availability.

Given all these shortcomings, people question whether these new investment practices are profitable.

The following research aims to find whether there exists a market anomaly related to ESG investing and in particular to assess whether fund managers can obtain superior returns through implementing ESG investment strategies. Moreover, the aim is to answer to the following questions: is it true that, in the long run, low ESG-rated stocks tend to outperform high-rated ones? If yes, is it possible to construct an anti-ESG factor that explains stocks' returns? Moreover, is it possible to obtain superior returns through the implementation of this new contrarian ESG strategy?

Thousands of empirical studies have tried to investigate the relation between companies' ESG ratings and stock returns: conclusions are far from being unanimous. Pástor et al. (2021) provide an empirical analysis of financial markets equilibrium and show that in equilibrium, companies with a high overall ESG rating should have a negative alpha. They highlight that when ESG preferences are stable in financial markets, high ESG rated stocks tend to underperform the low-rated stocks. On the other hand, Hong and Kacperczyk (2009) show the existence of an economically remarkable sin premium: stocks belonging to sin sectors[1], outperform similar stocks that belong to other industries. Auer and Schuhmacher (2016), highlight that there is no real evidence that portfolios with high ESG ratings outperform those with low ratings in the European stock market. On the contrary, Kempf and Osthoff (2007) using as reference the US stock market, show that ESG friendly portfolios obtain higher returns than non-ESG friendly portfolios.

It is worth mentioning that the majority of these academic studies focus on the American Stock Market. However, in March 2018, the European Union adopted the Sustainable Finance Action Plan, which among its other objectives, aims to "foster transparency and long-termism in financial and economic activity" (European Commission 2018) and to induce investors to consider ESG-related issues. Since then, the EU regulation regarding ESG investing has been growing, suggesting that the ESG phenomenon is more prominent in Europe than in the USA. Hence, a hypothetical market anomaly linked to the sphere of green investing must be searched in the European stock market rather than the American one.

For this reason, this study will use as reference a Europe-based investible universe[2] and will be focused on constructing eleven anti-ESG factors, one for each Global Industry Classification Standard (GICS) sector, according to the Fama and French (1992) procedure. Each anti-ESG sector factor is constructed by going long on non-green stocks and going short on green stocks that belong to the sector of reference. The idea on which this thesis relies on, is that high ESG rated stocks have a higher price than low ESG rated stocks. However sooner or later all the European companies must be compliant with the EU ESG Regulations, thus reaching a higher ESG score and a higher price. This will lead them to outperform the green stocks in the medium term. It follows that the strategy developed aims to catch the premium by investing in those firms that will see their value increase once they will get a higher ESG score.

[1]Sin sectors are those that are associated with activities that are considered immoral and unethical. These sectors include tobacco, gambling, alcohol as well as weapon manufacturers.

[2]The set of STOXX EURO 600's components as of January 2022 covering the time-period that goes from 31/01/2008 to 31/12/2021.

The eleven anti- ESG factors are constructed using the ESG rating provided by Refinitiv-Asset 4. ESG rating providers have the function of reducing information asymmetries and acting as intermediaries between firms and investors, retrieving and analysing all the publicly available information disclosed by businesses. There are six ESG rating providers[3] and the choice to rely on one rather than the others can alter the results of the research. This means that, the results obtained by using one ESG rating might not be replicated with the ESG ratings of another rating provider. Indeed, Berg et al. (2019) investigated the divergence of ESG ratings based on the data from the six leading ESG rating providers and concluded that researchers and fund managers should carefully choose the data on which their ESG studies rely.

Overall, the thesis highlights that having invested 100 EUR in some of the developed anti-ESG factors would have generated superior returns if compared to the respective sector sub-indices. However, findings are not homogeneous across sectors. They show that, when compared to their sector index counterpart, some of the anti-ESG factor portfolios tend to have a higher Sharpe Ratio, with the exceptions being Utilities, Industrials, Information Technology, Consumer Staples, and Consumer Discretionary. An analysis of the anatomy of the portfolio's cumulative performances revealed that the strategy implemented tends to be more defensive than a long-only strategy (i.e., the strategy of the sector sub-indices). Hence, during market downturns, the eleven anti-ESG portfolios tend to be less severely impacted by negative returns, with some of them experiencing abnormal returns (Financials and Real Estate). After analysing the factors' behaviour, an extended version of the Carhart (1997) model was developed to assess whether the anti-ESG factor is a predictor of stock returns. Evidence shows that the alpha of nine of the eleven regressions is equal to zero and statistically insignificant, with the only two exceptions being the Real Estate and Utilities sectors.

The reminder of this paper proceeds as follows: Chapter 2 details the most salient features of the ESG market. Chapter 3 shows what are the main contributions that academic literature has made over the past years while Chapter 4 presents the methodology and data employed to answer the research questions. Chapter 5 and 6 highlights what are the results obtained by implementing the developed model and Chapter 7 draws conclusions and proposes further lines of research.

[3] KLD, Sustainalytics, Moody's, RobecoSAM (S&P Global), MSCI, and Refinitiv-Asset4.

Chapter 2

ESG Universe

2.1 Environmental, Social and Governance

ESG (Environmental, Social, and Governance) is based on three main pillars: the Environmental pillar (E) assesses the impact that a company has on the environment, the Social pillar (S) assesses the company's organisational policies regarding human rights and the Governance pillar (G) examines a company's management and governance issues. Figure 2.1 details each pillar's specific theme and related issues that might have a material impact on a company's performance as well as on the stability of the financial system. Indeed, according to the International Monetary Fund, integrating ESG factors into the company's business model can help to mitigate risks and to enhance the company's performance (IMF 2019).

Key Pillars	Key Themes	Key Issues	
Environment	Climate change	Carbon footprint	Vulnerabilities from climate change events
	Natural resources	Energy efficiency Sourcing of raw materials	Water efficiency Usage of land
	Pollution and waste	Toxic emissions Wastewater management Hazardous materials management	Air quality Electronic waste management
	Opportunities and policy	Renewable energy Clean technology	Green buildings Environmental and biodiversity targets and investment
Social	Human capital	Workplace health and safety Development opportunities	Employee engagement, diversity, and inclusion Labor practices (e.g., wages, working conditions)
	Product responsibility	Product safety and quality Selling practices and product labeling	Customer privacy and data security Access to products
	Relations	Community Government	Civil society
Governance	Corporate governance	Board structure and accountability Accounting and disclosure practices	Executive compensation and management effectiveness Ownership and shareholder rights
	Corporate behavior	Management of corruption Systemic risk management Earnings quality	Competitive behavior Management of business environment (e.g., legal, regulations) Transparency on tax and related-party transactions

Figure 2.1: Selected ESG Issues - The table shows the three ESG pillars' breakdown. For each pillar, the main key theme and key issues are highlighted. Source: Sustainable Finance ch.6 IMF

ESG data have been defined as "Alternative data" i.e., those data that arise from factors that are not orthodoxly used in the investment decision process but still have a crucial role in a firm's performance and sustainability (In et al. 2019). In the last decades, equity investors have largely included these types of data in their investment analysis, but it is only in the last ten years that investors have started to include them in their valuation process (IMF 2019).

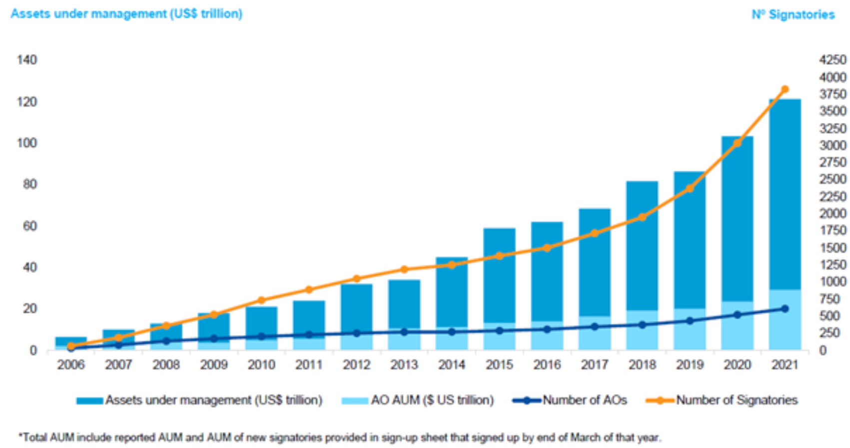

Figure 2.2: PRI signatory growth in 2020-2021- The blue bars represent the total AuM amount of PRI signatories from 2006 to 2021, while the light blue bars highlight the total Asset owner's AuM, which include both external and internally managed assets.The blue line indicates the number of Asset owners for the highlighted period, while the orange line indicates the number of signatories. Source: UNPRI

The plot in Figure 2.2 highlights the exponential growth in Principles for Responsible Investments (PRI)[1] signatories; the increase dates to 2008, however, the exponential growth only started in 2014. Indeed, in that year the number of signatories was 1500 for $45 trillion of AuM, while in 2021 the number quadruplicated reaching a level of 4000 for $120 trillion of AuM (PRI 2021). At the same time, Figure 2.3 shows that as of 2019, ESG funds covered a small percentage of the total investment funds universe, accounting for less than 2% (around $ 850Bn in assets). Nonetheless, they are rising fast with equity funds representing the greatest portion. (IMF 2019)

[1] In 2005, the then United Nations Secretary invited world's twenty largest investors to join a process to develop the Principles for Responsible Investment. The principles were first launched in 2006 at the NYSE (New York Stock Exchange) and since then the number of signatories started to increase. The PRI is an organization that promotes transparency on ESG-related issues and works to encourage the adoption of the principles to achieve a sustainable financial system(PRI 2020).

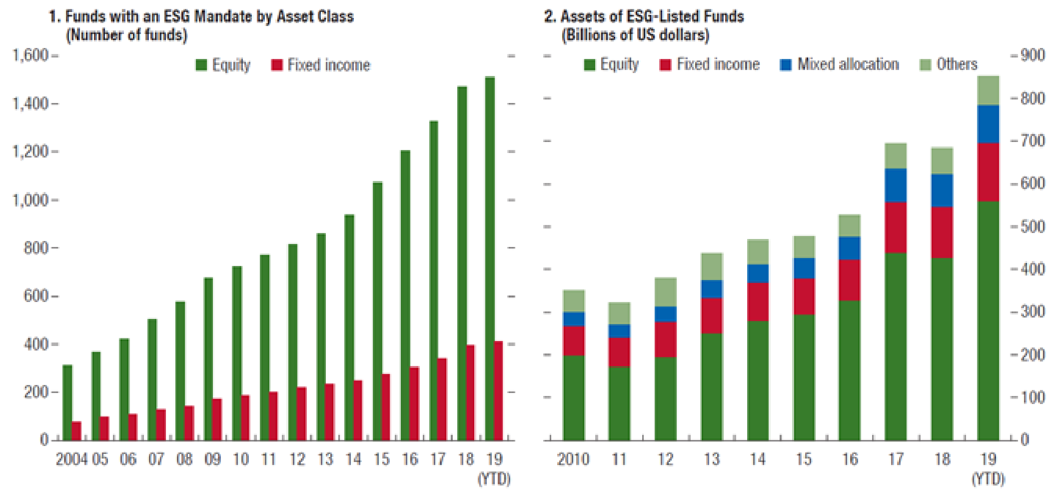

Figure 2.3: Growth of ESG-Dedicated Funds - (Left) Number of funds with an ESG mandated by Asset Class, equity or Bond. (Right) Amount, in billions of USD, of assets in which ESG listed funds invest in. Source: IMF 2019

Research conducted by Morgan Stanley highlights that passive ESG AuM is growing at a faster pace than active ESG AuM, accounting for approximately 24 % of the market. The reason behind this discrepancy is that investors prefer to invest in passively managed fund rather than actively managed ones because of the lower fees charged. Indeed, passive management offers investors the possibility to gain ESG exposure in a flexible and low-cost way, while active management requires careful analysis of both qualitative and quantitative data, as well as engagement with the issuer. Moreover, Morningstar data have shown that Europe has been the leading region for ESG investing covering 83 % of AuM (Morgan Stanley Research 2020).

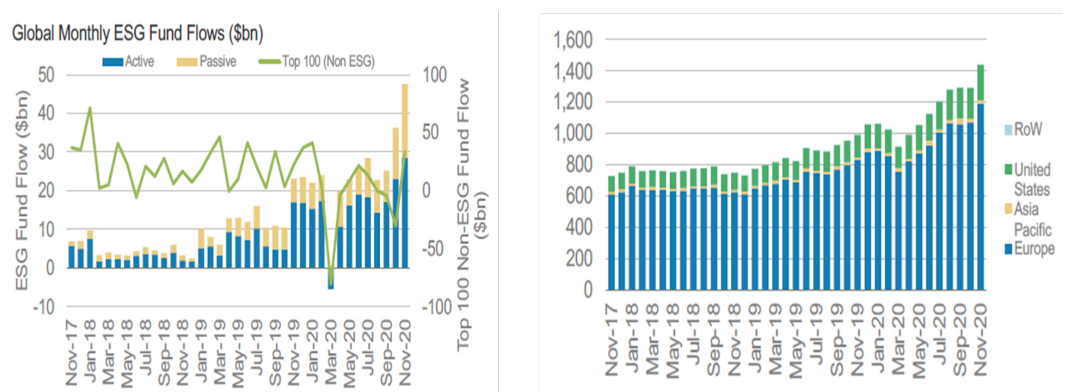

Figure 2.4: ESG Fund Flow-(Left) ESG funds flow breakdown by type of funds, active or passive funds. (Right) ESG fund flows breakdown by country. Source: Morgan Stanley Research

2.2 ESG Implementation

ESG is becoming an important investment theme for three reasons: (i) materiality, (ii) client demand, and (iii) regulation (PRI 2020). Materiality refers to the situation where there is growing recognition by institutional investors that ESG factors can influence investments return. As far as client demand is concerned, clients are calling for more transparency on how asset managers are investing their money. The reason is that in the last decade there was a growing awareness that ESG factors influence firms' returns (PRI 2020). Furthermore, a 2018 survey conducted by Morgan Stanley Institute showed that 87 % of high-net-worth millennials consider a firm's ESG rating an important factor in their decisions about whether to invest or not (MSCI Research 2020). The third reason why ESG factors are becoming more and more important is regulation. Figure 2.5 highlights that, since the late 20th century, and in particular after the 2008 crisis, the regulation concerning responsible investment has increased significantly. Regulatory changes have been driven by the realisation that the financial sector can and must play a crucial role in meeting global environmental and social challenges (PRI 2020).

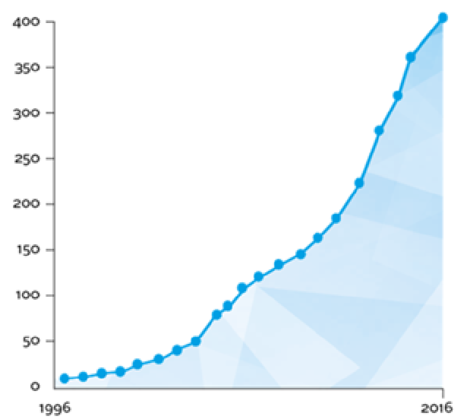

Figure 2.5: Regulation Growth- The graph shows the cumulative number of policy interventions (counting new policies and policy revisions)- Source: PRI

2.3 ESG Investing

During the last years, ESG investment strategies have provided a lot of benefits for investors, from outperformance in the long term to resilience in market drawdowns.

There are many strategies to invest responsibly and usually approaches combine two overarching areas:

1) Active Ownership or Stewardship, which aims to improve the investee's ESG performance.

2) ESG Incorporation, which refers to considering ESG issues when building a portfolio.

Active Ownership is when investors are involved in the decision-making process of the companies they already invested in, and their decisions are aimed at improving the company's ESG risk management or developing more responsible business practices. This can be achieved either through engagement or proxy voting. With regards to *engagement*, it is about discussing ESG issues with the company's board of directors to enhance their handling of sustainability. *Proxy voting* regards the formal approval or disapproval through voting, in the shareholders' meeting, against resolutions that happen to be non-sustainable friendly. The second approach, ESG incorporation, is a technique that incorporates ESG issues into already known investment practices using a combination of three different approaches: (i) integration, (ii) screening, and (iii) thematic investing. ESG integration is a comprehensive approach to investment analysis where ESG factors and financial factors are both identified and assessed to evaluate an investment. To do so, practitioners gather and analyze both financial and ESG data to identify material factors that can affect a company's performance. Once collected and analyzed, this information is included in the so-called "centralized research dashboard". Then, the already estimated valuation model multiples and variables, (discount factors, among others), are modified and adjusted according to the possible impact that material ESG issues might have on the company's performance. This type of strategy does not reduce the investment universe, but it offers the opportunity to choose between companies and sectors for which the only discriminant is their ESG performance. However, this investment approach is not free from biases and issues, since the sourcing quality of ESG data remains a big challenge. The selection of different securities is based on a quantitative and qualitative assessment of ESG factors, thus requiring analysts' expertise. Moreover, a long-term outlook is highly needed since it is very hard to time the occurrence of a negative event resulting from an ESG matter. Another common strategy is to apply some screens to the permissible investment universe, thus reducing it. The screening approach consists of four ways: exclusionary screening, positive screening, best-in-class approach, and norm-based screening. Exclusionary screening, also defined as negative, has the following objectives: aligning investors' portfolios with their ethical and moral values, mitigating ESG risk, and inducing a company to change its business model. By using this strategy, investors exclude from their investment universe the following 'sinful' sectors: weapons, pornography, tobacco, and animal testing (Eurosif 2018). Positive screening is when investors decide to tilt their portfolios towards those companies that are the best ESG performers, regardless of which sectors or countries they belong to. The objective here, besides mitigating the ESG score and achieving higher returns, is to improve the ESG score of the portfolio and support business models that are committed to solving an ESG issue. The best-in-class approach is a particular type of positive screening, where you only tilt your portfolio to companies outperforming their peers in ESG measures. This ensures an industry-balanced portfolio. The norm-based screening is when investments are selected and screened according to national and international norms that cover ESG issues. Finally, the last approach, thematic investing, happens when investors combine attractive risk returns with a given environmental and social outcome. This approach mainly comprehends two strategies: impact investing and sustainable themed investing. Impact investing is when investments are project-specific, meaning that the aim of choosing that investment is not only to achieve a higher return but also to generate an environmental or social impact. Microfinance and community investing are examples of the aforementioned strategy. Then, investors can implement sustainably themed investing to build thematic portfolios that are focused on a particular ESG issue, like climate change, water efficiency, or gender quotas. It is worth mentioning that these strategies can be combined to achieve superior returns and generate superior impact (Kumar et al. 2016).

2.4 ESG Regulation

Sustainability policies are evolving rapidly all over the world, however, it is the European Union that seems to be the global leader in sustainable finance policies. As a matter of fact, following the 2015 Paris Agreement, the EU commission developed, in 2018, the Sustainable Finance Action Plan setting the building blocks for creating new global sustainability policies. One of the key pillars of the Action Plan is to make ESG investing more transparent and to increase the number of sustainable investments. Having these objectives clear in mind, European policymakers developed a set of regulations and directives to drive ESG investments. The first to be implemented was the EU Taxonomy, a classification system that established a list of environmentally sustainable economic activities. The Taxonomy was then complemented by the EU Sustainable Finance Disclosure Regulation (SFDR), with the scope of helping investors to direct their money towards ESG investments. Then, the European Union published the EU Green Bond Standard, whose objective is to define a market standard for green bonds to enhance the credibility and transparency of this market and to encourage investors to play an active role in this new market segment. In 2023, the Corporate Sustainability Reporting Directive (CSRD) will replace the Non-Financial Reporting Directive (NFDR) whose aim is to define a set of rules that regards disclosure. It requires only large businesses to disclose information about how they manage environmental and social challenges (European Commission 2018).

Among this set of directives and regulations that are going to be implemented, the Sustainable Finance Disclosure Regulation is going to create a structural improvement in financial markets by imposing mandatory sustainability reporting and by forcing investment firms that market ESG Funds to change the way they manufacture, sell and market the products. This will, of course, force portfolio managers to integrate sustainability factors in the set of variables that they analyse when taking an investment decision (European Council and European Parliament 2019). Indeed, the aim of the regulation is to revolutionise investors' behavior and to shed a light on those businesses and funds that are ESG-oriented. Thus, this increase in disclosure requirements will create more transparency and ultimately will result in a growth of ESG investing (Laidlaw 2021).

Following the SFDR, asset managers, pension, and insurance funds are obliged to disclose how they account for ESG risk in their process of risk management and portfolio management selection. Indeed, this regulation aims to provide asset managers with a common set of rules on sustainability risk while reducing the information asymmetry between end-investors and agents, hence preventing the well-known practice of greenwashing[2]. On March 10, 2021, some parts of the Sustainable Finance Disclosure Regulation came into force, while as of July 1, 2021, some disclosure requirements became more stringent. However, the regulation is expected to evolve until mid-2023, and most notably it will apply not only to European Companies but also to those companies outside the European Union that have more than USD 3 Trillion in market capitalization. This suggests that as of late 2023, a vast majority of companies will have to be ESG compliant. Therefore, by 2023, portfolio managers will have to adapt their strategies and documentation to the new SFDR rules, adding new constraints and complexity to what is already a difficult task for investors. As disclosure requirements increase and become more prominent, all the potential risks in investment portfolios will become more visible.

According to Financial Services Leader of PwC Luxembourg, Olivier Carré, by 2025 half of Europe's mutual funds will comply either with SFDR's Art.8 - considered as "light green funds" that among other things promote environmental and social investments- or to Art.9 – known as "dark green funds" that have ESG as the main investment objective. As of February 2022, Luxembourg is the leader for sustainable finance in Europe, with sustainable funds accounting for € 371 billion by the end of 2020 and capturing 44% of total net flows made across all European domiciles since 2020.

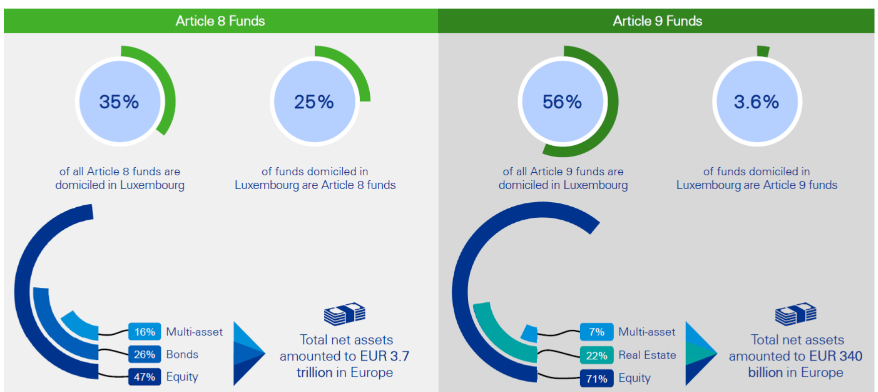

Figure 2.6: Main figures of ESG Funds in Luxembourg, with a breakdown by art.8 and art.9 type of funds- Source: EFAMA

According to Carré, when fund managers consider ESG risks in their investment decisions they are more likely to pay a premium for ESG products, while those funds that are not acknowledging ESG risks in their investments face trading at a discount (PwC 2021). Therefore, sustainable finance regulation seems to be the only way to ensure investment managers are integrating ESG into their portfolios.

[2]The term greenwashing refers to the common practice of presenting investments in a "green light" to give the impression that they are more sustainable than they are.

Chapter 3

Literature Review

3.1 ESG Rating

Since the onset of ESG investing, companies have started to engage in greenwashing, that is the practice of intentionally providing false and misleading information (Ramus and Montiel 2005). If investors use ESG commitment as one of their metrics when assessing an investment decision, but the only information that they have about the ESG policy of companies is incomplete or not reliable, the high responsible companies can be forced out of the market, even though they are providing what investor are looking for. This phenomenon is not new under the sun, and it is referred to as information asymmetry that leads the investor to not correctly identify sustainability-oriented companies (Akerlof 1978).

To avoid this type of asymmetry, that most of the time leads the market to collapse, ESG ratings were introduced. They measure the company's exposure to environmental, social, and governance risks and have the objective to help investors in assessing the value of a company. However academic literature has shown that ESG ratings have some deficiencies that can alter investor's allocation decisions. Two main shortcomings have been identified and will be analysed in the following paragraphs.

ESG Discrepancies

Many are the ESG rating providers, but the six most prominent have been subject to the empirical analysis of many academics: findings have shown that there is great disagreement across the ratings that these platforms offer. Figure 3.1 shows a heat map of the correlation coefficients between the six rating providers, red highlighting negative correlation and green highlighting positive correlation. The correlation range identified, across these six ratings, goes from 0.38 to 0.71, with the average being 0.54. This value is too low when compared to the correlation (around 0.99) across credit rating providers (Berg et al. 2019).

	KL SA	KL MO	KL SP	KL RE	KL MS	SA MO	SA SP	SA RE	SA MS	MO SP	MO RE	MO MS	SP RE	SP MS	RE MS	Average
ESG	0.53	0.49	0.44	0.42	0.53	0.71	0.67	0.67	0.46	0.7	0.69	0.42	0.62	0.38	0.38	0.54
E	0.59	0.55	0.54	0.54	0.37	0.68	0.66	0.64	0.37	0.73	0.66	0.35	0.7	0.29	0.23	0.53
S	0.31	0.33	0.21	0.22	0.41	0.58	0.55	0.55	0.27	0.68	0.66	0.28	0.65	0.26	0.27	0.42
G	0.02	0.01	-0.01	-0.05	0.16	0.54	0.51	0.49	0.16	0.76	0.76	0.14	0.79	0.11	0.07	0.30

Figure 3.1: Correlation between ESG Rating- The heatmap highlights the correlation among KLD, Sustainalytics, Moody's, RobecoSAM (SP Global), MSCI, and Refinitiv (Asset4). Positive correlation is highlighted in green, low correlation is highlighted in yellow, negative correlation is highlighted in red.

In practice, this very low correlation means that ESG rating issuers provide relatively noisy information to investors. Therefore, even though investors have preferences toward ESG performance, the discrepancy in the ratings scatters the effects of these predilections on asset prices. Berg et al. (2019) in their study show that different raters give different importance to the same factors mainly because they have different views of what is sustainable and what is not. Consequently, each rating agency decides according to their preferences what is the hierarchy of the different factors. Moreover, they highlight that measurement divergence is the main driver of divergence among ratings, meaning that even though two rating agencies agree on the same set of attributes, different ways of measurement would still yield different scores. It has been found that this divergence depends on the so-called rater effect. The rater effect assesses that there is a correlation between rater's assessments. It means that if a company receives a high score in one category, it is more likely to receive a high score in all the other categories from that same rater.

Lack of Independence and Transparency

Healy (2001) highlights that lack of transparency and lack of independence are two other ESG rating challenges and that these two problems need to be addressed to avoid investors losing confidence in ESG ratings. Indeed, researchers and practitioners highly criticise this kind of black-box approach that ESG rating agencies adopt and call for greater transparency, asking raters to disclose what are their methodologies as well as their measurement practices. Moreover, rating agencies need to have a close relationship with the rated companies in order to get not publicly available data that could help them to better assess the ESG score. However, this necessary interaction is even more dangerous and could potentially influence the rater's assessment.

Given all the shortcomings affecting ESG ratings, researchers are advised to carefully choose the data that underlies their studies involving ESG, in particular its correlation with financial performance. It is important to highlight that some results that have been obtained based on a given ESG score might not be replicable by using the rating of another ESG rating provider. As a matter of fact, in Chapter 4, the ESG rating provider used is described as well as its proprietary methodology.

3.2 ESG Premium

In the last years, investors have constantly questioned the profitability of ESG investing and what is the relation, if any, between a firm ESG score and stock returns. Moreover, academics have tried to investigate what is this relationship and if it does exist. A widely accepted conclusion from the meta-analysis of this academic literature is that evidence is partially mixed. Academic studies analyze which strategy is the most successful to have a social and environmental influence on financial markets. Some claim that stock screening and ESG integration are the best ways to make a social impact, while others claim that engagement is preferable. However, it must be noted that the impact of ESG screening on financial markets is an empirical question. Derwall et al. (2011) highlight that green firms are selected by those investors, who are profit-seeking and that believe there is a transitory upward shift in the expected cash flows. Most remarkably, through the screening approach investors can better reach their ESG target, but at a significant cost, namely an under-diversified portfolio.

Pedersen et al. (2021) show that there is weak return predictability of the overall ESG rating, and the evidence is mixed even when focusing on specific ESG dimensions. As a matter of fact, Cheema-Fox et al. (2019) display that high-carbon-emission firms underperform low-emission firms, while Bolton and Kacperczyk (2021) shows opposite findings, stocks with high carbon emissions outperform those that have low emissions. Avramov et al. (2021) find that there is a structural relation between high ESG rated stocks' returns and ESG demand and finally conclude arguing that these mixed evidence in the empirical literature is the result of the pervasive disagreement among ESG data vendors.

Twenty years ago, Heinkel et al. (2001) highlighted that in the sight of a large fraction of socially responsible investors, polluting firms are forced to reform. Indeed, his study showed that socially irresponsible firms, that are excluded by investors from the permissible investment universe, experience a higher cost of capital than that experienced by socially responsible firms. He concluded by claiming that an ESG factor that is long green stocks and short non-green stocks will experience a negative alpha. In a recent study, Pástor et al. (2021) claims that the existence of an ESG premium is contested and shows that this negative alpha is experienced especially when ESG preferences are stable in financial markets. Analogous conclusions were also drawn by Heinkel et al. (2001), Luo and Balvers (2017), and Zerbib (2020).

As aforementioned, Pástor et al. (2021) provide an empirical analysis of financial market equilibrium when investors are green investors. In equilibrium, companies with a high overall ESG rating should have a negative alpha. A two-factor model is used, with the factors being the ESG-specific and market factors. In addition, they also show a procedure to construct the ESG factor, whose portfolio weights are proportional to the ESG rating of the stocks of interest. However, as clearly mentioned in the paper, this procedure for the ESG factor construction deviates from the commonly used Fama and French (1992) methodology which first identifies stocks with high and low exposures to a firm characteristic of interest and then constructs a long-short portfolio. Indeed, deviations from the Fama and French factor model are common; for example, Bolton and Kacperczyk (2021), construct a carbon factor whose portfolio weights are proportional to firms' carbon emissions, instead of building a long-short portfolio of stocks that are sorted according to this characteristic.

Over the years, empirical studies have shown that there are two main procedures to construct an ESG factor: first using ESG ratings as a cardinal variable, and second using ESG ratings as an ordinal variable. Within the ordinal variable approach, ESG ratings are used to identify a cluster of green and non-green stocks. Within each cluster, stock returns are usually value-weighted and then the return spread between the green and non-green portfolios is the return of the ESG factor. This procedure follows the protocol developed by Fama and French (1992) and is extensively used in academic literature to construct equity factors based on specific firm characteristics. On the contrary, when ESG ratings are treated as a cardinal variable, they serve to determine what are the weights of the stock in a portfolio that tries to track the ESG premium. An empirical foundation for this procedure to construct the ESG factor was the one provided by Pástor et al. (2021) and represents a different method to equity factor construction suggested in Fama and French (1992), Fama (1976) and Back et al. (2013). This alternative method is known as the cross-sectional approach and is based on the cross-sectional predictability of ESG ratings on stock returns. To build an ESG cross-sectional factor accounting only for the ESG characteristic, the below cross-sectional regression is considered:

$$R_{i,t} = \lambda_{0,t1} N_{t-1} + \lambda_{1,t1} ESG_{t-1} + \epsilon_{i,t}, \tag{3.2.1}$$

where $R_{i,t}$ is the vector of stocks' excess returns in the cross section at time t=1,... T,i=1,..N is the number of assets, N_{t-1} is a vector of ones, and ESG_{t-1} is a vector of lagged stocks' ESG ratings. Following this procedure, the estimated coefficients in equation 3.2.1 can be interpreted as portfolios' excess returns. The two portfolios associated with the estimated coefficients are defined by the following weights:

$$w_{t-1} = [\frac{1}{\mathbb{N}_{t-1}} 1_{N_{t-1}}; \frac{ESG_{t-1}}{ESG'_{t-1} ESG_{t-1}}],$$

With the ESG portfolio being defined by

$$w_{t-1}^{ESG} = [\frac{ESG_{t-1}}{ESG'_{t-1} ESG_{t-1}}],$$

It is a long-short portfolio that goes long on high ESG rated stocks and short on low rated ones. It follows that $\lambda_{1,t1}$,t is the cross-sectional ESG factor excess return.

For this research both the two methodologies, the one proposed by Fama and French (1992) and the one by Pástor et al. (2021) have been implemented. However, the first methodology, being the most accredited one, dominates, hence the research results are those obtained by implementing the time-series factor construction protocol.

Chapter 4

Empirical Analysis

The purpose of this research is to find out a possible market anomaly in ESG investing. In particular, the objective is to understand if stocks that exhibit a low ESG score could outperform stocks exhibiting a high ESG score. To do so, ESG factors will be constructed using the empirical approach of constructing long-short portfolios. Then an extension of Carhart's model (1997) is employed to understand the exposure of each sector to the different factors developed.

4.1 Methodology

This section explains the methodology employed to answer the research question. It will be divided into three subsections. First, the Refinitiv ESG scoring methodology is presented. Then in the second section, a protocol to build the anti-ESG factors is developed while in the third one a sensitivity analysis of each stock to the different anti-ESG factors will be presented. The analysis has been developed on MATLAB R2020b.

4.1.1 ESG Rating Scoring Methodology

ESG Scoring

Refinitiv defines the overall ESG score as a "measure of a company's ESG performance based on verifiable reported data in a public domain" (Refinitiv 2021). By combining algorithmic and human ability of analysis, the provider computes more than 500 company-level ESG metrics, but only a subset of 186 metrics, the most comparable ones, enters the scoring process. To compute the overall score, these 186 measures are collected into ten different categories, each category having its score. Then the categories scores are grouped again into three pillars scores: environmental, social, and corporate governance. To better understand the process, a visual map is presented below in Figure 4.1.

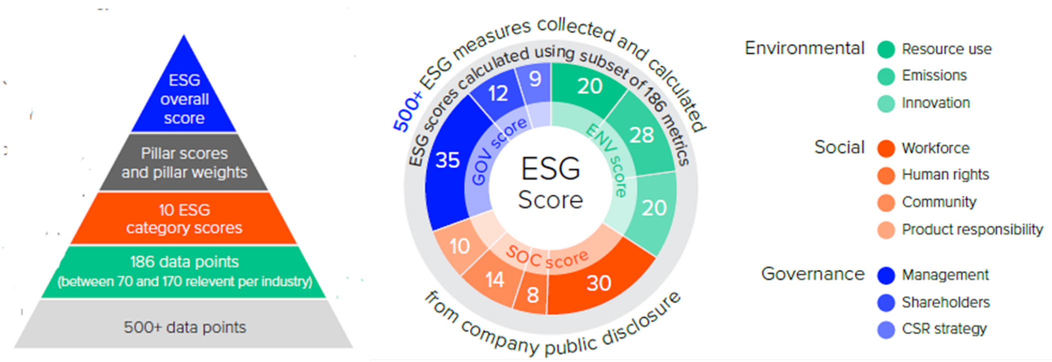

Figure 4.1: ESG Scoring Process- (Left) Pyramid showing the ESG score process starting from the data collection. (Center) Categories breakdown by number of metrics. (Right) Pillar breakdwon by categories. Source Refinitiv 2021

For the sake of clarity: the resource use, emissions, and innovation category metrics make up the environmental pillar; the workforce, human rights, community, and product responsibility measures make up the social pillar; the management, shareholders, and CSR strategy make up the governance pillar. The ESG pillar score is calculated as the relative sum of the category weights. When considering the seven categories making up the Environmental and Social pillar, each of these has a weight that varies depending on the industry. On the contrary, the remaining three categories belonging to the Governance pillar, given that the governance practices are highly influenced by the country of incorporation, have weights that are fixed across all industries. For the same reason, when computing the E and S category scores, the benchmark of reference is the industry group since these two pillars are more relevant to companies that belong to the same industries. At the same time, to compute the Governance pillar, the benchmark of reference is assumed to be the country of incorporation. The category score formula is presented below:

$$CS = \frac{\text{no. of companies with a worse value} + \dfrac{\text{no. of companies with the same value included in the current one}}{2}}{\text{no. of companies with a value}}$$

ESG Combined Score

The second score that Refinitiv offers is the ESG Combined Score (ESGC Score) which provides a broad evaluation of the company's sustainable conduct over time by overlying the ESG Score with the company's ESG Controversies. It is computed based on twenty-three ESG controversy issues. If during the fiscal year a scandal occurs, the company that is involved is penalized and this penalisation is reflected on its ESGC score and grading. Among these twenty-three topics, the analysts include issues such as public health controversies, safety, and privacy controversies, diversity and opportunity controversies, environmental controversies, and so on. Then if the company had no controversy during the fiscal year, it would get a score of 100 otherwise it will get a lower score depending on the number and magnitude of the controversies experienced. The score ranges from 0 to 100 and each controversy is benchmarked on the industry group. However, Refinitiv is aware of the so-called market cap bias from which large capitalisation companies suffer, since they are under a closer scrutiny from the media. To take into account this bias, severity weights are applied as shown in Figure 4.2.

Global benchmark	Cap class	Severity rate*
>=10 billion	Large	0.33
>=2 billion	Mid	0.67
<2 billion	Small	1

*Logic to derive weights: large = 1/3 or 0.33, mid = 0.67, small = 0.33+0.67 = 1.

Figure 4.2: Severity Weights used to account for the market capitalisation bias - Source: Refinitiv 2021

Once computed, the ESG controversies score is averaged with the ESG score to obtain the ESGC score. Indeed, the latter is calculated as the average of the two previously mentioned scores. When the controversies score is greater than the ESG score, then the ESG score is equal to the ESGC score. Even if the ESGC score seems to be more comprehensive, Refinitiv is the only provider offering this type of score, thus leading it to be very specific and not easy to retrieve when using other providers. For these reasons and given the fact that this thesis aims to construct a pure anti-ESG factor, using the overall ESG score seems to be more appropriate.

4.1.2 Anti-ESG Factor Construction

The anti-ESG factor is built as a long-short portfolio. By definition a long-short portfolio is a type of portfolio where the investor takes two opposite directions in the market, a long (buy) position in stocks with a certain characteristic (here the ESG score) and a short (sell) position in stocks with the same characteristic. In this thesis, the long/short portfolio constructed has the following composition: the long leg gathers stocks with low ESG scores, while the short leg gathers stocks with high ESG scores.

For this purpose, the stocks belonging to the investment universe of interest are, depending on their ESG score, sorted into quantiles. The stocks entering the top 10% quantile will constitute the investment universe of the short portfolio, while the stocks entering the bottom 10% quantile will constitute the long portfolio's investment universe. The choice of using the 10% quantile is arbitrary and has been taken according to what is the commonly accepted asset pricing practice (Fama and French 1993). Moreover, this allows for further screening, since it leads to short portfolios that are tilted towards the top performing green stocks (i.e. those with the highest ESG score) and long portfolios that are tilted towards the bottom performing brown stocks (i.e. those with the lowest ESG score). Indeed, for the purpose of this research, there are some stocks within both the green and brown stock universe that need to be excluded. Among the high-rated stock universe these are those that are still traded at a discounted price since they have scores that can still be improved. At the same time within the low-rated stock universe those that need to be avoided are the ones with higher-than-average score and that have already seen an increase in price.

The weight assigned to each stock in the portfolio is the one resulting from an equally weighted portfolio procedure, i.e.:

$$w = \frac{1}{\text{no. of stocks}},$$

then, the allocation to the long-short portfolio will be a dollar-neutral allocation, hence a portfolio that invests an equal dollar amount in short and long positions. By definition, the long-short portfolio constructed according to the aforementioned hedge ratio are exposed to the market. Indeed, using a hedge ratio of this type implies that the long side and the short side of the portfolio will completely offset each other, but only in dollar notional terms. Finally, the anti-ESG factor is constructed as follows:

$$aESG_t = w_{l,t}Rl_t - w_{s,t}Rs_t, \tag{4.1.1}$$

where $aESG_t$ stands for the factor return, Rl_t and Rs_t are respectively the return on the long and short portfolios, and $w_{l,t}$ and $w_{s,t}$ are their respective weights.

4.1.3 Model

Following Markowitz (1952) formulation of portfolio theory, Sharpe and Linter (1956) added two key assumptions to Markovitz's model, one of these being that all the investors can borrow and lend money at a risk-free rate. This new assumption led to the new formulation of the CAPM equation that is indicated below:

$$E[r_{i,t}] - r_{f,t} = \alpha + \beta_{mkt}E[r_{mkt,t} - r_{f,t}] + \epsilon_{i,t}. \tag{4.1.2}$$

In equation 4.1.2, $E[r_{i,t}] - r_{f,t}$ is the expected return of asset i in excess of the expected return on the risk-free asset; β_{mkt} is the market beta of the *i-th* asset and it is a measure of how a variation in the expected return of the market would affect the expected return on asset i. At the same time, it is well known that $r_{f,t}$ is not only the intercept of the regression but also the return on an asset that has e $\beta = 0$, i.e an asset whose return is uncorrelated with the market. In economic terms, the regression defined in the equation 4.1.2 suggests that the expected return on the *i-th* asset can be defined as the risk-free rate plus a risk premium, that is the market beta times the market risk premium.

Years later, Jensen (1968) questioned Sharpe and Lintner model, highlighting that the intercept term in the time series regression was not zero for each asset. On the contrary, research showed that the alpha of time-series regression of excess asset returns on the market risk premium was positive for assets whose beta was low and negative for those assets was beta was high. This finding led to the realisation that differences in excess asset returns were not entirely explained by their different market betas and that additional independent variables could add a further explanation for the differences across excess asset returns.

On top of that, Fama and French (1993) argued that many of the CAPM average return anomalies could be captured by a three factors model. The model explains that the excess return of a portfolio $E[r_{i,t}] - r_{f,t}$ is explained by its return's sensitivity to the three following factors: (i) the excess return on a market portfolio, the so-called MKT factor ; (ii) the return on a portfolio that takes a long position in small-cap stocks and a short position in large-cap stocks, the so-called SMB (small minus big) factor; (iii) the return on a portfolio that takes a long position in high book to market stocks and a short position in low book to market stocks, the so-called HML (high minus low) factor Fama and French (1992).

Four years later, Carhart (1997) added an extra factor to the above-mentioned three factors model: the momentum factor (UMD). This factor finds its roots in the momentum strategy; it is based on the idea that very recent winning stock will continue to gain value in the near future, while very recent losing stocks will continue to have a bad performance in the recent past (Carhart 1997). The two models are an extension of the CAPM model. These multifactor models use a time-series multivariate regression to quantify an asset's tendency to move with multiple risk factors.

This research will employ a multifactor model since the main aim of this paper is to capture a market anomaly that helps us to explain the stock's source of alpha. The model employed is a multivariate linear model estimated via Ordinary least squares and as such, it comprehends a dependent variable and several independent variables, depending on the study of interest. Eleven regressions are performed. For each of them, the independent variable is the excess return of each one of the eleven STOXX 600 sub-indices, while the dependents variables are sixteen identified factors, with the first being a vector of ones, representing the intercept. Introducing a constant of this type is a common practice in econometrics, especially when dealing with multiple regression models; the reason behind this is that by introducing an intercept the researcher ensures that the model will be unbiased, i.e., that the mean of the residuals is exactly zero. The other 4 factors used are the ones previously mentioned, namely Market, SMB, HML, and Momentum, while the remaining 11 factors are those constructed following the aforementioned methodology. They are m factors and each of them refers to a particular sector analyzed. The model is presented below:

$$R_{i,t} = \alpha_0 + \beta_{mkt} MKT_t + \beta_{SMB} SMB_t + \beta_{HML} HML_t + \beta_{UMD} UMD_t + \sum_{j=1}^{m} \beta_{ij,aESG} aESG_{j,t} + \epsilon_{i,t}, \tag{4.1.3}$$

where, i=1,..N is the number of assets, t=1,... T refers to the number of observations and $R_{i,t}$ is the stock excess returns.

4.2 Data

All the data used in this model are retrieved from Refinitiv's Datastream service, apart from the four equity factors that are retrieved from the AQR's data library which already provides the four factors, namely Market (MKT), Small minus Big (SMB), High minus Low (HML) and Momentum (UMD) for the European Equities. Indeed, the analysis of this paper will focus on the European Equity market, since, as shown in the Morgan Stanley Research, the ESG phenomenon is more accentuated in Europe rather than in the US. To include in the research only European equities, all the STOXX EUROPE 600 index's components are considered as the investible universe. This European index is a value-weighted index designed by STOXX Ltd. It is made of 600 components and represents large, mid, and small-cap companies of 17 European countries[1].

Once gathered, all the stocks belonging to the index as of January 2022 are screened. Only those for which there is available data are included in the investment universe, thus leading to a sample containing 303 components. Choosing a sample of this type introduces the so-called phenomenon of survivorship-bias, i.e. the tendency to consider market indexes as a representative comprehensive stock sample, without considering those stocks that have gone bust. The stock prices are those registered at the end of each month, and they cover a period that goes from 31/01/2007 to 31/12/2021 (fifteen years, 180 observations). This period and the frequency of the data have been chosen to have a time horizon as long as possible to guarantee the reliability and accuracy of the estimated values.

It is noted that the purpose of this study is to construct sectorial ESG factors. Based on this purpose, once gathered the 303 components another screening is carried out. The stocks are indeed grouped to the Global Industry Classification Standards (GICS), an industry taxonomy developed by S&P and MSCI. The GICS structure comprehends eleven sectors, and it is the most widely used sector classification in the financial industries[2]. Then, to analyse the sensitivity of each sector to the eleven different ESG factors fifteen sub-indices of the STOXX EUROPE 600 have been retrieved from Reuters [3]. However, with regards to the Consumer Staples and Consumer Discretionary sectors, there is no respective available sub-index that dates back to 2007. These two must be constructed by using the category that makes up each sector. For this reason, the Consumer Staples sub-index is constructed as an equally weighted portfolio investing in the STOXX EUROPE 600 Personal Households Goods and the STOXX EUROPE 600 Food Beverage. At the same time, the Consumer Discretionary sub-index is constructed as an equally weighted portfolio investing in STOXX EUROPE 600 Travel Leisure, STOXX EUROPE 600 Automobiles Parts and STOXX EUROPE 600 Retail.

As mentioned before, the four factors are retrieved from AQR's data library, and also in this case the data are monthly and cover the same time horizon. The ESG scores are those provided by Refinitiv Datastream (Asset4).

[1] Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Norway, Netherlands, Poland, Portugal, United Kingdom, Spain, Sweden, and Switzerland.

[2] Real Estate, Energy, Financials, Consumer Staples, Consumer Discretionary, Communication Services, Information Technology, Utilities, Industrials, Materials, Health Care.

[3] STOXX EUROPE 600 Real Estate, STOXX EUROPE 600 Utilities, STOXX EUROPE 600 Telecommunications, STOXX EUROPE 600 Financials, STOXX EUROPE 600 Industrials, STOXX EUROPE 600 Oil Gas, STOXX EUROPE 600 Basic Materials, STOXX EUROPE 600 Health Care, STOXX EUROPE 600 Technology, STOXX EUROPE 600 Travel Leisure, STOXX EUROPE 600 Automobiles Parts, STOXX EUROPE 600 Retail, STOXX EUROPE 600 Personal Households Goods, STOXX EUROPE 600 Food Beverage

Chapter 5

Empirical Results

5.1 ESG score Characteristics

Figure 5.1 highlights that the sample's ESG overall average ratings, in the period of interest, has been increasing, following a linear trend. It can be indeed noticed that from 2007 to 2021 the ESG score went from 51 to 74. Analysts claim that this linear growth is expected to increase in the coming years. This expected growth corroborates the assumptions that companies' ESG ratings are all converging to high values.

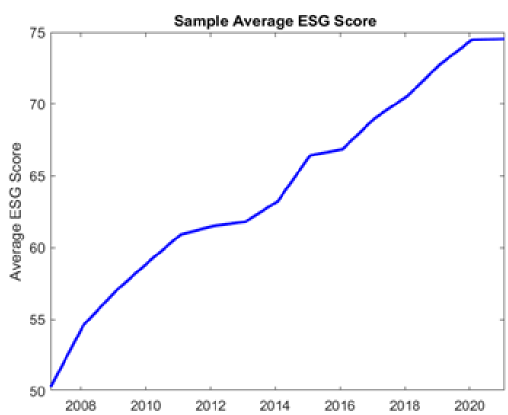

Figure 5.1: Sample Average ESG Score 2008-2021

Figure 5.2 displays the distribution of the sample overall average ESG score during four different points in time. The top left figure depicts the distribution of the sample average ESG score from 2007 to 2021. It is skewed to the right, meaning that fewer companies display lower scores, and more and more scores are concentrated around higher values. The remaining three plots confirm the above claim that ESG scores have been following a growing trend. Indeed, the ESG score distributions highlight the fact that there was a higher concentration of low scores in 2010 than in 2021.

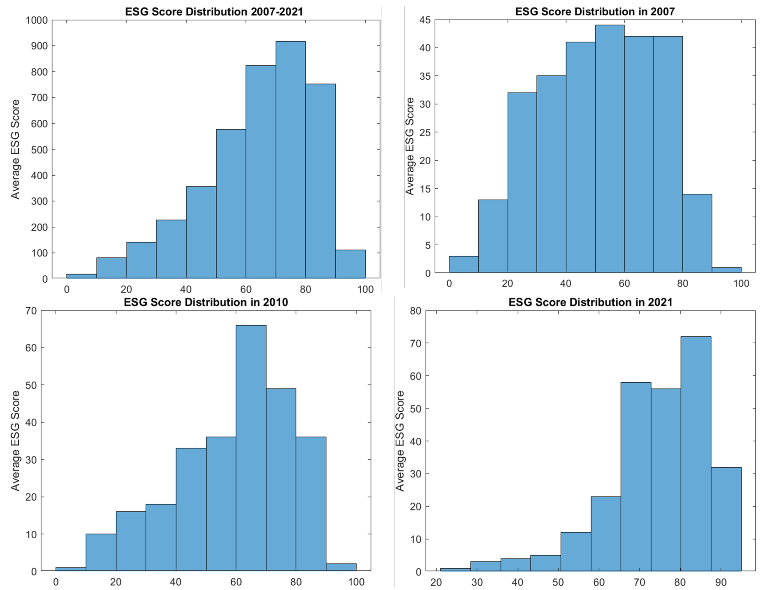

Figure 5.2: ESG Score Distribution- y-axis values show the number of data being binned that each bin comprehends, while the x-axis value represent the ESG score.(Top Left) ESG score distribution from 2007 to 2021. (Top Right) ESG Score distribution in 2007. (Bottom Left) ESG Score distribution in 2010. (Bottom Right) ESG Score distribution in 2021.

5.2 Anti-ESG Portfolio

After constructing the eleven anti-ESG factors, some statistical checks were performed, in order to assess the validity of the data.

First, an Augmented Dickey Fuller (ADF) test has been performed for all eleven anti-ESG time series. ADF tests the null hypothesis that there is a unit root in the observed time series samples under the alternative of weak stationarity. The intuition behind this is that if a time series is characterized by a unit root, then the time series is not stationary. For all the eleven-time series the null hypothesis has been rejected meaning that the samples are stationary. It follows that the statistical properties of the process generating the time series of interest do not change over time. Table 5.1 displays the results obtained when running the ADF test in MATLAB.

Table 5.1: *ADF Test and p-value- The MATLAB function for the ADF test returns 1 when the test rejects the null hypothesis of a unit root against the autoregressive alternative. Stationarity results are unanimous across the eleven anti-ESG portfolios.*

ADF Test											
	aESG RE	aESG U	aESG Com. Services	aESG F	aESG I	aESG M	aESG E	aESG HC	aESG IT	aESG CS	aESG CD
ADF Test	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
p-value	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Then, the normality assumption has been verified. In order to verify whether the eleven distributions of returns were normally distributed or not, a Jarque-Berra test has been performed. The results were not unanimous, yielding six out of eleven distributions being non-normally distributed due to positive skewness. It follows that fund managers investing in this strategy may expect more frequently small negative losses rather than frequent large gains. Table 5.2 displays the summary statistics of each of the eleven anti-ESG portfolios. A Jarque Berra test value equal to one indicates that the test rejects the null hypothesis of normality at 5% significance level. The standard deviations computed for each factor portfolio range between 2% and 4% showing that the volatility is pretty low if compared to those of the STOXX 600 indices that range between 4% and 8%.

Table 5.2: *Summary statistics- Mean, Median, Stndard Deviation, Excess Kurtosis,Skewness and Jarque-Berra test results for each anti-ESG Portfolio. (1) A JB test value equal to 1 indicates that jbtest rejects the null hypothesis of normality at the default 5% significance level.*

Summary Statistics											
	aESG RE	aESG U	aESG Com. Services	aESG F	aESG I	aESG M	aESG E	aESG HC	aESG IT	aESG CS	aESG CD
Mean	0,16%	-0,50%	0,45%	0,50%	0,26%	0,49%	0,48%	0,35%	0,07%	-0,07%	-0,04%
Median	0,32%	-0,40%	0,59%	0,39%	0,16%	0,51%	0,55%	0,55%	-0,27%	-0,03%	0,03%
Std.Dev.	3,69%	3,21%	3,81%	2,56%	1,98%	2,98%	3,68%	3,46%	4,17%	2,17%	3,51%
Ex.Kurtosis	14,68	1,41	1,23	1,19	1,79	0,75	6,73	1,05	0,98	2,43	1,17
Skewness	1,97	0,51	0,10	-0,03	0,70	-0,06	0,65	-0,31	0,52	0,91	0,08
JBtest[1]	1,00	1,00	0,00	0,00	1,00	0,00	1,00	0,00	1,00	1,00	0,00

However, to better understand whether these factor portfolios provide greater performance than their sub-indices of reference, the Sharpe Ratio has been used. It indeed provides information about a portfolio's risk-adjusted performance and is computed as follows:

$$SR_p = \frac{E(r_p) - r_f}{\sigma(r_p)},$$

where:

- r_f is the mean risk-free rate

- r_p is the historical average return for the *i-th* portfolio

-$\sigma(r_p)$ is the standard deviation for the *i-th* portfolio

It follows that the Sharpe Ratio, by comparing the portfolio's average excess return with its standard deviation, evaluates the risk premium that an investor earns for every additional unit of risk, aside from the risk being systematic or idiosyncratic. The results are presented in Table 5.3.

Table 5.3: *Sharpe Ratios of STOXX600 Sub-indices compared to those of the respective anti-ESG portfolios. The delta is the difference between the two.*

	Sharpe Ratios		
	SR STOXX600 sub-indices	SR anti-ESG Portfolios	Delta
Real Estate	-17,79%	-11,48%	6,31%
Utilities	-21%	-33,78%	-12,78%
Communication Services	-23,97%	-3,65%	20,32%
Financials	-15,62%	-3,49%	12,13%
Industrials	-7,42%	-16,67%	-9,25%
Materials	-6,76%	-3,45%	3,31%
Energy	-15,61%	-2,97%	12,64%
Health Care	-12,31%	-7,02%	5,29%
Infromation Technology	-6%	-12,30%	-6,20%
Consumer Staples	-6,55%	-30,26%	-23,71%
Consumer Discretionary	-10,53%	-17,90%	-7,37%

The Sharpe Ratios of all categories are negative and, when negative, the Sharpe Ratio is not truly indicative of portfolio performance. Indeed, it could be the case that either interest rates are too high or that the portfolio performance is negative. However, McLEOD and van Vuuren (2004) claim that Sharpe Ratios, especially when negative, "should be interpreted probabilistically and in that setting an investor should choose the fund with highest Sharpe Ratio because such fund has the highest probability of beating the risk-free rate". This leaves room for some comparisons. As can be noticed, the results are not unanimous, and clearly, not all the anti-ESG portfolios experience a greater performance than their sub-indices of reference. However, the anti-ESG portfolio for the Real Estate, Communication Services, Financials, Materials, Energy, and Health Care, appear to have a higher risk-adjusted return even if negative. However, when dealing with portfolios containing derivatives, as is the case of synthetic equity sub-indices, the Sharpe Ratio is not a reliable measure, and the use of the Sortino Ratio would be preferable. Indeed, the Sortino Ratio is widely used to measure the risk-adjusted performance of hedge funds, especially of those employing long-short strategies. It is based on the assumption that the returns' positive volatility is a benefit, hence investors should only be concerned about negative volatility. It follows that the Sortino Ratio considers only the negative deviation of a portfolio's returns from the mean and is computed as follows:

$$Sortino \quad Ratio_p = \frac{E(r_p) - r_f}{\sigma(r_{dp})},$$

where:

- r_f is the mean risk-free rate

- r_p is the historical average return for the *i-th* portfolio

-$\sigma(r_{dp})$ is the negative standard deviation for the *i-th* portfolio

The results presented in table 5.4 confirm what has been concluded above, i.e the Real Estate, Communication Services, Financials, Materials, Energy, and Health Care anti-ESG portfolio have a better risk-adjusted performance.

Table 5.4: *Sortino Ratios of STOXX600 Sub-indices compared to those of the respective anti-ESG portfolios.*

Sortino Ratios		
	SR STOXX600 sub-indices	SR anti-ESG Portfolios
Real Estate	2.56%	3.42%
Utilities	1.48%	4.56%
Communication Services	2.98%	3.67%
Financials	1.24%	2.49%
Industrials	3.37%	1.78%
Materials	1.56%	2.26%
Energy	1.03%	3.12%
Health Care	2,01%	5.04%
Infromation Technology	6,76%	3,45%
Consumer Staples	5.34%	1.59%
Consumer Discretionary	4.67%	3.27%

Then, to understand the behavior of each portfolio analysis of the anatomy of the portfolios' cumulative performance has been performed. This type of analysis was performed to assess whether the nature of each portfolio was defensive or aggressive. Fund Managers claim that a portfolio has a defensive behavior if during market downturns it tends to decrease less than its peers and if during market upturns it tends to increase more than its peers. At the same time, a portfolio is claimed to have aggressive behavior if the contrary is true, meaning that during market downturns it tends to collapse more than its peers and during market upturns, it tends to increase less than its peers.

In this research, the analysis has been performed by comparing the portfolios' cumulative performance to that of their sub-index of reference. For each portfolio, the analysis has been done by focusing on specific time periods, mainly the Great Financial Crisis and its subsequent rebound and the 2020 market crash and its subsequent recovery. The focus is indeed on shorter periods in order to see what truly happened in particular time frames. Indeed, when looking at the cumulative performance for longer periods, the researcher could miss some little crashes and rebounds that could be indicative of the nature of the portfolios of interest. Figure 5.3 shows the eleven anti-ESG portfolios' cumulative performance relative to that of their sub-index of reference. It is the evolution of 100 euro invested in both the anti-ESG portfolio and its respective sub-index. The grey shaded area highlights the recession period of 2008-2009 that followed the Great Financial Crisis. Even though, as mentioned before, the analysis was performed by analysing shorter time frames, in the graphs covering the full period cumulative performances, it appears evident that, during the markets downturn, the portfolio's performances have not been impacted at all, while the major STOXX 600 sub-indices experienced huge losses. Indeed, during the Great Financial crisis, all the STOXX 600 sub-indices dropped, while the eleven anti-ESG factors remained stable over that recession period.

The behavior of three anti-ESG Portfolios, namely, Financials, Real Estate, and Consumer Discretionary is remarkable; their return, during the Recession period, increased rather than decreasing. These three were among the three most impacted sectors during that period. Moreover, in March 2020, equity markets experienced another huge drop due to the spread of the Covid-19 pandemic. Again, some of the anti-ESG portfolios dropped less than and rebounded more than their respective sub-indices, hence confirming their defensive nature. However, in some cases, namely Consumer Staples, Consumer Discretionary, Industrials, Utilities, Health Care, and Information Technology, the defensive structure was not enough to outperform the sub-indices counterparts.

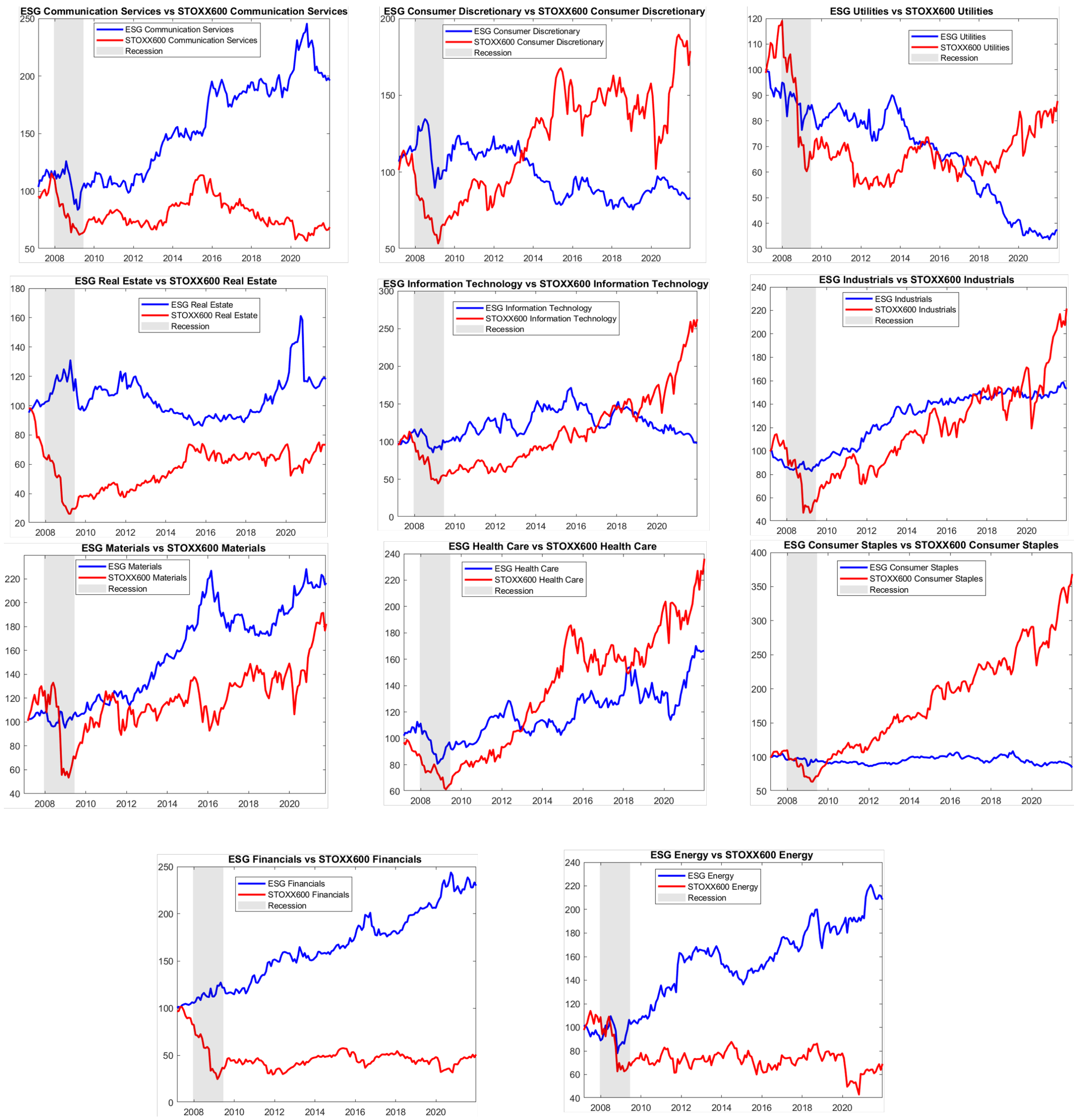

Figure 5.3: Anti-ESG Portfolio's Performance- For each sector two cumulative performances are shown. In red the cumulative performance of $100 invested in the EURO STOXX 600 sub-index, in blue the cumulative performance of $100 invested in the anti-ESG portfolio.

5.3 Regression Results

Table 5.6 displays the results of the Regression Model presented in equation 4.2.3. It shows the estimated values of the regression coefficients, along with their p-values. The p-values highlighted in the table are those that arise from a t-test run for all the regressions' coefficients. The aim is to verify whether the coefficients are significantly different from zero.

Table 5.5 shows the regressions' adjusted R^2 ($\bar{R}^2$) for two different cases: (i) a regression that only considers the four FF-factors and the constant, and (ii) a regression that considers all the fifteen regressors and the constant. The difference in the $\bar{R}^2$ value between the two cases ranges between 18% and 50%. Indeed, when considering all the fifteen factors, the eleven regressions' $\bar{R}^2$ are sufficiently high, ranging between 30% and 78%, with the majority of them concentrating on the upper end of the interval. This means that the model using 16 regressors well explains the return generating process of the indices analysed and that the elevated number of regressors does not negatively influence the goodness of the fit. It follows that using this model to exploit whether a market anomaly linked to ESG ratings exists, is a good choice.

Table 5.5: *Regressions' adjusted R^2 for two different cases: (i) a regression that only considers the four FF-factors and the constant, and (ii) a regression that considers all the fifteen regressors and the constant.*

	adjusted R^2										
	RE	U	C.Services	F	I	M	E	HC	IT	CS	CD
5 Regressors	45%	42%	29%	61%	58%	55%	46%	21%	50%	44%	46%
16 Regressors	53%	49%	44%	78%	66%	66%	61%	30%	62%	51%	60%

Table 5.6 shows that three of the four factors developed by Carhart (1997) have, in most cases, a statistically significant (i.e., p-value less than 10%) impact on the returns of the assets analysed. However, in all the eleven cases, the momentum factor appears to have no impact on the sub-indices returns.

Since this research focuses on finding a market anomaly linked to green investing, we will now focus on the level of significance of the eleven regressions' alphas. Table 5.6 presents the estimated values for the intercept term in the linear model presented in the equation 4.2.3. As we can see, besides the Real Estate and Utilities sub-indices, when controlling for all the fifteen factors, the alphas of the sector regressions become not statistically significant. At the same time, the estimated values for the aforementioned alpha are extremely close to zero. It is important to remark that when dealing with factor models, alphas are defined as unexplainable excess returns and interpreted as evidence of some kind of additional risk that is not captured by the model. Having an alpha of zero, or close to zero, means having a model that is able to totally explain the return generating process.

Table 5.7 shows the results obtained when performing an F-test for each of the eleven regressions. The aim is to test under the null hypothesis that all the coefficients are jointly equal to zero, in order to assess whether the model is significant or not. Findings show that the null hypothesis is rejected for each of the eleven regressions. Indeed, the p-value of this test is below the specified significance level set a 1% in all the eleven cases.

	Regressions															
	α	SMB	HML	UMD	MKT	aESG RE	aESG U	aESG Com. Services	aESG F	aESG I	aESG M	aESG E	aESG HC	aESG IT	aESG CS	aESG CD
RE	-0,01	0,30	-0,43	0,11	0,66	-0,43	0,11	-0,01	0,06	0,35	0,01	0,01	0,04	-0,18	-0,06	-0,06
p-value	-0,01	-0,14	-0,10	-0,45	-0,00	-0,00	-0,37	-0,94	-0,71	-0,08	-0,94	-0,95	-0,65	-0,06	-0,77	-0,69
U	-0,01	0,00	-0,29	0,15	0,55	-0,15	0,09	-0,07	-0,24	0,13	-0,09	-0,18	0,10	-0,12	-0,17	0,08
p-value	-0,08	-0,99	-0,15	-0,21	-0,00	-0,14	-0,39	-0,52	-0,13	-0,51	-0,39	-0,06	-0,26	-0,10	-0,36	-0,40
CServices	0,00	-0,07	-0,47	0,09	0,51	-0,15	0,21	-0,32	-0,37	0,06	-0,04	-0,17	0,05	-0,01	0,13	0,00
p-value	-0,20	-0,66	-0,03	-0,41	-0,00	-0,13	-0,07	-0,00	-0,02	-0,70	-0,75	-0,11	-0,63	-0,90	-0,54	-0,98
F	0,00	0,55	-0,24	0,09	0,77	-0,27	0,16	0,02	-1,15	0,37	0,00	0,11	0,01	-0,21	0,06	-0,07
p-value	-0,13	-0,00	-0,23	-0,43	-0,00	-0,01	-0,13	-0,86	-0,00	-0,03	-0,99	-0,32	-0,94	-0,01	-0,76	-0,57
I	0,00	0,52	-0,51	0,09	0,74	-0,21	0,24	-0,04	-0,27	0,12	-0,21	0,14	0,07	-0,21	-0,14	-0,01
p-value	-0,98	-0,00	-0,02	-0,50	-0,02	-0,05	-0,02	-0,70	-0,15	-0,54	-0,07	-0,20	-0,49	-0,01	-0,43	-0,91
M	0,00	,27	-0,28	0,16	0,79	-0,05	0,26	0,02	-0,20	0,00	-0,55	0,26	-0,01	-0,12	0,03	0,16
pvalue	-0,99	-0,16	-0,20	-0,18	-0,00	-0,65	-0,02	-0,88	-0,32	-1,00	-0,00	-0,02	-0,94	-0,19	-0,89	-0,20
E	0,00	-0,09	0,13	0,05	0,55	-0,30	0,27	-0,14	-0,58	0,08	-0,39	0,19	0,06	-0,17	0,12	0,04
p-value	-0,63	-0,66	-0,56	-0,65	-0,00	-0,14	-0,02	-0,30	-0,00	-0,69	-0,00	-0,06	-0,56	-0,06	-0,57	-0,71
HC	0,00	0,17	-0,57	0,09	0,43	-0,17	0,11	-0,07	0,18	0,29	0,06	-0,06	-0,22	-0,14	-0,21	-0,06
p-value	-0,42	-0,38	-0,00	-0,30	-0,00	-0,08	-0,31	-0,47	-0,23	-0,09	-0,58	-0,50	-0,03	-0,09	-0,26	-0,57
IT	0,00	0,45	-0,85	0,05	0,83	-0,14	0,25	0,08	-0,19	0,38	-0,12	-0,03	-0,13	-0,41	-0,08	0,04
p-value	-0,93	-0,01	-0,00	-0,63	-0,00	-0,21	-0,03	-0,40	-0,21	-0,07	-0,36	-0,77	-0,17	-0,00	-0,62	-0,71
CS	0,00	-0,04	-0,65	0,11	0,54	-0,27	0,13	-0,05	0,06	0,17	0,03	0,02	-0,03	-0,15	-0,24	-0,02
p-value	-0,87	-0,82	-0,00	-0,26	-0,00	-0,00	-0,17	-0,61	-0,61	-0,24	-0,74	-0,86	-0,73	-0,03	-0,15	-0,85
CD	0,00	0,28	-0,21	-0,10	0,68	-0,36	0,18	0,05	0,07	0,46	0,03	-0,01	-0,10	-0,21	-0,18	-0,41
p-value	-0,47	-0,11	-0,32	-0,28	-0,00	-0,00	-0,06	-0,62	-0,72	-0,01	-0,80	-0,92	-0,28	-0,01	-0,32	-0,00

Table 5.6: *Regressions' results- The displays the results of the Regression Model presented in equation 4.2.3. It shows the alphas and the beta coefficients of the fifteen factors, along with their p-values. The p-values are those that arise from a T-test run for all the regressions' coefficients.*

Table 5.7: *Regressions'F statistic to test under the null hypothesis that all the coefficients are jointly equal to zero, in order to assess whether the model is significant or not.*

	F-statistic										
	aESG RE	aESG U	aESG Com. Services	aESG F	aESG I	aESG M	aESG E	aESG HC	aESG IT	aESG CS	aESG CD
Fstat	12,92	10,9	8,79	39,61	21,49	20,66	17,22	4,63	18,04	11,33	16,61
p-value	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Table 5.6 also presents the level of significance and the sign of each beta related to the anti-ESG factors. Seven out of eleven regressions confirm the following hypothesis: If we use as a dependent variable the sub-index excess return of sector m, then the beta of the anti-ESG factor related to m will be negative and significant (at least at 10% confidence level). The reason behind being that the anti-ESG factor goes in the opposite direction of the index. It goes short on high-rated stocks, which are among those stocks that drive up the performance of the index during market stability.

The four cases in which this hypothesis has been rejected regard the following STOXX 600 indices: Energy, Utilities, Consumer Staples, and Industrials. However, it is true that the beta coefficients related to the anti-ESG Industrial, Utilities, and Consumer Staples factors are not statistically significant, hence no clear conclusion can be drawn. Regarding the Energy Sector, the beta related to the anti-ESG Energy factor is statistically significant at 10% level (p-value being 0.06) and has a positive beta at 0,19. Nevertheless, the reason behind this is that when it comes to Energy, the ESG issue remains a hot topic. Indeed, even if having high ESG scores, energy companies are, the majority of the time, excluded from the investible universe of those responsible investors. The problem is that, even though energy companies try to have a lower impact on the environment, their impact will always be higher than that of those companies belonging to another sector. For the reasons listed above, I believe that any results got regarding the energy sector should be analyzed in the microsphere of behavioral finance.

Chapter 6

Robustness

A robustness check is then performed to generalize and verify the reliability of the conclusions above. The next section check whether the results are biased by the time periods.

6.1 Time-period Bias

As far as time-series data are concerned, one must consider the possibility of time period bias, which is caused by selecting only a certain time period that is characterised by factors, circumstances, or particular events. Time period bias is then a sampling error that may lead to inaccurate results, since the results obtained by using a sample that produces this bias may be highly specific to the observations of the sample and thus may not be representative of the whole population.

The sample used in this study covers a time period that goes from the first months of 2007 to the last months of 2021. This time period covers two of the most important shocks that affected the equity market: the Great Financial Crisis in 2008 and the Covid-19 Pandemic. The first led to one of the greatest recessions that the world had ever experienced lasted from 2008 to 2010 and was characterized by highly negative returns of all asset classes and sectors. The second has led to a two-month recession of completely different anatomy (Cardani et al. 2021). In March 2020 markets crashed due to the spread of the new virus, while in 2021 the markets registered abnormal returns, recovering in full from the previous crash and registering also an all-time high.

In order to check whether the conclusions drawn before are affected by time period biases, the study has been performed again for other three different time spans. These are: (i) 2010-2019, a time period that excludes both the Great Financial Crisis and the Covid-19 markets shock, (ii)2010-2021, a time period that excludes the Great Financial Crisis but accounts for the Covid-19 market's shock, (iii) 2007-2019, a time period that includes the Great Financial Crisis but does not account for the market shock and rebound of 2020 and 2021. When analyzing the time period that goes from 2010 to 2019, however, a small divergence from the conclusion drawn before arises, thus leaving room for further future investigations. Indeed, when analysing this sample, it emerges that the alpha of the Financials, Industrials, Information Technology, and Consumer Staples regressions are significantly different from zero. This suggests that for these four sectors, the two crises and especially the great financial crisis could have played a crucial role, thus further research would be needed.

Chapter 7

Conclusions

This research, after giving an overview of the main ESG Universe's components, i.e., ESG Ratings, ESG investing Practices, and Regulation, shows that having invested 100 EUR in some of the developed anti-ESG factors would have generated superior returns if compared to the respective sector sub-indices. Moreover, the developed anti-ESG factor holds some explanatory power on the one-quarter-ahead returns.

The empirical analysis wanted to investigate whether there could be a market anomaly related to ESG investing. In particular, the aim of the research was to supply an answer to the following questions: is it true that in the long run, low ESG-rated stocks tend to outperform high-rated ones? If yes, is it possible to construct an anti-ESG factor that explains stocks' returns? Moreover is it possible to obtain superior returns through the implementation of this new contrarian ESG strategy?

Findings are mixed across industries. They show that, when compared to their sector index counterpart, some of the anti-ESG factor portfolios tend to have a higher Sharpe Ratio, hence a higher risk-adjusted performance, with the exceptions being Utilities, Industrials, Information Technology, Consumer Staples, and Consumer Discretionary.

However, when performing an analysis of the anatomy of the portfolio's cumulative performances, findings revealed that the strategy implemented tends to be more defensive than a long-only strategy (i.e., the strategy of the sector sub-indices). As a matter of fact, the graphs highlight how during a market downturn the eleven anti-ESG portfolios tend to be less severely impacted by negative returns, with some of them experiencing abnormal returns (Financials and Real Estate). After analysing the behaviour of the factors, the subindices sector returns are regressed against fifteen factors, four being the factors usually used in the Carhart model and eleven being the anti-ESG factors previously constructed. Evidence shows that the alpha of nine of the eleven regressions is equal to zero and statistically insignificant. The only two exceptions are the two regressions concerning the Real Estate and Utilities sectors. However, when accounting for time period bias, it has emerged that the two recent stock market crises, namely the Great Financial Crisis and the Covid—19 pandemic could have played a crucial role in this research. It follows that further studies could try to assess what could have been the impact of these two shocks on the performances of the anti-ESG factor portfolios. Indeed, the study suffers some limitations that could be further addressed. First, the factor construction is based on only one ESG rating provider. It follows that, since two providers could issue two different ratings for the same company, the study should be performed at least one more time using all the six different ESG rating providers to be certain that these results can be generalized and that completely represents what happens in financial markets. Lastly, since the sample considers only European stocks, it could be interesting to analyze whether this market inefficiency also affects the American Stock Market, or it is just the direct consequence of a more advanced European Regulation about Sustainable Responsible Investing.

Moreover, further research could address what is the role that the Russia-Ukraine War is playing concerning ESG principles and Regulations. Indeed, the current geopolitical crisis has posed one of the biggest dilemmas for ESG investors. Robert Stallard, a Vertical Research Partners' analyst, claimed that one of the results of the Russian invasion could be the reversal of the well-established ESG view that the defence and weapons sectors are sin sectors. According to the ESG view, sustainable funds would have excluded investments in the defence sector, which has been the best performing sector in the first quarter of 2022. Indeed, when all indexes were down more than 10%, the MSCI Aerospace and Defence Index and all the energy sector-related indexes were outperforming the world equities. ESG investors now will have to answer the following question: "How do you treat protecting a country from a foreign invader? Is it right that you don't actually support countries spending on defending themselves?". The answer will of course create a shift in ESG sentiment, thus revolutionizing the sustainable investment universe.

Chapter 8

Appendix

8.1 Time-period Bias

The following tables present the regression's results obtained for each time period of interest, namely (i) 2010-2019 (ii) 2010-2021 (iii) 2007-2019.

2010-2019																
	α	SMB	HML	UMD	MKT	aESG RE	aESG U	aESG Com. Services	aESG F	aESG I	aESG M	aESG E	aESG HC	aESG IT	aESG CS	aESG CD
RE	0,00	-0,19	-0,46	-0,07	0,55	-0,46	0,05	-0,02	0,29	0,02	-0,09	-0,06	0,06	-0,10	0,02	-0,34
p-value	0,42	0,31	0,05	0,41	0,00	0,00	0,63	0,88	0,08	0,90	0,37	0,52	0,51	0,10	0,89	0,00
U	0,00	-0,25	-0,24	0,03	0,50	-0,16	0,01	-0,16	0,08	0,05	-0,15	-0,31	0,05	-0,15	-0,23	-0,19
p-value	0,71	0,11	0,24	0,80	0,00	0,11	0,95	0,16	0,61	0,79	0,13	0,00	0,58	0,03	0,21	0,03
C.Services	0,00	-0,39	-0,48	0,08	0,45	-0,21	0,11	-0,41	-0,22	0,02	-0,13	0,16	-0,02	0,10	0,11	-0,11
p-value	0,55	0,06	0,02	0,39	0,00	0,03	0,26	0,00	0,18	0,88	0,26	0,06	0,86	0,23	0,58	0,30
F	0,00	0,32	-0,28	0,03	0,66	-0,35	0,06	-0,15	-0,94	0,29	-0,17	-0,01	-0,09	-0,14	0,11	-0,17
p-value	0,09	0,03	0,11	0,73	0,00	0,00	0,40	0,10	0,00	0,08	0,07	0,88	0,23	0,01	0,52	0,07
I	0,01	0,32	-0,45	-0,02	0,66	-0,26	0,15	-0,10	-0,03	0,10	-0,20	0,11	-0,07	-0,15	-0,08	-0,19
p-value	0,05	0,05	0,02	0,83	0,00	0,01	0,09	0,38	0,83	0,59	0,05	0,18	0,39	0,03	0,67	0,06
M	0,00	0,13	-0,16	0,06	0,71	-0,12	0,08	-0,01	0,17	0,00	-0,54	0,16	-0,15	-0,13	-0,10	-0,21
p-value	0,34	0,52	0,44	0,61	0,00	0,19	0,41	0,93	0,33	0,99	0,00	0,08	0,11	0,15	0,56	0,09
E	0,01	-0,51	0,31	0,09	0,44	-0,52	0,07	-0,14	-0,49	0,14	-0,46	0,23	-0,02	-0,10	0,06	-0,00
p-value	0,15	0,01	0,15	0,44	0,00	0,01	0,51	0,25	0,00	0,53	0,00	0,01	0,81	0,19	0,74	1,00
HC	0,00	-0,05	-0,54	0,13	0,45	-0,10	0,05	-0,12	0,40	0,09	-0,04	-0,10	-0,17	-0,09	-0,30	-0,14
p-value	0,35	0,85	0,01	0,25	0,00	0,28	0,59	0,28	0,04	0,64	0,78	0,37	0,14	0,24	0,09	0,37
IT	0,01	0,21	-0,86	-0,03	0,75	-0,18	0,12	-0,02	-0,10	0,26	-0,22	-0,03	-0,16	-0,36	-0,10	-0,07
p-value	0,02	0,26	0,00	0,77	0,00	0,07	0,22	0,84	0,52	0,25	0,10	0,76	0,09	0,00	0,55	0,49
CS	0,01	-0,37	-0,63	0,02	0,45	-0,26	0,09	-0,10	0,24	0,03	-0,07	0,02	-0,05	-0,13	-0,25	-0,20
p-value	0,01	0,04	0,00	0,85	0,00	0,00	0,28	0,32	0,06	0,83	0,47	0,85	0,47	0,04	0,07	0,05
CD	0,00	0,18	-0,37	-0,02	0,61	-0,35	0,11	-0,11	-0,09	0,31	-0,13	0,17	-0,12	-0,16	0,17	-0,38
p-value	0,20	0,41	0,09	0,84	0,00	0,00	0,26	0,41	0,63	0,13	0,29	0,08	0,20	0,02	0,36	0,00

Table 8.1: *Regressions' results 2010-2019*

2010-2021																
	α	SMB	HML	UMD	MKT	aESG RE	aESG U	aESG Com. Services	aESG F	aESG I	aESG M	aESG E	aESG HC	aESG IT	aESG CS	aESG CD
RE	0,31	-0,39	-0,50	-0,08	0,44	-0,49	-0,01	0,07	0,07	-0,01	-0,05	-0,06	0,01	-0,07	0,28	-0,35
p-value	0,07	0,06	0,05	0,42	0,00	0,00	0,95	0,54	0,64	0,95	0,64	0,56	0,95	0,29	0,09	0,00
U	-0,14	-0,45	-0,18	0,05	0,43	-0,06	-0,14	-0,05	-0,02	0,09	-0,15	-0,30	-0,06	-0,12	0,08	-0,23
p-value	0,07	0,01	0,33	0,59	0,00	0,68	0,16	0,65	0,91	0,61	0,12	0,00	0,41	0,08	0,61	0,01
C.Services	0,00	-0,65	-0,64	0,07	0,44	-0,12	-0,01	-0,36	-0,38	0,05	-0,07	-0,19	-0,02	0,10	0,37	-0,20
p-value	0,97	0,00	0,01	0,55	0,00	0,40	0,96	0,00	0,02	0,74	0,51	0,04	0,85	0,27	0,05	0,06
F	0,00	0,22	-0,31	0,08	0,62	-0,29	-0,01	-0,03	-1,02	0,22	-0,14	-0,06	-0,17	-0,14	0,35	-0,17
p-value	0,30	0,16	0,11	0,43	0,00	0,01	0,93	0,75	0,00	0,21	0,14	0,46	0,01	0,01	0,02	0,08
I	0,00	0,25	-0,38	0,11	0,60	-0,27	0,05	-0,00	-0,07	0,07	-0,20	0,12	-0,15	-0,16	0,09	-0,19
p-value	0,29	0,23	0,11	0,36	0,00	0,06	0,67	0,98	0,70	0,73	0,05	0,20	0,14	0,03	0,62	0,08
M	0,00	0,01	0,18	0,15	0,59	-0,22	0,00	0,04	0,13	0,07	-0,58	0,20	-0,17	-0,08	-0,07	-0,24
p-value	0,85	0,97	0,45	0,28	0,00	0,16	0,99	0,78	0,46	0,75	0,00	0,06	0,12	0,39	0,72	0,06
E	0,00	-0,65	0,42	0,00	0,39	-0,11	-0,03	0,07	-0,45	0,08	-0,37	0,35	0,01	-0,14	0,21	-0,08
p-value	0,78	0,01	0,07	0,99	0,00	0,47	0,81	0,60	0,01	0,73	0,00	0,00	0,95	0,06	0,28	0,43
HC	0,00	-0,32	-0,56	0,04	0,37	0,03	-0,07	-0,04	0,16	0,11	0,04	-0,07	-0,13	-0,03	-0,02	-0,20
p-value	0,50	0,13	0,02	0,80	0,00	0,80	0,50	0,76	0,44	0,58	0,75	0,51	0,26	0,65	0,92	0,14
IT	0,01	0,04	-0,80	0,06	0,67	-0,16	0,06	0,09	-0,14	0,16	-0,18	-0,02	-0,16	-0,38	0,10	-0,10
p-value	0,16	0,84	0,00	0,63	0,00	0,34	0,63	0,50	0,43	0,51	0,23	0,86	0,16	0,00	0,63	0,36
CS	0,00	-0,43	-0,76	0,03	0,40	-0,18	0,03	-0,03	0,16	0,02	-0,08	-0,01	-0,14	-0,10	-0,19	-0,23
p-value	0,45	0,04	0,00	0,81	0,00	0,13	0,74	0,82	0,26	0,91	0,38	0,92	0,09	0,14	0,24	0,03
CD	0,00	-0,09	-0,52	0,15	0,53	-0,33	0,08	0,00	-0,18	0,15	-0,08	0,09	-0,18	-0,16	0,31	-0,45
p-value	0,52	0,68	0,04	0,23	0,00	0,02	0,40	0,98	0,34	0,47	0,45	0,37	0,07	0,03	0,07	0,00

Table 8.2: *Regressions' results 2010-2021*

2007-2019																
	α	SMB	HML	UMD	MKT	aESG RE	aESG U	aESG Com. Services	aESG F	aESG I	aESG M	aESG E	aESG HC	aESG IT	aESG CS	aESG CD
RE	-0,01	0,23	-0,39	0,17	0,60	-0,47	0,04	0,05	-0,04	0,34	0,01	0,01	0,03	-0,17	0,12	-0,06
p-value	0,01	0,32	0,20	0,32	0,00	0,00	0,74	0,64	0,82	0,14	0,93	0,92	0,78	0,10	0,55	0,68
U	-0,01	-0,12	-0,19	0,21	0,50	-0,10	-0,03	0,02	-0,32	0,15	-0,11	-0,17	0,05	-0,09	0,10	0,06
p-value	0,01	0,47	0,35	0,07	0,00	0,46	0,83	0,85	0,06	0,45	0,30	0,09	0,58	0,19	0,56	0,51
C.Services	-0,01	-0,21	-0,55	0,12	0,52	-0,09	0,13	-0,26	-0,47	0,08	-0,01	-0,19	0,06	-0,03	0,35	-0,02
p-value	0,10	0,22	0,03	0,37	0,00	0,53	0,35	0,01	0,01	0,65	0,92	0,09	0,54	0,75	0,10	0,84
F	-0,01	0,50	-0,23	0,15	0,75	-0,23	0,10	0,10	-1,20	0,31	0,01	0,09	-0,02	-0,21	0,26	-0,08
p-value	0,04	0,01	0,33	0,27	0,00	0,12	0,40	0,34	0,00	0,12	0,92	0,45	0,85	0,00	0,21	0,51
I	0,00	0,47	-0,43	0,19	0,69	-0,25	0,17	0,01	-0,27	0,07	-0,22	0,15	0,06	-0,23	0,00	-0,04
p-value	0,53	0,01	0,09	0,15	0,00	0,07	0,15	0,90	0,20	0,76	0,06	0,20	0,60	0,01	1,00	0,69
M	0,00	0,23	-0,01	0,24	0,71	-0,10	0,25	0,05	-0,22	0,01	-0,60	0,30	0,02	-0,10	0,10	0,12
p-value	0,50	0,30	0,96	0,07	0,00	0,55	0,05	0,73	0,30	0,98	0,00	0,01	0,86	0,30	0,66	0,31
E	-0,01	-0,19	0,14	0,13	0,52	0,00	0,19	0,03	-0,51	0,09	-0,35	0,25	0,06	-0,19	0,26	0,02
p-value	0,09	0,35	0,54	0,15	0,00	0,99	0,13	0,85	0,00	0,67	0,01	0,02	0,59	0,02	0,19	0,83
HC	0,00	-0,02	-0,52	0,08	0,37	-0,13	0,01	0,00	-0,01	0,34	0,10	-0,05	-0,17	-0,08	0,01	-0,07
p-value	0,21	0,89	0,01	0,45	0,00	0,30	0,91	0,98	0,94	0,07	0,38	0,55	0,11	0,33	0,95	0,45
IT	0,00	0,34	-0,81	0,14	0,78	-0,13	0,19	0,17	-0,19	0,28	-0,11	-0,03	-0,11	-0,43	0,09	0,01
p-value	0,39	0,10	0,00	0,19	0,00	0,41	0,16	0,11	0,27	0,21	0,43	0,82	0,30	0,00	0,59	0,93
CS	0,00	-0,04	-0,69	0,14	0,51	-0,27	0,08	0,00	0,03	0,17	0,01	0,00	-0,06	-0,13	-0,16	-0,01
p-value	0,47	0,81	0,00	0,19	0,00	0,02	0,46	0,97	0,85	0,30	0,93	0,99	0,51	0,06	0,37	0,90
CD	0,00	0,11	-0,34	-0,02	0,63	-0,36	0,13	0,15	0,04	0,33	0,05	-0,07	-0,14	-0,20	0,35	-0,44
p-value	0,16	0,56	0,13	0,88	0,00	0,01	0,21	0,19	0,84	0,08	0,64	0,55	0,15	0,01	0,06	0,00

Table 8.3: *Regressions' results 2007-2019*

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Summary

In 2004, the concept of Sustainable and Responsible Investing (SRI) was first introduced to a broader audience in a report, sponsored by the United Nations (UN), whose title was 'Who Cares Wins'. The report was part of a UN project, where a coalition of financial institutions attempted to find a set of general guidelines on how to efficiently incorporate ESG (Environmental, Social and Governance) challenges in asset management (The Global Compact (2004)). Since then, due to investors' increasing awareness and research for green investing, Assets under Management (AuM) and fund flow in socially responsible investments have grown exponentially, especially during the COVID-19 pandemic. According to a report released by The Global Sustainable Investment Alliance (2020), global sustainable investments in 2020 were $35.3 trillion, resulting in a 15% increase in the period 2018-2020 and a 55% increase in the period 2016-2020. The same study assesses that in 2020, 35.9% of total AuM was in sustainable investments. At the same time, Morningstar highlights that 46% of the total world AuM in sustainable investments are from Europe, with Luxembourg being the leading country.

There are three main reasons why Fund managers decide to incorporate ESG metrics in their investment process, these being materiality, client demand and regulation. Materiality refers to the situation where there is growing recognition by institutional investors that ESG factors can influence investments return. As far as client demand is concerned, clients are calling for more transparency on how asset managers are investing their money. The reason is that in the last decade there was growing awareness that ESG factors have an influence on firms' returns. The third reason why ESG factors are becoming more and more important is regulation. Regulatory changes have been driven by the realisation that the financial sector can and must play a crucial role in meeting global environmental and social challenges.

To include ESG factors in the investment process, two approaches can be used: incorporation and active ownership. Fund managers use the incorporation approach when they want to directly account for the ESG risk in their existing investment valuation process and it can be pursed using three main different strategies: thematic investing, screening, and integration. Active ownership, on the other hand, is when investors are involved in the decision-making process of the companies they already invested in, and their decisions are aimed at improving the company's ESG risk management or developing more responsible business practices. However, there are many obstacles when incorporating ESG factors in the investment decision-making pro-

cess. Among them, there is the lack of common parameters for ESG valuation, the difficulty of having reliable and high-quality data, and lastly the belief that ESG investing means reducing the permissible investment universe, therefore, leading to sub-optimal portfolios. The absence of common parameters means that investors use different metrics to incorporate and measure ESG factors. As a matter of fact, Kotsantonis and Serafeim (2019) analyse fifty companies listed in Fortune 500 and highlight that these firms use more than twenty different ways to report data about the safety of their employee, in particular, they use different units of measure and terminology. Unfortunately, these divergences in data reporting exist for any ESG factor, interfering with the comparability of firms' ESG performances and leaving room for arbitrage opportunities. It follows that finding reliable ESG data is a difficult task, even though the increasing technology improves data transparency and availability.
Given all these shortcomings, people question whether these new investment practices are profitable. The following research aims to find whether there exists a market anomaly related to ESG investing and in particular to assess whether fund managers can obtain superior returns through implementing ESG investment strategies. For this purpose, an anti-ESG factor is constructed. It is a portfolio that goes long on brown stocks and short on green stocks. This paper wants to supply an answer to the following questions: is it true that in the long run, low ESG-rated stocks tend to outperform the high-rated ones? And based on this, is it possible to construct an anti-ESG factor that explains stocks' returns? Moreover, is it possible to obtain superior returns through the implementation of this new contrarian ESG strategy?

Thousands of empirical studies have tried to investigate the relation between companies' ESG ratings and stock returns. However, a common conclusion from an analysis of this academic literature is that findings yield mixed results. Academic studies analyze which strategy is the most successful to have a social and environmental influence on financial markets. Some claim that stock screening and ESG integration are the best ways to make a social impact, while others claim that engagement is preferable. However, it must be noted that the impact of ESG screening on financial markets is an empirical question. Derwall et al. (2011) display that negative screening strategies are pursued by investors that are ethic-oriented and care about the social benefits of investing. Moreover, they highlight that green firms are selected by those investors, who are profit-seeking and that believe there is a transitory upward shift in the expected cash flows. Most remarkably, through the screening approach investors can better reach their ESG target, but at a significant cost, namely an under-diversified portfolio. Pedersen et al. (2021) show that there is weak return predictability of the overall ESG rating, and the evidence is mixed even when focusing on specific ESG dimensions. As a matter of fact, Cheema-Fox et al. (2019) display that high-carbon-emission firms underperform low-emission firms, while Bolton and Kacperczyk (2021) shows opposite findings, stocks with high carbon emissions outperform those that have low emissions. Hong and Kacperczyk (2009) show the existence of an economically remarkable sin premium: stocks belonging to the alcohol, tobacco, and gaming industries, i.e., to those sin sectors, outperform similar stocks that belong to other industries. Avramov et al. (2021) find that there is a structural relation between high ESG rated stocks' returns and ESG demand and finally conclude arguing that these mixed evidence in the empirical literature is the result of the pervasive disagreement among ESG data vendors.

Twenty years ago, Heinkel et al. (2001) highlighted that in the sight of a large fraction of socially responsible investors, polluting firms are forced to reform. Indeed, his study showed that socially irresponsible firms, that are excluded by investors from the permissible investment universe, experience a higher cost of capital than that experienced by socially responsible firms. He concluded by claiming that an ESG factor that is long green stocks and short non-green stocks will experience a negative alpha. In a recent study, Pástor et al. (2021) claims that the existence of an ESG premium is contested and shows that this negative alpha is experienced especially when ESG preferences are stable in financial markets. Analogous conclusions were also drawn by Heinkel et al. (2001), Luo and Balvers (2017), and Zerbib (2020).

As aforementioned, Pástor et al. (2021) provide an empirical analysis of financial market equilibrium when investors are green investors. In equilibrium, companies with a high overall ESG rating should have a negative alpha. A two-factor model is used, with the factors being the ESG-specific and market factors. In addition, they also show a procedure to construct the ESG factor, whose portfolio weights are proportional to the ESG rating of the stocks of interest. However, as clearly mentioned in the paper, this procedure for the ESG factor construction deviates from the commonly used Fama and French (1992) methodology which first identifies stocks with high and low exposures to a firm characteristic of interest and then constructs a long-short portfolio.

Indeed, deviations from the Fama and French factor model are common; for example, Bolton and Kacperczyk (2021), construct a carbon factor whose portfolio weights are proportional to firms' carbon emissions, instead of building a long-short portfolio of stocks that are sorted according to this characteristic.

Over the years, empirical studies have shown that there are two main procedures to construct an ESG factor: first using ESG ratings as a cardinal variable, and second using ESG ratings as an ordinal variable. Within the ordinal variable approach, ESG ratings are used to identify a cluster of green and non-green stocks. Within each cluster, stock returns are usually value-weighted and then the return spread between the green and non-green portfolios is the return of the ESG factor. This procedure follows the protocol developed by Fama and French (1992) and is extensively used in academic literature to construct equity factors based on specific firm characteristics. On the contrary, when ESG ratings are treated as a cardinal variable, they serve to determine what are the weights of the stock in a portfolio that tries to track the ESG premium.

An empirical foundation for this procedure to construct the ESG factor was the one provided by Pástor et al. (2021) and represents a different method to equity factor construction suggested in Fama and French (1992), Fama (1976) and Back et al. (2013). This alternative method is known as the cross-sectional approach and is based on the cross-sectional predictability of ESG ratings on stock returns. To build an ESG cross-sectional factor accounting only for the ESG characteristic, the below cross-sectional regression is considered:

$$R_{i,t} = \lambda_{0,t1} N_{t-1} + \lambda_{1,t1} ESG_{t-1} + \epsilon_{i,t}, \tag{8.1.1}$$

where $R_{i,t}$ is the vector of stocks' excess returns in the cross section at time t=1,... T,i=1,..N is the number of assets, N_{t-1} is a vector of ones, and ESG_{t-1} is a vector of lagged stocks' ESG ratings. Following this procedure, the estimated coefficients in equation 8.2.1 can be interpreted as portfolios' excess returns. The two portfolios associated with the estimated coefficients are defined by the following weights:

$$w_{t-1} = [\frac{1}{\mathbb{N}_{t-1}} 1_{N_{t-1}}; \frac{ESG_{t-1}}{ESG'_{t-1} ESG_{t-1}}],$$

With the ESG portfolio being defined by

$$w_{t-1}^{ESG} = [\frac{ESG_{t-1}}{ESG'_{t-1} ESG_{t-1}}],$$

It is a long-short portfolio that goes long on high ESG rated stocks and short on low rated ones. It follows that $\lambda_{1,t1}$,t is the cross-sectional ESG factor excess return.

For this research both the two methodologies, the one proposed by Fama and French (1992) and the one by Pástor et al. (2021) have been implemented. However, the first methodology, being the more accredited one dominates, hence the research results are those obtained by implementing the time-series factor construction protocol.

It is worth mentioning that the majority of these academic studies focus on the American Stock Market. However, in March 2018, the European Union adopted the Sustainable Finance Action Plan, which among its other objectives, aims to "foster transparency and long-termism in financial and economic activity" (European Commission 2018) and to induce investors to consider ESG-related issues. Since then, the EU regulation regarding ESG investing has been growing, suggesting that the ESG phenomenon is more prominent in Europe than in the USA. Hence, a hypothetical market anomaly linked to the sphere of green investing must be searched in the European stock market rather than the American one. Indeed, the analysis of this paper will focus on the European Equity market. To include in the research only European equities, all the STOXX EUROPE 600 index's components are considered as the investible universe. This European index is a value-weighted index designed by STOXX Ltd. It is made of 600 components and represents large, mid, and small-cap companies of 17 European countries[1] .

Once gathered, all the stocks belonging to the index as of January 2022 are screened. Only those for which there is available data are included in the investment universe, thus leading to a sample containing 303 components. The stock prices are those registered at the end of each month, and they cover a period that goes from 31/01/2007 to 31/12/2021 (fifteen years, 180 observations).This period and the frequency of the

[1] Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Norway, Netherlands, Poland, Portugal, United Kingdom, Spain, Sweden, and Switzerland.

data have been chosen to have a time horizon as long as possible to guarantee the reliability and accuracy of data.

It is noted that the purpose of this study is to construct sectorial ESG factors. Based on this purpose, once gathered the 303 components another screening is carried out. The stocks are indeed grouped to the Global Industry Classification Standards (GICS), an industry taxonomy developed by S&P and MSCI. The GICS structure comprehends eleven sectors [2], and it is the most widely used sector classification in the financial industries.

Then, to analyse the sensitivity of each sector to the eleven different ESG factors fifteen sub-indices of the STOXX EUROPE 600 have been retrieved from Reuters [3]. However, with regards to the Consumer Staples and Consumer Discretionary sectors, there is no respective available sub-index that dates back to 2007. These two must be constructed by using the category that makes up each sector. For this reason, the Consumer Staples sub-index is constructed as an equally weighted portfolio investing in the STOXX EUROPE 600 Personal Households Goods and the STOXX EUROPE 600 Food Beverage. At the same time, the Consumer Discretionary sub-index is constructed as an equally weighted portfolio investing in STOXX EUROPE 600 Travel Leisure, STOXX EUROPE 600 Automobiles Parts and STOXX EUROPE 600 Retail. Concerning ESG Score Data, the ESG rating used in this research are those provided by Refinitiv-Asset 4. ESG rating providers have the function of reducing information asymmetries and acting as intermediaries between firms and investors, retrieving and analysing all the publicly available information disclosed by businesses. There are six ESG rating providers[4] in financial markets, and the choice to rely on one rather than the others can hamper the results of the research, meaning that the results obtained by using one ESG rating might not be replicated with the ESG ratings of another rating provider. Indeed, Berg et al. (2019) investigated the divergence of ESG ratings based on the data from the six leading ESG rating providers and concluded that researchers and fund managers should carefully choose the data on which their ESG studies rely. Once the data have all been gathered a two steps procedure has been implemented. In the first step the anti-ESG factors are constructed while in the second one a sensitivity analysis of each stock to the different anti-ESG factors has been performed. The analysis has been developed on MATLAB R2020b. The anti-ESG factor is built as a long-short portfolio. By definition a long-short portfolio is a type of portfolio where the investor takes two opposite directions in the market; he takes a long (buy) position in stocks with a certain characteristic and takes a short (sell) position in stocks with another type of characteristic. The considered characteristic in this paper is the ESG score. As a matter of fact, the long/short portfolio

[2]Real Estate, Energy, Financials, Consumer Staples, Consumer Discretionary, Communication Services, Information Technology, Utilities, Industrials, Materials, Health Care.

[3]STOXX EUROPE 600 Real Estate, STOXX EUROPE 600 Utilities, STOXX EUROPE 600 Telecommunications, STOXX EUROPE 600 Financials, STOXX EUROPE 600 Industrials, STOXX EUROPE 600 Oil Gas, STOXX EUROPE 600 Basic Materials, STOXX EUROPE 600 Health Care, STOXX EUROPE 600 Technology, STOXX EUROPE 600 Travel Leisure, STOXX EUROPE 600 Automobiles Parts, STOXX EUROPE 600 Retail, STOXX EUROPE 600 Personal Households Goods, STOXX EUROPE 600 Food Beverage

[4]KLD, Sustainalytics, Moody's, RobecoSAM (SP Global), MSCI, and Refinitiv-Asset4.

constructed has the following composition: the long leg gathers stocks with low ESG scores, while the short leg gathers stocks with high ESG scores. For this purpose, the stocks belonging to the investment universe of interest are, depending on their ESG score, sorted into quantiles. The stocks entering the top 10% quantile will constitute the investment universe of the short portfolio, while the stocks entering the bottom 10% quantile will constitute the long portfolio's investment universe. The choice of using the 10% quantile is arbitrary and has been taken according to what is the commonly accepted asset pricing practice (Fama and French 1993. Moreover, this allows for further screening, since it leads to short portfolios that are tilted towards the top performing green stocks (i.e. those with the highest ESG score) and long portfolios that are tilted towards the bottom performing brown stocks (i.e. those with the lowest ESG score). Indeed, for the purpose of this research, there are some stocks within both the green and brown stock universe that need to be excluded. Among the high-rated stock universe these are those that are still traded at a discounted price since they have scores that can still be improved. At the same time within the low-rated stock universe those that need to be avoided are the ones with higher-than-average score and that have already seen an increase in price.

The weight assigned to each stock is the one resulting from an equally weighted portfolio procedure, i.e.:

$$w = \frac{1}{\text{no. of stocks}},$$

Then, the allocation to the long-short portfolio will be a dollar-neutral allocation, hence a portfolio that invests an equal dollar amount in short and long positions. By definition, the long-short portfolio constructs according to the aforementioned hedge ratio are exposed to the market. Indeed, using a hedge ratio of this type implies that the long side and the short side of the portfolio will completely offset each other, but only in dollar notional terms. Finally, the anti-ESG factor is constructed as follows:

$$aESG_t = w_l Rl_t - w_s Rs_t, \tag{8.1.2}$$

Where $aESG_t$ stands for the factor return, Rl_t and Rs_t are respectively the return on the long and short portfolios, and $w_{l,t}$ and $w_{s,t}$ are their respective weights. Then, to capture a market anomaly that helps us to explain the stock's source of alpha, an extended version of the Carhart (1997) multifactor model is used. The model employed is a multivariate linear model estimated via Ordinary least squares and as such, it comprehends a dependent variable and several independent variables, depending on the study of interest. Eleven regressions are performed. For each of them, the independent variable is the excess return of each one of the eleven STOXX 600 sub-indices, while the dependents variables are sixteen identified factors, with the first being a vector of ones, representing the intercept. Introducing a constant of this type is a common practice in econometrics, especially when dealing with multiple regression models; the reason behind this is that by introducing an intercept the researcher ensures that the model will be unbiased, i.e., that the mean of the residuals is exactly zero. The other 4 factors used are the well-known factors developed by Carhart

(1997), namely Market factor (MKT), Small minus Big (SMB), High minus Low (HML), and Momentum (UMD), while the remaining 11 factors are those constructed following the aforementioned methodology. They are m factors and each of them refers to a particular sector analyzed. The model is presented below:

$$R_{i,t} = \alpha_0 + \beta_{mkt} MKT_t + \beta_{SMB} SMB_t + \beta_{HML} HML_t + \beta_{UMD} UMD_t + \sum_{j=1}^{m} \beta_{ij,aESG} aESG_{j,t} + \epsilon_{i,t}, \tag{8.1.3}$$

where, i=1,..N is the number of assets, t=1,... T refers to the number of observations and $R_(i,t)$ is the stock excess returns.

Overall, the thesis highlights that having invested 100 EUR in some of the developed anti-ESG factors would have generated superior returns if compared to the respective sector sub-indices. However, the findings are not unanimous. They show that, when compared to their sector index counterpart, some of the anti-ESG factor portfolios tend to have a higher Sharpe Ratio, with the exceptions being Utilities, Industrials, Information Technology, Consumer Staples, and Consumer Discretionary. Then, to understand the behavior of each portfolio analysis of the anatomy of the portfolios' cumulative performance has been performed. This type of analysis was performed to assess whether the nature of each portfolio was defensive or aggressive. Fund Managers claim that a portfolio has a defensive behavior if during market downturns it tends to decrease less than its peers and if during market upturns it tends to increase more than its peers. At the same time, a portfolio is claimed to have aggressive behavior if the contrary is true, meaning that during market downturns it tends to collapse more than its peers and during market upturns, it tends to increase less than its peers.

In this research, the analysis has been performed by comparing the portfolios' cumulative performance to that of their sub-index of reference. For each portfolio, the analysis has been done by focusing on specific time periods, mainly the Great Financial Crisis and its subsequent rebound and the 2020 market crash and its subsequent recovery. The focus is indeed on shorter periods in order to see what truly happened in particular time frames. Indeed, when looking at the cumulative performance for longer periods, the researcher could miss some little crashes and rebounds that could be indicative of the nature of the portfolios of interest. Figure 8.1 shows the eleven anti-ESG portfolios' cumulative performance relative to that of their sub-index of reference. It is the evolution of 100 euro invested in both the anti-ESG portfolio and its respective sub-index. The grey shaded area highlights the recession period of 2008-2009 that followed the Great Financial Crisis. Even though, as mentioned before, the analysis was performed by analysing shorter time frames, in the graphs covering the full period cumulative performances, it appears evident that, during the market's downturn, the portfolio's performances have not been impacted at all, while the major STOXX 600 sub-indices experienced huge losses. Indeed, during the Great Financial crisis, all the STOXX 600 sub-indices dropped, while the eleven anti-ESG factors remained stable over that recession period.

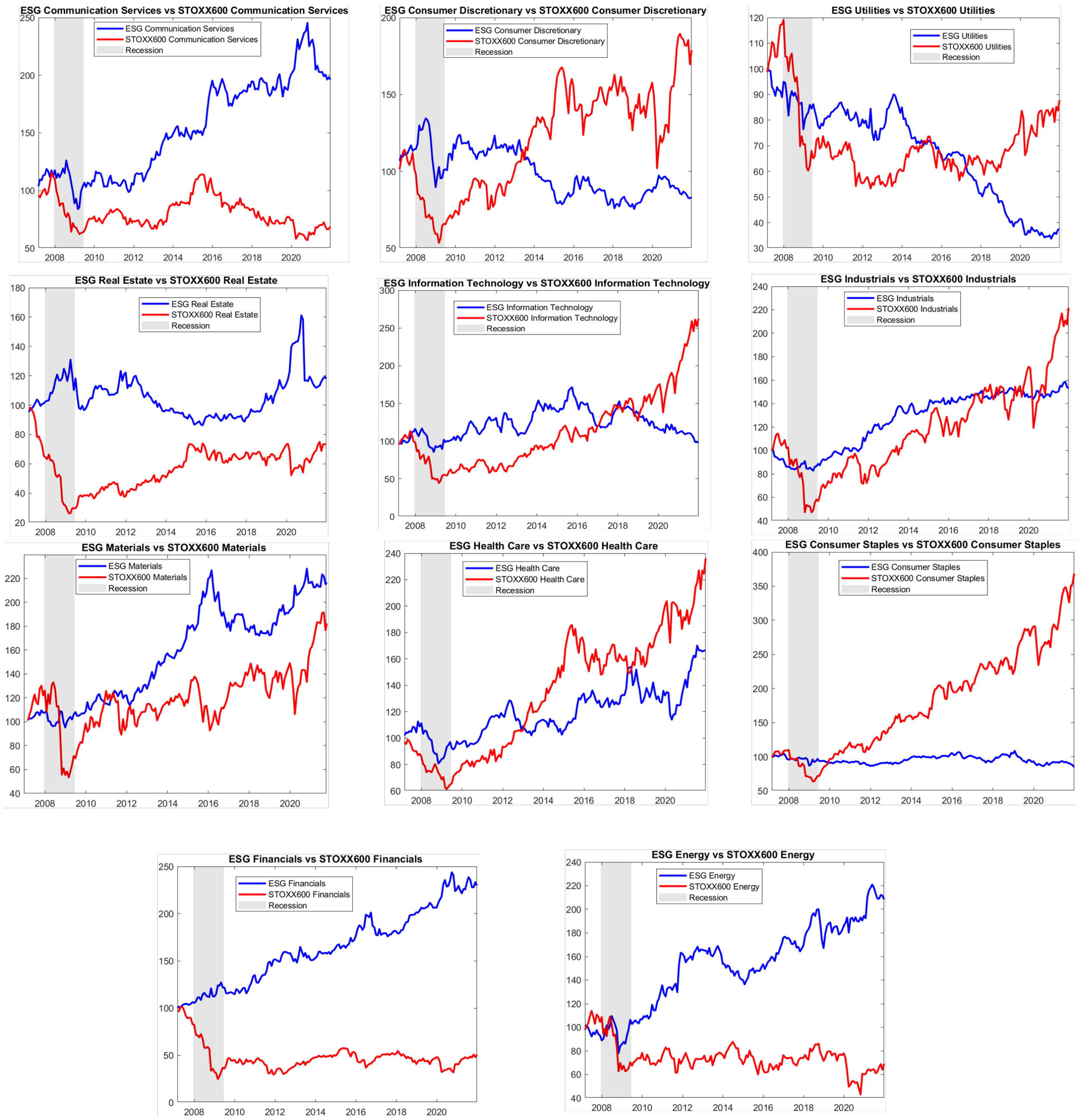

Figure 8.1: Anti-ESG Portfolio's Performance- For each sector two cumulative performances are shown. In red the cumulative performance of $100 invested in the EURO STOXX 600 sub-index, in blue the cumulative performance of $100 invested in the anti-ESG portfolio.

Remarkable is the behavior of three anti-ESG Portfolios, namely, Financials, Real Estate, and Consumer Discretionary that, instead of dropping during the Recession period, increased. These three were among the three most impacted sectors during that period. Moreover, in March 2020, equity markets experienced another huge drop due to the spread of the Covid-19 pandemic. Again, some of the anti-ESG portfolios dropped less than and rebounded more than their respective sub-indices, hence confirming their defensive nature. However, in some cases, namely Consumer Staples, Consumer Discretionary, Industrials, Utilities, Health Care, and Information Technology, the defensive structure was not enough to outperform the sub-indices counterparts. After analysing the factors' behaviour, an extended version of the Carhart (1997) highlights that the alpha of nine of the eleven regressions is equal to zero and statistically insignificant, with the only two exceptions being the Real Estate and Utilities sectors. Table 8.6 displays the results of the Regression Model presented in equation 8.2.3. It shows the estimated values of the regression coefficients, along with their p-values. The p-values highlighted in the table are those that arise from a t-test run for all the regressions' coefficients. The aim is to verify whether the coefficients are significantly different from zero. Table 8.5 shows the regressions' adjusted R^2 ($\bar{R}^2$) for two different cases: (i) a regression that only considers the four FF-factors and the constant, and (ii) a regression that considers all the fifteen regressors and the constant. The difference in the $\bar{R}^2$ value between the two cases ranges between 18% and 50%. Indeed, when considering all the fifteen factors, the eleven regressions' $\bar{R}^2$ are sufficiently high, ranging between 30% and 78%, with the majority of them concentrating on the upper end of the interval. This means that the model using 16 regressors well explains the return generating process of the indices analysed and that the elevated number of regressors does not negatively influence the goodness of the fit. It follows that using this model to exploit whether a market anomaly linked to ESG ratings exists, is a good choice.

Table 8.4: *Regressions' adjusted R^2 for two different cases: (i) a regression with the four FF-factors and the constant, and (ii) a regression with the fifteen regressors and the constant.*

	adjusted R^2										
	RE	U	C.Services	F	I	M	E	HC	IT	CS	CD
5 Regressors	45%	42%	29%	61%	58%	55%	46%	21%	50%	44%	46%
16 Regressors	53%	49%	44%	78%	66%	66%	61%	30%	62%	51%	60%

Table 8.6 shows that three of the four factors developed by Carhart (1997) have, in most cases, a statistically significant (i.e., p-value less than 10%) impact on the returns of the assets analysed. However, in all the eleven cases, the momentum factor appears to have no impact on the sub-indices returns.

Since this research focuses on finding a market anomaly linked to green investing, we will now focus on the level of significance of the eleven regressions' alphas. Table 8.6 presents the estimated values for the intercept term in the linear model presented in Equation 8.2.3. As we can see, besides the Real Estate and Utilities sub-indices, when controlling for all the fifteen factors, the alphas of the sector regressions become not statistically significant. At the same time, the estimated values for the aforementioned alpha are extremely close to zero. It is important to remark that when dealing with factor models, alphas are defined as unexplainable excess returns and interpreted as evidence of some kind of additional risk that is not captured by the model. Having an alpha of zero, or close to zero, means having a model that is able to

	Regressions															
	α	SMB	HML	UMD	MKT	aESG RE	aESG U	aESG Com. Services	aESG F	aESG I	aESG M	aESG E	aESG HC	aESG IT	aESG CS	aESG CD
RE	-0,01	0,30	-0,43	0,11	0,66	-0,43	0,11	-0,01	0,06	0,35	0,01	0,01	0,04	-0,18	-0,06	-0,06
p-value	-0,01	-0,14	-0,10	-0,45	-0,00	-0,00	-0,37	-0,94	-0,71	-0,08	-0,94	-0,95	-0,65	-0,06	-0,77	-0,69
U	-0,01	0,00	-0,29	0,15	0,55	-0,15	0,09	-0,07	-0,24	0,13	-0,09	-0,18	0,10	-0,12	-0,17	0,08
p-value	-0,08	-0,99	-0,15	-0,21	-0,00	-0,14	-0,39	-0,52	-0,13	-0,51	-0,39	-0,06	-0,26	-0,10	-0,36	-0,40
CServices	0,00	-0,07	-0,47	0,09	0,51	-0,15	0,21	-0,32	-0,37	0,06	-0,04	-0,17	0,05	-0,01	0,13	0,00
p-value	-0,20	-0,66	-0,03	-0,41	-0,00	-0,13	-0,07	-0,00	-0,02	-0,70	-0,75	-0,11	-0,63	-0,90	-0,54	-0,98
F	0,00	0,55	-0,24	0,09	0,77	-0,27	0,16	0,02	-1,15	0,37	0,00	0,11	0,01	-0,21	0,06	-0,07
p-value	-0,13	-0,00	-0,23	-0,43	-0,00	-0,01	-0,13	-0,86	-0,00	-0,03	-0,99	-0,32	-0,94	-0,01	-0,76	-0,57
I	0,00	0,52	-0,51	0,09	0,74	-0,21	0,24	-0,04	-0,27	0,12	-0,21	0,14	0,07	-0,21	-0,14	-0,01
p-value	-0,98	-0,00	-0,02	-0,50	-0,02	-0,05	-0,02	-0,70	-0,15	-0,54	-0,07	-0,20	-0,49	-0,01	-0,43	-0,91
M	0,00	,27	-0,28	0,16	0,79	-0,05	0,26	0,02	-0,20	0,00	-0,55	0,26	-0,01	-0,12	0,03	0,16
pvalue	-0,99	-0,16	-0,20	-0,18	-0,00	-0,65	-0,02	-0,88	-0,32	-1,00	-0,00	-0,02	-0,94	-0,19	-0,89	-0,20
E	0,00	-0,09	0,13	0,05	0,55	-0,30	0,27	-0,14	-0,58	0,08	-0,39	0,19	0,06	-0,17	0,12	0,04
p-value	-0,63	-0,66	-0,56	-0,65	-0,00	-0,14	-0,02	-0,30	-0,00	-0,69	-0,00	-0,06	-0,56	-0,06	-0,57	-0,71
HC	0,00	0,17	-0,57	0,09	0,43	-0,17	0,11	-0,07	0,18	0,29	0,06	-0,06	-0,22	-0,14	-0,21	-0,06
p-value	-0,42	-0,38	-0,00	-0,30	-0,00	-0,08	-0,31	-0,47	-0,23	-0,09	-0,58	-0,50	-0,03	-0,09	-0,26	-0,57
IT	0,00	0,45	-0,85	0,05	0,83	-0,14	0,25	0,08	-0,19	0,38	-0,12	-0,03	-0,13	-0,41	-0,08	0,04
p-value	-0,93	-0,01	-0,00	-0,63	-0,00	-0,21	-0,03	-0,40	-0,21	-0,07	-0,36	-0,77	-0,17	-0,00	-0,62	-0,71
CS	0,00	-0,04	-0,65	0,11	0,54	-0,27	0,13	-0,05	0,06	0,17	0,03	0,02	-0,03	-0,15	-0,24	-0,02
p-value	-0,87	-0,82	-0,00	-0,26	-0,00	-0,00	-0,17	-0,61	-0,61	-0,24	-0,74	-0,86	-0,73	-0,03	-0,15	-0,85
CD	0,00	0,28	-0,21	-0,10	0,68	-0,36	0,18	0,05	0,07	0,46	0,03	-0,01	-0,10	-0,21	-0,18	-0,41
p-value	-0,47	-0,11	-0,32	-0,28	-0,00	-0,00	-0,06	-0,62	-0,72	-0,01	-0,80	-0,92	-0,28	-0,01	-0,32	-0,00

Table 8.5: *Regressions' results- The displays the results of the Regression Model presented in equation 4.2.3. It shows the alphas and the beta coefficients of the fifteen factors, along with their p-values. The p-values are those that arise from a T-test run for all the regressions' coefficients.*

totally explain the return generating process.

Table 8.7 shows the results obtained when performing an F-test for each of the eleven regressions. The aim is to test under the null hypothesis that all the coefficients are jointly equal to zero, in order to assess whether the model is significant or not. Findings show that the null hypothesis is rejected for each of the eleven regressions. Indeed, the p-value of this test is below the specified significance level set a 1% in all the eleven cases.

Table 8.6: *Regressions'F statistic to test under the null hypothesis that all the coefficients are jointly equal to zero, in order to assess whether the model is significant or not.*

	F-statistic										
	aESG RE	aESG U	aESG Com. Services	aESG F	aESG I	aESG M	aESG E	aESG HC	aESG IT	aESG CS	aESG CD
Fstat	12,92	10,9	8,79	39,61	21,49	20,66	17,22	4,63	18,04	11,33	16,61
p-value	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Table 8.6 also presents the level of significance and the sign of each beta related to the anti-ESG factors. Seven out of eleven regressions confirm the following hypothesis: If we use as a dependent variable the sub-index excess return of sector m, then the beta of the anti-ESG factor related to sector m will be negative and significant (at least at 10% confidence level). The reason behind being that the anti-ESG factor goes in the opposite direction of the index. It goes short on high-rated stocks, which are among those stocks that drive up the performance of the index during market stability.

The four cases in which this hypothesis has been rejected regard the following STOXX 600 indices: Energy, Utilities, Consumer Staples, and Industrials. However, it is true that the beta coefficients related to the anti-ESG Industrial, Utilities, and Consumer Staples factors are not statistically significant, hence no clear conclusion can be drawn. Regarding the Energy Sector, the beta related to the anti-ESG Energy factor is statistically significant at 10% level (p-value being 0.06) and has a positive beta at 0,19. Nevertheless, the reason behind this is that when it comes to Energy, the ESG issue remains a hot topic. Indeed, even if having high ESG scores, energy companies are, the majority of the time, excluded from the investible universe of those responsible investors. The problem is that, even though energy companies try to have a lower impact on the environment, their impact will always be higher than that of those companies belonging to another sector. For the reasons listed above, I believe that any results got regarding the energy sector should be analyzed in the microsphere of behavioral finance. However, when accounting for time period bias, it has emerged that the two recent stock market crises, namely the Great Financial Crisis and the Covid—19 pandemic could have played a crucial role in this research. It follows that further studies could try to assess what could have been the impact of these two shocks on the performances of the anti-ESG factor portfolios.

The study suffers some limitations that could be further addressed. First, the factor construction is based on only one ESG rating provider. It follows that, since two providers could issue two different ratings for the same company, the study should be performed at least one more time using all the six different ESG rating providers to be certain that these results can be generalized and that completely represents what happens in financial markets. Lastly, since the sample considers only European stocks, it could be interesting to analyze whether this market inefficiency also affects the American Stock Market, or it is just the direct consequence of a more advanced European Regulation about Sustainable Responsible Investing.

Moreover, further research could address what is the role that the Russia-Ukraine War is playing concerning ESG principles and Regulations. Indeed, the current geopolitical crisis has posed one of the biggest dilemmas for ESG investors. Robert Stallard, a Vertical Research Partners' analyst, claimed that one of the results of the Russian invasion could be the reversal of the well-established ESG view that the defence and weapons sectors are sin sectors. According to the ESG view, sustainable funds would have excluded investments in the defence sector, which has been the best performing sector in the first quarter of 2022. Indeed, when all indexes were down more than 10%, the MSCI Aerospace and Defence Index and all the energy sector-related indexes were outperforming the world equities.

ESG investors now will have to answer the following question "How do you treat protecting a country from a foreign invader? Is it right that you don't actually support countries spending on defending themselves?". The answer will of course create a shift in ESG sentiment, thus revolutionizing the sustainable investment universe.