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Can ESG scores boost the performance of equity portfolios? A comparative study between the U.S. and Europe

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ABSTRACT

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This thesis assesses the performance of ESG-related investment strategies in the US and European stock markets over a long investment horizon, as well as in the short term (i.e., during the COVID-19 crisis). The examined ESG-related strategies are more frequently investigated high ESG score strategy and a recently introduced ESG momentum strategy. In the first strategy, the long-only top-decile portfolios are formed of the highest ESG-score stocks, whereas in the latter, the stocks with the highest relative ESG-score rise (determined on the basis of the ratios of two previous years' ESG scores) are selected, correspondingly. The portfolios are updated on an annual basis. The performance of ESG portfolios is evaluated in terms of raw and excess returns (over the market index), as well as on the basis of risk-adjusted ratios and the Fama-French- Carhart 6-factor model.

In terms of raw returns, both European ESG top and momentum strategies have beaten the market index over the long sample period. However, the 6-factor regression results show that their excess returns are tightly associated with the market risk factor but not with the five remaining spread factors. In the US markets, ESG investment strategies have generated below-market returns in absolute terms. In terms of risk-adjusted performance metrics, their underperformance against the stock market index is even statistically significant. During the COVID-19 period, both US and European ESG-related strategies have generated above-market raw returns. However, the 6-factor regressions revealed that these returns are explained by significant exposures to many of the five spread factors, whereas such exposures were non-existent in the full-length sample period.

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Tämä maisterintutkielma tutkii ESG investointistrategioiden suoriutumista pitkän sijoitushorisontin sekä COVID-19 kriisin aikana, kun huomioon otetaan riski ja markkina faktorit. Tutkimuksessa hyödynnettävät ESG-strategiat ovat jo paljon tutkittu ESG top sekä lisäksi uudempi ESG momentum, joka on noussut akateemisessa kirjallisuudessa esiin vasta verraten vähän. ESG strategioiden suoriutumista tutkitaan Euroopan ja Yhdysvaltain osakemarkkinoilla niin, että portfoliot on päivitetty vuosittain perustuen edellisen vuoden ESG menestykseen. Portfoliot on muodostettu tasapainotettuina, soveltaen long-only sijoitusstrategiaa. Tavoitteena oli muodostaa käytännössä helposti implementoitava vastuullisen sijoittamisen strategia, käyttäen kiinteää 10% fraktiilirajaa. Näin ollen muodostetut portfoliot sisältävät puhtaasti parhaiten vastuullisuuden osalta suoriutuneita yhtiöitä (ESG top), tai vastaavasti parhaiten ESG-pisteytystä kasvattaneita yhtiöitä (ESG momentum). Tutkimuksen nollahypoteesina on, että osakemarkkinat ovat tehokkaat, joten ESG-sijoittaminen ei täten tarjoa sijoittajille ylituottoja. ESG portfolioiden suoriutumista tutkitaan verraten tuottoja markkinaindeksiin, riskikorjatun tuoton mittareilla sekä hyödyntäen Fama-French-Carhart 6-faktori mallia.

Mitattuna kumulatiivisena tuottona yli markkinaindeksin sekä ESG-top, että -momentum strategiat johtivat ylituottoihin Euroopassa pitkällä sijoitushorisontilla. Perustuen regressiotuloksiin tuotot näyttävät kuitenkin selittyvän markkinariskillä. Yhdysvalloissa ESG-strategiat johtivat pitkällä sijoitushorisontilla jopa absoluuttisiin alituottoihin verrattuna markkinaindeksiin. Lisäksi ESG-portfoliot alisuoriutuivat Yhdysvalloissa tilastollisesti merkitsevästi myös riskikorjatun tuoton mittareilla tarkasteltuna. COVID-19 kriisin aikana vastaavasti sijoittaminen ESG-portfolioihin johti korkeisiin absoluuttisiin tuottoihin sekä Euroopan, että Yhdysvaltain osakamarkkinoilla. ESG-portfolioiden tuotot nousivat huomattavasti suhteessa markkinaindeksiin loppuvuodesta 2020 alkaen. Perustuen regressiomallin tuloksiin, vahva ESG-portfolioiden suoriutuminen COVID-19 kriisin aikana selittyy vahvasti useilla Fama-French-Carhart-mallin faktoreista.

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I would like to dedicate this thesis to my family. Special thanks to my dad for always believing in me and for teaching me about goal-oriented working, as well as to my mother, who always motivated me when I was feeling down. Also, I would like to thank my friends who supported me in this process.

Sincerely,

Heidi Ruppa

6th of August 2021, Kuopio, Finland.

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LIST OF ABBREVIATIONS

Alpha = An investment strategy's ability to beat the market.

CAPM = Capital Asset Pricing Model

COVID-19 = Coronavirus Disease 2019

EMH = Efficient Market Hypothesis

ESG = Environmental, Social, and Governance

ESG top = Method of responsible investing, which favors ESG leaders in portfolio construction, with a specified cut-off-point.

ESG Momentum = Method of responsible investing, which favors stocks with increasing ESG scores.

IVA = MSCI ESG Research Intangible Value Assessment (IVA). Research provider on environmental, social, and governance (ESG) factors.

ROE = Return on Equity

ROI = Return on Investment

SFDR = Sustainable Finance Disclosure Regulation

SKASR = Skewness and Kurtosis Adjusted Sharpe ratio

SRI = Socially Responsible Investing

TR = Total Return

TRBC = The Refinitiv Business Classification

1. INTRODUCTION

Investors are integrating ESG (Environmental, Social, and Governance) investing in their equity portfolios besides the value and norm-based reasons, also obtaining increased portfolio returns. Today, responsible investments cannot be considered as an optional component among asset managers. The long-standing question about whether an investor can consistently generate abnormal returns on stock markets seeks a straightforward explanation in ESG investing.

1.1 Background of the research

Sustainable investing plays a defining role in shaping the recovery of the COVID-19 crisis as sustainability is integrated into the recovery measures of several regulators, such as the European Commission. The most extensive stimulus package ever financed through the EU budget has been introduced to help repair the causes of the COVID- 19 crisis, highlighting the need to integrate green transition principles (European Commission 2021a). The growth of the responsible investment imperative is highly detectable also on a broader view. A clear shift in mindset is noticeable – here and now, investing is more than money. The phenomenon has also been referred to as “Stakeholder Capitalism.” Through time, the main objective of a public company has been to maximize the shareholder value and the wealth created for its shareholders. According to the updated statement about a corporation's purpose (Business Roundtable 2019), besides increasing the shareholder value, the objective is to benefit customers, employees, suppliers, and communities. The exact change of thinking can also be noted at an individual investor level: besides maximizing the expected returns on a given risk associated, also integrating the ESG characteristics.

Moreover, ESG has evolved as a critical pillar in sales, especially in wholesale and institutional distribution. The phenomenon has created societal pressure within asset management

operators when integrating the ESG investing within their strategies and product design. The regulation on sustainability-related disclosure in the financial services sector (SFDR), applying on the 10th of March 2021, expanded the discussion even wider. The regulation defines sustainability disclosure obligations for manufacturers of financial products and financial advisers toward end-investors making the sustainability categorization of the financial products obligatory (European Commission 2021b).

Today, ESG investing is more popular than ever. At the beginning of the COVID-19 pandemic in 2020, ESG fund inflows boomed widely, with supporters proving ESG equity markets' rank in terms of risk-adjusted returns. After the first dropdowns of the COVID- 19 crisis, high ESG scoring firms have been argued to be protected in the equity market, especially among the industry operators (see, e.g., Blackrock 2020; Nagy & Giese 2020). However, asset managers easily fall for a high ESG alpha, while in reality, the source of returns lacks further investigation. The high ESG alpha is argued to be caused by common market factors and sector biases (Bruno, Esakia, Goltz 2021).

According to Fama's famous Efficient Market Hypothesis (EMH) (1970), it is impossible for an investor to consistently generate abnormal returns as the market already reflects all the information available. However, challenging findings have been presented, employing several portfolio formation methods as sources of abnormal risk-adjusted returns. The ESG investing cannot be counted among the most famous exceptions of the EMH, and the received wisdom is arguable. However, the first positive findings on ESG as a creator of abnormal returns were first introduced already nearly 50 years ago (e.g., Moskowitz (1972). In recent years, the number of positive findings on ESG stocks outperformance has grown widely (See, e.g., Nagy, Kassam, Lee 2016; Giese, Lee, L.E., Melas, Nagy, Nishikawa 2019; Borovkova & Wu 2020; Broadstock, Chan, Cheng, Wang 2021. Bose, Shams, Ali, & Mihret 2021).

This research fills an academic gap bringing new information about the possible ESG anomaly, its fractal characteristics and investigating the relatively new ESG momentum investing approach (Nagy et al. 2013 & 2016). Significantly, the widely speculated ESG stock market performance on COVID-19 lacks further investigation regarding risk-adjusted returns

and the ESG alpha when controlling the most common market factors. This study is among the first covering more than a year of the COVID-19 pandemic, while the earlier evidence mainly covers the beginning of the year 2020. The ESG stock market performance is also examined over a long investment horizon. This thesis investigates the relationship between the ESG scores and the stock market performance using Refinitiv's ESG scores for actively managed ESG portfolios. Beside the new ESG momentum, the investing strategies on the scope are also the widely known ESG top approach. The portfolios are constructed separately for the developed European and US markets.

1.2 Research objectives

Stock return patterns that cannot be explained by the Capital Asset Pricing Model (CAPM) of Sharpe (1964), Lintner (1965), and Mossin (1966) are generally called anomalies. This thesis examines the existence of the ESG anomaly and critically analyzes evidence about its fractal characteristics, measuring the performance in two different geographical universes, for two different ESG- related investing strategies, during the COVID-19 crisis, as well as over a long investment horizon. The thesis analyses to find the relationship between the stock market returns and ESG scores within developed European and US equity markets. The portfolios formed using the ESG investing strategies will be described in section 5. The null hypothesis of this thesis is that markets are efficient, making it impossible to generate abnormal returns by using ESG investing strategies.

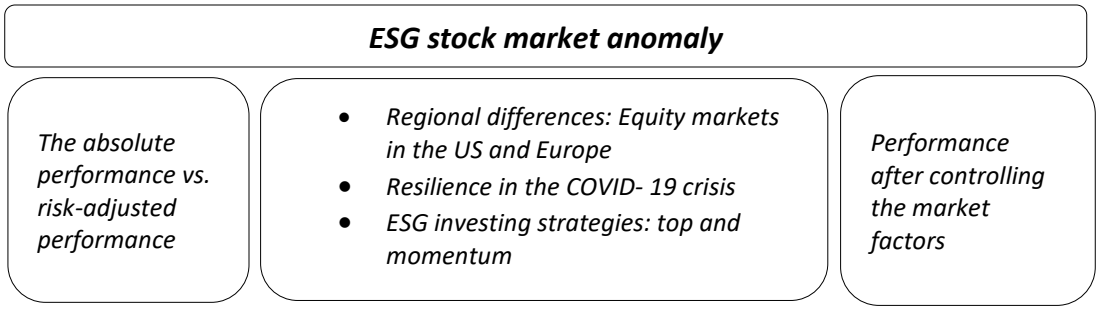

Figure 1. The subcomponents of the research problem

Figure 1. illustrates the subcomponents of the leading research objective about finding the ESG stock market anomaly. The subcomponents of the phenomenon are forming the research questions presented below. The research aims to comprehensively examine the ESG anomaly's extensiveness through two distinct regions and ESG stock selection methods. The study's goal is to examine the possible outperformance when considering risk-adjusted returns and factor exposures in addition to standalone returns.

Question 1: *"Is it possible to beat the market index by following ESG investing strategies in terms of absolute returns?"*

Question 2: *"Does the ESG anomaly appear on a risk-adjusted basis?"*

Question 3: *"Does the ESG momentum strategy generate better returns compared to the ESG top strategy?"*

Question 4: *"Are there statistically significant ESG-related anomalies over the entire sample period after controlling the market factors? "*

Question 5: *"How have the ESG portfolios performed during the COVID-19 crisis in terms of absolute, risk-adjusted, and factor-controlled returns"?*

1.3 Methodology

The European portfolios include 16 developed European countries: the United Kingdom, France, Germany, Belgium, Switzerland, Netherlands, Spain, Italy, Sweden, Norway, Finland, Denmark, Ireland, Austria, Portugal, and Luxembourg. The actively managed, yearly updated, and rebalanced equity portfolios are formed based on the ESG scores of the Refinitiv database, one of the most used ESG databases in academic research. Refinitiv's ESG scores are designed to transparently measure a company's relative ESG performance, commitment, and effectiveness across ten main themes, such as emissions, environmental product innovation, human rights, and shareholders (Refinitiv 2021). The ESG scores are collected over the period of 2011-2020, and the portfolios are updated subsequently based on past year scores.

The Top ESG portfolios include the top decile of the best-ESG-scored stocks, whereas the ESG Momentum- portfolios comprise the top decile of the best-grown ESG-scores. The thesis examines two sample-periods: The full-sample period and the sub-period of the COVID-19 crisis. The returns are calculated from monthly stock total return data for the entire sample period. The COVID-19 sub-sample period returns are calculated using the daily total return data. Both the ESG score- and total return data are obtained from Refinitiv's DataStream. The benchmarks used for comparison purposes are S&P 500 and Euro Stoxx 600 indexes.

The research investigates the returns and risk of the formed portfolios by measuring the absolute cumulative return, geometric mean annualized return, volatility, beta, Sharpe Ratio, and skewness- and kurtosis adjusted Sharpe Ratio. The test statistics of Jobson and Korkie (1981) and Memmel (2003) indicates the statistical significance of the relative risk-adjusted performance. The study also conducts factor regressions for each of the created ESG portfolios. The results of the regressions models also identify the statistical significance of a possible existence of an ESG anomaly.

1.4 Limitations of the research

Terms such as ESG investing, sustainable investing, socially responsible investing (SRI), and green investing are often mixed interchangeably, mainly due to a lack of standardized terminology (Tucker & Jones 2020, 57). This study uses the terms "ESG investing" and "Sustainable Investing," referring to all kinds of socially oriented investing. The sample period is limited from March 2012 to April 2021, covering only equity markets. In the research field of measuring the performance of ESG stocks, the financial performance has been measured either by using accounting indicators, such as ROE and ROI or by applying stock market indicators or alternatively applying both. This thesis covers only the stock market performance of the formed ESG portfolios.

The ESG investing strategies on the scope are the "ESG top" and "ESG momentum" methods. This thesis's ESG top- investing technique refers to an approach in which the highest ESG rated stocks are selected in the portfolio. In industry terminology, a similar process that selects the companies to make the most effort to meet the responsible investment criteria is often referred to as the "Best-in-class" method (Robeco 2020). In this research, the ESG momentum strategy follows an approach that gives an overweight to stocks that have increased their ESG scores over recent time periods. Even though the two investing processes are different, both use the historical ESG scores as proxies for future returns.

ESG ratings have gained notable criticism on their goodness and viability (see, e.g., Dorfleitner, Halbritter & Nguyen 2015; Dimson, Marsh & Staunton 2020). There are various rating providers, and the same company might get a different rating depending on the agency. The weightings among the ESG themes also vary across the raters. This research is entirely excluding the evaluation of the ESG measures. The calculation of the Refinitiv's ASSET4 ESG scores is shortly introduced in section 5, and then finally, the results are critically compared with the earlier evidence. Refinitiv's ASSET4 database is one of the most used ones in the field of ESG performance research. This thesis does not

account for trading costs through all the portfolio transactions. In reality, actively managed and yearly updated portfolios would cause transaction costs, taxes, and other optional costs that might affect the outcome.

1.5 Structure

The first section gives an overview of the research, followed by a short description of ESG. Section 3 presents the most used ESG strategies in addition to previous studies related to abnormal returns on ESG investing. Section 4 provides the theoretical background and assumptions behind the empirical part. Section 5 describes the data and the formed portfolios. Section six examines the empirical results, and section seven discusses them more comprehensive inclusive of the reasoning behind. Finally, section 8 concludes the study.

2 ESG BRIEFLY

ESG investing refers to an approach in which investment decisions are made based on environmental, social and governance criteria alongside financial factors. However, the field's glossary is not standardized, and numerous terms are used as synonyms to describe the phenomenon (e.g., corporate social responsibility (CSR) and socially responsible investing (SRI)). The heterocenoucity in terminology has been explained besides the lack of stabilization by cultural and ideological differences (Sandberg, Juravle, Hedesström & Hamilton 2009).

2.1 Responsible investments

Eurosif (2021), the leading European association of sustainable and responsible investments across Europe, defines an investment to be responsible when;

1. *Environmental, Social, and Governance factors are considered essential,*
2. *investment is creating long-term sustainable returns, and*
3. *it has stable, well-functioning, and well-governed social, environmental, and economic systems.*

The earliest ESG approaches were centralized in environmental dimensions concerning climate change, greenhouse gas emissions, air and water pollution, and renewable energy use. Over the last decade, the social and governance-related factors have grown by the same token. The social dimension includes aspects of diversity, human rights, and labor standards, whereas the governance dimension focuses on board independence and diversity, bribery, corruption, and auditor independence. (MSCI 2021; Tucker & Jones 2020, 57).

The demand for ESG investing is often considered a strong ideology among the millennial generation, referring to the generation born between 1981 and 1996. Tucker and Jones (2020) suggest that ESG investing's demand cannot be considered vital only among the millennials but also among the older generations. Their analysis also solved no apparent differences in gender preferences for ESG investing. Among institutional investors, ESG has become a mandatory component to consider in the investment process.

The most common motivations for ESG investing can be divided into four categories (Bruno et al. 2021). The first motivation is to match the equity portfolio characteristics with investors' values and norms. The second one is to make a social impact by using voting rights and driving firms towards responsibility in the long term. The third reason is risk-management based, more precisely reducing exposure to risks such as climate or litigation risk that ESG laggards may be exposed. The last one is generating abnormal returns by following the ESG investing strategies, and so, this research is interested in that exact motivation. Silvola & Landau (2019) found that most of the largest Finnish institutional investors are following responsible investment strategies not only for value- and norm-based reasons but pursuing higher returns. The research argues that the large majority of Finnish investment managers also consider responsibility as a risk management tool.

2.2 ESG disclosure

According to the Directive 2014/95/E.U., all listed companies in the European Union have a legal obligation to publish reports on their social responsibility (EUR-Lex 2014). For manufacturers of financial products and financial advisers, ESG disclosure is further defined and settled by the Sustainable Finance Disclosure Regulation (SFDR), Regulation (EU) 2019/2088. The purpose of the regulation, applied in March 2021, besides supporting the green deal, is to make the responsibility easier and more transparent to understand towards end investors (European Commission 2021b). SFDR requires financial advisers to classify their

products into articles 6, 8, and 9 according to their ESG characteristics (EUR-Lex 2019). Financial products belonging to the category of article 6 are not including sustainability in terms of the investment process. Category 6 might consist of tobacco companies or thermal coal producers, for instance (Robeco 2021). Article 8 applies when a product promotes, among other characteristics, environmental or social characteristics, or a combination of those characteristics, inclusive of a good governance practice of the company selling those products. The products belonging in the category of article 9 are targeting sustainable investments. Article 6 has been seen as a considerable marketing problem as the products are forced to be matched against more sustainable ones (Robeco 2021).

In contrast to the European Union, the disclosure of ESG information is currently optionally in the US and Switzerland. In Switzerland, the ESG reporting is announced to become mandatory for “Companies of Public Interest” as of 2023. The voluntary-based reporting has been defended, among other things, with the statement that companies would report voluntarily to fill stakeholders’ requirements nonetheless and legitimize their existence, and thus, the regulation not being necessary (Fallan and Fallan 2009).

3 LITERATURE REVIEW

As already discussed, except for ethical and value-based reasons, investors are applying ESG investing practices to obtain higher portfolio returns. According to Alford (2019), building a solid basis for an ESG investing strategy might be a long and complex process, while historical simulations giving counterintuitive implications and trusting an intuition alone might also be questionable. When the markets are efficient, it is impossible to generate abnormal returns as all information is already priced in the stock markets (Fama 1970).

This section is divided into two sub- sections. The first part (2.1) describes the most common ESG investing strategies, their historical development, applications, and the critic gained in the academic literature. The second part (2.2) makes a more comprehensive review of ESG as an anomaly. The second part also discusses regional differences in ESG stock market returns between the US and Europe and reviews the earlier evidence about the much-discussed ESG stock market boom during the COVID-19 crisis.

3.1 Responsible investing strategies

As discussed earlier, the terminology in ESG investing is highly heterogeneous, which also applies when talking about stock market investing strategies. The strategies described in this section appear in academic and practical industry fields; however, the terminology is often different. The first sub-chapter introduces the traditional ESG investing strategies, moving to more advanced methods and the momentum strategy. Figure 2 concludes the most popular ESG investing strategies.

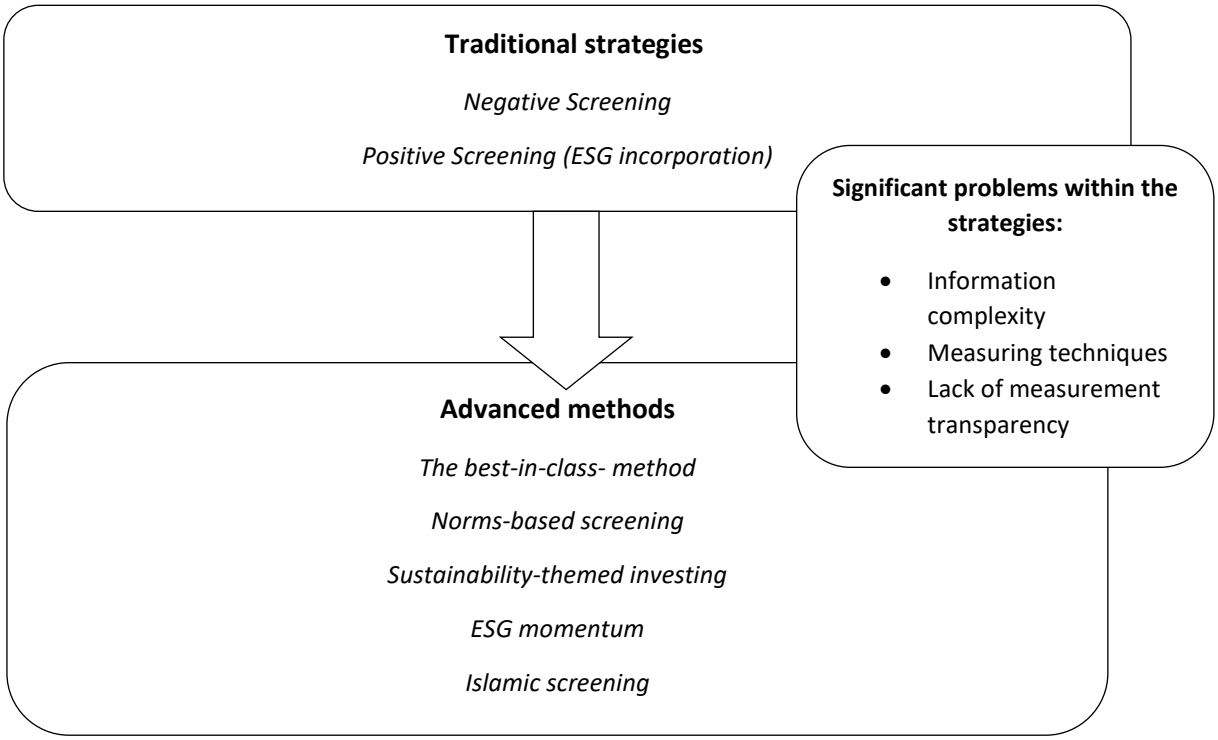

Figure 2. The most common ESG investing strategies. *(Eurosif 2021; Dewandaru et al. 2015; Nagy et al. 2013.)*

This research examines two different ESG investing strategies; the first one conducts the portfolios based on the best ESG scored firms (ESG top). This method can be seen as a mix of positive screening and the "best-in-class" method, as the stocks are selected based on the best ESG scores but among a specified geographical universe. The corresponding method has been referred to with "top ESG" or "the highest ESG score," among other terms in the earlier academic findings. The second method under review is "ESG momentum," a relatively yet unknown ESG investing strategy.

3.1.2 Traditional screening strategies

Even though the ESG strategy terminology is not standardized, according to Sandberg et al. (2009), negative - and positive screening (also referred to as ESG incorporation) can be counted as the most academically noted ones. The earliest ESG strategies were based on the negative screening method. (Renneboog, Horst, Zhang 2011) In the ESG performance investing research, the portfolios are often build using mixed strategies by going long in ESG performers and short in ESG laggards (e.g., see Kempf & Osthoff 2007, among others) Also, negative- and positive screens have traditionally been the most used among the fund industry.

When following the negative screening, an investor excludes certain ‘‘sin stocks” such as alcohol or tobacco based on criteria selected by asset managers or asset owners (Scholtens 2014). Negative screening has been considered the most straightforward method for companies to use (Colle & York 2008), which also explains the technique's popularity. While the negative screening focuses on “sin” stocks to be excluded, the positive screening aims to find those that add value to the community (Blank, Sgambati, Truelson 2016). Humphrey and Tan (2012) describe typical positive screening portfolios to include preferred stocks highly scored in good labor relations and community development involvement. Also, Eurosif (2021) recognizes a similar approach, in which the investments are based on the intention to generate social and environmental impact alongside a financial return (i.e., ESG incorporation).

Both screening methods have been criticized in academic literature. Barnett and Salomon (2006) argue in favor of positive screening, while Humphrey and Tan (2012) do not find any impact in portfolios’ risk-return relationship when applying positive or negative screening approaches. However, the critic gained by negative screening is much broader. Scholtens & Trinks (2017) argue that the negative screening approach is leading to clear portfolio underperformance. The study of Scholtens & Trinks (2017) suggest, covering a sample of more than twenty years, that negative screening includes opportunity costs. The proposition

is explained by investments in controversial stocks often leading to outperformance when observing the risk-adjusted returns. As a notable example, the US tobacco producer Altria Group has performed the best among the S&P500 equities for an almost eigh t-year period (1925-2003), delivering on the average annual return of 17%, dividends re-invested (Siegel 2005). Hong and Kacperczyk (2009) argue that sin stocks have higher expected returns, and thus, investors pay a cost when abstaining. Also, the ethical effectiveness of negative screens has been questioned as to the assumption behind has seen flawed, assuming no company can corporate in responsible way among a "sin" category (Colle & York 2008). It is noteworthy that both screening methods include significant information complexity problems, measuring technique-related issues, and lack of measurement transparency (See, e.g., Sandberg et al. 2009). The problem occurs if the chosen method by definition includes selecting companies and excluding others (i.e., when comparing the firms with each other), thus implying the case of the most advanced techniques.

3.1.3 Advanced methods

Several advanced responsible investing methods have been rising in popularity over the past decade. As the techniques are advancing, the demand for reliable data increases equally. Better data allows better comparisons among firms and will enable researchers to study the statistical influences, which leads investors to apply those ever-more-refined strategies in practice. Investors are more and more interested not only in what the companies are producing but also in how they are doing that compared to their peers in the industry. (Blank et al. 2016)

When the positive screening focuses on ESG favorable firms, the best-in-class process selects the top ESG scored firms for specific ESG criteria within a specified category. Following the best-in-class strategy, an investor sorts or weights the top ESG scored investments within a

universe, variety, industry, or class (Eurosif 2021). When an asset manager includes in his portfolio stocks of only those firms belonging to the top 30% within their industry in terms of ESG performance, the best-in-class method is applied (Scholtens 2014). Several authors have reported positive contributions of risk-adjusted returns when utilizing the equivalent approach, which includes classifications in the specified industry, country, or other categories (see, e.g., Kempf & Osthoff 2007; Eccles et al. 2014; Verheyden, Eccles, Feiner 2016; Giese et al. 2019). Moreover, the "best-in-class" is the most used ESG investing method of the earlier academic papers, as the method can be counted to be used when the investment universe is limited in a specific country, area, or industry.

In addition to the above-mentioned best-in-class method, Eurosif (2021) is recognizing three additional modern strategies: "Engagement & Voting," "Norms-based screening," and "sustainability-themed investing." Engagement and voting -strategy refers to an approach in which an investor seeks to influence the ESG behavior in the long term by using his voting rights. The engagement process, in which investors actively use their voting right to request companies improve their level of sustainability factors, is also noted in the academic literature (see, e.g., Dimson, Karakaş, & Li 2015; Barko, Cremers, Renneboog 2018). Some authors support Engagement & voting strategy as it excludes the earlier discussed measurement and transparency problems, focusing instead on long term-improvement (Scholten & Trinks 2017). Eurosif (2021) defines norm-based screening as an approach that involves screening investments based on international ESG norms or combinations of standards defined by international bodies such as the United Nations. In academic literature, social norms-based investing is a relatively unknown concept. Social norms-based investing is often studied by boycotting stocks inconsistent with social norms rather than including those with high social standards (see, e.g., Hong & Kacperczyk 2009). Sustainability-themed investments cover investments linked to sustainability development, focusing on specific or multiple issues within the factors, such as climate change of eco-efficiency (Eurosif 2021). In other words, sustainability-themed investments can be seen focusing on the environmental dimension of ESG investing. The strategy is also applied in academic papers, and as discussed

earlier, the earliest ESG approaches were mainly centralized in the environmental dimension. Still today, sustainability focusing investment strategies are widely popular (i.e., The sustainability focusing global Green Climate Fund, intending to invest in low-emission and climate-resilient development as the world's largest climate fund.)

Over the last decade, Islamic screening has experienced tremendous growth (Dewandaru, Masih, Bacha, Mansur, Masih 2015). The popularity of the Islamic investment method can be explained besides the religion's adherents and non-Muslim individuals' and companies' attentiveness in ethical values that the strategy is exercising or the attractive returns as the market grows (Lai 2014, 439). The academic research has been raising by the same token. The method follows a somewhat similar procedure as the traditional ESG negative screening by excluding non-ethical components. The Shariah (Islamic) ethic excludes stocks considered harmful for human beings and the planet, such as tobacco, betting, pork-related products, and alcohol. Islamic finance also imposes a specific upper limit of interest-based leverage, interest income, and cash-equivalent assets. The exclusions are driven by Islamic ethical values, such as being free of interest and avoiding speculation (Lai 2014, 439). Moreover, the Islamic investing strategy has been computed with various traditional investment strategies, such as momentum, as it also creates a unique risk and returns setting (See, e.g., Dewandaru et al. 2015; Derigs & Marzban 2008).

3.1.4 ESG Momentum

When the traditional screening strategies make the investment decisions based on the absolute value of a company's ESG score, the relatively new ESG momentum strategy selects the companies increasing their ESG score over time. In industry terminology, the process is also referred to as the "Best-in-universe" -strategy (Eurosif 2021). Even though the approach is new, some academic papers have noted it during the last years, Nagy et al.'s (2016) analysis being one of the most referred ones.

As the traditional momentum style makes the investment decisions based on the recent pattern, so does the ESG momentum. When a stock has a solid growth in ESG performance, it is likely to maintain the upward trend in ESG and in many cases also in stock market performance. In other words, an excellent recent ESG improvement is a sign of future outperformance potential. In contrast, the stocks with poor recent ESG improvement are expected to underperform against the market. Investors' tendency to overreact in positive ESG score publications has been seen as an explanatory factor for the ESG momentum effect (Chen & Yang 2020). The ESG momentum strategy appeared first by Nagy, Cognan & Sinnreich (2013). The research used MCSI ESG ratings from February 2008 until December 2012. The study results showed that the ESG momentum significantly outperformed the benchmark index with an abnormal positive annual return of 0.35% in a four-year time period. The ESG momentum portfolio included a relatively low ESG score tilt, but the scores climbed higher on a portfolio level.

The following research of Nagy et al. (2016) found a strong outperformance against the MSCI World Index over the past eight years. Furthermore, the evidence pointed out that an increase in ESG rating was not strongly associated with the stock's beta, volatility, or valuation. Also, Verheyden et al. (2016) investigate the phenomenon of past ESG growers to continue being winners in a five-year period in developing countries. The authors conducted six portfolios, some of which including ESG momentum as the stock selection criteria. As a result, those portfolios, including the ESG momentum element, performed the best in terms of annualized and risk-adjusted returns. The authors define ESG momentum as a strategy in which the firms making significant efforts to improve their ESG score are selected in portfolio holdings, even though they are still among the worst scores. The strategy, however, was not investigated purely. The study was using ESG scores provided by Sustainalytics.

Nagy et al. (2016) highlight the ESG momentum strategy being a short-term focused strategy as the market could be expected to react to a change in rating shortly. The argument is aligned with the analysis of Chen and Yang (2020), which identified a significantly positive relationship between ESG momentum strategies and financial performance in the Taiwanese

market in the short run. In the long run, the results were reversal. Chen and Yang (2020) find the holding interval that reverses the returns statistically insignificant to be one and a half years. The authors argue that investors may be reacting over-optimistically on good ESG signals and over-pessimistically on bad ESG news, but in the long run the market is efficient. As a result, the ESG momentum effect applies only short term. The positive, statistically significant alpha was obtained using the traditional Capital Asset Pricing Model (CAPM) and the Fama-French three-factor model. The ESG alpha was significant even after controlling the market factors. However, the authors did not take the transaction costs into account. Similar to this thesis, their study used Refinitiv's ESG database,

3.2 ESG Anomaly

When the Efficient Market Hypothesis holds, the market prices fully reflect all the available information (Fama 1970). The Capital Asset Pricing Model (CAPM), invented by Sharpe (1964), Lintner (1965), and Mossin (1966), assumes efficient markets. It states that the returns of an asset depend on risk-free rate, asset's return fluctuations relative to the market fluctuations, and market risk premia, which is the difference between market return and the risk-free market rate. However, various studies have identified patterns that are arguing against the CAPM and efficient markets. If average stock return patterns cannot be explained by the capital asset pricing model (CAPM), they are often called anomalies (Fama & French 1996). This section introduces the previous findings of ESG investing as an anomaly. The first part focuses on the most extensive meta-analyses and the history of the field of study. The first sub-section is followed by the findings on regional differences and evidence of excess returns in times of crisis, assessing the consistency of the ESG anomaly. Lastly, the earlier results about the performance of ESG investing strategies on the scope will be introduced. The evidence on the strategy performance, especially on ESG Momentum strategy, is a new field of study, and thus, the earlier evidence is relatively narrow.

The financial performance has been measured using accounting indicators, such as ROE and ROI, or by applying stock market indicators or applying both. Also, the construction of those indicators varies across studies. This literature review does not focus on accounting-based evidence, as the thesis focuses on the stock market performance. However, the most comprehensive meta-analyses in the field of ESG financial performance also include accounting-based performance. The ESG portfolio construction methods vary across the studies, and some of them employ an index-based passive approach, whereas others select the stocks individually and manage them actively as a portfolio.

3.2.1 ESG stock market performance

The return patterns that the CAPM cannot explain have also been identified several times in ESG investments. However, the earlier evidence is not entirely unanimous. The relation between high ESG criteria and financial performance on stock markets has been seeking its explanation for more than 50 years. Since the 1970s, more than 2000 empirical studies have been made around the topic (Friede, Busch, and Bassen 2015). As one of the earliest instances, the analysis of Moskowitz (1972) using correlation and regression modeling. The results showed a high and positive correlation between corporate social responsibility (CSR) awareness, firm commitment, and organizational performance. The large majority of the ESG stock market performance-related studies are conducted using regression modeling, often inclusive of factor loadings (See, e.g. Kempf and Osthoff; Nagy et al. 2016; Nagy et al. 2013; Serafeim 2018).

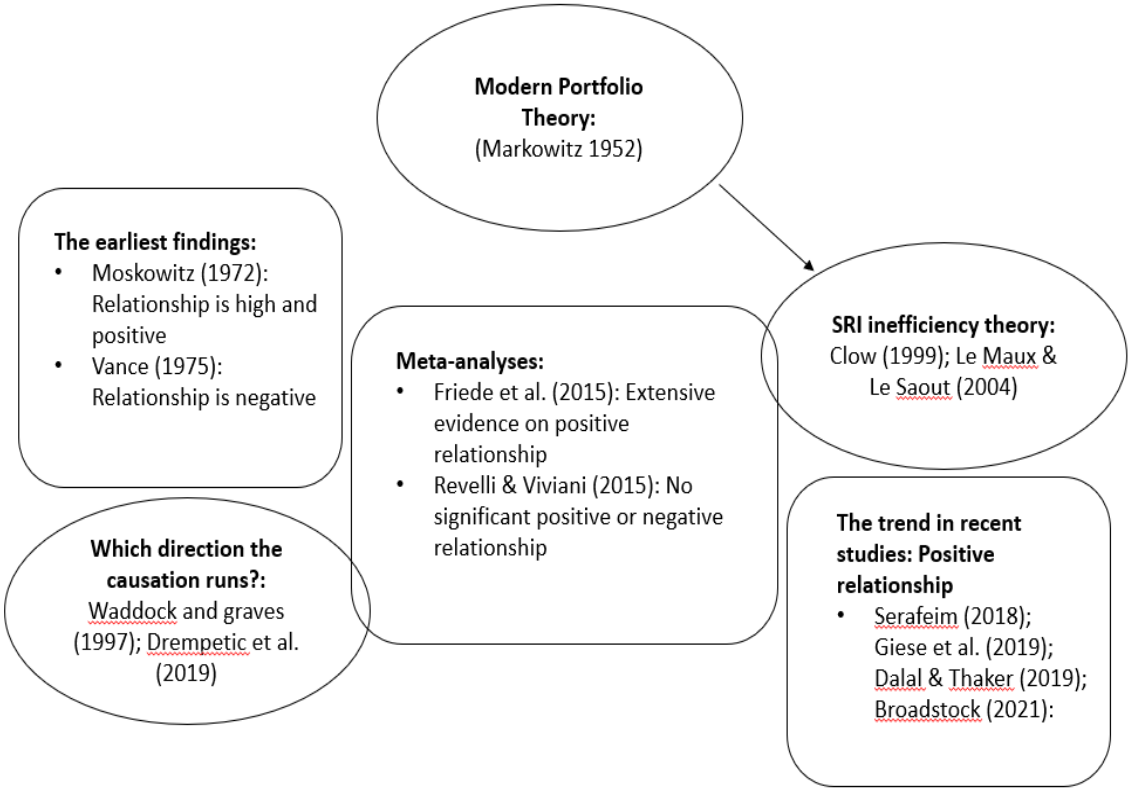

Figure 3. Earlier evidence on ESG investing and stock market performance.

Figure 3 describes the overall development of the ESG stock market performance research. The meta-analyses of Friede et al. (2015) combined the findings of around 2200 research, aiming to extract all provided primary as well as secondary data of previous academic reviews. The results show that most studies are reporting positive findings. Furthermore, the results remain positive on a portfolio as well as nonportfolio studies within different regions. The study's ESG performance measures included several indicators: accounting and market-based performance, operational and perceptual performance, growth, and risk metrics.

Also, Revelli and Viviani (2015) investigate the relationship between socially responsible investing (SRI) and financial performance with a meta-analysis. The analysis covered 85 different studies and 190 experiments in a 20-year time period from 1972 to 2012. The results find no significant relationship between ESG investing and ESG financial performance.

The research discusses that the level of performance seems to depend on researchers' methodological choices. However, the meta-analysis found that the adoption of ESG standards is neither generating costs for an investor observed from a global perspective. The study of Revelli and Viviani (2015) challenges the theory of SRI inefficiency (see, e.g., Le Maux & Le Saout 2004; Clow 1999.) The SRI inefficiency theory derives the principles of the Modern Portfolio Theory (Markowitz 1952). The poor performance of ESG investing is argued to be caused by a limited investment universe, including only stocks with high ESG standards and a limited investment universe, indeed leading to reduced diversification. Still, several studies are finding a negative relationship between ESG investing and stock market performance.

Auer & Schuhmacher (2015) analyzed the risk-adjusted performance of ESG portfolios using the Sharpe ratio. They found no evidence of ESG portfolio risk-adjusted outperformance. In fact, the risk-adjusted return of European ESG portfolios was significantly lower than the corresponding index benchmarks. Moreover, evidence on ESG portfolio non-superiority has been introduced throughout the whole 50 years (see. e.g., Vance 1975; Demers et al. (2021))

Kempf and Osthoff (2007) study the effect of choosing ESG favorable firms in portfolio construction and examine the results using the Carhart 4-factor model. The authors formed several portfolios based on negative- and positive screenings in addition to the best-in-class method. The portfolios were rebalanced each year, and the authors included strategies investing long-only in highly ESG scored firms, short- only on low scores firms, and combinative long-short strategies. The strategy delivering the best outperformance was the best-in-class method, which delivered a positive alpha. The alpha remained positive also after taking the transaction costs into account. Moreover, the other strategies were generating abnormal returns, although not economically significant.

Today, as the demand and legislation for ESG information are increasing rapidly, so do academic research. Serafeim (2018) finds the effect of public sentiment momentum about a company’s sustainability metrics significantly affecting both the price paid for the high ESG metrics and the returns of ESG portfolios. The study combined ESG scores of one of the most

popular ESG score providers, MSCI, with big data provided by TruValue Labs. A growth in ESG scores led from two to three times better market value for those companies, whose responsibility has gained positive attention in public media. Moreover, the trend in the recent studies is to find a positive relationship between ESG characteristics and financial performance (see, e.g., Broadstock, Chan, Cheng, Wang 2021; Giese, Lee, Melas, Nagy, Nishikawa 2019; Dalal & Thaker. 2019)

Bruno et al. (2021) argue that the recent strong stock market performance of ESG strategies is caused by an increase in investor attention. The authors argue that the estimated ESG excess returns are up to four times lower than during high investor attention periods. According to the study, recent evidence focuses on stock market returns over recent periods, which leads them to appear higher for ESG strategies. According to the authors, ESG stock market outperformance appears when observing the raw returns only. The outperformance disappears when applying the classic risk adjustments, and common market factors and sector biases can explain the performance. If investors falsely assume the outperformance to be caused by the ESG factor, they suffer losses. The research pointed negative exposure to size factor to be common within the ESG investing strategies, and it concluded ESG strategies resembling widely used large-cap quality strategies. The study used ESG scores data from MSCI (IVA) from January 2007 to June 2020, and it included, besides going long for ESG winners and short for ESG laggards, the ESG momentum strategy.

Furthermore, several studies prove that ESG performance and firm sizes correlate highly and positively (see, e.g., Drempetic, Klein, Zwergel 2019; Borovkova & Wu 2020). If the positive relationship between high ESG engagement and financial outperformance exists, a reasonable question is which direction the causation runs. The positive link between financial performance and socially responsible investing has been argued to be caused by a well financially performed firm's ability to choose to spend their resources socially responsible way (Waddock and Graves 1997; Drempetic et al. 2019).

In this thesis, the actively managed, yearly updated portfolios investigate causality from high or grown ESG scores to better stock market performance. The portfolios are updated after

the publication of the new ESG scores. The momentum portfolios provide further evidence on the direction of the causality, as the indicator is not a high ESG score of a large firm but the growth of the score that a firm has gained. The null hypothesis of this thesis is that since the markets are efficient, it is not possible to generate abnormal returns by using ESG investing strategies.

3.2.2 Regional differences

The research on regional differences in ESG investing performance has gained some attention in the past few years. Especially, the difference between the US and other world has gained some attention in the academic papers. Even though the earlier evidence is still relatively narrow, a few studies seem to identify somewhat lower performance for the ESG stocks in the US compared to the other word.

Giese et al. (2019) investigated the regional variations of ESG outperformance using index-based approaches in a roughly seven-year period. ESG integration led to a lower risk level at a global level besides showing slightly positive performance. However, the evidence showed significant regional variation. In the US, avoiding poorly ESG- scored firms even led to underperformance in the tech sector. At the same time, the outperformance in the world excluding the US was achieved by following the same investing method. However, within all regions, the research proved significant risk reduction. Also, Kaiser (2019) investigates European and US ESG stocks within the ESG style factors. According to the multi-factor regression results, both US and European investors can add ESG stocks to their portfolios, simultaneously increasing the risk-adjusted performance. However, the evidence argues that the adoption rate of ESG is higher in Europe, leading to ESG information being more efficiently priced in the European market. Thus, in the US market, an investor could benefit from the underpriced ESG information better.

Borovkova et al. (2020) suggest the European stocks with higher ESG scores enhancing returns and the reversed situation in the US. The study found highly ESG scored companies having a significant negative relationship with excess returns over the market index in the US. The analysis revealed the results being caused by less focus on sustainability issues in the US; In other words, the ESG stocks having less demand in the United States. Besides the US, the research found a negative relationship between ESG scores and excess returns for Asian firms. The study used Refinitiv's ESG scores for over a nine-year period.

In contrast, the analysis of Eccles, Ioannou, and Serafeim (2014) found high ESG scored US companies to significantly outperform their benchmark over 18 years within a matched sample of 180 firms. The study included both the stock market performance and accounting-based indicators, and it was also conducted using a factor regression model.

Several findings propose high social responsibility factors in a firm leading to lower investment risk (e.g., Shane & Spicer 1983; Spicer 1978). The analysis of Waddock and Graves (1994) presents strong support for a preference of stocks with higher corporate social performance, which indirectly leads to a lower discount rate. The authors argue that a rational investor places a higher value on a stock with higher ESG characteristics and lower investment risk, keeping the other factors constant and assuming efficient markets. In the light of this evidence, lower demand for ESG stocks driven by consumer preferences in the US markets may be seen as a questionable conclusion as the investors are avoiding risk regardless of one's responsibility preferences.

3.2.3 Performance in COVID-10 crisis

As discussed above, ESG stocks shown good performance record in various academic research. To better understand a possible ESG anomaly, describing its fractal characteristics in the COVID-19 crisis is also appropriate. After the first dropdowns of the Covid- 19 pandemic, high ESG scoring firms have been argued to be protected in the equity market among the industry operators (see, e.g., Blackrock 2020; Nagy & Giese 2020). Also, some academic evidence and white papers have already been published considering the phenomenon (Bose, Shams, Ali, & Mihret, 2021; Demers, Hendrikse, Joos, Lev 2021; Borowkova & Wu 2020). However, as the crisis is still very recent, the existing evidence is naturally narrow and focuses only on the first months of the crisis.

The white paper of Borovkova & Wu (2020) investigates the stock market movement of high ESG score firms in the US market during the COVID-19 crisis. The research found that the top-10% ESG scoring firms' losses stayed in 2/3 of the defeats of the bottom 10% scored companies. From a sectoral perspective, the effect was even higher. The research, however, covered a relatively short five-month period from January till May 2020, and thus, the entire crisis period is not included. However, the performance in the COVID-19 period was observed by looking at raw average returns.

Moreover, Bose et al. (2021) present supporting findings by stating that the COVID-19 crisis impacted less on firms with better ESG performance. Their sample period covered seven first months of the COVID-19 crisis, as of January, using Refinitiv's ESG score data. The study measured the financial performance controlling both the book value of total assets and the market value of equity. The positive impact of ESG on firms' performance was found with an international sample.

A high ESG score working as a shield in times of crisis has been subsequently challenged. Demers et al. (2021) argue that ESG is an insignificant factor for returns in the first quarter of

the 2020 COVID-19 crisis period and the full year 2020 in total. The authors classified high ESG performers as the highest decile firms of the scores and showed the high performance of top ESG scores portfolios to be caused by market- and accounting-based factors rather than by COVID-19. The results remained the same when using several ESG data providers, inclusive of Refinitiv. The study was conducted in the US markets, employing factor regression models.

The stock market performance of the ESG portfolio has also been examined during other market crises. For instance, Kaiser (2020) explains investors' behavior with less interest in paying attention to social issues when market liquidity is low and uncertainty high based on the research sample on the financial crisis (2007-2008). This thesis fills the literature gap by investigating the performance of ESG stocks with a 15-month sub-sample period, covering several waves of the crisis. The period on the scope is significantly longer than examined in the previous studies. The observation period starts in March 2020 before the equity stock market crash[1] and lasts till May 2021. At the time of writing, the ending point of the crisis can still be seen as questionable.

[1] The COVID-19 stock market crash started on March 9 when Dow Jones Industrial Average (DJIA) dropped 7.79%. The event was followed by two plunges on March 12 and March 16 with 9.99% and 12.93%.

4 PORTFOLIO PERFORMANCE METRICS

The theoretical framework behind the performance metrics provides the guiding principles and makes the results easier to understand. This chapter describes the theoretical framework of the main concepts used in the regression modelling and measuring risk-adjusted excess returns, which are applied later in the empirical section.

Most ESG performance studies are based on the Capital Asset Pricing Model (CAPM) and its risk- extended applications. Following the previous literature, this study investigates the factor loadings of the ESG portfolios. Sharpe ratio and skewness- and kurtosis- adjusted Sharpe ratio are employed as the measures of total- risk-adjusted-performance.

4.1 Fama-French factor models

Even though the original CAPM is one of the most used financial models, it has gained critics through time. When CAPM bases its calculation method only on the market risk factor, factor models gather the excess return, including exposure to other market factors. In 1992, Fama and French found evidence of a violation in linear cross-sectional that the CAPM assumes. Therefore, Fama and French (1992) supplement the CAPM model by introducing additional small-minus-big (SMB) and high-minus-low (HML) factors. The reasoning behind the SMB factor is the small-cap firms tending to outperform large-cap firms. As formula three illustrates, the HML factor explains that companies with a high book-to-market multiple outperforming companies with a low book-to-market multiple in the long run. In other words, the model is gathering the size and value anomalies, and the expected stock return depends on beta, size, and value factors. The Fama-French-three factor model (FF3) can be written as follows:

$$r_p - r_f = \alpha_p + \beta_p(r_m - r_f) + S_p SMB + h_p HML + e_i \quad \textbf{(1)}$$

With,

$$r_p - r_f = \textit{Portfolio excess return over the risk-free rate}$$

$$\alpha_p = Overall\ excess\ returns\ explained\ by\ the\ model$$

$$r_m - r_f = Market\ excess\ return\ over\ risk\ free\ rate$$

$$\beta_p, S_{p,} h_p = Loading\ or\ sensitivity\ of\ the\ asset\ p\ to\ a\ change\ in\ factor$$

$$SMB = Excess\ return\ of\ small - cap\ firms\ over\ large - cap\ firms$$

$$HML = Excess\ return\ of\ high\ \frac{B}{P}\ firms\ over\ low\ \frac{B}{P}\ firms$$

$$e_i = Error\ term$$

If the alpha (α_p) coefficient becomes statistically significant and positive, the portfolio being analyzed in creating greater than the market returns, explained by other factors. In turn, if the alpha becomes statistically significant but negative, the portfolio is delivering below-market returns. When the alpha is not statistically significant, the returns are explained by the model. The explanatory power of the three-factor model has been widely questioned, resulting in adding more explanatory factors to the formula. One of the most used extensions of the 3- factor model is the Carhart four-factor model by Carhart (1997), which adds the earlier discussed momentum factor of Jegadeesh & Titman (1993) into contribution. The momentum factor describes the return difference between the past winners and losers (WML), adding the momentum factor (WML) as follows:

$$r_p - r_f = \alpha_p + \beta_p(r_m - r_f) + S_p SMB + h_p HML + W_p WML + e_i \quad \textbf{(2)}$$

With,

$$W_p = Loading\ or\ sensitivity\ of\ the\ asset\ p\ to\ a\ change\ in\ factor$$

$$WML = Excess\ returns\ on\ momentum\ effect$$

Fama and French (2015) extend the model and introduce two additional factors, making the three-factor model a five-factor model. The two added factors, robust-minus-weak (RMW) profitability, and conservative-minus-aggressive (CMA) investment activity factor providing an even more comprehensive model for examining the excess return. The momentum factor has also been added in Fama and French's five-factor model (2018), making it the six-factor model as follows:

$$r_p - r_f = \alpha_p + \beta_p(r_m - r_f) + S_p SMB + h_p HML + W_p WML + R_p RMW + C_p CMA + e_i \quad \textbf{(3)}$$

With,

$$R_p, C_p = Loading\ or\ sensitivity\ of\ the\ asset\ p\ to\ a\ change\ in\ factor$$

$$RMW = Excess\ returns\ of\ firms\ with\ robust\ profitability\ over\ firms\ with\ weak\ profitability$$

$$CMA = Excess\ returns\ of\ high\ investment\ firms\ over\ low\ investment\ firms$$

The RMW factor describes the difference between the returns on diversified portfolios of stocks with robust and weak probability measures by return on equity (ROE), and the CMA factor is the difference between the average returns of the stocks with conservative and aggressive investing firms. The CMA factor describes the development in firms investing behavior. In other words, it measures the excess returns of firms investing aggressively over those investing more conservatively (Fama & French, 2015).

4.2 Sharpe ratio and adjusted Sharpe ratio

Volatility measures the price variation of an asset over time, and historical volatility can be measured from past prices as the standard deviation. The more volatile an asset, the higher the risk. The Sharpe ratio (Sharpe 1966) adds the volatility dimension in the portfolio performance measurement, making the returns risk-adjusted. The "reward-to-variability ratio," as Sharpe (1966) himself calls it, describes the return on investment compared to its total risk level. The addition of the risk dimension is making two portfolios with different risk levels comparable with each other. In general, the greater the Sharpe ratio, the more attractive a portfolio is.

$$Sharpe\ Ratio = \frac{R_p - R_f}{\sigma_p} \quad \textbf{(4)}$$

With,

$$R_p = Return\ of\ the\ portfolio$$

$$R_f = Risk\ free\ rate$$

$$\sigma_p = Standard\ deviation\ of\ the\ portolios\ excess\ return$$

As equation (5) describes, the Sharpe ratio provides the excess return of a portfolio per one unit of volatility. The risk of a portfolio of an asset can be divided into two separate risk components. The unsystematic risk describes a firm-specific risk that can be deleted with good diversification, whereas systematic risk includes the market risk inherent to all assets. The Sharpe ratio considers the total risk, in other words, both systematic and unsystematic risk of an asset or a portfolio.

The main weakness of the Sharpe Ratio is that it assumes the returns to be normally distributed. When the returns are not following the normal distribution, the ratio may provide misleading results. The distribution of financial returns is often skewed, varying significantly from the normal distribution. The Sharpe ratio, basing its calculation method on standard deviation, has been seen as a questionable risk-adjusted return measure by several scholars (see, e.g., Sortino & Meer 1991; Pezier and White 2006; Pätäri 2008).

The Sharpe Ratio can be adjusted by capturing the skewness and kurtosis of a portfolio or asset's return distributions (Pezier and White 2006; Pätäri 2011). The idea behind capturing the skewness of return distributions is to separate positive- and negative skewness, or as Sortino & Meer (1991) conclude, distinguishing good and bad volatility and further the mean return for positive skewness becoming higher than its median. Pätäri (2011) introduces SKASR (Skewness and Kurtosis Adjusted Sharpe Ratio) as follows:

$$SKASR = \frac{r_{P-}r_f}{SKAD_p^{\frac{ER}{|ER|}}} \qquad \textbf{(5)}$$

With,

$SKAD_i$ = *Skewness- and kurtosis-adjusted standard deviation of excess returns of portfolio i*

$$ER = Portfolio's\ average\ excess\ return$$

SKASR captures the thirds and the fourth moments of return distributions on a scope. The SKAD in the formula is utilizing the fourth-order Cornish-Fisher (1937) application of Z value. Finally, the SKAD is calculated by multiplying the standard deviation by the quotient of the adjusted Z value and the critical value for normal distribution. The adjusted Z value is calculated as follows:

$$Z_{cf} = Z_C + \frac{1}{6}(z_C^2 - 1)S + \frac{1}{24}(Z_c^3 - 3Z_c)K - \frac{1}{36}(2Z_c^3 - 5Z_{c)}S^2 \quad \textbf{(6)}$$

With,

$$Z_c = The\ critical\ calue\ for\ the\ probability\ based\ on\ standard\ normal\ distibution$$

$$S = Skewness\ of\ the\ return\ distribution$$

$$K = Kurtosis\ of\ the\ return\ distribution$$

As equations (6) and (7) show, SKASR corrects the traditional Sharpe ratio, and the direction of correction depends on the direction of skewness. A positive direction of skewness increases the ratio and vice versa. In the case of normally distributed returns, S and K are equal to zero. It is worth mentioning that the Sharpe ratios cannot be utilized in the original format when a risk-free asset provides better returns than a portfolio or an asset. However, both the ratios can be adjusted to make them provide correct rankings in the case of negative excess returns (Israelsen, 2005).

5 DATA AND METHODOLOGY

5.1 Data

This thesis uses Refinitiv ASSET4[1] databases' ESG scores collected from 2011-2019. Several scholars have used Refinitiv's database in the earlier ESG research (see ex., Kaiser 2020; Bose et al. 2021; Demers et al. 2021), though ESG Momentum strategy has not yet been expounded under it. This thesis uses the yearly ESG scores, which is a typical ESG score publication frequency in the field. The scores are given on a scale from 0 to 100, with zero indicating the lowest score possible. The study accounts for a potential survivorship bias, as the scores include joiners and leavers.

Refinitiv's ESG scores are calculated for more than 10 000 firms globally, based on the self-reported information in the environmental, social, and corporate governance pillars. Refinitiv collects over 450 ESG-related variables, from which it sorts a subset of 186 of the most comparable ones. These subsets are grouped into ten categories forming the three pillars: Environmental, Social, and Governance, and weighted proportionately (Refinitiv 2021). In this study, the ESG performance is treated as a total score without separating the three dimensions. Table 1 describes the ten subcategories of the three dimensions.

[1]The same database was previously provided by Thomson Reuters. The renaming related to acquisitions with the Blackstone Group LP 2019.

Table 1. Categories and subcategories of Refinitiv's ESG scores

Category	*Subcategory*
Environmental	*Resource use*
	Emissions
	Innovation
Social	*Workforce*
	Human Rights
	Community
	Product responsibility
Governance	*Management*
	Stakeholders
	CSR strategy

Similarly, the stock price data is collected from Refinitiv. The study utilizes the total return instead of the pure price data. The total return (TR) shows a theoretical growth in value of a shareholding. The ratio assumes that dividends are reinvested to purchase additional units of an equity or unit trust at the closing price applicable on the ex-dividend date. The stock price data has been collected at monthly frequency for the whole sample period and daily frequency for the COVID-19 subsample period. The US portfolios are treated in USD and European portfolios in euros. The foreign currencies (GBP, SEK, NOK, CHF) are converted to euros using the monthly foreign exchange rates provided by Refinitiv. Correspondingly, for the COVID-19 period, the foreign currencies are converted to euros by using daily exchange rates of Refinitiv.

The ESG portfolios are conducted separately for the US and Europe, similarly to Kaiser (2020), to geographically compare ESG stock market performance. In this research, Europe covers 16 developed European countries: The United Kingdom, France, Germany, Belgium, Switzerland, Netherlands, Spain, Italy, Sweden, Norway, Finland, Denmark, Ireland, Austria, Portugal, and Luxembourg.

The European sample is as large as possible to achieve a sample comparable to the US; although, limited to developed countries. The benchmark is S&P 500 for the US portfolios and Euro Stoxx 600 for the European ones. The thesis uses 1- month US Treasury bill as a risk-free rate of return. The risk-free rate of returns and factor data used in the regressions is retrieved from the Kenneth French's data library[1].

Table 2 describes the substantial increase in ESG data availability over nine years. The growth of available scores has been 259.8% for the US and 113.1% for Europe. In 2021, the US is leading the disclosure as the ESG scores are available for 94% of the total companies. On average, the ESG scores have notably higher means and medians in Europe. The UK firms account alone 29,4% of the total amount of European companies, and the three largest European countries (UK, Germany, and France) 50,84% in total.

Table 2. ESG score statistics

The United States						
Year	**Count**	**Mean**	**Median**	**Std**	**Max**	**Min**
2011	799	42.74	40.01	19.99	92.57	1.77
2012	802	43.37	41.83	19.64	91.4	1.37
2013	817	43.63	42.70	19.48	92.06	1.46
2014	847	43.78	42.03	19.19	92.26	1.1
2015	1416	39.21	35.89	19.14	93.03	0.87
2016	2073	37.13	32.90	18.31	91.23	0.39
2017	2340	36.86	32.72	18.34	91.23	0.43
2018	2506	37.46	33.32	18.48	93.11	1.05
2019	2875	37.30	33.43	18.43	92.87	0.98
Average	1608	40.17	37.20	19.00	92.20	1.05
Europe						
Year	**Count**	**Mean**	**Median**	**Std**	**Max**	**Min**
2011	742	51.81	52.67	20.96	93.96	1.70
2012	759	52.22	52.50	20.33	94.50	1.55
2013	772	52.57	53.46	20.05	94.47	0.63
2014	794	53.06	53.33	19.89	93.19	1.04
2015	901	52.80	53.09	20.78	93.55	0.70
2016	932	54.09	55.64	20.08	92.00	1.03
2017	1042	54.41	55.71	20.02	94.33	2.30
2018	1501	51.12	51.58	21.13	94.51	2.05
2019	1581	52.38	53.31	20.51	94.44	1.50
Average	1003	52.72	53.48	20.42	93.88	1.39

[1]2021 Kenneth R. French http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

As Table 2 describes the number of available scores has been significantly increasing over the past decade. As the ESG disclosure increases, the ESG score mean, and median have simultaneously been decreasing in the US. In contrast, the mean and median have slightly increased in Europe over the years, even though the data availability has increased as well. The standard deviations are higher on average in Europe. However, the standard deviations have slightly decreased for both regions through the observation period.

On average, European companies have higher maximum and minimum scores. Also, their means and medians are notably higher based on the available data, indicating that the European companies have on average a higher sustainability level in terms of ESG. However, as the disclosure is higher in the US, straightforward conclusions cannot be made. The worst score over the sample period (0.39) was obtained in 2016 by COMSCORE, an American media measurement and analytics company. Conversely, the highest score (94.51) instead was documented in 2018 for German enterprise application software producer SAP.

1

5.2 Methodology

This section explains how the portfolios based on Refinitiv's ESG rating data are formed (Section 5.2.1) using two portfolio construction strategies, two different geographical universes. (Section 5.2.2) describes how the performance of these portfolios is measured.

5.2.1 Portfolio construction

The portfolios are formed and later updated based on their ESG performance. The stocks that remain in the portfolio holdings are equally rebalanced. The portfolios are constructed by utilizing R-studio and Microsoft Excel. Look-ahead bias[1] is taken into account by rebalancing and updating the portfolios each year on the 1st of July based on the ESG score on the previous year, 31st of December (for i = 12:20, 1.7.2000 + i). A missing ESG score or the missing total return data of stock leads to exclusion from the portfolio formation procedure.

The selection of portfolio holdings is based on ESG top and ESG momentum strategies. The ESG top portfolio prefer stocks with a high ESG score, whereas the momentum strategy seeks the top growth in the score. The momentum indicator is calculated simply by dividing the ESG score of the year N by the score of the year N-1, as the equation x presents.

$$(1) \quad Momentum\ indicator\ of\ a\ firm\ (f) = \left(\frac{ESG\ score\ (f)_n}{ESG\ score\ (f)_{n-1}} - 1\right) * 100 \qquad \textbf{(9)}$$

With,

$$ESG\ score\ (f)_n = ESG\ score\ of\ a\ firm\ (f)\ on\ a\ year\ n$$

[1] Look-ahead bias occurs, when investment decisions are made based on information, that is not yet published or otherwise available. Look-ahead bias might lead in incorrect results.

The point, which determines the portfolio holding inclusion limit is generally called the cut-off-point. Jegadeesh & Titman (1993) proved the portfolio returns to significantly decrease when the cut-off-point increases, as the level of information decreases equally. Also, Kempf and Osthoff (2007) found that ESG strategies should focus on extremely highly ESG scores firms, as the portfolio returns were higher when applying strict criteria. In this thesis, the yearly updated ESG- top portfolios include firms belonging in the top decile of the last year, and the momentum portfolios include the firms belonging in the top decile of the momentum indicators. Thus, this study follows the constant cut-off-point method similarly to Kempf & Osthoff (2007) and Demers et al. (2021). The thesis focuses on the long-only portfolios for better practical implement ability.

The portfolios are equally weighted. The holding periods for top portfolios are 1.7.2012-1.5.2021 and for the ESG momentum portfolios 1.7.2013-1.5.2021. The holding periods for momentum portfolios are one year shorter, as the change between the two first scores is needed for the ESG momentum portfolio construction. However, when comparing the returns of the two strategies, the top portfolio holding period is adjusted to correspond to the momentum portfolio holding period. The COVID-19 sub-samples comprise the same portfolio holdings as the full sample portfolios on 2019-2020, but in that case, the holding period is from 31.2.2020 to 6.5.2021. Thus, the rebalancing operations are calculated separately for the full sample period and the COVID-19 period, the full sample period using monthly total return data, and the COVID-19 period daily data. Appendix 1 describes the cut-off points off ESG scores for top and momentum portfolios separately for Europe and the U.S.

The portfolio inclusion ESG score boundaries for the European portfolios are higher throughout the sample period (Appendix 1). In contrast, the limits of ESG momentum indicators are higher for the US. The difference indicates that the US firms have had a higher growth in ESG scores on average, while the absolute scores are still lower than in Europe. Table 3 describes the development of average portfolio ESG incorporation over the years.

Table 3. Development of average ESG scores of the portfolios over the years

	Top portfolios		*Mom. portfolios*	
	Europe	*The US*	*Europe*	*The US*
Holding year				
2012	*84.64*	*79.16*		
2013	*84.15*	*77.88*	*39.31*	*37.72*
2014	*84.47*	*78.20*	*39.03*	*37.04*
2015	*84.26*	*77.81*	*41.34*	*37.88*
2016	*84.91*	*76.27*	*46.24*	*37.19*
2017	*85.13*	*74.76*	*41.03*	*35.10*
2018	*85.49*	*74.58*	*40.95*	*33.14*
2019	*85.17*	*75.00*	*44.03*	*35.07*
2020	*84.93*	*74.91*	*39.71*	*38.77*

As expected, the ESG integration is notably higher within the ESG top portfolios. Unlike in the research of Nagy et al. (2013), the ESG momentum portfolios did not constantly improve their average ESG score over the years. European top- ESG portfolio stayed around the same average score through the holding period, whereas the comparable US top- ESG portfolio significantly decreased the ESG incorporation at portfolio level. Appendix 2 describes the number of the final holdings over the years after sorting out the missing data. As the data availability increases, the number of the holdings increased equally for each of the portfolios.

Tables 4 and 5 present the final US portfolios' average sector allocations throughout the sample period. The sector contributions are classified by The Refinitiv Business Classification (TRBC), including 33 business sectors. The most extensive contributions came from food and beverages for the US top portfolio and real estate for the US momentum portfolio.

Table 4. Business sector allocations of the US top portfolio

**Other includes the firms, which do not belong to any of the TRBC business sectors.*

Business sector	*Average allocation US top*
Food & Beverages	*8.14 %*
Technology Equipment	*7.61 %*
Healthcare Services & Equipment	*7.54 %*
Real Estate	*6.96 %*
Energy - Fossil Fuels	*6.22 %*
Software & IT Services	*6.20 %*
Banking & Investment Services	*5.59 %*
Retailers	*5.39 %*
Industrial Goods	*5.14 %*
Industrial & Commercial Services	*4.97 %*
Utilities	*4.75 %*
Pharmaceuticals & Medical Research	*3.36 %*
Cyclical Consumer Services	*3.30 %*
Chemicals	*3.27 %*
Cyclical Consumer Products	*3.01 %*
Transportation	*2.65 %*
Consumer Goods Conglomerates	*2.37 %*
Mineral Resources	*2.33 %*
Applied Resources	*1.84 %*
Automobiles & Auto Parts	*1.82 %*
#N/A	*1.68 %*
Personal & Household Products & Services	*1.67 %*
Food & Drug Retailing	*1.60 %*
Insurance	*1.08 %*
Telecommunications Services	*0.58 %*
Renewable Energy	*0.27 %*
Academic & Educational Services	*0.04 %*

Table 5. Business sector allocations of the US momentum portfolio.

**Other includes the firms, which do not belong to any of the TRBC business sectors.*

Business sector	Average allocation US mom.
Real Estate	9.47 %
Software & IT Services	7.75 %
Industrial Goods	7.61 %
Energy - Fossil Fuels	7.47 %
Healthcare Services & Equipment	7.23 %
Banking & Investment Services	6.79 %
Pharmaceuticals & Medical Research	6.25 %
Industrial & Commercial Services	5.80 %
Cyclical Consumer Services	5.28 %
Technology Equipment	5.25 %
Cyclical Consumer Products	3.46 %
Retailers	3.31 %
Insurance	2.66 %
Chemicals	2.32 %
Transportation	1.78 %
Mineral Resources	1.76 %
Automobiles & Auto Parts	1.71 %
Applied Resources	1.67 %
Food & Beverages	1.51 %
Utilities	1.12 %
Telecommunications Services	1.09 %
Academic & Educational Services	1.09 %
Personal & Household Products & Services	0.43 %
Consumer Goods Conglomerates	0.35 %
Food & Drug Retailing	0.31 %
Collective Investments	0.30 %
Renewable Energy	0.28 %
Financial Technology (Fintech) & Infrastructure	0.23 %
Other*	5.74 %

The average business sector allocations for the US portfolios in the COVID-19 period are shown in appendices 3 and 4. The most significant contributions switch to real estate (9.04%) and technology equipment for the top portfolio (7.98%) and pharmaceuticals and medical research (13.41%) and real estate (11.49%) for the ESG momentum portfolio.

Tables 6 and 7 describe the average sector allocations for European portfolios correspondingly. Both European portfolios' returns are most influenced by Banking and Investment Services sector. The second highest sector exposure of the top European portfolio comes from the energy sector, more precisely fossil fuels.

Table 6. Business sector allocations of the European top portfolio.

**Other includes the firms, which do not belong to any of the TRBC business sectors.*

Business sector	*Average allocation Europe top*
Banking & Investment Services	*10.68 %*
Energy - Fossil Fuels	*8.42 %*
Mineral Resources	*6.38 %*
Food & Beverages	*6.17 %*
Pharmaceuticals & Medical Research	*6.04 %*
Industrial Goods	*5.93 %*
Automobiles & Auto Parts	*5.50 %*
Utilities	*4.59 %*
Applied Resources	*4.45 %*
Insurance	*4.40 %*
Cyclical Consumer Services	*3.99 %*
Cyclical Consumer Products	*3.62 %*
Real Estate	*3.46 %*
Industrial & Commercial Services	*3.25 %*
Telecommunications Services	*3.23 %*
Technology Equipment	*3.06 %*
Chemicals	*2.73 %*
Retailers	*2.47 %*
Personal & Household Products & Services	*2.30 %*
Transportation	*2.15 %*
Software & IT Services	*2.09 %*
Healthcare Services & Equipment	*1.76 %*
Food & Drug Retailing	*1.09 %*
Consumer Goods Conglomerates	*1.08 %*
Renewable Energy	*0.30 %*
Holding Companies	*0.15 %*
Financial Technology (Fintech) & Infrastructure	*0.14 %*
*Other**	*0.55 %*

The European ESG momentum is getting its second-highest exposure in industrial and commercial services (table 7). Also, the exposure to banking and investment services is slightly higher than for the top- ESG European portfolio. The highest European sector exposures on the whole sample period are slightly heavier compared to the comparable.

Table 7. Business sector allocations of the European Momentum portfolio.

**Other includes the firms, which do not belong to any of the TRBC business sectors.*

Business sector	*Average allocation Europe mom.*
Banking & Investment Services	*12.35 %*
Industrial & Commercial Services	*8.23 %*
Real Estate	*7.49 %*
Industrial Goods	*7.11 %*
Energy - Fossil Fuels	*4.73 %*
Mineral Resources	*4.56 %*
Cyclical Consumer Services	*4.53 %*
Software & IT Services	*4.28 %*
Cyclical Consumer Products	*4.07 %*
Collective Investments	*3.93 %*
Technology Equipment	*3.75 %*
Chemicals	*3.50 %*
Retailers	*3.47 %*
Pharmaceuticals & Medical Research	*3.47 %*
Food & Beverages	*3.45 %*
Insurance	*2.99 %*
Healthcare Services & Equipment	*2.79 %*
Telecommunications Services	*2.45 %*
Transportation	*2.37 %*
Applied Resources	*1.88 %*
Automobiles & Auto Parts	*1.64 %*
Utilities	*1.39 %*
Consumer Goods Conglomerates	*0.64 %*
Personal & Household Products & Services	*0.54 %*
Food & Drug Retailing	*0.46 %*
Holding Companies	*0.44 %*
Renewable Energy	*0.38 %*
Financial Technology (Fintech) & Infrastructure	*0.21 %*
Academic & Educational Services	*0.09 %*
*Other**	*2.84 %*

The European portfolio sector exposures during the COVID-19 period are available in Appendices 5 and 6. The banking and investment services remain the highest weight within both portfolios (top 9.44%, momentum 11.73%). Compared to the full sample period, the sector exposures do not change as radically as in the US portfolios.

The sector allocations vary among the portfolios depending on the ESG construction methods. For instance, both the US and European portfolios consisting of ESG leaders have high weights in food and beverages, indicating that this sector has maintained relatively good ESG scores over the nine years. In contrast, real estate gets a relatively high weight in the ESG momentum portfolios, thereby indicating an excellent sectoral growth in ESG ratings. Interestingly, the banking and insurance sector is the best ESG score maintainer as well as the best score improver in the European markets.

Appendix 3 presents the average country allocations for the European portfolios through the entire holding period. The three-largest European economies (i.e., United Kingdom, Germany, and France) are leading the contributions for the ESG top portfolio covering on average 58.35% of the portfolio holdings. Instead, the three-largest contributors in the European momentum portfolio at a country level are United Kingdom, Germany, and Switzerland, covering 55.22% of the total holdings. The share of the UK stocks is significantly higher (36. 83%) for the ESG momentum portfolio, compared to the ESG top portfolio (23.88%). Moreover, the most significant currency exposure faced by the European portfolios the GBP/EUR exchange rate.

5.2.2 Empirical methods

The performance of the conducted ESG portfolios is measured by using cumulative and mean returns and comparing them to the returns of corresponding market indexes. The risk-adjusted performance is examined in terms of the Sharpe ratio, similarly to Auer and Schuhmacher (2015). Unlike the previous studies on ESG stock market performance, this thesis also employs the Skewness- and kurtosis adjusted Sharpe ratio (SKASR). The ratios are correspondingly compared to the market indexes, and the statistical significance testing follows the notation of Jobson and Korkie (1981) and Memmel (2003). The Z- value, which measures the statistical significance of differences in Sharpe- and adjusted Sharpe ratios, is calculated as follows:

$$Z_{value} = \frac{\widehat{Sr_p} - \widehat{Sr_m}}{\sqrt{\hat{\theta}}} \quad \textbf{(10)}$$

With,

$$\widehat{Sr_p} = Sharpe\ ratio\ or\ adjusted\ Sharpe\ ratio\ for\ portfolio\ p$$

$$\widehat{Sr_m} = Sharpe\ ratio\ or\ adjusted\ Sharpe\ ratio\ of\ market\ portfolio\ m$$

$$\hat{\theta} = Asymptotic\ variance\ between\ the\ ratios$$

The risk level is 5%, divided into 2,5% for the positive and negative tails. If the Z value exceeds 1.96 or undercuts -1.96 correspondingly, the difference between Sharpe or adjusted Sharpe is statistically significant. The asymptotic variance between the ratios is calculated as follows:

$$\hat{\theta} = \frac{1}{T}\left[2 - 2\sigma_{mp} + \frac{1}{2}(Sr_m^2 + Sr_p^2 - 2Sr_m Sr_p \sigma_{mp}^2)\right] \quad \textbf{(11)}$$

With,

$$\sigma_{mp} = Correlation\ between\ market\ portfolio\ m\ and\ a\ portfolio\ p$$

$$T = Number\ of\ observations$$

Furthermore, the study finds more empirical evidence using the factor regression model, which is the most used empirical research method in earlier ESG performance literature (e.g., Eccless et et al. 2014, Kaiser 2020; Bose et al. 2021). The regression model used in this thesis is the earlier presented Fama-French-Carhart 6-Factor model. As most of the earlier studies are including the momentum factor in the regression model (e.g., Kempf et al. 2007; Eccless et al. 2014; Nagy et al. 2013, Nagy et al. 2016; Serafeim et al. 2018), it is reasonable to include it also in this study. The dependent variable is the excess return over the risk-free rate, and the earlier discussed market risk, HML, SML, WML, RMW, and CMA, are the explanatory factors. One of the most common problems when operating with time series data is that the returns are correlated over time. This thesis uses the Newey-West (1987) standard errors in the regression analyses to correct the problems of autocorrelation and heteroskedasticity. Lag-length in the Newey-West corrected standard errors is defined as three for the whole sample period and four for the COVID-19 period. The Lag-Length is calculated based on the commonly used estimation of the lag size to be N^(1/4). The thesis does not include the trading costs through all the portfolio transactions. In reality, portfolios would cause transaction costs, taxes, and other optional costs that might affect the outcome.

6 RESULTS

This section aims to identify the existence of a possible ESG anomaly. The anomaly is examined based on two different ESG investing strategies, two different investing universes, and two sample periods (i.e., the whole sample period and COVID-19). First, the performance in terms of absolute returns is presented, including comparison them with the market portfolios. After the absolute returns, the chapter examines the annualized geometric mean returns, risk-adjusted returns and verifies the statistical significance of the observations, including the regression results.

6.1 Absolute returns and risk-adjusted based metrics

Figure 4 compares the two US ESG portfolios' value development for one million initial investment. The holding period covers eight years from 1.7.2013 to 1.5.2021. In absolute terms, the US portfolio basing on the ESG momentum indicator decile delivers a slightly better cumulative return (166.93%) over the holding period compared to the US portfolio basing on ESG top decile (162.60%). Portfolio returns within both strategies increased highly at the end of 2020, the ESG momentum finally exceeding the cumulative returns of the ESG top strategy.

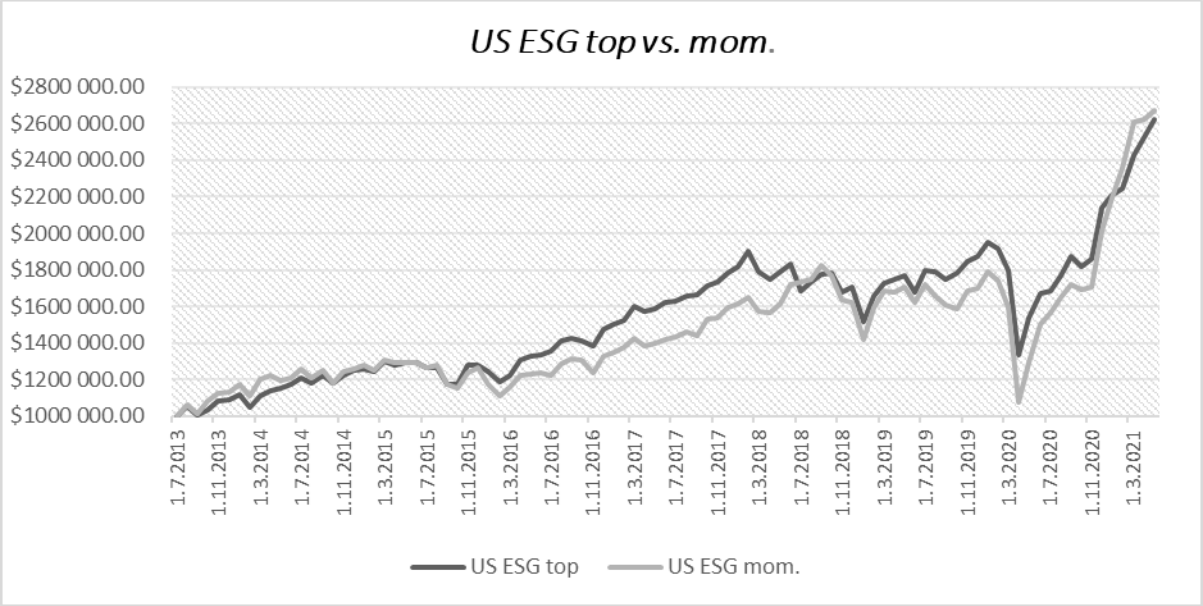

Figure 4. One million USD invested in the US ESG top- and momentum portfolios.
ESG portfolios in comparison with each other's. Both portfolios are scaled in the holding period of 1.7.2013-1.5.2021. Portfolio returns calculated as total returns, including dividends re-invested. Calculation based on monthly total return data. The equally weighted portfolios are rebalanced each year in the beginning of July.

Figures 5 and 6 illustrate the development of one million USD invested in the yearly updated ESG top- and momentum portfolios of US ESG portfolios compared to the market index (S&P 500). The holding period for the top portfolio is a nearly nine-year period from 1.7.2012 to 1.5.2021. For the ESG momentum portfolio, the holding period is one year shorter, eight years (1.7.2013 to 1.5.2021), as the first-year holdings are calculated based on the ESG score development between 2011 and 2012. Neither of the US ESG portfolios managed to beat the market index in terms of cumulative returns. As Figure 5 describes, the cumulative returns of the US ESG top and the market index are highly correlated. Investing in top- decile ESG portfolio in the US markets resulted in -8.50% below-market cumulative returns over the nine-year holding period.

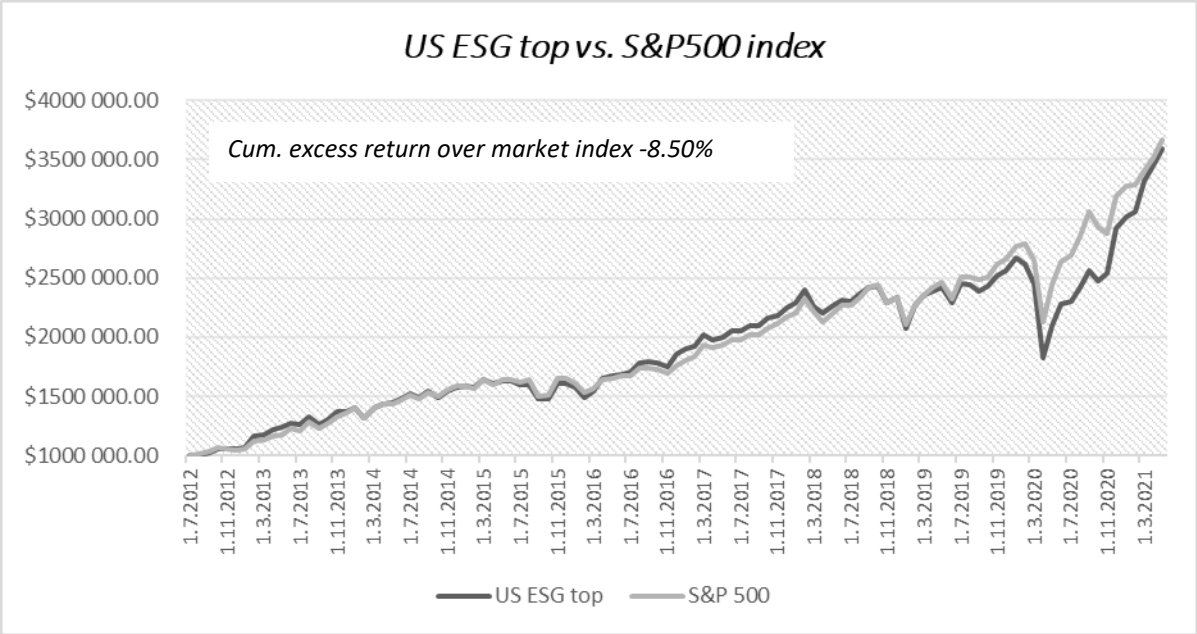

Figure 5. One million USD invested in the US ESG top portfolio.
ESG top portfolios value development in comparison with the market index portfolio. Cumulative returns over the top portfolio holding period 1.7.2012-1.5.2021. Portfolio return as total return, including dividends re-invested. Calculation based on monthly total return data. The equally weighted portfolios are rebalanced each year in the beginning of July.

As shown in Figure 6, the US ESG momentum portfolio value is significantly lower than the market portfolio value over the years. Even though the portfolio is highly correlated with the market index, the eight-year holding period results in a notable below-market cumulative return of 36.66%. An investment in a passive S&P 500 index portfolio would have resulted in significantly higher performance than investing in the active portfolio consisting of the best decile of ESG growers.

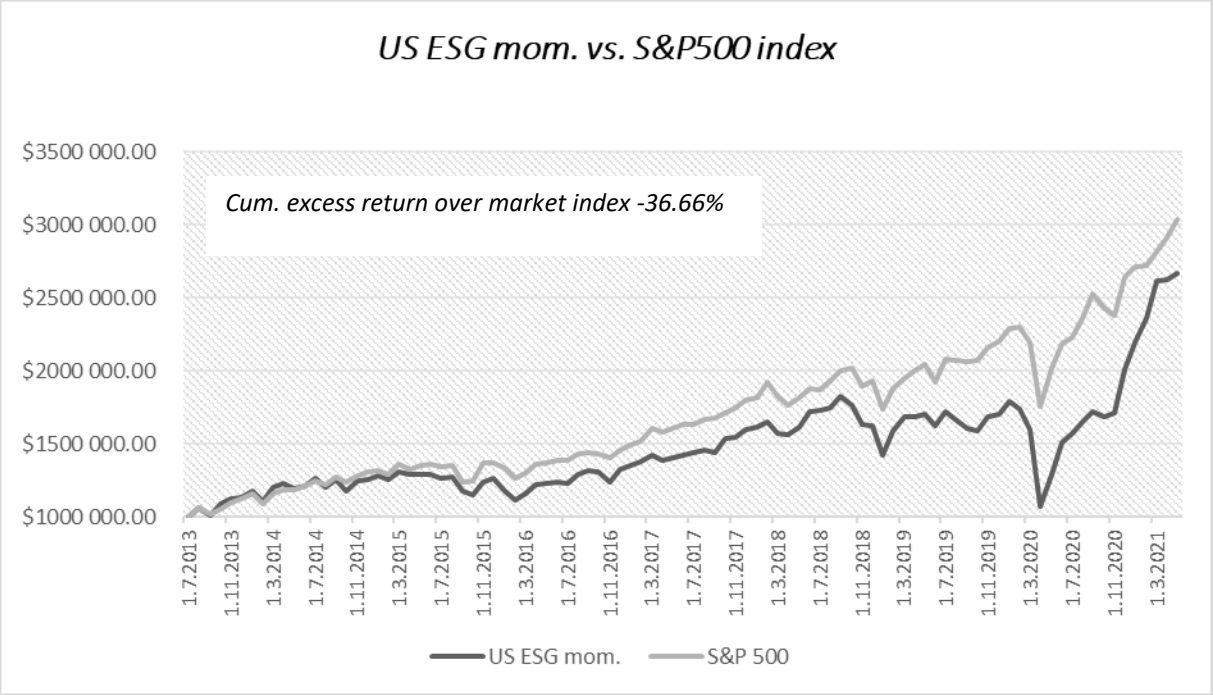

Figure 6. One million USD invested in US ESG momentum portfolio.

ESG momentum portfolio value in comparison with the market index. Cumulative returns over the momentum portfolio holding period 1.7.2013-1.5.2021. Portfolio return as total return, including dividends re-invested. Calculation based on monthly total return data. The equally weighted portfolios are rebalanced each year in the beginning of July.

Figure 7 demonstrates the development of two European ESG portfolio values on the scaled eight-year holding period from 1.7.2012 to 1.5.2021. The European portfolios follow the same trend as the U.S. ESG portfolios in comparison between the two strategies. The portfolio based on ESG momentum indicator decile has generated a higher cumulative return over the holding period (106.11%) than the portfolio based on ESG top decile (103.56%).

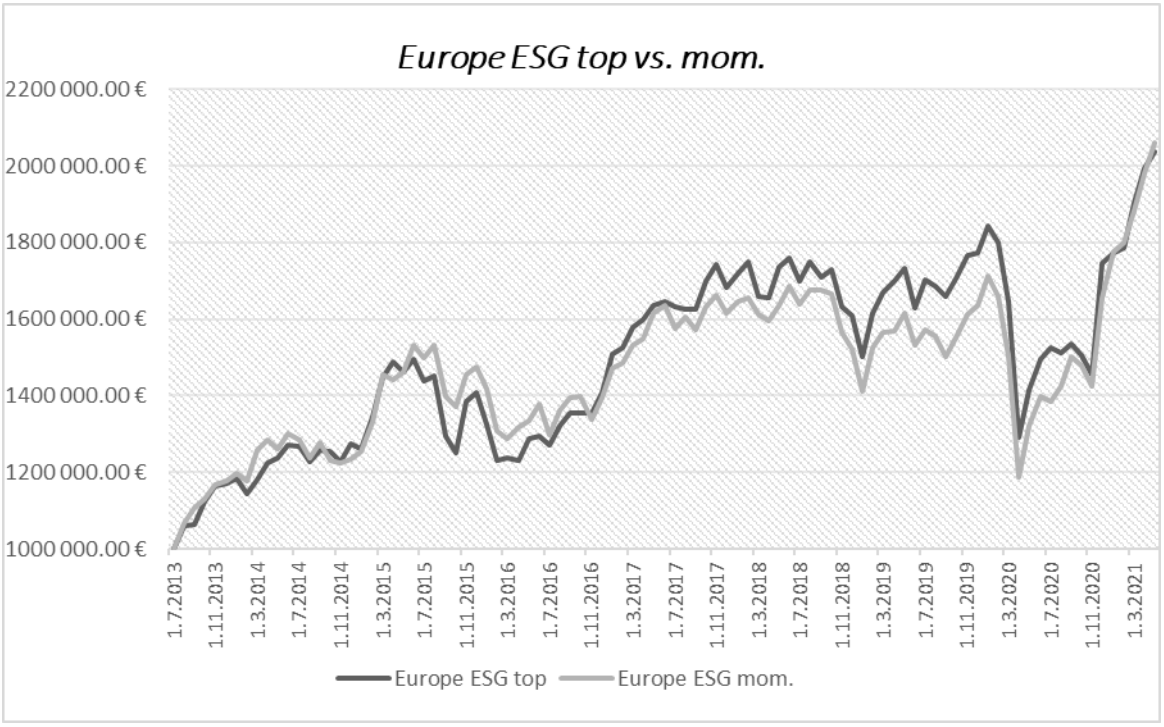

Figure 7. One million EUR invested in Europe ESG top and momentum portfolios*.*
Portfolios in comparison with each other's. Both portfolios scaled in the holding period 1.7.2013-1.5.2021. Portfolio returns as total return, including dividends re-invested. Calculation based on monthly total return data. The equally weighted portfolios are rebalanced each year in the beginning of July.

Figures 8 and 9 present the development of one million euros invested in yearly updated European ESG portfolios compared to the market index. Correspondingly to the US portfolios, the holding period for the ESG top portfolio is a nearly nine-year period from 1.7.2012 to 1.5.2021, and for the ESG momentum portfolio, a period of almost eight years from 1.7.2013 to 1.5.2021. European ESG portfolios have generated higher returns than the stock market average on cumulative basis. The top strategy has beaten the market index by 13.69 percentage points, correspondingly (Figure 8).

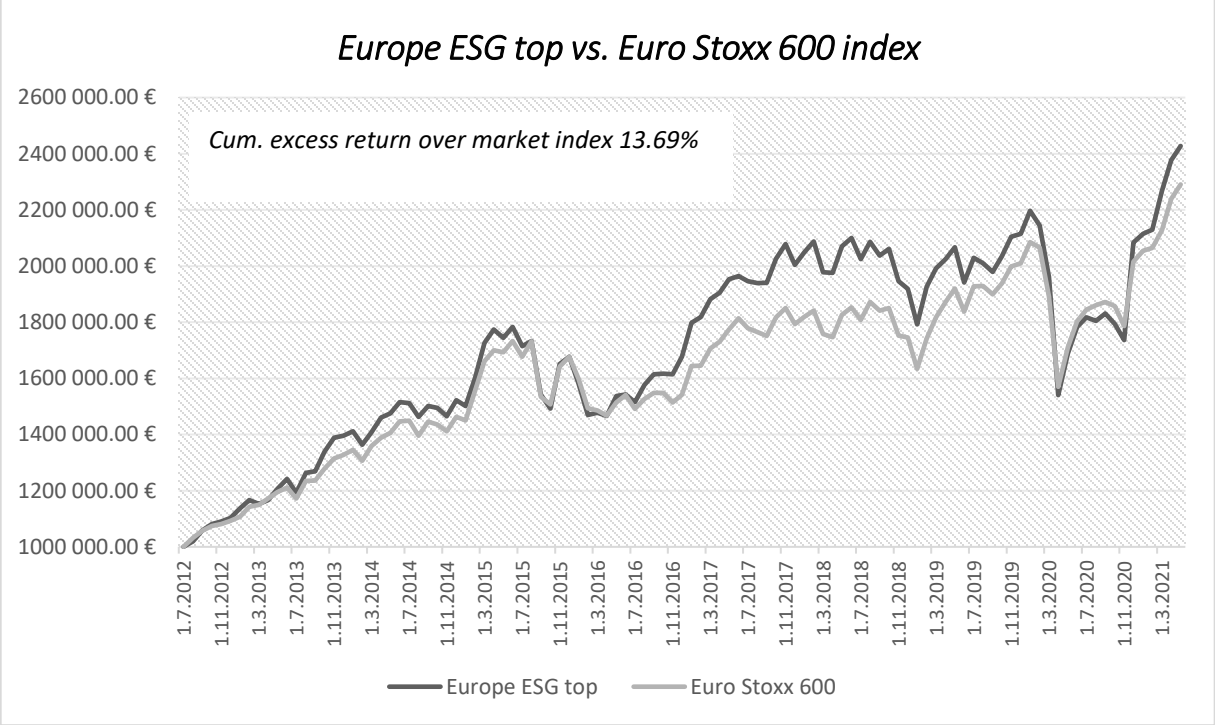

Figure 8. One million EUR invested in Europe ESG top portfolio.
Portfolios in comparison with the market index. Cumulative return over the top portfolio holding period 1.7.2012-1.5.2021. Portfolio and index return as total return, including dividends re-invested. Calculation based on monthly total return data. Equally weighted portfolios are rebalanced each year in the beginning of July.

In the European investment universe, the better-performing strategy has been the ESG momentum, with the cumulative excess return over the market of 15.05 percentage points (Figure 9). Until March 2019, the portfolio's cumulative value has been mainly higher than the market index portfolio through the investment horizon. Like for other ESG portfolios, the graph has been heavily upward-sloping since the end of 2020.

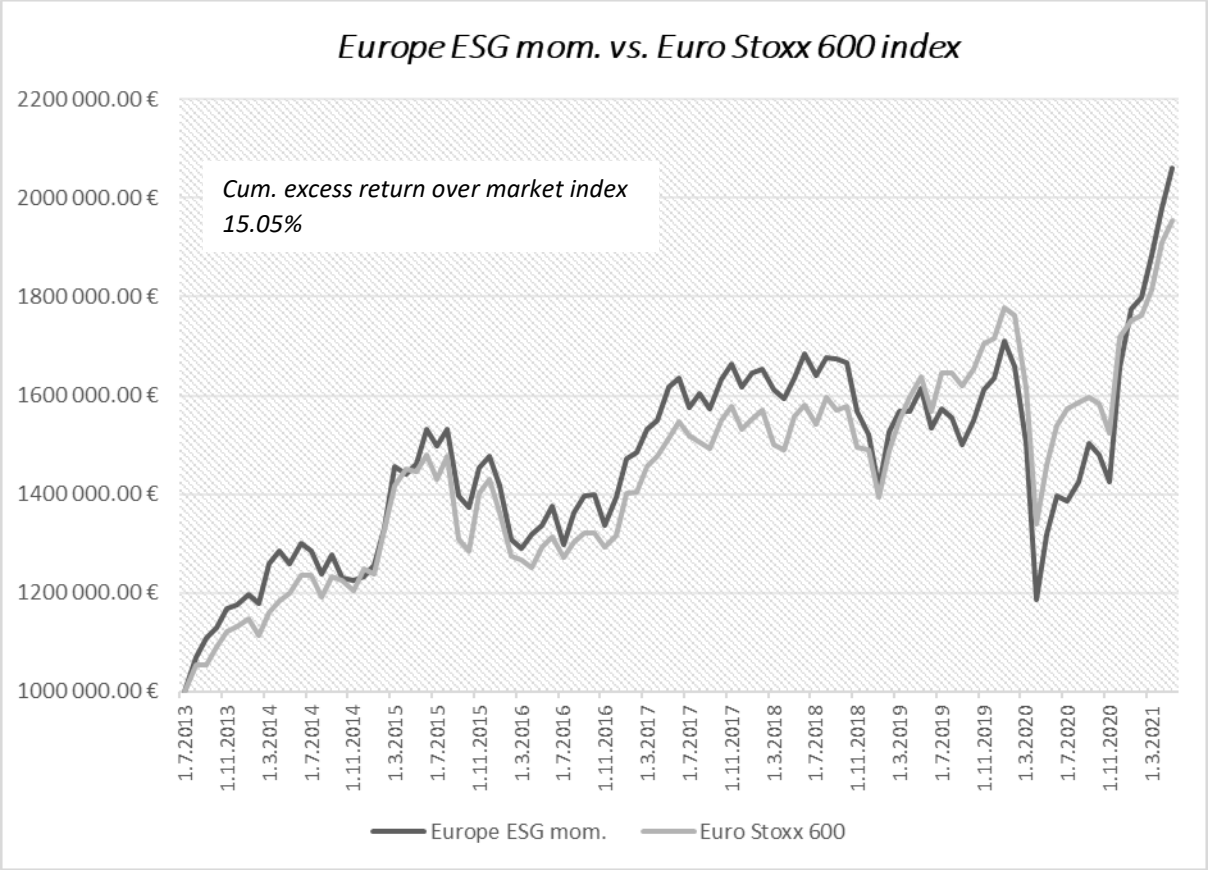

Figure 9. One million EUR invested in Europe ESG momentum portfolio.

Portfolios in comparison with the market index. Cumulative returns through the top portfolio holding period 1.7.2013-1.5.2021. Portfolio and index return as total return, including dividends re-invested. Calculation based on monthly total return data. The equally weighted portfolios are rebalanced each year in the beginning of July.

Figures 10 and 11 illustrate the development of the ESG portfolio values over the COVID-19 sub-sample period, 28.2.2020-7.5.2021. Each of the four ESG portfolios has beaten the benchmark. The ESG momentum has generated the highest returns in both geographical universes. In terms of absolute returns, the best-performing portfolio over the COVID-19 period has been the US ESG momentum, with a cumulative absolute return of 60.99 percentage points. The end of the year 2020 presents a prominent peak in the cumulative performance of ESG strategies, especially for the momentum strategies.

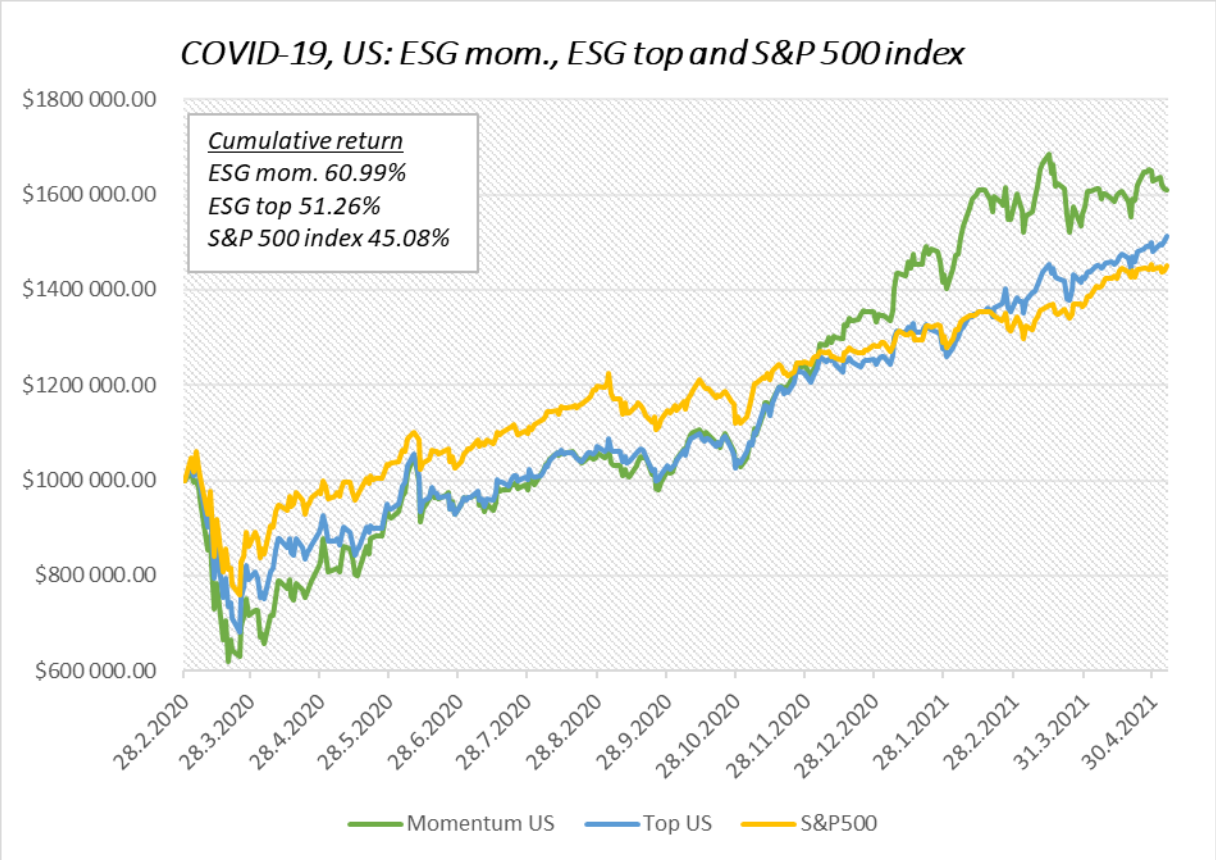

Figure 10. COVID-19: One million USD invested in US ESG momentum and ESG top portfolios. *The ESG portfolios are compared with the benchmark index, S&P 500. Cumulative returns through the portfolio COVID-19 holding period 28.2.2020-6.5.2021. Portfolio and index return as total returns, including dividends re-invested. Calculation based on daily total return data. Equally weighted portfolios have been rebalanced 1.7.2020.*

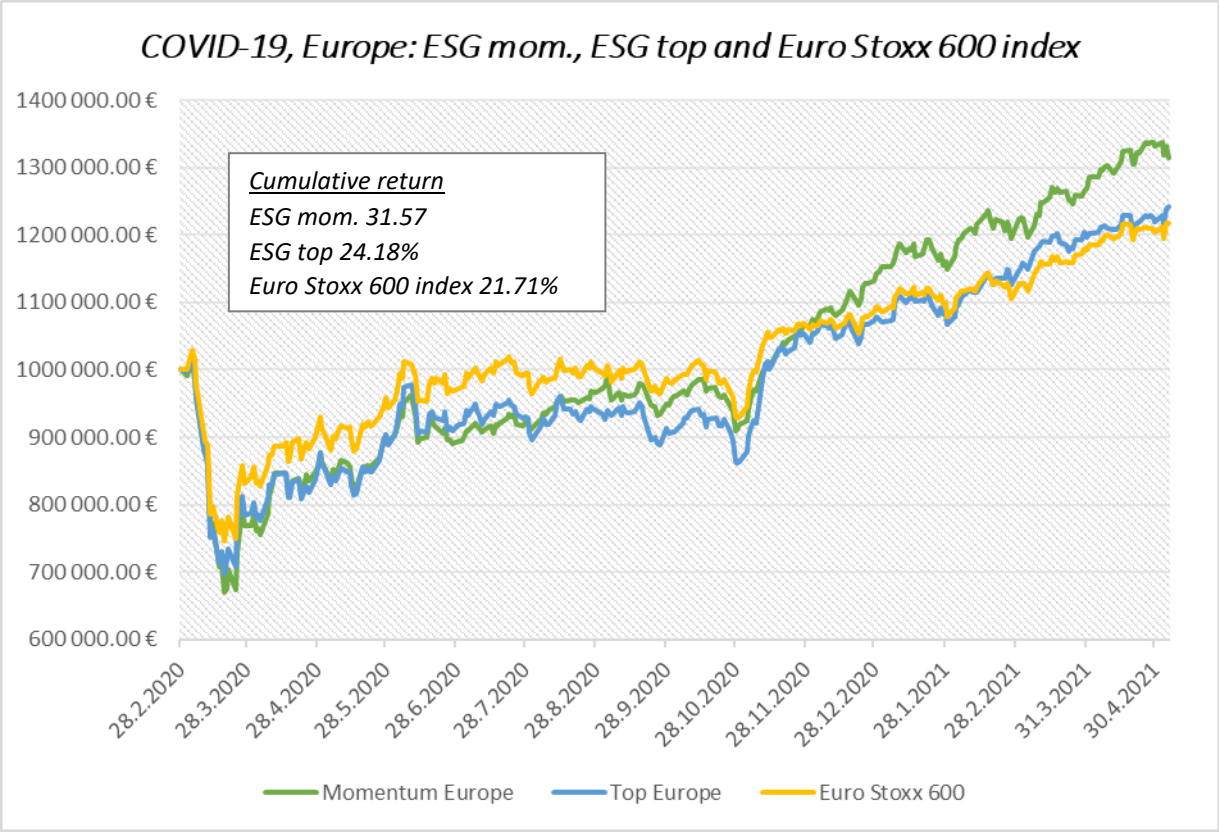

Figure 11. COVID-19: One million EUR invested in European ESG momentum and ESG top portfolios.

Portfolios compared with the benchmark index, Euro Stoxx 600. Cumulative return over holding period 28.2.2021-6.5.2021. Portfolio and index return as total returns, including dividends re-invested. Calculation based on daily total return data. Equally weighted portfolios have been rebalanced 1.7.2020.

Table 8 describes the return- and risk-adjusted metrics for each ESG portfolio and corresponding index benchmarks over the full sample period. US portfolios' annualized volatilities are higher than those of their European counterparts (ESG top 16.79%, ESG momentum 22.21%). The stock market beta is notably higher for the US ESG momentum portfolio (1.29) than others.

First, the risk-adjusted performance metrics of the ESG strategies shows that none of the portfolios have managed to beat the market indexes in terms of the standard and Skewness- and Kurtosis adjusted Sharpe ratios. The underperformance is significant for the US ESG portfolios, at the 10% risk level, whereas is it weakly significant for the European portfolios.

Table 8. Returns and risk-adjusted metrics of ESG top and momentum long-only portfolios.

Portfolios are formed using two different ESG strategies: ESG top and momentum separately for the US and Europe. Both strategies are examined within the whole sample periods, nine years for the top portfolios and eight years for the momentum portfolios. The yearly updated and rebalanced portfolios are consisting of the top deciles of the desired ESG characteristics. Portfolio- and index return calculated as total returns, including dividends re-invested. Calculation based on monthly total return data for the whole sample period. Equally weighted portfolios rebalanced each year 1.7.2020. 1-month U.S. treasury bill is used as a risk-free rate. Returns are calculated as annualized geometric excess returns over risk-free rate for each zero-cost portfolios and corresponding market indexes. Statistical significance of 10% marked with "".*

Top portfolios

1.7.2012-1.5.2021	Geomean (p.a)	Volatility (p.a)	Beta	SR	SKASR	Z value
S&P 500	15.16 %	15.02 %		1.0128	0.7532	
US ESG top	14.85 %	16.79 %	1.0801	0.8875	0.5930	1.6783*
Euro Stoxx 600	9.16 %	9.33 %		0.6684	0.5173	
Europe ESG top	9.88 %	16.15 %	1.1367	0.6137	0.4629	0.6258

Mom. portfolios

1.7.2012-1.5.2021	Geomean (p.a)	Volatility (p.a)	Beta	SR	SKASR	Z value
S&P 500	14.45 %	15.67 %		0.9223	0.6976	
US ESG mom.	12.58 %	22.21 %	1.2886	0.5684	0.3936	1.8596*
Euro Stoxx 600	8.18 %	14.46 %		0.5681	0.4500	
Europe ESG mom.	8.92 %	16.65 %	1.0576	0.5372	0.4198	0.2096

Zooming in the COVID-19 period, (Table 9) indicates that the best performing strategy has been the U.S. ESG momentum with a superior geometric annualized mean return over the risk-free rate of 48.79%. When comparing the strategies during this spesific sub-sample period, the ESG momentum has generated higher returns in both regions. Furthermore, the annualized volatility is highest for the US ESG momentum strategy, whereas it is lowest for the European ESG momentum.

The risk-adjusted metrics in the COVID-19 sample period shows that the Sharpe ratio of European ESG momentum (0.8596) defeats the market Sharpe (0.6946). Moreover, the skewness and Kurtosis -adjusted Sharpe ratio (SKASR) of the European ESG momentum

(0.5896) also overcomes the ratio of the market index (0.4468). The results, however, fall short of statistical significance.

Table 9. COVID-19: Returns and risk-adjusted metrics of ESG top and momentum long-only portfolios.

Portfolios are formed using two different ESG strategies: ESG top and momentum separately for the US and Europe. Both strategies are examined within the COVID-19 sub-sample period. The yearly updated and rebalanced portfolios are consisting of the top deciles of the desired ESG characteristics. Portfolio- and index return calculated as total returns, including dividends re-invested. Calculation based on weekly total return data for the COVID-19 sub-sample period. Equally weighted portfolios rebalanced once, as per 1.7.2020. 1-month U.S. treasury bill is used as a risk-free rate. Returns are calculated as annualized geometric excess returns over risk-free rate for each zero-cost portfolios and corresponding market indexes. Statistical significance of 10% marked with "".*

COVID-19						
28.2.2020-6.5.2021	Geomean (p.a)	Volatility (p.a)	Beta	SR	SKASR	Z value
S&P 500	37.23 %	27.29 %		1.3748	1.0572	
US ESG top	41.22 %	35.09 %	1.2019	1.1838	0.9535	0.3015
US ESG mom.	48.79 %	42.99 %	1.3938	1.1438	0.9648	0.2548
Euro Stoxx 600	17.70 %	25.67 %		0.6946	0.4468	
Europe ESG top	19.71 %	31.01 %	1.1771	0.6404	0.4344	0.0718
Europe ESG mom.	25.55 %	29.95 %	1.0878	0.8595	0.5896	0.3380

The SKASRS being lower than the Sharpe ratio indicates a negative skewness of returns. The difference between these ratios is relatively high for the US ESG top and - momentum portfolios (decreasing by 33.18% for ESG top and 30.76% for ESG mom.) compared with the European ones (decreasing 24.58% for ESG top and 21.85% for ESG mom.). Conversely, during the COVID-19 period, instead, the European portfolios show a higher negative Skewness (decreasing 32.16% for ESG top and 31.41% for mom.) compared with the US (decreasing 19.46% for top and 15.65% for mom.).

To conclude, the mean returns indicate that in the long run on the European stock markets, an investor could have achieved abnormal returns following both the ESG top and momentum strategies with a simple long-only approach, in contrast to the US, where ESG

investing would not have led to higher returns compared to the stock market average. However, this conclusion is based on returns in absolute terms. When considering the risk-adjustment, the ESG investing strategies do not enhance risk-adjusted returns in the US nor in Europe in the long run.

The absolute performance of ESG portfolios is notable during the COVID-19 period, in both regions, and using both top and momentum ESG strategies. The ESG momentum has generated the greatest performance difference during the shorter COVID-19 period in terms of raw returns. Furthermore, the European ESG momentum strategy's risk-adjusted metrics indicate better performance than that of the market index; however, the result is statistically insignificant.

6.2 Regression results

Table 10 presents the regression results of the Fama-French-Carhart 6-Factor model for the ESG top and momentum portfolios in the full sample period. The comprehensive factor model statistics are available in appendixes 8-15. According to the results, the European ESG momentum is the only portfolio generating a positive alpha (0.03% p.m.), still falling clearly below the statistical significance. Insignificant alphas indicates that abnormal returns of following the simple approach of the ESG top strategy not statistically differ from zero. Also, the negative alphas of US ESG top, momentum, and European top portfolios are statistically insignificant. Expectedly, the market risk factor slope is significant for all the portfolios at the one percent significance level (Table 10). The slope is highest for the US ESG momentum portfolio (1.3058). The R-squared values are higher for the top portfolios, explaining that the model fits better for the top portfolio data. The goodness-of-fit is the highest for the US top portfolio (0.9419).

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Table 10. Fama-French-Carhart 6-factor regression results for the whole sample period.

Table 10 concludes the results of the Fama-French- Carhart 6-factor model whole sample period for top portfolios with the data from 07/2012 to 05/2021 and from 07/2013 to 05/2021 for momentum portfolios. Regression conducted with Newey-West standard errors. Factor data is retrieved from the Kenneth French data library. Rm-Rf, SMB, HML, WML, RMW and CMA are representing the factor loadings. R-squared describes the *goodness-of-fit of* the model. *Portfolios are formed using two ESG strategies: ESG top and momentum, separately for the US and European markets. Both strategies are examined within the whole sample periods, nine years for the top portfolios and eight years for the momentum one's. The yearly updated and rebalanced portfolios are consisting of stocks belonging in the top deciles of the desired ESG characteristics. Portfolio- and market returns are calculated as total returns, including dividends re-invested. Calculation based on monthly total return data. Equally weighted portfolios rebalanced and the holdings updated each year 1.7.20XX.*

, ** and * are describing the significance levels of 10%,5% and 1% respectively.*

6- Factor model

Regression with Newey-West standard errors

Max. Lag: 3

	ESG top	***ESG momentum***
The US markets		
Alpha	*-0.0008*	*-0.0035*
Rm-Rf	*1.0913****	*1.3058****
SMB	*-0.0151*	*0.0880*
HML	*0.0659*	*0.0571*
WML	*-0.0628*	*-0.0917*
RMW	*-0.0875*	*-0.0715*
CMA	*0.0611*	*0.0736*
R-squared	*0.9419*	*0.8433*
European markets		
Alpha	*0.0000*	0.0003
Rm-Rf	*1.1365****	*1.0614****
SMB	*0.0278*	-0.0028
HML	*0.0529*	0.1086
WML	*-0.0366*	0.0453
RMW	*0.0194*	0.2467
CMA	*0.0153*	0.2111
R-squared	*0.9397*	0.8501

Table 11 summarises the COVID-19 period Fama-French-Carhart 6-Factor regression results based on ESG top and momentum strategies for the two geographical investment universes. The model captures excess returns associated with market risk, size, book-to-market multiple, momentum effect, profitability, and investment factors. Also, for this specific sub-period all the alphas are insignificant. R squared is highest for the European momentum (98.66), indicating the goodness-of-fit.

Besides the market factor, the returns are explained by several other factors of the model, unlike for the full sample period. Also, most of the coefficients are highly significant, at the 1% level. The findings indicate that especially those firms that increased their ESG rating over the past year have had a significant small-cap tilt. Also, the loading on the SMB factor is statistically significant and positive for the ESG top portfolios, however not that high. In addition, each of the portfolios have some tilt on value factor. The European ESG momentum gets the highest positive loading on the market risk factor (1.1334) as well as for the SMB factor (0.9618), whereas the HML factor is loading highest for the US ESG momentum portfolio (0.3867).

Moreover, the momentum slope is statistically significant but negative for both ESG top portfolios. The statistically significant negative loadings for the momentum factor indicate that the portfolios have been tilted towards past losers. It is important to remember that the period on the scope is a crisis period when the financial markets are not working under normal circumstances. The COVID-19 crisis caused radical short-term changes in the stock market performance within different industries as the crisis changed the whole consumption basis and resulted in effective changes in average sector returns. As described earlier in section 5.2.1, the most significant sector weights in the COVID-19 sample period for the US top portfolio were real estate and technology equipment, both of which have experienced radical changes in the COVID-19 crisis. The highest contribution for the US ESG momentum portfolio in the COVID-19 period was pharmaceuticals and medical research, the sector that experienced a radical growth in the COVID-19 crisis. Furthermore, the European ESG top portfolio had a relatively high weight in the energy sector, a sector that also experienced

significant changes by the pandemic outbreak. In the crisis circumstances, a statistically significant loading in momentum factor might, instead of the momentum effect, prove the radical sectoral changes that the ESG portfolios are exposed to.

In addition to the above mentioned factors, the US ESG momentum portfolio and top European portfolio have statistically significant loadings on the profitability factor (RMW). The slope for the U.S. ESG momentum portfolio is negative, whereas positive for the European ESG top portfolio, indicating tilts towards negative and positive operating profitability. returns to be explained by the tendency of a high return on equity firms to outperform the low ROE firms. The slope of the investment factor (CMA) is loading highly significant but negative for the US ESG momentum portfolio, indicating the tilt towards high asset-growth stocks.

Table 11. Fama-French-Carhart 6-factor regression results, COVID-19 period

Table 11 concludes the results of the Fama-French-Carhart 6-factor model on COVID-19 period for ESG portfolio returns from 03/02/2020 to 30/04/2021. The period on scope is five data points shorter due to data availability-based reasons. Regression conducted with Newey-West standard errors. Factor data is retrieved from the Kenneth French data library. Rm-Rf, SMB, and HML, WML, RMW and CMA are representing the factor loadings. R-squared describes the *goodness-of-fit of* the model. *Portfolios are formed using two ESG strategies: ESG top and momentum, separately for the US and Europe. The portfolios are consisting of stocks belonging in the top deciles of the desired ESG characteristics. Portfolio- and index return calculated as total returns, including dividends re-invested. Calculation based on daily total return data for the COVID-19 period. Equally weighted portfolios rebalanced, and the holdings updated as of 1.7.2020.*

, ** and * are describing the significance levels of 10%,5% and 1% respectively.*

6- Factor model - COVID-19

Regression with Newey-West standard errors

Max. lag: 4

	ESG top	***ESG momentum***
The US markets		
Alpha	*0.0001*	*0.0000*
Rm-Rf	*0.9867****	*1.0581****
SMB	*0.2865****	*0.9536****
HML	*0.3345****	*0.3867****
WML	*-0.0522****	*-0.0434*
RMW	*-0.0720*	*-0.2367****
CMA	*0.0717*	*-0.5294****
R-squared	*0.9779*	*0.9710*
European markets		
Alpha	*0.0001*	*-0.0001*
Rm-Rf	*1.0348****	*1.1334****
SMB	*0.1702****	*0.9618****
HML	*0.3475****	*0.2047****
WML	*-0.1104****	*0.0525*
RMW	*0.0781**	*0.0092*
CMA	*-0.0755*	*-0.0856*
R-squared	*0.9866*	*0.9479*

7 DISCUSSION

This thesis investigated the ESG anomaly over a long-run period and during the COVID-19 crisis based on ESG top and – momentum strategies in the U.S. and European equity markets. The stock market performance was examined using portfolio returns on an absolute and risk-adjusted basis. The factor exposures were examined using the Fama-french-Carhart 6-factor regression model. This section answers the research questions presented in chapter 1. The results are also compared to earlier evidence. The null hypothesis of this study was that markets are efficient, and thus, it is impossible to generate abnormal returns by using ESG investing strategies. The null hypothesis remains valid.

7.1 Answering the research questions

Question 1: *"Is it possible to beat the market index by following ESG investing strategies in terms of absolute returns?"*

In the affirmative with the first research question, ESG investing led to higher than market returns in absolute terms during the full sample period in the European equity markets. In the US markets, the performance of ESG strategies was weaker than the market performance during the full sample period. However, during the COVID-19 period, both regions and all the examined portfolios generated a higher than market return in absolute terms.

Question 2: *"Does the ESG anomaly appear on a risk-adjusted basis?"*

The results show notably lower Sharpe and SKASR ratios using both ESG top and -momentum investing strategies in the US markets. The ESG anomaly is not appearing on a risk-adjusted basis, and in fact, ESG investing led to below-market risk-adjusted returns in the US markets over the long sample period, with the significant Jobson-Korkie-Memmel z-values. In that sense, the results align with Borovkova et al. (2020), who found highly ESG scored firms having a significant negative relationship with excess returns in the US markets. As Borovkova et al. (2020) suggest, the results might be caused by less focus on sustainability issues in the US. On the other hand, even though the European ESG portfolios showed notable performance in terms of absolute cumulative returns, the risk-adjusted metrics do not indicate the superiority of these strategies.

Question 3: *"Does the ESG momentum strategy generate better returns compared to the ESG top strategy?"*

In absolute terms, the better-performing strategy over the full sample period was ESG momentum when scaling each of the portfolios in the eight-year investing horizon. However, 6-factor regression results did not indicate any statistically significant ESG alphas. Based on these findings, one cannot set either of the strategies above the other.

This study did not prove the superiority of the momentum strategy, and thus the results are not in line with the earlier evidence on ESG momentum strategy. Unlike this research, Nagy et al.'s (2013 & 2016) study used the Intangible Value Assessment (IVA) ESG ratings provided by MSCI to build the ESG portfolios. As discussed earlier, there are significant problems with the ESG rating data regarding information complexity, measuring techniques, and lack of measurement transparency (Sandberg et al. 2009). In addition, the correlation between the

ESG scores provided by different raters does not coincide largely, which makes the results incomparable (Dorfleitner et al. 2015; Dimson et al. 2020). Nagy et al. (2013 & 2016) used a different ESG database, which might significantly explain the different results. In the light of this knowledge, when comparing the findings of this thesis with the findings of other scholars using a different database, a reasonable question to ask is; which provider's ESG scores and further on research results to trust. According to Dorfleitner et al. (2015), The Refinitiv's Asset4 ESG scores are highly correlated with Bloomberg ESG scores, while overall, measured by 8500 firms worldwide, the ratings do not coincide.

Moreover, the study of Chen & Yang 2020 used the same Refinitiv's ESG database and still finding the existence of a positive ESG alpha for the holding intervals of one and a half years. However, the geographical universe of the study (Chen & Yang 2020) was limited in the Taiwanese market, which has notably different characteristics compared to the geographical universes of this thesis. Also, the portfolio construction method is different.

Question 4: *"Are there statistically significant ESG-related anomalies over the entire sample period after controlling the market factors? "*

After observing the absolute and risk-adjusted results, the study examined the factor exposures of the ESG portfolios. Based on the Fama-French-Carhart 6-factor model results on the full sample period, the market risk factor is the only significant explanatory factor for the portfolio returns. The study did not identify any statistically significant ESG-related anomalies over the entire sample period when considering the market factors.

Question 5: *"How have the ESG portfolios performed during the COVID-19 crisis in terms of absolute, risk-adjusted, and factor-controlled returns"?*

COVID-19 sub-period showed an interesting behavior within the ESG portfolios, each of them outperforming the benchmark index in absolute terms. The highest outperformer was the U.S. ESG momentum strategy, with a cumulative excess return of 15.91% over the market index. The risk-adjusted statistics tell a different story, as only the European ESG momentum has performed better than the market index; However, the results are statistically insignificant.

Based on the regression results, the factor model indicates that ESG returns are almost fully by the six explanatory factors. The Fama-French- Carhart 6-factor model showed highly significant coefficients for the market risk factor and the Small-minus-Big (SMB), high-minus-low (HML) factors in the case of each of the portfolios. Especially, the SMB factors were notably high for the ESG momentum portfolios. In addition, the momentum factor shows a negative return relation to the top portfolios. The US ESG momentum portfolio returns were also explained by RMW and CMA factors but with negative exposures.

To summarize the COVID-19 period results, the high performance of ESG portfolios in Europe and the US was significantly explained by other factors than the responsibility, being at least:

1) *The market risk factor*
2) *The size exposure*
3) *The value exposure*

The results are supporting the findings of Demers et al. (2021), who argued against the ESG outperformance during the full COVID 2020 year. The study of Demers et al. (2021) pointed out that once industry affiliation, accounting- and market-based determinants of returns

have been considered, the ESG outperformance effect disappears. Compared to the earlier evidence, this thesis extends the crisis period, as the COVID-19 crisis can still be seen ongoing in early 2021. In addition, this study adds more explanatory variables and the European markets under COVID-19 review, confirming the same finding that the performance of ESG-related portfolios is explained by conventional style factors.

8 CONCLUSIONS

H0: *"The markets are efficient, and thus ESG investing strategies cannot provide abnormal returns for an investor."*

Despite the valid null hypothesis, the empirical evidence does not prove the ESG investing leading to statistically significant underperformance in the European markets. In contrast, the ESG portfolio underperformance was observed in absolute and risk-adjusted terms over a long investment horizon in the US equity markets. Expectedly, the ESG portfolio return distributions are highly associated with the market risk factor. The study does not show the superiority of the ESG momentum strategy, in contrast to earlier evidence. However, the different databases employed in this thesis and earlier studies makes the comparability questionable.

During the COVID-19 period, the ESG strategies showed a clear upward trend in terms of absolute returns in both the US and European equity markets. The performance boost was notable for both investing strategies; ESG top investing in ESG leaders and ESG momentum investing in the best ESG score improvers. The actual outbreak started at the end of 2020 and lasted until the very end of the observation period (6.5.2021), with ESG momentum leading the race. However, based on the regression results, the superiority was explained by other market factors than the responsibility itself.

8.1 Research criticality and suggestions for further research

As of the time of writing, it is still questionable when the COVID-19 crisis will end. In future research, a better understanding of the ending of the crisis can be made, allowing more comprehensive research on the relation of the COVID-19 crisis to ESG stock performance. Furthermore, a more specific time frame would also allow dividing the crisis period into different waves and estimate the effects on bull and bear markets separately. It needs to be noted that it is challenging to model any behavioral theories in crisis circumstances, as the financial markets are interrupted. Even though the portfolios were constructed by updating the portfolios each year on the 1st of July based on the ESG score on the previous year, the 31st of December, light look-ahead bias may occur.

Moreover, the significant problem with incomparable ESG score data could be further investigated to find solutions for harmonization between the different score providers. Also, dividing the ESG scores into the classes, including only scores of those raters that are comparable with each other, would improve the research design. Even though Refinitiv's ESG scores are one of the most used ones, the incomparable ESG score data equally shades the results of this research. Future research could also focus on how regulators can alleviate data-related problems and encourage green products adoption.

There are numerous ways to form the ESG portfolios in terms of ESG strategies, countries on scope, cut-off-points, and mixing between the long, short, and long-short strategies. While the ESG score data quality and quantity improve, the research could be extended to the emerging markets and cover more restricted areas, such as northern Europe. However, as the ESG portfolio returns seem to be associated with other market factors, investors could benefit from investigating other advantages that sustainable finance for the society. A more comprehensive information on investors' motivations, sustainable economic growth, and the role of sustainable finance would allow better adoption of sustainable products in the financial markets.

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APPENDIX

Appendix 1. Portfolio inclusion limits over the years

The momentum indicator is calculated by dividing the ESG score of the year N by the score of the year N-1.

	Top portfolios		Mom. Portfolios	
	Europe	The US	Europe	The US
Holding year	ESG score over		Mom. Indicator over	
2012	78.56	71.34		
2013	78.33	71.00	26.15	33.31
2014	78.68	70.83	13.79	19.85
2015	78.76	71.00	23.02	31.99
2016	79.70	67.92	26.66	35.58
2017	80.39	65.37	25.68	36.64
2018	80.68	64.60	27.26	31.02
2019	79.30	65.96	25.07	31.66
2020	79.36	65.96	30.82	43.22
Average	79.31	68.22	24.81	32.91

Appendix 2. The number of final portfolio holdings and missing observations.

Missing observations (N/A) due to the inclusion of joiners and leavers in the ESG score data.

	Number of holdings, top portfolios		Number of holdings, mom. portfolios	
Holding year	Europe	The US	Europe	The US
2012	73	78	-	-
2013	74	79	73	75
2014	76	80	75	79
2015	80	81	77	77
2016	90	138	76	84
2017	93	204	86	141
2018	103	229	92	205
2019	149	248	103	230
2020	158	286	144	235
Firm data N/A total	4	25	12	19

Appendix 3. Business sector allocations of the US top portfolio on COVID-19 sample period

Business sector	*Average allocation US top*
Real Estate	*9.04 %*
Technology Equipment	*7.98 %*
Banking & Investment Services	*7.80 %*
Industrial Goods	*7.43 %*
Healthcare Services & Equipment	*6.83 %*
Software & IT Services	*5.97 %*
Food & Beverages	*5.94 %*
Industrial & Commercial Services	*5.91 %*
Retailers	*4.30 %*
Cyclical Consumer Services	*4.25 %*
Chemicals	*4.08 %*
Energy - Fossil Fuels	*4.05 %*
Utilities	*3.73 %*
Cyclical Consumer Products	*3.33 %*
Pharmaceuticals & Medical Research	*3.16 %*
*Other**	*2.61 %*
Transportation	*2.29 %*
Applied Resources	*2.24 %*
Food & Drug Retailing	*1.66 %*
Mineral Resources	*1.66 %*
Automobiles & Auto Parts	*1.49 %*
Consumer Goods Conglomerates	*1.12 %*
Personal & Household Products & Services	*0.92 %*
Insurance	*0.75 %*
Renewable Energy	*0.75 %*
Telecommunications Services	*0.55 %*
Academic & Educational Services	*0.17 %*

*******Other includes the firms, which are not belonging any of the TRBC business sectors.*

Appendix 4. Business sector allocations of the US momentum portfolio on COVID-19 sample period

Business sector	*Average allocation US Mom.*
Pharmaceuticals & Medical Research	*13.41 %*
Real Estate	*11.49 %*
Software & IT Services	*8.09 %*
Industrial Goods	*7.87 %*
Energy - Fossil Fuels	*6.39 %*
*Other**	*6.17 %*
Healthcare Services & Equipment	*5.96 %*
Banking & Investment Services	*5.53 %*
Industrial & Commercial Services	*5.53 %*
Cyclical Consumer Products	*4.47 %*
Technology Equipment	*4.25 %*
Cyclical Consumer Services	*3.83 %*
Chemicals	*2.56 %*
Retailers	*1.91 %*
Transportation	*1.91 %*
Mineral Resources	*1.70 %*
Utilities	*1.28 %*
Telecommunications Services	*1.06 %*
Insurance	*1.06 %*
Applied Resources	*0.85 %*
Automobiles & Auto Parts	*0.85 %*
Food & Beverages	*0.85 %*
Renewable Energy	*0.64 %*
Food & Drug Retailing	*0.64 %*
Academic & Educational Services	*0.43 %*
Financial Technology (Fintech) & Infrastructu	*0.43 %*
Personal & Household Products & Services	*0.43 %*
Consumer Goods Conglomerates	*0.42 %*
Collective Investments	*0.00 %*

Other includes the firms, which are not belonging any of the TRBC business sectors.

Appendix 5. Business sector allocations of the European top portfolio on COVID-19 sample period

Business sector	*Average allocation Europe top*
Banking & Investment Services	*9.44 %*
Industrial Goods	*7.15 %*
Energy - Fossil Fuels	*6.86 %*
Mineral Resources	*6.18 %*
Pharmaceuticals & Medical Research	*5.85 %*
Cyclical Consumer Services	*5.57 %*
Real Estate	*5.49 %*
Industrial & Commercial Services	*4.88 %*
Cyclical Consumer Products	*4.55 %*
Utilities	*4.55 %*
Food & Beverages	*4.25 %*
Chemicals	*3.91 %*
Automobiles & Auto Parts	*3.89 %*
Insurance	*3.60 %*
Applied Resources	*3.26 %*
Healthcare Services & Equipment	*3.26 %*
Transportation	*2.61 %*
Telecommunications Services	*2.59 %*
Retailers	*1.98 %*
Personal & Household Products & Services	*1.96 %*
Technology Equipment	*1.96 %*
Food & Drug Retailing	*1.64 %*
Software & IT Services	*1.62 %*
*Other**	*0.99 %*
Renewable Energy	*0.67 %*
Consumer Goods Conglomerates	*0.65 %*
Financial Technology (Fintech) & Infrastructure	*0.65 %*
Holding Companies	*0.00 %*

**Other includes the firms, which are not belonging any of the TRBC business sectors.*

Appendix 6. Business sector allocations of the European momentum portfolio on COVID-19 sample period

Business sector	*Average allocation Europe mom.*
Banking & Investment Services	*11.73 %*
Real Estate	*8.78 %*
Industrial Goods	*6.93 %*
Industrial & Commercial Services	*6.51 %*
Collective Investments	*5.76 %*
Energy - Fossil Fuels	*5.42 %*
Technology Equipment	*5.21 %*
Software & IT Services	*4.60 %*
Pharmaceuticals & Medical Research	*4.46 %*
Transportation	*3.77 %*
Cyclical Consumer Services	*3.64 %*
Chemicals	*3.43 %*
Healthcare Services & Equipment	*3.36 %*
Insurance	*2.95 %*
Cyclical Consumer Products	*2.88 %*
Mineral Resources	*2.67 %*
*Other**	*2.47 %*
Retailers	*2.33 %*
Food & Beverages	*2.05 %*
Applied Resources	*1.99 %*
Automobiles & Auto Parts	*1.78 %*
Utilities	*1.78 %*
Telecommunications Services	*1.65 %*
Food & Drug Retailing	*1.30 %*
Financial Technology (Fintech) & Infrastruc	*0.82 %*
Consumer Goods Conglomerates	*0.68 %*
Academic & Educational Services	*0.34 %*
Personal & Household Products & Servic	*0.34 %*
Renewable Energy	*0.34 %*
Holding Companies	*0.00 %*

Other includes the firms, which are not belonging any of the TRBC business sectors.

Appendix 7. Average country contributions through the holding period for European portfolios

Europe top

Country	*Average contribution*
UK	*23.88 %*
FR	*18.64 %*
DE	*15.83 %*
ES	*8.65 %*
IT	*8.07 %*
CH	*7.96 %*
SE	*5.83 %*
NL	*3.66 %*
FI	*2.70 %*
NO	*2.11 %*
IE	*0.75 %*
PT	*0.50 %*
AT	*0.44 %*
DK	*0.44 %*
BE	*0.43 %*
LU	*0.12 %*

Europe mom.

Country	*Average contribution*
UK	*36.83 %*
DE	*10.04 %*
CH	*8.35 %*
FR	*6.40 %*
SE	*6.40 %*
BE	*5.59 %*
IT	*5.42 %*
ES	*3.67 %*
NL	*3.46 %*
NO	*3.29 %*
DK	*2.68 %*
AT	*2.09 %*
IE	*2.03 %*
FI	*1.71 %*
LU	*1.31 %*
PT	*0.74 %*

Appendix 8. Regression results Fama-Fench-Carhart 6 -Factor model – US ESG TOP

Statistically significant variables bolded

Max. Lag: 3

US ESG TOP
Regression Analysis

OVERALL FIT			
Multiple R	0.97051195	AIC	-930.02088
R Square	0.94189344	AICc	-928.53635
Adjusted R Squa	0.93837183	SBC	-911.37681
Standard Error	0.01204905		
Observations	106		

ANOVA				Alpha	0.05	
	df	*SS*	*MS*	*F*	*p-value*	*sig*
Regression	6	0.23297952	0.03882992	267.461047	7.8033E-59	yes
Residual	99	0.01437279	0.00014518			
Total	105	0.24735231				

ols	*coeff*	*std err*	*t stat*	*p-value*	*lower*	*upper*	*vif*
Intercept	-0.0008	0.0012	-0.6507	0.5168	-0.0032	0.0016	
Mkt-RF	**1.0913**	0.0276	39.4740	**0.0000**	1.0364	1.1461	1.0417
SMB	-0.0151	0.0556	-0.2712	0.7868	-0.1254	0.0952	1.4285
HML	0.0659	0.0537	1.2257	0.2232	-0.0408	0.1725	1.9644
WML	-0.0628	0.0404	-1.5572	0.1226	-0.1429	0.0172	1.5845
RMW	-0.0875	0.0816	-1.0722	0.2862	-0.2494	0.0744	1.3480
CMA	0.0611	0.0862	0.7088	0.4801	-0.1099	0.2322	1.4243

newey-west	*coeff*	*std err*	*t stat*	*p-value*
Intercept	-0.0008	0.0013	-0.5991	0.5505
Mkt-RF	**1.0913**	0.0546	19.9962	**0.0000**
SMB	-0.0151	0.0575	-0.2624	0.7935
HML	0.0659	0.0525	1.2554	0.2123
WML	-0.0628	0.0622	-1.0100	0.3149
RMW	-0.0875	0.1159	-0.7548	0.4522
CMA	0.0611	0.0804	0.7598	0.4492

Appendix 9. Regression results Fama-French-Carhart 6 -Factor model – US ESG momentum

Statistically significant variables bolded

Max. Lag: 3

US ESG Momentum
Regression Analysis

OVERALL FIT			
Multiple R	0.91831015	AIC	-677.40361
R Square	0.84329352	AICc	-675.70949
Adjusted R Squa	0.83248618	SBC	-659.60054
Standard Error	0.02627899		
Observations	94		

ANOVA					Alpha	0.05
	df	*SS*	*MS*	*F*	*p-value*	*sig*
Regression	6	0.32331697	0.05388616	78.029679	7.0341E-33	yes
Residual	87	0.06008093	0.00069059			
Total	93	0.3833979				

ols	*coeff*	*std err*	*t stat*	*p-value*	*lower*	*upper*	*vif*
Intercept	-0.0035	0.0029	-1.1990	0.2338	-0.0092	0.0023	
Mkt-RF	**1.3058**	0.0612	21.3416	**0.0000**	1.1842	1.4274	1.0415
SMB	0.0880	0.1245	0.7066	0.4817	-0.1595	0.3355	1.4667
HML	0.0571	0.1201	0.4754	0.6357	-0.1816	0.2958	1.9649
WML	-0.0917	0.0890	-1.0302	0.3058	-0.2687	0.0852	1.5843
RMW	-0.0715	0.1894	-0.3775	0.7067	-0.4479	0.3049	1.4121
CMA	0.0736	0.1938	0.3800	0.7049	-0.3116	0.4588	1.4155

newey-west	*coeff*	*std err*	*t stat*	*p-value*
Intercept	-0.0035	0.0030	-1.1375	0.2585
Mkt-RF	**1.3058**	0.1211	10.7853	**0.0000**
SMB	0.0880	0.1361	0.6464	0.5197
HML	0.0571	0.1231	0.4638	0.6439
WML	-0.0917	0.0852	-1.0771	0.2844
RMW	-0.0715	0.1642	-0.4353	0.6644
CMA	0.0736	0.2070	0.3558	0.7229

Appendix 10. Regression results Fama-French-Carhart 6 -Factor model – Europe ESG top

Statistically significant variables bolded

Max. Lag: 3

Europe ESG TOP
Regression Analysis

OVERALL FIT	
Multiple R	0.9693686
R Square	0.9396755
Adjusted R Square	0.9360194
Standard Error	0.0118133
Observations	106

AIC	-934.2108
AICc	-932.72627
SBC	-915.56673

ANOVA				Alpha	0.05	
	df	*SS*	*MS*	*F*	*p-value*	*sig*
Regression	6	0.215207974	0.035868	257.02049	4.961E-58	yes
Residual	99	0.013815753	0.0001396			
Total	105	0.229023727				

ols	*coeff*	*std err*	*t stat*	*p-value*	*lower*	*upper*	*vif*
Intercept	0.0000	0.0013	-0.0038	0.9970	-0.0025	0.0025	
Mkt-RF	**1.1365**	0.0299	38.0120	**0.0000**	1.0772	1.1958	1.0634
SMB	0.0278	0.0735	0.3788	0.7057	-0.1179	0.1736	1.1564
HML	0.0529	0.1000	0.5291	0.5979	-0.1456	0.2514	5.6449
WML	-0.0366	0.0519	-0.7056	0.4821	-0.1395	0.0663	1.9399
RMW	0.0194	0.1273	0.1523	0.8793	-0.2331	0.2719	2.7084
CMA	0.0153	0.1388	0.1101	0.9125	-0.2601	0.2906	2.5125

newey-west	*coeff*	*std err*	*t stat*	*p-value*
Intercept	0.0000	0.0012	-0.0040	0.9968
Mkt-RF	**1.1365**	0.0501	22.7060	**0.0000**
SMB	0.0278	0.1002	0.2777	0.7818
HML	0.0529	0.1213	0.4364	0.6635
WML	-0.0366	0.0440	-0.8325	0.4071
RMW	0.0194	0.1328	0.1460	0.8842
CMA	0.0153	0.1334	0.1145	0.9091

Appendix 11. Regression results Fama-French-Carhart 6 -Factor model – Europe ESG momentum

Statistically significant variables bolded

Max. Lag: 3

Europe ESG Momentum
Regression Analysis

OVERALL FIT	
Multiple R	0.9219999
R Square	0.8500839
Adjusted R Square	0.8397448
Standard Error	0.0192865
Observations	94

AIC	-735.5645
AICc	-733.87038
SBC	-717.76143

ANOVA				Alpha	0.05	
	df	*SS*	*MS*	*F*	*p-value*	*sig*
Regression	6	0.18350072	0.0305835	82.220738	1.04E-33	yes
Residual	87	0.032361184	0.000372			
Total	93	0.215861904				

ols	*coeff*	*std err*	*t stat*	*p-value*	*lower*	*upper*	*vif*
Intercept	0.0003	0.0022	0.1223	0.9029	-0.0041	0.0046	
Mkt-RF	**1.0614**	0.0498	21.3328	**0.0000**	0.9625	1.1603	1.0817
SMB	-0.0028	0.1318	-0.0215	0.9829	-0.2648	0.2591	1.2565
HML	0.1086	0.1847	0.5879	0.5581	-0.2585	0.4756	6.1296
WML	0.0453	0.0940	0.4824	0.6308	-0.1414	0.2321	2.2704
RMW	0.2467	0.2159	1.1427	0.2563	-0.1824	0.6758	2.4242
CMA	0.2111	0.2538	0.8319	0.4078	-0.2933	0.7155	2.9103

newey-west	*coeff*	*std err*	*t stat*	*p-value*
Intercept	0.0003	0.0017	0.1539	0.8781
Mkt-RF	**1.0614**	0.0646	16.4306	**0.0000**
SMB	-0.0028	0.1270	-0.0224	0.9822
HML	0.1086	0.1530	0.7095	0.4799
WML	0.0453	0.0751	0.6035	0.5477
RMW	0.2467	0.1983	1.2439	0.2169
CMA	0.2111	0.1814	1.1639	0.2476

Appendix 12. Regression results Fama-French-Carhart 6 -Factor model – US ESG TOP – COVID-19

Statistically significant variables bolded

Max. Lag: 4

US ESG TOP: COVID-19
Regression Analysis

OVERALL FIT			
Multiple R	0.988900017	AIC	-3389.74
R Square	0.977923244	AICc	-3389.24
Adjusted R Square	0.977469612	SBC	-3363.84
Standard Error	0.003413468		
Observations	299		

ANOVA					Alpha	0.05
	df	*SS*	*MS*	*F*	*p-value*	*sig*
Regression	6	0.150711	0.025118	2155.764	1.7055E-238	yes
Residual	292	0.003402	1.17E-05			
Total	298	0.154113				

ols	*coeff*	*std err*	*t stat*	*p-value*	*lower*	*upper*	*vif*
Intercept	0.0001	0.0002	0.3932	0.6945	-0.0003	0.0005	
Mkt-RF	**0.9867**	0.0106	92.6894	**0.0000**	0.9657	1.0076	1.1626
SMB	**0.2865**	0.0234	12.2186	**0.0000**	0.2403	0.3326	1.3490
HML	**0.3345**	0.0251	13.3425	**0.0000**	0.2852	0.3839	4.3289
WML	**-0.0522**	0.0177	-2.9503	**0.0034**	-0.0871	-0.0174	3.4384
RMW	**-0.0720**	0.0406	-1.7726	**0.0773**	-0.1518	0.0079	1.8875
CMA	0.0717	0.0459	1.5617	0.1194	-0.0187	0.1620	1.5891

newey-west	*coeff*	*std err*	*t stat*	*p-value*
Intercept	0.0001	0.0002	0.3902	0.6967
Mkt-RF	**0.9867**	0.0111	88.6466	**0.0000**
SMB	**0.2865**	0.0475	6.0305	**0.0000**
HML	**0.3345**	0.0324	10.3259	**0.0000**
WML	**-0.0522**	0.0201	-2.6031	**0.0097**
RMW	-0.0720	0.0441	-1.6325	0.1037
CMA	0.0717	0.0900	0.7964	0.4264

Appendix 13. Regression results Fama-French-Carhart 6 -Factor model – US ESG momentum – COVID-19

Statistically significant variables bolded

Max. Lag: 4

US ESG Momentum: COVID-19
Regression Analysis

OVERALL FIT	
Multiple R	0.985386
R Square	0.970985
Adjusted R Square	0.970389
Standard Error	0.004613
Observations	299

AIC	-3209.61486
AICc	-3209.118308
SBC	-3183.711755

ANOVA				Alpha	0.05	
	df	*SS*	*MS*	*F*	*p-value*	*sig*
Regression	6	0.207966	0.034661	1628.623255	3.6E-221	yes
Residual	292	0.006214	2.13E-05			
Total	298	0.21418				

ols	*coeff*	*std err*	*t stat*	*p-value*	*lower*	*upper*	*vif*
Intercept	0.0000	0.0003	0.0378	0.9698	-0.0005	0.0005	
Mkt-RF	**1.0581**	0.0144	73.5492	**0.0000**	1.0298	1.0865	1.1626
SMB	**0.9536**	0.0317	30.0956	**0.0000**	0.8912	1.0159	1.3490
HML	**0.3867**	0.0339	11.4124	**0.0000**	0.3200	0.4534	4.3289
WML	**-0.0434**	0.0239	-1.8126	**0.0709**	-0.0905	0.0037	3.4384
RMW	**-0.2367**	0.0549	-4.3139	**0.0000**	-0.3446	-0.1287	1.8875
CMA	**-0.5294**	0.0620	-8.5354	**0.0000**	-0.6515	-0.4074	1.5891

newey-west	*coeff*	*std err*	*t stat*	*p-value*
Intercept	0.0000	0.0002	0.0422	0.9664
Mkt-RF	**1.0581**	0.0237	44.6754	**0.0000**
SMB	**0.9536**	0.0322	29.6217	**0.0000**
HML	**0.3867**	0.0528	7.3234	**0.0000**
WML	-0.0434	0.0354	-1.2264	0.2210
RMW	**-0.2367**	0.0518	-4.5720	**0.0000**
CMA	**-0.5294**	0.0960	-5.5131	**0.0000**

Appendix 14. Regression results Fama-French-Carhart 6 -Factor model – Europe ESG top – COVID-19

Statistically significant variables bolded

Max. Lag: 4

Europe ESG TOP: COVID-19
Regression Analysis

OVERALL FIT			
Multiple R	0.993254083	AIC	-3726.72
R Square	0.986553674	AICc	-3726.23
Adjusted R Square	0.986281113	SBC	-3700.72
Standard Error	0.002109905		
Observations	303		

ANOVA					Alpha	0.05
	df	*SS*	*MS*	*F*	*p-value*	*sig*
Regression	6	0.09668	0.016113	3619.575	1.2E-273	yes
Residual	296	0.001318	4.45E-06			
Total	302	0.097997				

ols	*coeff*	*std err*	*t stat*	*p-value*	*lower*	*upper*	*vif*
Intercept	0.0001	0.0001	0.8051	0.4214	-0.0001	0.0003	
Mkt-RF	**1.0348**	0.0098	105.3169	**0.0000**	1.0154	1.0541	1.6453
SMB	**0.1702**	0.0261	6.5292	**0.0000**	0.1189	0.2216	1.5969
HML	**0.3475**	0.0262	13.2669	**0.0000**	0.2960	0.3991	3.7105
WML	**-0.1104**	0.0162	-6.8309	**0.0000**	-0.1422	-0.0786	3.2790
RMW	0.0781	0.0485	1.6104	0.1084	-0.0173	0.1735	1.5422
CMA	**-0.0755**	0.0411	-1.8347	**0.0676**	-0.1564	0.0055	1.9802

newey-west	*coeff*	*std err*	*t stat*	*p-value*
Intercept	0.0001	0.0001	0.8101	0.4186
Mkt-RF	**1.0348**	0.0149	69.6250	**0.0000**
SMB	**0.1702**	0.0456	3.7351	**0.0002**
HML	**0.3475**	0.0291	11.9355	**0.0000**
WML	**-0.1104**	0.0279	-3.9561	**0.0001**
RMW	**0.0781**	0.0468	1.6672	**0.0965**
CMA	-0.0755	0.0549	-1.3751	0.1702

Appendix 15. Regression results Fama-French-Carhart 6 -Factor model – Europe ESG momentum – COVID-19

Statistically significant variables bolded

Max. Lag: 4

Europe ESG Momentum: COVID-19
Regression Analysis

OVERALL FIT	
Multiple R	0.973605
R Square	0.947908
Adjusted R Squ	0.946852
Standard Error	0.00378
Observations	303

AIC	-3373.4
AICc	-3372.91
SBC	-3347.4

ANOVA				Alpha	0.05	
	df	*SS*	*MS*	*F*	*p-value*	*sig*
Regression	6	0.076952	0.012825	897.7013	1.2E-186	yes
Residual	296	0.004229	1.43E-05			
Total	302	0.081181				

ols	*coeff*	*std err*	*t stat*	*p-value*	*lower*	*upper*	*vif*
Intercept	-0.0001	0.0002	-0.6441	0.5200	-0.0006	0.0003	
Mkt-RF	**1.1334**	0.0176	64.3935	**0.0000**	1.0988	1.1681	1.6453
SMB	**0.9618**	0.0467	20.5906	**0.0000**	0.8699	1.0537	1.5969
HML	**0.2047**	0.0469	4.3630	**0.0000**	0.1124	0.2971	3.7105
WML	**0.0525**	0.0290	1.8114	**0.0711**	-0.0045	0.1095	3.2790
RMW	0.0092	0.0869	0.1056	0.9160	-0.1618	0.1801	1.5422
CMA	-0.0856	0.0737	-1.1614	0.2464	-0.2306	0.0594	1.9802

newey-west	*coeff*	*std err*	*t stat*	*p-value*
Intercept	-0.0001	0.0002	-0.7146	0.4754
Mkt-RF	**1.1334**	0.0264	42.9208	**0.0000**
SMB	**0.9618**	0.0501	19.1998	**0.0000**
HML	**0.2047**	0.0543	3.7727	**0.0002**
WML	0.0525	0.0380	1.3788	0.1690
RMW	0.0092	0.0948	0.0967	0.9230
CMA	-0.0856	0.0733	-1.1668	0.2442