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ESG Meets Fama French Portfolio Performance

A Risk/Return study of the Norwegian markets

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Abstract

By examining the research question: *How does ESG score integration affect the performance and risk characteristics of portfolios constructed using Fama-French factor models in the Norwegian market.*

This thesis explores the integration of Environmental, Social, and Governance (ESG) scores into portfolio performance analysis using the Fama-French factor models in the Norwegian stock market. The study addresses how ESG score integration impacts the performance and risk characteristics of portfolios constructed based on the Oslo All Share Index (OSEAX). By constructing portfolios based on ESG scores and analyzing them through the Fama-French 3-factor and 5-factor models, plus an ESG factor (TMB), the findings reveal that portfolios with low ESG scores significantly outperform those with high ESG scores. These results suggest that low ESG scores can be associated with higher returns, highlighting a complex relationship and importance of ESG factors in investment strategies and offering insights for sustainable finance for the Norwegian stock market.

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List of Symbols:

$\boldsymbol{Ri} = Return\ of\ portfolio$

$\boldsymbol{Rf} = Risk - free\ rate$

$\boldsymbol{ai} = Intercept\ of\ the\ regression\ (alpha)$

$\boldsymbol{\beta 1, \beta 2, \beta 3, \beta 4, \beta 5} = Sensitivities\ to\ the\ respective\ factors\ (betas)$

$\boldsymbol{Rmt - Rft} = Market\ premium$

$\boldsymbol{SMB}\ (\boldsymbol{Small\ Minus\ Big}) = Return\ spread\ of\ small\ minus\ large\ stocks$

$\boldsymbol{HML}\ (\boldsymbol{High\ Minus\ Low}) = Return\ spread\ of\ cheap\ minus\ expensive\ stocks$

$\boldsymbol{RMM} = Return\ spread\ of\ the\ most\ profitable\ firms\ minus\ the\ least\ profitable$

$\boldsymbol{CMA} = Return\ spread\ of\ firms\ that\ invest\ conservatively\ minus\ aggressively$

$\boldsymbol{\epsilon} = Error\ term\ for\ each\ portfolio\ in\ month\ t$

1.0 Introduction

Markets are dynamic, constantly adapting to changes and new opportunities that appear most attractive. In this paper, we will utilize the well-recognized Fama-French factor models and attempt to enhance them by incorporating an additional factor based on ESG (Environmental, Social, and Governance) scores. This adjustment is motivated by the growing interest in sustainable investing and the regulatory changes observed primarily in the western world, but also increasingly on a global scale. We will therefore explore deeper into ESG integration in portfolios, and how it affects portfolio performance through the Fama-French model in the Norwegian markets, by looking at this research question:

How does ESG score integration affect the performance and risk characteristics of portfolios constructed using Fama-French factor models in the Norwegian market?

1.1 Context - Sustainable Investing

Investor priorities around sustainable practices have notably increased. Back in the 1970s, Milton Friedman's theory, which argued that a company's primary objective is to maximize profits for its shareholders (Friedman, 1970), was highly influential.

According to Friedman, individuals bear social responsibilities, corporations discharge their obligations to society by focusing on enhancing shareholder value. However, this perspective has been challenged over the years. Critics argue that corporations have broader responsibilities that extend beyond mere profit generation, encompassing aspects of corporate social responsibility (CSR) towards environmental and social welfare.

Research by Schaefer, Orlitzky et al., and Russo and Fouts has demonstrated a positive correlation between a company's financial success and its social and environmental contributions. This positive correlation implies that companies

who have ESG implemented in their day-to-day operation and actively report on this should outperform companies who avoid this.

From the 1970s to the present, a marked transformation in investor sentiment is notable. The United Nations' introduction of the Millennium Development Goals in 2000 (World Health Organization, 2018), aimed at promoting a sustainable development, equality, and the eradication of global poverty, marked a pivotal moment. These goals were further evolved into the Sustainable Development Goals of 2015, highlighting the growing emphasis on sustainability, human rights, and social responsibility across nations, businesses, and the investment community.

The concept of sustainable investing is commonly spoken in terms like "Socially Responsible Investment" (SRI) and "Environmental Social Governance" (ESG). The latter term gained ground following a report by the United Nations Global Compact in 2004, signifying a growing trend among investors towards seeking both financial returns and societal benefits. Both SRI and ESG approaches reflect a desire to balance ethical considerations with investment decisions, whether through excluding companies that don't meet certain ethical standards or selectively investing in entities that contribute positively to society. This should create more influx of capital towards socially aware companies and by common supply and demand rules the returns for these would also increase given nothing else changes.

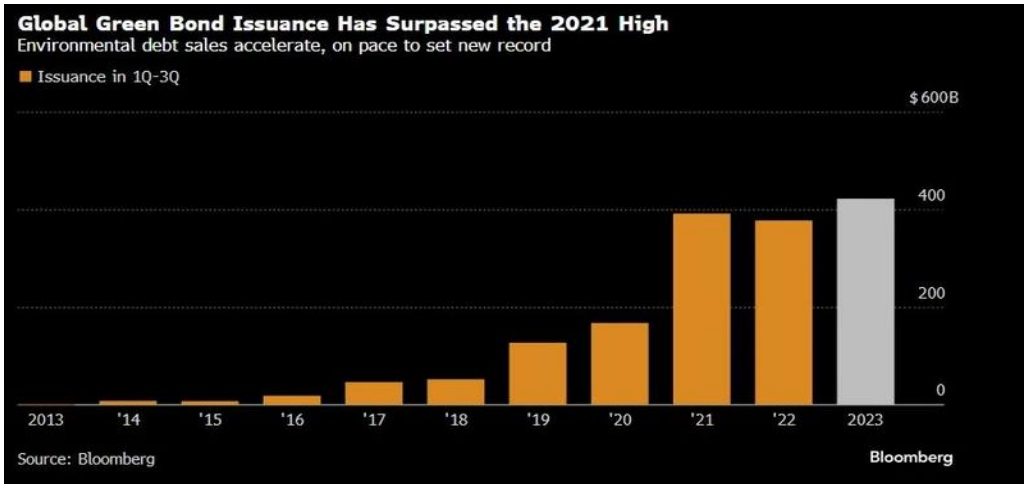
The ESG score hence serves as a framework for evaluating a company's impact on the environment, its social relationships, and governance practices. These metrics provide insights into a company's sustainability efforts, including its environmental footprint, social contributions, and governance structures. Such an assessment not only helps in identifying companies that are likely to offer stable long-term returns, but also underscores the role of corporate governance in achieving sustainable growth.

It is logic that as the interest grows for sustainable actions, more capital will start to flow towards these businesses creating abnormal stock returns, or some ”unexplained” returns. This paper will hence attempt to explain this better, through models or frameworks, such as the Fama-French factor models, with both the 3 factor and 5 factor models.

Moreover, the influence of investors in shaping the sustainability profile of companies is increasingly recognized (Ahmad, Yaqub, & Lee, 2024). Their investment decisions can significantly impact corporate practices, encouraging companies to adopt more sustainable and responsible business models.

Looking at how capital moves in the world of finance is a good indicator to see markets growing or declining. In table 1.1 we see the growth in green bonds and how the market has grown drastically the past decade. This proves that both government incentives and sustainable regulations combined with investors showing a growing interest in investments with ESG in focus.

Table 1.1 *(Nov 7, 2023 Bloomberg)*



In this context, global agreements like the Paris Agreement, and its objectives such as limiting global warming to well below 2 degrees Celsius, underscore the urgent need for sustainable investment practices. By aligning investment strategies with these global sustainability goals, investors wield considerable power in driving corporate action towards a more sustainable future.

We will therefore study how these ESG scores impact portfolio performance, and we are almost certain that the performance will change, but we are not sure in what way this will happen. We then hope to see that high ESG score directly correlates with the best performing portfolio, but we also have a hypothesis that companies who recently have adopted ESG metrics can perform better as investors see that the businesses are moving in the right direction, therefore proving that stocks with lower ESG scores can be the top performer in our findings. The last idea of an outcome is that the inclusion of ESG scores in stock picking decreases the risk/reward ratio, meaning our portfolio performs worse than the benchmark or a random portfolio without ESG considerations.

1.2 What is ESG

ESG, or Environmental, Social, and Governance, is a common term among shareholders and stakeholders today, and judging a firm's ESG score has become a common tool for assessing the impact and sustainability of organizations worldwide (Park, Choi, & Jung, 2022). This approach to investment and business analysis is designed to help investors and stakeholders understand how an organization is managing risks and opportunities related to three categories:

1.2.1 Environmental Criteria

Firstly, the "Environmental" component of ESG focuses on the organization’s impact on the natural environment. This includes how a company responds to challenges such as climate change, pollution, biodiversity, deforestation, water scarcity, energy and so on. Environmental criteria hence assess a company's dedication to the environment, looking at its environmental policies, the sustainability of its products and services, its waste management practices, and its resource utilization efficiency. With the world's growing concerns about the planet’s health, the environmental criteria help shareholders and stakeholders identify companies that prioritize and implement sustainable practices (Wan Mohammad & Wasiuzzaman, 2021).

1.2.2 Social Criteria

Secondly, the "Social" aspect of ESG examines how a company manages relationships with its employees, suppliers, customers, and the communities where it operates. This includes evaluating labor practices, employee relations and diversity, work conditions, health and safety measures, and the company's impact on the local and broader communities. Social criteria are therefore crucial for assessing the integrity and ethical standards which a company operates, ensuring they contribute positively to society, and creating a supportive and healthy corporate culture ("What is S-ESG Investing?", 2022).

1.2.3 Governance Criteria

Thirdly, “Governance” involves the evaluation of a company’s leadership, executive pay, audits, internal controls, and things like shareholder rights. This pillar also emphasizes things like transparency, accountability, and board diversity, hence assessing the quality of management and the board of directors in their duty to make decisions in the best interest of shareholders while ensuring fairness, transparency, and integrity in their operations. This means that it helps to ensure that companies avoid conflicts of interest, manage themselves responsibly, and cultivate a corporate culture that values ethical behavior and compliance with for example laws and regulations (World Economic Forum, 2022).

1.3 The Impact of ESG

The integration of Environmental, Social, and Governance (ESG) scores into investment analysis and decision-making processes marks a significant shift towards more sustainable and responsible business practices. By offering a score through which investors can evaluate potential risks and opportunities beyond traditional financial metrics, ESG factors enable the identification of longterm value creation prospects, risk mitigation strategies, and contributions to societal goals like environmental sustainability and social welfare. This approach has debunked the misconception that sustainable investing necessitates a compromise on financial performance, as ESG investing has

evidently shown a strong correlation with reduced volatility and potentially enhanced long-term returns (J.P. Morgan Private Bank, n.d.).

As public awareness and regulatory changes of sustainability and ethical business practices intensify, companies excelling in ESG practices are increasingly gaining a competitive edge, attracting investors, talent, and customer loyalty (Petrova, 2023). This growing global consciousness is propelled by an understanding of the lasting impacts of climate change, social inequality, and corporate governance on economic stability and society in general.

The momentum behind ESG investing is supported by evidence suggesting that companies with robust ESG profiles are likely to outperform their less sustainable counterparts over the long term, offering potentially lower risks and higher returns (Zhou et al., 2016). This trend benefits from regulatory changes and policy initiatives aimed at promoting sustainable finance, such as impact funds, and reflects a generational shift in investment preferences, with more investors particularly favoring investments that align with their values and concerns for the planet's future (Niewińska & Mijał, 2024).

Consequently, ESG stocks, once considered a niche interest, have gained momentum in investment strategies focused on sustainable growth, long term value creation, and capital preservation. The transition from niche to mainstream shows the increasing role of ESG considerations in crafting investment strategies that adapt to the evolving demands of the market.

2.0 Literature Review

Like we have mentioned earlier, the environmental concerns and sustainability have gained interest among investors due to the increased focus on climate change. Understanding the finance behind these companies has therefore become crucial. One of the most significant aspects of financial analysis lies in the pricing of the share (Bai 2022). Empirically, shares within these green sectors demonstrate a distinct pricing pattern outperforming the rest of the market (Stotz, O. 2022). This divergence in pricing is primarily attributed to the extended timeframe within which cash flows are generated (Dinh, M. T. H. 2023), presenting a unique aspect that sets these shares apart from other financial instruments.

This literature review aims to explore the existing body of knowledge on portfolio construction and returns in the context of extensive ESG research in the stock market. We will then apply these insights to the Norwegian stock market. With the research question at the core of this investigation we see a need to gain a better understanding of how ESG scores affect portfolio performance when constructed using Fama French, and whether or not taking this into consideration can yield a better performing portfolio.

As we look into the existing literature, our review will explore studies, theories, and empirical evidence that can help us shed light on the relationship between industry dynamics, share pricing, and the potential need for tailored adjustment factors for these green stocks. By understanding the insights from various sources, this literature review seeks to contribute to the ongoing discourse surrounding the financial valuation of companies in the Norwegian stock market.

2.1 ESG and Performance

According to a report made by Morgan Stanley's institute for sustainable investing, funds constructed based on ESG (or sustainability) have a median return of 12,6% while traditional funds deliver a return of 8,6% in 2023 (Morgan Stanley, 2023). Interesting to see in this report is how regions are heavily affecting the returns where the best performing US fund had a return of 21,3% while the best Europe focused fund delivered a return of 14,1%. This fact could indicate that ESG returns are very dependent on regions which means that looking only at the Norwegian market can provide interesting results and provide a better understanding of the field. We have seen similar attempts on research to explain the Nordic region, but we believe there to be even country specific differences due to different goals and regulations by their respective governments.

Several of our sources write about the relationship between Corporate social, responsibility (CSR) and financial performance, but the research of Ameer and Othman (2012) sticks out, as they interestingly suggest that CSR practices can influence the cost of equity capital, with better CSR disclosure potentially leading to a reduction in the cost of equity. Ameer and Othman (2012) also state that companies adopting these CSR practices may experience increased valuation due to improved environmental, social, and governance performance (ESG). CSR practices can have a direct impact on the cost of equity capital. The suggestion that enhanced CSR disclosure might lead to a reduction in the cost of equity (Ameer & Othman 2012). We see a lot of value in this for our research as CSR is highly correlated with ESG and a reduction in cost of equity would imply better valuations. Constructing ESG portfolios should therefore provide better returns. The notion that companies adopting improved CSR practices may experience increased valuation aligns with our interest in understanding the financial implications of sustainability initiatives. This paper contributes valuable insights into the potential financial benefits associated with robust CSR practices, which could be a crucial factor in our analysis of Norwegian ESG stock valuation and further strengthens our beliefs that portfolio construction with ESG in focus will yield better performing portfolios.

Sahut and Pasquini-Descomps (2015) looked at the impact ESG had on performance for Switzerland, US and UK during 2007-2011. The results are derived from a non-parametric kernel regression and find evidence showing that stock performance based on ESG -score changes is non-linear. The study is performed based on many reasons but the most crucial of them is the widely accepted theory in SRI "the cost of capital" reduction saying that the costs incurred by a socially responsible structure provides better value for the firm. Companies are offset by the decrease in cost of capital. Another reason for the study is the theoretical position around ESG and firms referred to as the information effect (Kurtz 2005) or Sharfman and Fernando 2008) which in principle means that high ESG ratings would mean lower residual risk. Through our study we will see if their findings also apply for the Norwegian markets. Another study by Choet (2023) employs research, incorporating financial metrics, ESG ratings, and industry-specific factors, highly relevant to our research. They sample Korean firms from 2011 to 2019 and find that on average ESG is positively associated with firm value. This relationship is contingent on a firm's financial performance. Notably, the positive association weakens as performance deteriorates, showcasing the nature of the relationship between ESG practices and firm value. The research also delves into information asymmetry, demonstrating that the impact of ESG on firm value is more pronounced in firms facing higher information asymmetry. Through these performance metrics we can imply that firms who have this as a focused area will prove to be better investment opportunities and therefore their valuation should increase. We can capture this by creating our own factor for the Fama French model incorporating the ESG metrics for picking stocks to our portfolios.

2.2 ESG Ratings

Whether or not ESG and/or sustainable investing could improve returns for investors is a debatable topic. An article based on 2000 empirical studies shows that 42,7% of studies in North America, 26,1% of studies in Europe and 33,3% of studies in Australia/Asia found there to be a non-negative relationship between ESG and corporate financial performance. (Friede, Busch, & Bassen, 2015) The interesting part of this is that the non-negative relationship seems to become less significant in studies that look at portfolios. Friede, Busch, and Bassen (2015) also looked at the ESG effect over a longer time horizon, where they hypothesized that if ESG awareness increased in investment strategies, it is expected to see a decreasing ESG alpha based on the adaptabilities in the capital markets, as one could argue that they are efficiently inefficient Pedersen, L. H. (2019) and assets will eventually price themselves correctly. It is interesting to see if our studies can help capture the price imbalance before the assets are priced more correctly, or if our study simply catches these assets at the right moment, but the ESG considerations taken by the respective companies proves to improve future growth and a decreasing alpha. Derwall et al. (2005) studied socially responsible investing strategies which contained the high valued US companies who also had high environmental and social scores. By using the Carhart four-factor model, the strategy had a positive alpha of 4,15% annually. Derwall is not the only one who has found interesting results as Kempf and Osthoff (2007) also looked at this through the four-factor model and found evidence of positive abnormal returns on ESG portfolios. Pollard, Sherwood, and Klobus (2018) also found there to be a positive ESG risk premia when regressed on the Fama-French factors model. Jin (2018) looked at ESG risk factors for mutual funds and found evidence that the risk factors were significant to returns, but their impact had variations over time. For example before 2010 portfolios weighted with ESG were outperformed by the market index, but the opposite happened after, to see if we still outperform the market with most recent market events and global tensions is exciting as the world has changed alot since 2018. The paper (Jin 2018) also found that including ESG factors in the FF5 factor model gave

a significant contribution to returns compared to not including these, which we will have a look at through the model.

2.3 Sustainability and Innovation

While recognizing the potential benefits, the literature by Park and Ravenel (2013) acknowledges challenges in integrating sustainability into financial practices. Building on this paper, Zeidan and Spitzeck (2015) issue the lack of standardized accounting schemes, information asymmetry, and the need for specific materiality and sustainability reporting standards are identified. Their study proposes collaborations between environmental managers and financial departments to generate data and encourage policymakers to promote more transparent sustainability reporting. The content of this topic is interesting for our research as it helps to shed light on the challenges and considerations in integrating sustainability into financial practices, a key aspect of our investigation is the identification of Norwegian ESG scores which can be wrong either by the company not being transparent enough or their data and statistics are manipulated. Park and Ravenel (2013) also highlight the difficulties associated with this integration, including the absence of standardized accounting schemes and information asymmetry, something we have to account for in our research as not all companies will be rated.

Zeidan and Spitzeck (2015), proposed a new methodology called the Sustainability Delta, aiming to assess the impact of ESG scenarios on firm value. The research focuses on a small sugar manufacturer, evaluating the potential effect of sustainability initiatives, particularly in bioenergy and organic sugar production. The Sustainability Delta is presented as a percentage change in enterprise value when a firm transitions from a Business as Usual (BAU) to a Sustainable Business (SB) path. The study claims a positive change of 1,24% in enterprise value in the presented simulation. However, the methodology has limitations, including information requirements, applicability to single-product companies, and challenges in assumptions regarding Sustainable Business (SB) and Full Sustainable Business (FSB) paths. However it is interesting to see that more sustainable business practices

increases the value which builds up on our argument to construct portfolios based on a company's approach to sustainability.

The content of the text by Zeidan and Spitzeck (2015) is highly relevant to our research, providing valuable insights into the integration of sustainability factors in firm valuation. The proposed Sustainability Delta methodology offers a structured approach to assess the impact of ESG scenarios on enterprise value. The focus on a small sugar manufacturer demonstrates the applicability of the methodology to specific industries. The quantification of the impact, with a claimed change of 1.24% in enterprise value during the transition from a Business as Usual (BAU) to a Sustainable Business (SB) path, provides a tangible metric that aligns with our objective of analysing ESG stock valuation. Moreover, the acknowledgement of limitations, such as information requirements and challenges in assumptions, contributes to an understanding of the methodology's scope and potential constraints, guiding our research approach and interpretation of results.

2.4 Factors

Constructing Portfolios based purely on ESG factors shows that there is no significant alphas (Naffa & Fain, 2021), they found no significant evidence for ESG as valid factors to complement the FF5 model. They do however acknowledge that ESG may quantify investment portfolio risks through performance attribution. Mercereau et al. (2022) provides an analysis of the relationship between environmental, social, and governance (ESG) factors and shareholder value creation. Through utilizing extensive data on various ESG metrics, financial variables, and regional considerations the methodology seems robust. The paper emphasizes the importance of ESG engagement strategies, suggesting that improvements in specific ESG variables can contribute to shareholder value, while the research design is thorough, a critical evaluation may consider the challenges and limitations associated with the availability and accuracy of ESG data across different countries and industries (Mercereau 2022). This further strengthens our beliefs that including ESG factors in portfolio construction will increase our risk/reward ratio, but at the same time we must acknowledge that some information may be

manipulated, wrong or lacking which could provide some false findings or errors in our model.

The findings from Ketolas (2022) paper and Larsen and Larsen (2022) are both focused on the relationship between news and how the ESG related stocks react. Ketolas (2022) who studied the nordic markets found that negative news were statistically significant market reaction implying that there is an asymmetry between positive and negative news imposing that the market will punish companies who do not act responsibly. Larsen and Larsen (2022) who studied the Norwegian energy sector found the news to be of somewhat equal impact on the stock prices, indicating that the market penalizes negative news while rewarding positive news. This asymmetry in market reactions underscores the challenges in determining fair adjustment factors for pricing ESG stocks, as the market appears to be more reactive to negative information than positive, potentially influencing the development of adjustment models that adequately capture this asymmetry. Exploring whether or not the pattern is consistent across ESG rated companies in either a sector or a region can provide deeper understanding in regards to pricing of these assets.

2.5 Risk Adjusted Returns

Risk and returns are closely correlated and a normal idea in the world of finance is that higher risk has the potential to yield higher returns. This relationship is explained by risk-adjusted returns, where the goal is to lower portfolio risk while achieving the same or higher return (Kumar 2016). Elton (1996) discovered that alpha from the ff factor models is a way to measure risk adjusted returns where lower alphas indicated a better risk-adjusted portfolio as the models adjust for the risk which is explained by the factors. Kumar (2016) who looked at ESG stocks compared to the market found that ESG yielded a better Sharpe and Treynor ratio in 9 out of 12 industries. There is therefore some proof that investing in ESG yields a higher average return for a relatively equal risk as for similar stocks who do not have ESG incentives in their organization. Both Kumar et al. (2016) and Díaz et al. (2021) research suggests that taking ESG into investment decisions improves the risk-adjusted returns and can even increase the return. We have the same idea but as we

discussed earlier we think there are differences across regions and a study of the Norwegian market is therefore contributing to the studies of other markets like the USA.

2.6 Hypothesis Development

The existing literature provides a thorough foundation for our investigation into how ESG score integration affects portfolio performance and risk characteristics when constructed using Fama-French factor models in the Norwegian market. There is proof that ESG is somehow altering the pricing of stocks in the markets worldwide and we have seen that this alters between regions. Empirical evidence from various markets, including the Nordic region, shows the complex relationship between ESG scores and stock performance. At the same time we see multiple attempts to explain why pricing is different or how we can capture it to benefit our portfolio performance

In conclusion, the literature suggests that sustainability considerations can have a significant impact on firm valuation. The proposed methodologies, such as the Sustainability Delta, attempt to address the gaps in existing ESG methodologies and provide a deeper understanding of the relationship between sustainability and firm value.

2.6.1 Primary Hypothesis:

- Constructing Portfolios based on an ESG factor and combining this with both the Fama French 3-factor model and 5-factor model will have a statistically significant improvement in both models' explanatory power for portfolio returns.

2.6.2 Secondary Hypotheses:

- ESG considerations in portfolio construction will outperform the market
- ESG scores positively correlate with company valuation metrics in the Norwegian stock market

Based on these insights and more, our hypothesis is that integrating ESG scores into the Fama-French factor models will alter the performance and risk characteristics of portfolios in the Norwegian market. Specifically, we expect that portfolios incorporating ESG factors will exhibit different risk-return profiles compared to those constructed solely on traditional financial metrics. By exploring this hypothesis, we aim to contribute to the ongoing discourse on ESG integration in financial models and its implications for sustainable investing in the Norwegian market.

3.0 Data and Methodology

3.1 Data Collection Process

In order to collect data for our study, we targeted the Oslo All Share Index (OSEAX) to identify the stocks for our analysis, given its representation of the Norwegian market. All the data, except for the ESG scores, were extracted on a monthly basis to ensure consistency and facilitate a detailed temporal analysis. This is better systematically shown in Table 3.1. Despite some variables only changing annually (fiscal 1 July – 30 June), the monthly extraction provided a full dataset, allowing for more refined factor calculations and regression analysis.

Table 3.1

Data Overview	Observations	Frequency	Source
Stock Price	33657	Monthly	LSEG EIKON
Risk Free Rate (NIBOR)	265	Monthly	LSEG EIKON
Market Capitalization	33470	Monthly	LSEG EIKON
Book Value Per Share	38277	Monthly	LSEG EIKON
Common Shares	38385	Monthly	LSEG EIKON
EBIT	38169	Monthly	LSEG EIKON
Common Equity	39189	Monthly	LSEG EIKON
Total Assets	39189	Monthly	LSEG EIKON
ESG Score	852	Yearly	LSEG EIKON

3.1.1 Fama-French Factors

To analyze the Fama-French factors, we needed specific financial data for each stock. The data were extracted on a monthly basis, even though some variables only change annually due to their fiscal nature. The factors we focused on include (Fama & French 2014):

1. **Market Risk Premium (Rmkt − Rf):** To determine the Market Risk Premium, we collected the returns of the market index (Rmkt) and the risk-free rate (Rf). The market index returns were sourced monthly, reflecting the overall market performance. The risk-free rate was the 3-month Treasury yield from Norges Bank, providing a reliable benchmark for risk-free returns. By subtracting the risk-free rate from the market index returns, we calculated the Market Risk Premium, allowing us to measure the excess return that investors expect from holding a risky market portfolio over a risk-free asset. This monthly data enabled a consistent analysis of the Market Risk Premium over the studied period.
2. **Size Factor (SMB):** We collected the Market Capitalization (Market Cap) for each stock. Market Cap data were retrieved monthly, providing a view of size fluctuations over time.
3. **Value Factor (BTM):** For calculating the Book-to-Market ratio, we obtained the Book Value per share and the number of Common Shares. Using these figures, we calculated the total Book Value. This monthly data enabled us to compute the Book to Market BTM ratio consistently over the studied period.
4. **Profitability Factor (RMW):** We also sourced Earnings Before Interest and Taxes (EBIT) and Common Equity data. These metrics allowed us to calculate the profitability of each stock, the component of the RMW factor. The monthly data ensured that we could track changes in profitability over time.
5. **Investment Factor (CMA):** To evaluate the investment factor, we acquired Total Assets data and calculated the Change in Total Assets. By comparing the total assets month by month, we assessed the investment behavior of the companies, the element for the CMA factor.

3.1.2 ESG Scores

We started by collecting ESG scores for all our selected stocks. We used the EIKON database, and we gathered yearly ESG scores, extending our dataset as far back as possible. This retrospective approach allowed us to establish 2002 as the starting point for our analysis, defining our timeframe.

Despite EIKON being a reliable database, we quickly saw that some stocks did not have available ESG scores, even though they were operational during the period we wanted to study. To address this gap, we employed a simulation method (R code) using linear regression to estimate the missing ESG scores. By applying linear regression to the available ESG data for each company, we predicted the potential ESG scores for the periods lacking this information. But make note, this approach assumes a linear development in the company's ESG performance, whether in a positive or negative direction. We also changed all negative simulated results to zero, as there are no negative ESG scores in the framework we use. It is also important to note that by creating this assumption we might not fully capture the complexity of a company's ESG trajectory. Furthermore, stocks that lacked sufficient ESG data and could not be reliably simulated were excluded from our portfolios.

3.1.3 Return and Excess Return Calculation

We also needed returns for our analyses. We collected the monthly return for each stock and calculated the excess return by using the 3-month Treasury yield (NIBOR) from LSEG and used the adjusted close prices from the first of each month over the past five years. The 3-month Treasury yield is employed as the risk-free rate because it represents the minimum return an investor expects from an investment with no risk. Norwegian Treasury securities are considered virtually risk-free due to the backing of the Norwegian government, though some risks like reinvestment risk remain. We calculated excess returns by subtracting the Treasury yield from our stock returns.

3.1.4 The ESG scoring framework

The London Stock Exchange Group (LSEG) has developed a framework, shown in Table 3.1.4, for evaluating Environmental, Social, and Governance (ESG) factors, in order to offer a tracking variable for the companies sustainability practices. This framework employs, according to London Stock Exchange Group (2024), a multi-dimensional approach, assessing various facets of ESG performance to provide a comprehensive picture.

In the table we see that the framework considers environmental factors such as carbon footprint through emissions and resource usage, evaluating companies efforts towards mitigating ecological impact.
The Social dimensions encompass labor practices through workforce, community engagement, and human rights, reflecting companies commitments to stakeholders beyond shareholders.
For the Governance criteria the framework looks into board composition through management, as well as executive compensation structures, transparency to shareholders, and ethical business conduct, proving the quality of corporate governance practices.

The framework in EIKON also has a separate score for each of the ESG dimensions, something that could be interesting to use in further or similar research.

The reason we chose the framework provided by London Stock Exchange Group (2024), is because they state that their scoring methodology is designed to capture the intricacies of ESG performance, enabling investors to discern between companies excelling in sustainability and those needing improvement. By integrating these quantitative data and qualitative insights, one hence is facilitating for more informed investment decisions, and one promotes sustainable finance practices and driving positive societal and environmental outcomes through finance, which we find very important and fascinating.

Tabel 3.1.4: This is what the LSEG framework looks like:

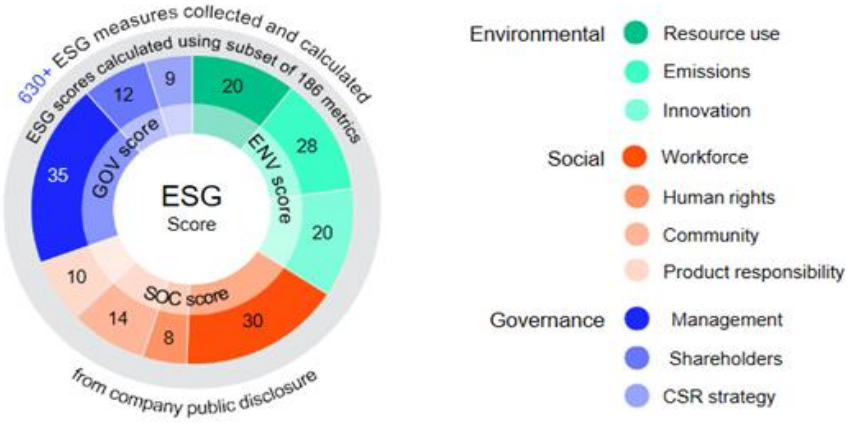


Table 3.1.1: Scoreboard range and description:

Score Range	Description	
0 to 25	First Quartile	Poor relative ESG performance and insufficient degree of transparency in reporting material ESG data publicly.
> 25 to 50	Second Quartile	Satisfactory relative ESG performance and moderate degree of transparency in reporting material ESG data publicly.
> 50 to 75	Third Quartile	Good relative ESG performance and above average degree of transparency in reporting material ESG data publicly.
>75 to 100	Fourth Quartile	Excellent relative ESG performance and high degree of transparency in reporting material ESG data publicly.

London Stock Exchange Groups evaluation also seems thorough and hence reliable, as their process includes a five-step approach, starting with the evaluation of ESG category scores based on a percentile ranking methodology. These scores are then weighted according to a materiality matrix, which determines the relative importance of each theme to different industry groups. Categories are then weighted based on objective and data driven criteria, considering both industry medians and transparency levels. The overall ESG score is then derived by category weights (E, S and G), providing a holistic assessment of a company's ESG performance. Additionally, controversies scores are taken into account, reflecting recent controversies within the fiscal year, and applying weights to address market cap bias. (London Stock Exchange Group, 2024).

An extensive and in depth explanation on how the calculations and evaluation is done is available in a downloadable PDF on LSEGs website. (London Stock Exchange Group, 2024)

3.2 Methodology

This section includes our data collection process, and descriptive statistics of our portfolio construction. Additionally, we will provide insights into our sample selection procedure, due to some limitations caused by inadequate data availability from certain companies listed on Oslo Børs and how we deal with this, as issues may arise in large data collection (Zhang, Wolfram, & Ma, 2023).

3.2.1 Factor Investing

We have stated earlier that the world of investment strategies is both diverse and dynamic, hence reflecting the constant evolution of financial markets, and the increasing sophistication of investment theory, always chasing excess returns.

Amidst this, the concept of factor investing has emerged as a framework that seeks to systematically and intuitively exploit an assets underlying factors, such as value, size, momentum, and volatility, etc., that are believed to academically explain the variations in stock returns.

The origin of most factor investing strategies can be traced back to the Capital Asset Pricing Model (CAPM), which introduced the market factor as the only driver of returns.

Fama-French models:

The Fama-French model is one of the factor investing models that extends on the Capital Asset Pricing Model (CAPM), introducing multiple factors in order to explain stock returns (Fama & French 2014). Developed by Eugene F. Fama and Kenneth R. French in the early 1990s, the model was a response to what they saw as an empirical weakness of the CAPM, which uses only the market risk factor to explain returns. The Fama-French model, in contrast, suggests that stock returns are influenced by several factors, offering a more nuanced and comprehensive model for understanding market behavior, shown through a regression on historical data, introduced in two models:

3.2.2 3-factor model:

The Fama-French 3-factor model revolutionized the understanding of stock returns by identifying three key factors that Fama-French significantly explain the variation in stock returns across companies. Beyond the market risk factor found in the CAPM, the model adds two additional factors: size and value.

Firstly, the size factor suggests that smaller companies have higher adjusted returns than larger firms, while secondly, the value factor indicates that companies with high book-to-market ratios (value stocks) tend to outperform those with low book-to-market ratios (growth stocks).

This model has since its introduction in the 70s been adopted by portfolio management due to its effectiveness in explaining historical patterns of stock returns, and provides a framework for evaluating the impact of size and value factors on investment performance, beyond the somewhat limited CAPM.

Fama-French Three-Factor Model:

$$Ri - Rf = ai \ + \beta 1(Rmkt - Rf) + \beta 2(SMB) + \beta 3(HML) + \epsilon$$

3.2.3 5-factor model:

Building on the 3-factor model, Fama and French also introduced a 5-factor model in 2015 to further expand on their analysis of stock returns. This model retains the original market risk, size, and value factors from the 3-factor model, but adds two more factors: profitability and investment.

The profitability factor proposes that companies with high profitability perform better than those with low profitability, while the investment factor suggests that firms with lower growth in total assets (conservative investment practices) yield higher returns than those with high asset growth.

The 5-factor model hence aims to provide a more comprehensive explanation of stock returns by accounting for profitability and investment dimensions, addressing some of the limitations not explained by the 3-factor model.

Fama-French Five-Factor Model:

$$Ri - Rft = ai + \beta 1(Rmkt - Rf) + \beta 2(SMB) + \beta 3(HML) + \beta 4(RMW) + \beta 5(CMA) + \epsilon$$

3.3 Our addition to the Fama-French Models

In our research, we aim to construct and introduce a new factor, the TMB (Top Minus Bottom) factor, to investigate the impact of ESG score on investment returns. The TMB factor is calculated by subtracting the returns of companies with the Top ESG scores from those with the Bottom ESG scores.

A positive value for this factor indicates that companies with high ESG scores have outperformed their low ESG score counterparts. By focusing on this metric, we can demonstrate whether ESG criteria contribute positively to financial performance. This approach hence allows us to assess the value of ESG considerations in investment strategies and understand their implications for investors. Through this analysis, we therefore seek to provide empirical evidence for the financial benefits of integrating ESG factors into investment decisions.

3.4 Regression

This section describes how we calculated the Fama-French factors by creating portfolios. We created univariate portfolios to get the returns for each factor we used in our regression: SMB (Small Minus Big), HML (High Minus Low), RMW (Robust Minus Weak), CMA (Conservative Minus Aggressive), and TMB (Top Minus Bottom). We classified stocks by market cap, book-to-market, profitability, investment, and ESG to get these factors. These right-hand side portfolios were used to run our regression to see how different market characteristics affect stock returns.

3.4.1 Right-hand side portfolio

In order to calculate the Fama-French factors, we categorized and sorted stocks into two separate portfolios (univariate). These portfolios were subsequently used to calculate the returns for each factor used in our regression:

SMB (Small Minus Big)

To construct the SMB factor, we first classified all stocks based on their market capitalization, using the 30^{th} and 70^{th} percentiles. Stocks above the 70^{th} percentile were categorized as "Big," and those below the 30^{th} percentile as "Small." We then calculated the average monthly returns for both the "Small" and "Big" stock portfolios. These returns were aggregated into yearly (fiscal) returns, and the SMB factor was determined by subtracting the yearly returns of the "Big" portfolio from those of the "Small" portfolio.

$$SMB\_t = annual\_return\_Small\_ptf\_t - annual\_return\_Big\_ptf\_t$$

HML (High Minus Low)

For the HML factor, we classified stocks based on their Book-to-Market (BTM) value, using the 30^{th} and 70^{th} percentiles. Stocks above the 70^{th} percentile were abelled as "High," and those below the 30^{th} percentile as "Low." We calculated the average monthly returns for both the "High" and "Low" stock portfolios. These returns were summed into yearly (fiscal)

returns, and the HML factor was derived by subtracting the yearly returns of the "Low" portfolio from the "High" portfolio.

$$HML\_t = annual\_return\_High\_ptf\_t - annual\_return\_Low\_ptf\_t$$

RMW (Robust Minus Weak)

To construct the RMW factor, we sorted stocks based on their profitability, using EBIT and common equity data, with the 30th and 70th percentiles as thresholds. Stocks above the 70th percentile were classified as "Robust," and those below the 30th percentile as "Weak." We computed the average monthly returns for both the "Robust" and "Weak" portfolios. These were summed into yearly (fiscal) returns, and the RMW factor was obtained by subtracting the yearly returns of the "Weak" portfolio from those of the "Robust" portfolio.

$$RMW\_t = annual\_return\_Robust\_ptf\_t - annual\_return\_Weak\_ptf\_t$$

CMA (Conservative Minus Aggressive)

For the CMA factor, stocks were categorized based on their investment value, measured by changes in total assets, using the 30th and 70th percentiles. Stocks above the 70th percentile were abelled as "Aggressive," and those below the 30th percentile as "Conservative." The average monthly returns for both "Aggressive" and "Conservative" portfolios were calculated, summed into yearly (fiscal) returns, and the CMA factor was determined by subtracting the returns of the "Aggressive" portfolio from the "Conservative" portfolio.

$$CMA_t = annual\_return\_Concerv\_ptf_t - annual\_return\_Aggres\_ptf\_t$$

TMB (Top Minus Bottom)

To construct the TMB factor for our new ESG factor, we classified stocks based on their ESG scores, using the 30th and 70th percentiles. Stocks above the 70th percentile were categorized as "Top," and those below the 30th percentile as "Bottom." We calculated the average monthly returns for both the "Top" and "Bottom" stock portfolios. These returns were summed into yearly (fiscal) returns, and the TMB factor was obtained by subtracting the yearly returns of the "Bottom" portfolio from the "Top" portfolio.

$$TMB\_t = annual\_return\_Top\_ptf\_t - annual\_return\_Bottom\_ptf\_t$$

3.4.2 Left-hand side portfolios

For each Fama-French model we created three portfolios to regress on:

ESG Top Portfolios

In constructing the ESG Top Portfolios, we selected stocks with the highest ESG scores, specifically those above the 70th percentile. These stocks are considered the Top in environmental, social, and governance practices. The monthly returns of these top-performing ESG stocks were calculated into yearly returns. This approach allowed us to analyze the performance of companies with strong ESG scores, and assess the impact of superior ESG practices on overall portfolio returns, in our regression.

ESG Bottom Portfolios

For the ESG Bottom Portfolios, we focused on stocks with the lowest ESG scores, falling below the 30th percentile. These stocks are then seen as laggards in adopting and implementing robust ESG practices. By calculating and summing the monthly returns of these bottom-performing ESG stocks into yearly returns, we aimed to investigate the influence of poor ESG performance on portfolio returns, providing a contrast to the ESG Top Portfolios.

ESG Random Portfolios

The ESG Random Portfolios were constructed using a random sampling method. By applying the =RAND() function in Excel, each stock was assigned a random number. The stocks were then sorted based on these random numbers, and a selection of the top stocks was made to form the portfolio. This random sampling approach allowed us to create a sort of benchmark for comparison, ensuring that the observed effects in the ESG Top and Bottom Portfolios were not due to random variation, but rather the result of specific ESG characteristics.

Final Regression

The final regression ended up looking like this:

$$Ri - Rf = ai + \beta 1(Rmkt - Rf) + \beta 2(SMB) + \beta 3(HML) + \beta 4(RMW) + \beta 5(CMA) + \beta 6(TMB) + \epsilon$$

4.0 Results and Analysis

In this section, we present and analyse our main findings. Our analysis covers the study period from the fiscal year of 2002 to 2022 to examine the impact and role of ESG scores as a systematic risk factor in the multi-factor model for portfolios with this ESG characteristic. The portfolios are created at the start of each fiscal year, on July 1st, and are updated annually based on the companies' performance in the preceding fiscal year.

4.1 Summary Statistics of Factor Returns (Annual) – Right side

Table: 4.1a

Factor	Mean	STD	Minimum	Maximum	Observations
SMB	-0,076	0,311	-0,526	0,513	21
HML	-0,236	0,222	-0,654	0,163	21
RWM	0,208	0,272	-0,534	0,622	21
CMA	0,074	0,206	-0,340	0,499	21
ESG	0,078	0,230	-0,263	0,687	21

The table above presents summary statistics for the five factors over a period of 21 observations. These factors are analyzed to give us a first impression of the performance and variability of the factors, in the context of a multi-factor model.

The SMB (Small Minus Big) factor shows a mean of -0,076, indicating that, on average, small-cap stocks underperformed large-cap stocks by 7,6% during the study period. The standard deviation of 0,311 reflects a relatively high variability in the SMB factor.

The HML (High Minus Low) factor has a mean of -0,236, suggesting that high book-to-market stocks underperformed low book-to-market stocks by 23,6% on average. The standard deviation is 0,222, indicating moderate variability.

The RWM (Risk Weighted Market) factor exhibits a mean of 0,208, implying an average return of 20,8%. The standard deviation of 0,272 signifies moderate to high variability.

The CMA (Conservative Minus Aggressive) factor shows a mean of 0,074, indicating that conservative investment strategies outperformed aggressive ones by 7,4% on average. The standard deviation is 0,206, reflecting moderate variability.

Finally, the ESG (Environmental, Social, and Governance) factor has a mean of 0,078, suggesting that companies with higher ESG scores outperformed those with lower scores by 7,8% on average. The standard deviation of 0,230 points to moderate variability.

However, more evidence is needed to draw any conclusions, as this is only the first impression of or data.

4.2 Fama French Model Results

4.2.1 Fama French 3 Factor Model - Baseline

Table: 4.2.1

	α	β_1 Rm-Rf	β_2 SMB	β_3 HML	β_4 ESG	R^2	SE
3F-TOP	0,020	0,993	2,571	0,085		0,945	0,093
	(0,606)	(0,000)	(0,006)	(0,433)			
3F-BTM	0,153	1,166	2,872	0,035		0,770	0,245
	(0,154)	(0,000)	(0,203)	(0,901)			
3F-RND	0,039	1,078	2,249	0,011		0,866	0,161
	(0,569)	(0,000)	(0,133)	(0,951)			

Table 4.1 is our first Fama-French 3 factor regression, and the ESG factor is excluded from the portfolios we regressed on. We intend this to serve as a sort of baseline for upcoming regressions, that will include the ESG factor, so we have something to compare to.

In the first portfolio, the 3F-TOP portfolio, we see a significant exposure to market risk and size factors, with the market risk factor (β_1) being highly significant ($p < 0,01$). The size factor (β_2) is also significant ($p < 0,01$), indicating that this portfolio has a strong tilt towards smaller firms. The value factor (β_3) is not significant. The high R-squared value (0,945) suggests that the model explains a bigger portion of the variation in portfolio returns.

For the 3F-BTM portfolio, the market risk factor (β_1) remains highly significant ($p < 0,01$), suggesting a strong market exposure. The size factor (β_2) is not significant at conventional levels ($p > 0,05$), indicating a lesser influence on the portfolio. The value factor (β_3) also shows no significance. The R-squared value of 0,770 is lower compared to the 3F-TOP portfolio, indicating that the model is less effective in explaining the variations in returns for the portfolio.

The random 3F-RND portfolio displays a significant market risk factor (β_1) with a p-value of 0,000, indicating a robust market exposure. The size factor (β_2) and value factor (β_3) are not significant. The R-squared value of 0,866 indicates a good fit of the model in explaining the portfolio returns, though not as high as the 3F-TOP portfolio.

The alphas of the regressions are insignificant, at all confidence levels, suggesting that the model successfully explains the majority of variations of left-side excess returns.

In summary, the Fama-French three-factor model provides insight into the different exposures of the three portfolios:

- **The 3F-TOP Portfolio:** has the highest explanatory power (R^2 = 0,945) with significant market and size factors.
- **The 3F-BTM Portfolio:** shows less explanatory power (R^2 = 0,770), with significant market risk, but not size or value factors.
- **The 3F-RND Portfolio:** also has a high explanatory power (R^2 = 0,866), seemingly driven by market risk.

4.2.2 Fama French 3 Factor Model – with ESG (TMB)

Table 4.2.2

	α	β_1 Rm-Rf	β_2 SMB	β_3 HML	β_4 TMB	R^2	SE
3FE-TOP	0,027	1,003	2,579	0,083	-0,053	0,946	0,095
	(0,502)	(0,000)	(0,007)	(0,454)	(0,589)		
3FE-BTM	0,029	0,980	2,733	0,072	0,949	0,967	0,096
	(0,898)	(0,000)	(0,006)	(0,523)	(0,000)		
3FE-RND	0,009	1,033	2,215	0,020	0,231	0,882	0,156
	(0,898)	(0,000)	(0,128)	(0,910)	(0,164)		

In our second regression, shown In Table 4.2, the ESG factor is included.

The 3FE-TOP portfolio shows a significant exposure to market risk (β_1) with a coefficient of 1,003 ($p < 0,01$) and to size (β_2) with a coefficient of 2,579 ($p < 0,01$). The value factor (β_3) and the ESG factor (β_4) are not significant. The ESG coefficient is negative but not statistically significant, suggesting no clear evidence that high ESG scores impact returns positively for this portfolio. The R-squared value is high (0,946), indicating a strong explanatory power of the model.

For the 3FE-BTM portfolio, the market risk (β_1) and size (β_2) factors are significant. Importantly, the ESG factor (β_4) is highly significant ($p < 0,01$) with a positive coefficient of 0,949, indicating that companies with high ESG scores have significantly outperformed those with lower ESG scores. The R-squared value is 0,967, the highest among the three portfolios, suggesting high explanatory power of the model.

The 3FE-RND portfolio exhibits a significant market risk factor (β_1) but the size (β_2) and value (β_3) factors are not significant. The ESG factor (β_4) is positive but not statistically significant. The R-squared value is 0,882, indicating good explanatory power of the model.

The alphas of the regressions are insignificant, at all confidence levels, here too, and still suggests that the model successfully explains the majority of variations of left-side excess returns. Compared to the Fama French 3 Factor Baseline above, we see that 2 of 3 alphas become less significant suggesting an even better model explanation.

In summary, the inclusion of the ESG factor (TMB) in the Fama-French model reveals differing impacts across the portfolios:

- **3FE-TOP Portfolio:** has high and increased explanatory power (R^2 = 0,946). The ESG factor is negative and not significant, indicating no strong evidence that high ESG scores affect returns for top-performing firms.
- **3FE-BTM Portfolio:** has the highest explanatory power (R^2 = 0,967). The ESG factor is positive and highly significant, suggesting that firms with low ESG scores significantly outperform those with high scores. This indicates that the ESG criteria have a positive impact on returns in this portfolio.
- **3FE-RND Portfolio:** has the less, but increased, explanatory power (R^2 = 0,882) The ESG factor is positive but not significant, implying no evidence of ESG impact on returns in the randomly selected firms.

These findings suggest that while ESG criteria can enhance returns, particularly in certain portfolios (like 3FE-BTM), the impact may vary depending on the composition and characteristics of the portfolio. The significant positive ESG factor in the 3FE-BTM portfolio supports the hypothesis that ESG scores can contribute positively to portfolio performance.

4.2.3 Fama French 5 Factor Model - Baseline

Table 4.2.3

	α	β_1 Rm-Rf	β_2 SMB	β_3 HML	β_4	β_5 CMA	R^2	SE
5F-TOP	0,032	0,991	2,334	0,085	-0,545	-0,645	0,946	0,098
	(0,496)	(0,000)	(0,032)	(0,457)	(0,631)	(0,639)		
5F-BTM	0,174	1,179	2,394	0,034	-1,131	-0,230	0,772	0,260
	(0,173)	(0,000)	(0,375)	(0,910)	(0,707)	(0,950)		
5F-RND	0,078	1,082	1,429	0,010	-1,906	-1,564	0,878	0,164
	(0,328)	(0,000)	(0,400)	(0,957)	(0,322)	(0,499)		

In Table 4.2.3 we present our findings for our first Fama-French 5 factor regression, and the ESG factor is excluded from these portfolios. Again, we intend this to serve as a baseline for upcoming regressions, that will include the ESG factor.

The 5F-TOP portfolio shows significant exposure to market risk (β_1) with a coefficient of 0,991 ($p < 0,01$) and to size (β_2) with a coefficient of 2,334 (p

< 0,05). The value (β_3), profitability (β_4), and investment (β_5) factors are not significant. The R-squared value is high (0,946), indicating that the model explains a substantial portion of the variation in portfolio returns.

For the 5F-BTM portfolio, the market risk factor (β_1) is highly significant (p < 0,01), indicating strong market exposure. The size factor (β_2), value factor (β_3), profitability factor (β_4), and investment factor (β_5) are not significant. The R-squared value of 0,772 suggests that the model is less effective in explaining the variations in returns for this portfolio compared to the 5F-TOP portfolio.

The 5F-RND portfolio shows significant market risk exposure (β_1) with a coefficient of 1,082 (p < 0,01). The size (β_2), value (β_3), profitability (β_4), and investment (β_5) factors are not significant. The R-squared value is 0,878, indicating good explanatory power of the model.

Similarly to the 3-factor model, the alphas of the 5 factor regressions are all insignificant, at all confidence levels, suggesting that the model successfully explains the majority of variations of left-side excess returns.

We then see that the Fama-French five-factor model provides detailed insights into the performance of the three portfolios:

- **5F-TOP Portfolio:** Significant exposure to market risk and size factors, with high explanatory power (R^2 = 0,946). The other factors (value, profitability, investment) are not significant.
- **5F-BTM Portfolio:** Significant market risk exposure, but no significant size, value, profitability, or investment factor influences. The explanatory power (R^2 = 0,772) is lower compared to the 5F-TOP portfolio.
- **5F-RND Portfolio:** Significant market risk exposure with no significant impact from size, value, profitability, or investment factors. The model has good explanatory power (R^2 = 0,878).

In summary, these results suggest that the market risk factor plays a critical role across all portfolios, while the size factor is significant only for the 5F-TOP portfolio. The lack of significance for the value, profitability, and

investment factors across all portfolios indicates that these factors do not have a substantial impact on the returns of these portfolios in our context.

4.2.4 Fama French 5 Factor Model – with ESG (TMB)

Table 4.2.4

	α	β_1 Rm-Rf	β_2 SMB	β_3 HML	β_4 RMW	β_5 CMA	β_6 TMB	R^2	SE
5FE-TOP	0,039	1,002	2,331	0,083	-0,571	-0,615	-0,054	0,947	0,100
	(0,435)	(0,000)	(0,037)	(0,480)	(0,624)	(0,663)	(0,607)		
5FE-BTM	0,043	0,978	2,444	0,072	-0,666	-0,763	0,949	0,968	0,101
	(0,398)	(0,000)	(0,031)	(0,544)	(0,572)	(0,593)	(0,000)		
5FE-RND	0,046	1,033	1,441	0,019	-1,794	-1,692	0,229	0,893	0,159
	(0,562)	(0,000)	(0,382)	(0,916)	(0,337)	(0,452)	(0,178)		

In Table 4.2.4, we see the 5FE-TOP portfolio demonstrates significant exposure to market risk (β_1) with a coefficient of 1,002 ($p < 0,01$) and to size (β_2) with a coefficient of 2,331 ($p < 0,05$). The value (β_3), profitability (β_4), investment (β_5), and ESG (β_6) factors are not significant. The R-squared value is high (0,947), indicating that the model explains a substantial portion of the variation in portfolio returns.

For the 5FE-BTM portfolio, the market risk (β_1) and size (β_2) factors are significant. Notably, the ESG factor (β_6) is highly significant ($p < 0,01$) with a positive coefficient of 0,949, suggesting that firms with low ESG scores have significantly outperformed those with high ESG scores. The R-squared value of 0,968 is the highest among the three portfolios, indicating excellent explanatory power of the model.

The 5FE-RND portfolio displays significant market risk exposure (β_1) with a coefficient of 1,033 ($p < 0,01$). The size (β_2), value (β_3), profitability (β_4), investment (β_5), and ESG (β_6) factors are not significant. The R-squared value of 0,893 indicates good explanatory power of the model.

The alphas of this regressions is also insignificant, at all confidence levels, still suggesting that the model successfully explains the majority of variations of left-side excess returns. Similarly, if we compare the results to the Fama French 5 Factor Baseline above, we see that 2 of 3 alphas become less significant suggesting an even better model explanation.

The inclusion of the ESG factor (TMB) in the Fama-French five-factor model gives us the following insights:

- **5FE-TOP Portfolio:** The ESG factor is negative and not significant, indicating no strong evidence that high ESG scores affect returns for top-scoring firms. The model shows high explanatory power (R^2 = 0,947).
- **5FE-BTM Portfolio:** The ESG factor is positive and highly significant, suggesting that firms with low ESG scores significantly outperform those with high scores. This indicates that ESG criteria have a positive impact on returns in this portfolio, with the highest explanatory power (R^2 = 0,968).
- **5FE-RND Portfolio:** The ESG factor is positive but not significant, implying no strong evidence of ESG impact on returns in the randomly selected firms. The model has good explanatory power (R^2 = 0,893).

Our findings demonstrate that the impact of ESG factors obviously varies across different portfolios. The significant positive ESG factor in the 5FE-BTM portfolio supports the hypothesis that high ESG scores contribute positively to financial performance, highlighting the importance of ESG criteria in investment decision-making for certain portfolios.

4.3 Alphas

In the factor models we can use alpha to explain what can't be explained by the factors. As we want the factors to pick up most parts of our performance there will always be the unexplained bit captured by alpha. We therefore wish to see alpha decrease to have a better risk-adjusted return for our portfolio Elton (1996).

Table 4.3a

3 Factor α		5 Factor α	
3F-TOP	0.020434103	**5F-TOP**	0.031993534
3FE-TOP	0.027391317	**5FE-TOP**	0.039398342
3F-BTM	0.152911764	**5F-BTM**	0.174013055
3FE-BTM	0.029025018	**5FE-BTM**	0.043119098
3F-RND	0.039042681	**5F-RND**	0.077670677
3FE-RND	0.008869366	**5FE-RND**	0.046057505

The results of the regressions show us that alpha is decreasing for all portfolios when ESG is introduced as a factor except for the TOP ones. We are therefore able to better explain the random and bottom portfolios. As alpha increases for the top portfolio in both models there is some unexplained factor that well performing companies in terms of ESG score has that is not captured by our models.

4.3.1 Implication of Alpha

1. **ESG as a Risk Factor:** ESG factors are effectively capturing some of the risks-adjusted returns that were previously unexplained by the traditional factors in the Fama-French models. This suggests that ESG considerations are an important aspect of asset pricing and risk management.
2. **Market Efficiency:** The integration of ESG factors might be leading to a more efficient market where fewer anomalies exist. As ESG factors become more mainstream, their impact is better understood and priced in by the market, reducing.

4.4 ANOVA

In terms of ANOVA all of the regressions show to be statistically significant meaning we have significant differences between the mean of our independent variables. This indicates a good fit to the data and that a significant portion of the variance in the dependent variable is explained by the factors included in the models. However, a statistically significant factor might not be economically significant (Howell, 2010).

5.0 Discussion

Our analysis revealed that the impact of ESG integration varies across the different portfolios we created:

1. **BTM Portfolios**: The ESG factor is highly significant and positively correlated with returns in the BTM portfolios. This indicates that firms with high ESG scores tend to significantly outperform those with lower scores in these value-oriented portfolios. This finding suggests that integrating ESG criteria can enhance the performance of portfolios focusing on undervalued or book-to-market strategies.
2. **TOP and RND Portfolios**: In contrast, the TOP and RND portfolios show no significant impact from ESG scores. This suggests that the benefits of ESG integration may be more pronounced in specific types of portfolios, particularly those with a value-oriented approach rather than growth or random selection strategies.

These findings show the potential for ESG factors to enhance portfolio performance, particularly in value oriented portfolios. For investors and portfolio managers, this underscores the importance of considering ESG criteria in their investment decision-making process, especially for long-term investments aimed at capturing value.

5.1 Recent World Events

Before looking into the discussion we must shed a light on the recent world events that have affected the financial markets in their own respective ways and how this may have an influence over the results, especially within the most recent years.

Which have significantly impacted portfolio returns. The COVID-19 pandemic initially caused economic disruptions, leading to both volatility and declines in stock markets worldwide. Lockdowns and supply chain interruptions resulted in reduced earnings, affecting stock prices. Although markets have since rebounded, the effects of the pandemic continue to influence investor sentiment and economic stability. Central banks have responded to inflationary

pressures by increasing interest rates. Higher interest rates tend to reduce corporate profits and consumer spending, which can negatively affect stock prices although this has not been the case on average, but we have seen lower volume and more volatility in the markets. The ongoing war in Ukraine has created global economic uncertainties. It has disrupted energy supplies, particularly in Europe, causing spikes in oil and gas prices. This volatility affects various sectors, especially those reliant on energy, leading to fluctuating stock prices. Similarly, the conflict in Gaza has heightened geopolitical risks, which often lead to investor caution and reduced market liquidity, impacting returns. Taking this into consideration we can discuss the results of our analysis in the next chapter.

5.2 Why is the BTM Portfolio Significant and the TOP Portfolio Not?

To understand the significance of the BTM portfolio compared to the TOP portfolio, we have to examine the composition of the stocks within our two portfolios.

5.2.1 BTM Portfolio Analysis:

We see in Table 5.1.1, that the most common stocks in our BTM portfolio consists of companies from a broad spectrum of industries, many of which have significant environmental impacts through their operations and emissions. These companies are often referred to as "brown" stocks due to their reliance on fossil fuels, high emission levels, or lack of sustainable practices. Examples include companies in the oil and gas industry, shipping, and traditional industrial activities, often associated with significant carbon emissions. However, some companies in this portfolio, such as those in renewable energy, might initially appear ESG-focused but have shown substantial improvement in their ESG scores in recent times, suggesting a shift in focus when it comes to sustainability practices.

Companies adopting ESG into their core values, may initially score low on the metrics to begin with but investors may see this as a sign to get in early as they can improve their overall ESG score over time and therefore receive the

premium of taking on some extra risk buying into the stock early as companies adopts better systems to report related to their ESG performance.

It is also worth mentioning that the majority of the lowest ranking companies have not reported their ESG data consistently, hence forcing us to simulate a low score for them, in order to do our analysis, hence creating a reporting bias. Consequently, our analysis may be skewed due to the imputation of data for these companies, potentially affecting the accuracy and reliability of our findings.

Table: 5.2.1a

Company Name - Bottom	Industry	Occur.
BONHEUR ASA	Investment company (Renewable Energy, Wind	20
ITERA ASA	Digitalization and consultancy services	20
OLAV THON EIENDOMSS.	Real estate (shopping centers and commercial	20
NEL ASA	Hydrogen production and renewable energy	18
ODFJELL B	Shipping and tank terminal operations	18
OTE	Telecommunications	18
AXACTOR ASA	Debt management and financial services	17
ODFJELL ASA	Shipping and tank terminal operations	17
BOUVET	IT consultancy	15
HEXAGON COMPOSITES	Gas storage and transportation solutions	14

5.2.2 Top Portfolio Analysis:

In contrast, the TOP portfolio consists of companies that are more likely to have integrated sustainability into their operations, leading to their classification as "green" stocks or ESG-friendly investments, as shown in Table 5.1.2. These companies, such as Equinor ASA, Norsk Hydro ASA, and SAS AB, have invested significantly in renewable energy projects, sustainable production processes, and transparent ESG reporting. Our ESG data also shows that they are more transparent and consistent in their ESG reporting, demonstrating a genuine commitment to sustainability, which allows the stakeholders to accurately monitor their progress.

Table: 5.2.2a

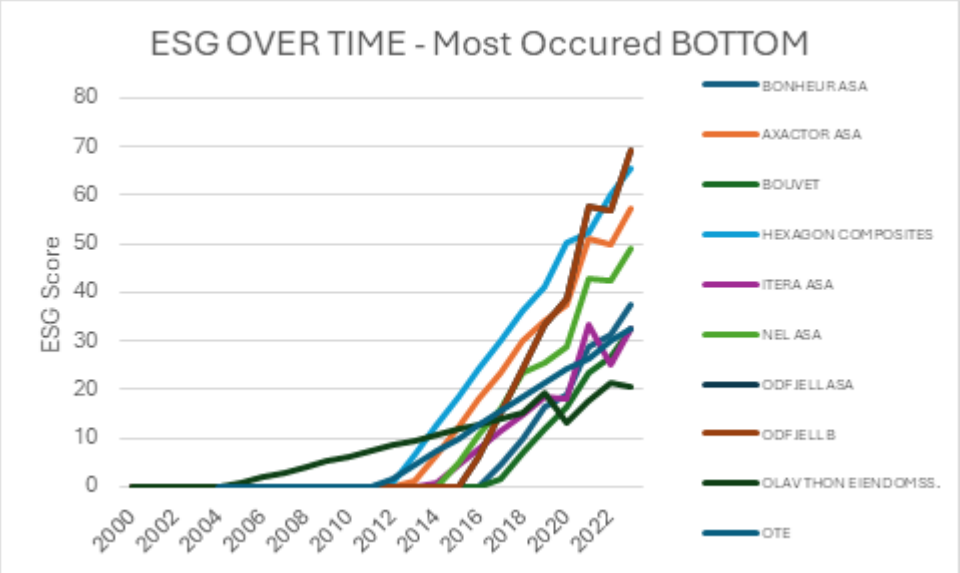
Company Name - Top	Industry	Occur.
TELENOR GROUP	Telecommunications	21
SPAREBANK 1 SR BANK	Banking and financial services	21
EQUINOR ASA	Oil and gas	21
KONGSBERG GRUPPEN	Defense, aerospace, and maritime	21
NORSK HYDRO ASA	Aluminum and renewable energy	21
ATEA ASA	IT infrastructure and services	21
SAS AB	Aviation	20
DNB BANK ASA	Banking and financial services	20
ORKLA ASA	Consumer goods	17
YARA INTERNATIO	Agricultural products and chemicals	16

5.2.3 Comparative Insights, Biases, and Conclusion for Reflection

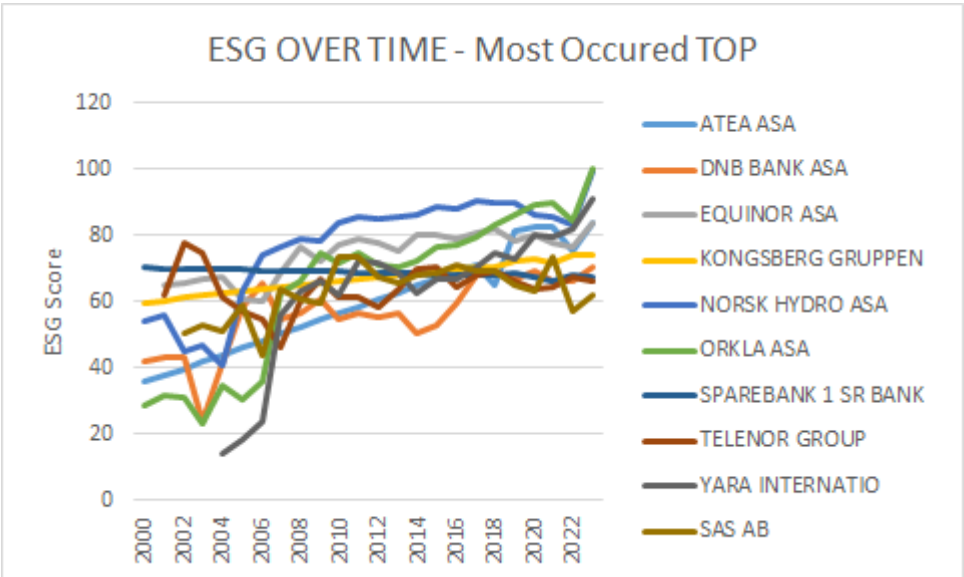
When examining the BTM companies, we observe significant positive developments in ESG scores, as illustrated in Graph 5.1.3.1. It is important to mention that this trend may introduce survivorship bias into our model, creating a misleading correlation with returns. Because, by focusing on companies that only have room to show improvement, given that the ESG scoring framework starts at 0 and only allows for upward movement, we risk overlooking the less successful or stagnant "brown" companies. This oversight can lead to skewed conclusions, emphasizing the performance of surviving or improved entities while neglecting those that did not improve or failed. To avoid drawing incorrect conclusions based on a subset of successful cases, it is important to be mindful of this, and adjust our analysis to account for the full spectrum of BTM companies.

In contrast, the TOP companies have maintained relatively consistent ESG scores, as reflected in their ESG reports. Their ESG data also show more commitment to sustainability as they are more regular in their reporting. However, the TOP portfolio can because of this suffer from stability bias, as shown in Graph 5.1.3.2, which occurs when data remains relatively consistent over a long period, potentially obscuring the changes or effects expected. This can lead to underestimating the impact of certain variables or interventions, as the lack of variation in the data does not reflect the underlying dynamics.

Graph: 5.2.3a



Graph: 5.2.3b



6.0 Limitations and Future Research

6.1 Research Limitations

Our research, while trying to be as comprehensive and true to nature as possible, does have certain limitations that can impact the generalizability and robustness of our results:

6.1.1 Data Availability and Quality:

Like we have mentioned earlier in the paper, the study's reliance on ESG scores from companies listed on Oslo Børs presented challenges due to inconsistent reporting. Some companies have not reported ESG data consistently, necessitating the simulation of scores for analysis, which may introduce biases in the results. In order to address this, we simulated some of the ESG scores from the past, but this is explained more in depth in chapter 3.1.2.

6.1.2 Survivorship Bias:

In the BTM portfolios, the focus on companies showing significant ESG improvements might lead to survivorship bias. Which could skew the results, emphasizing the performance of successful entities while overlooking less successful or stagnant companies. This is discussed more in depth in chapter 5.2.3.

6.1.3 Stability Bias in TOP Portfolios:

The TOP portfolios' consistency over time may underestimate the impact of certain variables or interventions, as data variation was minimal. This could lead to a conservative assessment of the ESG factors' influence. This is also discussed and shown more visually in in chapter 5.2.3

6.1.4 Regional Focus:

It is also important to remember that our study is limited to the Norwegian market, which may have unique regulatory and market dynamics, like for example subsidies and fees for respectively “green” and “brown” companies, hence making the findings not directly applicable to other regions without further validation.

6.2 Implications of Our Findings and Future Work

In this chapter we look at how our study has contributed to the literature and possibly the theories within ESG and portfolio performance, we also look at how further research can build on our contribution.

6.2.1 Literature Contribution (For Theory)

Enhanced Asset Pricing Models: The inclusion of ESG factors into the Fama-French models supports our theory that ESG considerations can be an important component of asset pricing. This aligns with the growing body of literature suggesting that ESG factors capture unique risks and returns not explained by traditional financial metrics.

Market Efficiency: Our findings suggest that as ESG factors become more integrated into financial models, markets may become more efficient. The better understanding and pricing of ESG risks and returns could lead to fewer unexplained anomalies in asset pricing.

6.2.2 Real world application (For Practice)

Investment Strategies: Portfolio managers and investors should consider ESG in their investment strategies. Our results show that ESG can add value, especially for long term value investors.

Risk Management: Including ESG in portfolio construction can improve risk management. By factoring in ESG risks, investors can build more robust portfolios that can withstand market volatility and other uncertainties.

Focus on Improvement: Investors should not only seek high ESG scores but also recognize companies showing significant improvement in ESG performance. These improvements can signal positive future returns and reduced risks.

6.2.3 Future Research

Longitudinal Studies: It would be interesting to see future research extend the analysis to other markets, and longer time periods, to validate the findings and explore the long-term impact of ESG integration on portfolio performance and risk.

Sector-Specific Analysis: It could also be interesting to investigate the impact of ESG factors across different sectors, as this can provide more in depth insights. Certain sectors may exhibit stronger or weaker correlations between ESG performance and financial returns, like for example oil companies, with a perceived low ESG score, but high earnings.

ESG Pillars: As ESG reporting standards evolve, future studies should incorporate more in depth and comprehensive ESG metrics. LSEG provides the score for the separate E,S and G dimensions, which would be a great addition to our model. Not only will this help us gauge the effect of ESG more precisely, but also help us see what dimensions are most effective and influential on the return.

Regional Studies: Earlier in the paper we discussed the regional perspective of our idea and mentioned that returns may differ from regions/countries, future research could use our model to compare more countries up against each other, looking at Scandinavia compared to europe or comparing the scandinavian countries can help the field in understanding how regulatory differences affects returns within ESG.

7.0 Conclusion

By analysing data from 2002 to 2022, we investigated the influence of ESG factors on various portfolios, revealing their role as a systematic risk factor in multi-factor investing. We are excited to see that our results proves to better understand the performance of our portfolios and this is what we found:

7.1 Key Findings

7.1.1 Performance Impact:

We found that adding ESG scores to the Fama-French models generally improved performance, especially in the BTM (Bottom) portfolios. Our results show that companies with low ESG scores outperform those with higher scores, especially if you're a value investor. The BTM portfolios which are often made up of companies initially labeled as "brown" showed a strong positive correlation between high ESG scores and returns. So ESG scores can enhance performance, and integrating ESG can give you better risk adjusted returns.

7.1.2 Risk Characteristics:

We also find evidence that the inclusion of ESG factors can influence the risk characteristics of the portfolios. We see that the ESG portfolios exhibit higher R-squared values than the random RND portfolio, indicating a better model fit and risk explanation when ESG factors were deliberately included. This suggests that ESG considerations are relevant for portfolio risk, particularly for portfolios with lower ESG scores. By integrating ESG factors, the risk associated with poor ESG performance can be mitigated, enhancing the overall stability and resilience of the portfolio.

7.2 Answering the Research Question

How does ESG score integration affect the performance and risk characteristics of portfolios constructed using Fama-French factor models in the Norwegian market?

Our research concludes that integrating ESG scores into the Fama-French factor models significantly affects both the performance and risk characteristics of portfolios in the Norwegian market. ESG integration generally leads to improved portfolio performance, particularly in value oriented BTM portfolios, where low ESG scores correlate with higher returns. Additionally, ESG factors contribute to better risk management by enhancing the explanatory power of the models, thereby providing a more comprehensive understanding of portfolio risks. These findings underscore the importance of ESG considerations in modern investment strategies, highlighting their role in achieving superior risk-adjusted returns and more resilient portfolios.

To answer our secondary hypotheses, we did see an improvement in the returns created when implementing ESG factors compared to a portfolio where this was not considered. This was not a shocking finding as we have seen multiple papers find the same results, but it is important to note that this applies to the Norwegian markets isolated as well. The other secondary hypothesis was that ESG scores positively correlate with company valuation metrics, meaning that we believed that companies that actively reporting on ESG metrics would be valued higher either in general or towards the future. Our models found that the lower end ESG portfolio (bottom) proved to be the best performing in both the 3 (4) factor and 5 (6) factor model which proves that the hypotheses were right, and that companies that take ESG into consideration for their reporting does perform better in the stock markets and their valuation is therefore increased and positively correlated with ESG scores.

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APPENDIX:

	α	β_1 Rm-Rf	β_2 SMB	β_3 HML	β_4 RMW	β_5 CMA	β_6 ESG	R^2	SE	Significance
5F-TOP	0.031993534	0.990718076	2.334087293	0.085064652	-0.545099208	-0.64521365		0.946456975	0.097765193	0.0000000052805940
P-value	*0.495720701*	*6.31756E-10*	*0.031591919*	*0.457078221*	*0.630750889*	*0.638862589*				
5F-BTM	0.174013055	1.178951605	2.393782972	0.033928669	-1.13080727	-0.229955271		0.772364186	0.259758051	0.0002100481567250
P-value	*0.173408414*	*1.77143E-05*	*0.374663781*	*0.910284777*	*0.70700897*	*0.949619996*				
5F-RND	0.077670677	1.081886679	1.428658496	0.010332658	-1.90641926	-1.563517422		0.877820985	0.163889126	0.0000023287900257
P-value	*0.327970306*	*2.00673E-07*	*0.400375176*	*0.956618276*	*0.322197816*	*0.499274638*				
5FE-TOP	0.039398342	1.002089853	2.33123312	0.082929859	-0.571395164	-0.615047846	-0.053681714	0.947495659	0.100210223	0.0000000360441792
P-value	*0.435082233*	*3.13752E-09*	*0.036661833*	*0.480036721*	*0.623934739*	*0.663080457*	*0.606938254*			
5FE-BTM	0.043119098	0.977933972	2.444235861	0.071665169	-0.665976589	-0.763192812	0.94892566	0.967826626	0.101083119	0.0000000012133370
P-value	*0.397993189*	*4.8186E-09*	*0.030818268*	*0.544177706*	*0.571618013*	*0.592663015*	*2.52137E-07*			
5FE-RND	0.046057505	1.033337418	1.440843748	0.019446681	-1.79415455	-1.69230358	0.229182082	0.893193823	0.158610388	0.0000046916834327
P-value	*0.562312238*	*6.64385E-07*	*0.382333862*	*0.91591663*	*0.336841342*	*0.451980448*	*0.177628057*			

	α	β_1 Rm-Rf	β_2 SMB	β_3 HML	β_4 ESG	R^2	SE	Significance
3F-TOP	0.020434103	0.992672535	2.570917746	0.085208919		0.944938897	0.093127177	0.0000000000663
P-value	*0.60605769*	*1.88017E-11*	*0.006255842*	*0.433140311*				
3F-BTM	0.152911764	1.165887591	2.872307669	0.035200045		0.770128049	0.245195718	0.0000114339176
P-value	*0.153657489*	*2.54967E-06*	*0.203307929*	*0.901235338*				
3F-RND	0.039042681	1.078019946	2.248955063	0.011444952		0.86647297	0.160937627	0.0000001189334
P-value	*0.568901678*	*2.32132E-08*	*0.132902373*	*0.950972053*				
3FE-TOP	0.027391317	1.003118353	2.578726709	0.083149375	-0.053305329	0.945967245	0.095092663	0.0000000006225
P-value	*0.502135093*	*1.01822E-10*	*0.00744045*	*0.45436566*	*0.588693413*			
3FE-BTM	0.029025018	0.979879464	2.733253872	0.071874239	0.949205237	0.966503492	0.096479296	0.0000000000138
P-value	*0.898257247*	*1.79293E-10*	*0.005584205*	*0.522843155*	*4.27931E-08*			
3FE-RND	0.008869366	1.032716619	2.215087727	0.020377158	0.231184283	0.882179394	0.155828932	0.0000002992036
P-value	*0.898257247*	*8.09812E-08*	*0.127968801*	*0.910129906*	*0.163523175*			

Summary Output 3-Factor Top Portfolio:

Regression Statistics	
Multiple R	0.972079676
R Square	0.944938897
Adjusted R Squar	0.935222232
Standard Error	0.093127177
Observations	21

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	2.530233562	0.843411187	97.2493	6.6346E-11
Residual	17	0.147435407	0.008672671		
Total	20	2.677668969			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.020434103	0.038888856	0.525448803	0.6060577	-0.061614212	0.102482	-0.061614212	0.102482418
SMB	2.570917746	0.824491477	3.11818596	0.0062558	0.831392785	4.310443	0.831392785	4.310442707
HML	0.085208919	0.106132361	0.802855206	0.4331403	-0.13871079	0.309129	-0.13871079	0.309128628
Rm-Rf Fiscal	0.992672535	0.064134412	15.47800161	1.88E-11	0.857360753	1.127984	0.857360753	1.127984317

Summary Output 3-Factor Bottom Portfolio:

Regression Statistics	
Multiple R	0.877569398
R Square	0.770128049
Adjusted R Square	0.72956241
Standard Error	0.245195718
Observations	21

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	3.424141024	1.14138	18.98474	1.14339E-05
Residual	17	1.02205598	0.060121		
Total	20	4.446197004			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.152911764	0.102390961	1.493411	0.153657	-0.06311428	0.368937807	-0.06311428	0.368937807
SMB	2.872307669	2.170814009	1.323148	0.203308	-1.707709544	7.452324882	-1.707709544	7.452324882
HML	0.035200045	0.279437233	0.125968	0.901235	-0.554360982	0.624761072	-0.554360982	0.624761072
Rm-Rf Fiscal	1.165887591	0.168860303	6.90445	2.55E-06	0.809623494	1.522151689	0.809623494	1.522151689

Summary Output 3-Factor Random Portfolio:

Regression Statistics	
Multiple R	0.9308453
R Square	0.86647297
Adjusted R Square	0.84290938
Standard Error	0.16093763
Observations	21

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	2.857261159	0.952420386	36.77168	1.18933E-07
Residual	17	0.440315636	0.02590092		
Total	20	3.297576794			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.03904268	0.067205734	0.580942707	0.568902	-0.102749024	0.180834386	-0.102749024	0.180834386
SMB	2.24895506	1.424844032	1.578386836	0.132902	-0.757203071	5.255113196	-0.757203071	5.255113196
HML	0.01144495	0.183412523	0.062400055	0.950972	-0.375521646	0.398411549	-0.375521646	0.398411549
Rm-Rf Fiscal	1.07801995	0.110833813	9.726453622	2.32E-08	0.84418104	1.311858852	0.84418104	1.311858852

Summary Output 3-Factor ESG Top Portfolio:

Regression Statistics	
Multiple R	0.972608475
R Square	0.945967245
Adjusted R Square	0.932459056
Standard Error	0.095092663
Observations	21

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regression	4	2.532987137	0.63324678	70.0291695	6.2248E-10
Residual	16	0.144681832	0.00904261		
Total	20	2.677668969			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.027391317	0.041663013	0.65744925	0.52023879	-0.0609303	0.11571296	-0.060930326	0.11571296
SMB	2.578726709	0.842011622	3.06257852	0.00744045	0.79374181	4.363711608	0.79374181	4.363711608
HML	0.083149375	0.108436576	0.76680192	0.45436566	-0.1467259	0.313024646	-0.146725896	0.313024646
Rm-Rf Fiscal	1.003118353	0.068168955	14.7151786	1.0182E-10	0.85860662	1.147630082	0.858606623	1.147630082
ESG	-0.053305329	0.096598236	-0.5518251	0.58869341	-0.2580844	0.151473783	-0.258084441	0.151473783

Summary Output 3-Factor ESG Bottom Portfolio:

Regression Statistics	
Multiple R	0.983109095
R Square	0.966503492
Adjusted R Square	0.958129365
Standard Error	0.096479296
Observations	21

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	4.29726493	1.074316	115.4154	1.38392E-11
Residual	16	0.148932074	0.009308		
Total	20	4.446197004			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.029025018	0.04227054	0.686649	0.502135	-0.060584524	0.11863456	-0.060584524	0.11863456
SMB	2.733253872	0.854289769	3.199446	0.005584	0.922240464	4.54426728	0.922240464	4.54426728
HML	0.071874239	0.110017789	0.653297	0.522843	-0.161353055	0.305101533	-0.161353055	0.305101533
Rm-Rf Fiscal	0.979879464	0.06916299	14.16769	1.79E-10	0.833260476	1.126498452	0.833260476	1.126498452
ESG	0.949205237	0.098006824	9.685093	4.28E-08	0.741440052	1.156970422	0.741440052	1.156970422

Summary Output 3-Factor ESG Random Portfolio:

Regression Statistics	
Multiple R	0.939244055
R Square	0.882179394
Adjusted R Square	0.852724243
Standard Error	0.155828932
Observations	21

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	2.909054298	0.727264	29.94992	2.99204E-07
Residual	16	0.388522496	0.024283		
Total	20	3.297576794			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.008869366	0.068273437	0.129909	0.898257	-0.13586385	0.153602586	-0.135863854	0.153602586
SMB	2.215087727	1.379809628	1.605357	0.127969	-0.70997802	5.140153469	-0.709978015	5.140153469
HML	0.020377158	0.177695684	0.114674	0.91013	-0.35632086	0.39707518	-0.356320864	0.39707518
Rm-Rf Fiscal	1.032716619	0.111708887	9.244713	8.1E-08	0.795904358	1.269528879	0.795904358	1.269528879
ESG	0.231184283	0.158296124	1.460454	0.163523	-0.10438851	0.566757074	-0.104388509	0.566757074

Summary Output 5-Factor Top Portfolio:

Regression Statistics	
Multiple R	0.972860203
R Square	0.946456975
Adjusted R Square	0.9286093
Standard Error	0.097765193
Observations	21

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	2.534298473	0.506859695	53.0297072	5.28059E-09
Residual	15	0.143370496	0.009558033		
Total	20	2.677668969			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.031993534	0.04582139	0.698222685	0.495720701	-0.065672447	0.129659516	-0.065672447	0.129659516
SMB	2.334087293	0.984636832	2.370505771	0.031591919	0.235383565	4.43279102	0.235383565	4.43279102
HML	0.085064652	0.111432114	0.763376453	0.457078221	-0.152447277	0.322576581	-0.152447277	0.322576581
Rm-Rf Fiscal	0.990718076	0.07183698	13.79119891	6.31756E-10	0.837601178	1.143834973	0.837601178	1.143834973
RMW	-0.545099208	1.110897818	-0.49068348	0.630750889	-2.912921858	1.822723443	-2.912921858	1.822723443
CMA	-0.64521365	1.347066311	-0.478976903	0.638862589	-3.516417527	2.225990228	-3.516417527	2.225990228

Summary Output 5-Factor Bottom Portfolio:

Regression Statistics	
Multiple R	0.878842526
R Square	0.772364186
Adjusted R Square	0.696485581
Standard Error	0.259758051
Observations	21

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	3.434083329	0.686816666	10.17894555	0.000210048
Residual	15	1.012113675	0.067474245		
Total	20	4.446197004			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.174013055	0.121745527	1.429317844	0.173408414	-0.085481394	0.433507504	-0.085481394	0.433507504
SMB	2.393782972	2.616139089	0.915006003	0.374663781	-3.182385501	7.969951445	-3.182385501	7.969951445
HML	0.033928669	0.29607049	0.114596591	0.910284777	-0.597130643	0.664987981	-0.597130643	0.664987981
Rm-Rf Fiscal	1.178951605	0.190867866	6.176794618	1.77143E-05	0.77212638	1.585776831	0.77212638	1.585776831
RMW	-1.13080727	2.951609277	-0.383115502	0.70700897	-7.422013522	5.160398981	-7.422013522	5.160398981
CMA	-0.229955271	3.579099135	-0.064249483	0.949619996	-7.858624496	7.398713955	-7.858624496	7.398713955

Summary Output 5-Factor Random Portfolio:

Regression Statistics	
Multiple R	0.936921013
R Square	0.877820985
Adjusted R Square	0.837094647
Standard Error	0.163889126
Observations	21

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	2.89468211	0.578936	21.55413	2.3288E-06
Residual	15	0.402894684	0.02686		
Total	20	3.297576794			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.077670677	0.076812896	1.011167	0.32797	-0.0860521	0.241393488	-0.08605213	0.241393488
SMB	1.428658496	1.650600424	0.865539	0.400375	-2.089513	4.946830019	-2.08951303	4.946830019
HML	0.010332658	0.18679973	0.055314	0.956618	-0.3878215	0.408486859	-0.38782154	0.408486859
Rm-Rf Fiscal	1.081886679	0.120424247	8.983961	2.01E-07	0.82520847	1.338564886	0.825208472	1.338564886
RMW	-1.90641926	1.862258602	-1.02371	0.322198	-5.8757295	2.062890991	-5.87572951	2.062890991
CMA	-1.563517422	2.258160727	-0.69239	0.499275	-6.3766731	3.249638235	-6.37667308	3.249638235

Summary Output 5-Factor ESG Top Portfolio:

Regression Statistics	
Multiple R	0.973393887
R Square	0.947495659
Adjusted R Square	0.924993799
Standard Error	0.100210223
Observations	21

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	6	2.537079725	0.422847	42.10744	3.6044E-08
Residual	14	0.140589244	0.010042		
Total	20	2.677668969			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.039398342	0.049029655	0.803561	0.435082	-0.06575981	0.14455649	-0.06575981	0.14455649
SMB	2.33123312	1.009276387	2.309806	0.036662	0.16655056	4.49591568	0.166550561	4.49591568
HML	0.082929859	0.114290952	0.725603	0.480037	-0.16219985	0.32805957	-0.16219985	0.32805957
Rm-Rf Fiscal	1.002089853	0.076738645	13.05848	3.14E-09	0.83750183	1.16667788	0.837501828	1.16667788
RMW	-0.57139516	1.139776262	-0.50132	0.623935	-3.01597212	1.87318179	-3.01597212	1.87318179
CMA	-0.61504785	1.381944636	-0.44506	0.66308	-3.5790243	2.34892861	-3.5790243	2.34892861
ESG	-0.05368171	0.102004237	-0.52627	0.606938	-0.27245904	0.16509561	-0.27245904	0.16509561

Summary Output 5-Factor ESG Bottom Portfolio:

Regression Statistics	
Multiple R	0.983781798
R Square	0.967826626
Adjusted R Square	0.954038038
Standard Error	0.101083119
Observations	21

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	6	4.303147847	0.717191	70.19041	1.2133E-09
Residual	14	0.143049157	0.010218		
Total	20	4.446197004			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.043119098	0.049456735	0.871855	0.397993	-0.06295505	0.149193245	-0.062955	0.14919325
SMB	2.444235861	1.018067836	2.400858	0.030818	0.26069752	4.627774204	0.26069752	4.6277742
HML	0.071665169	0.1152865	0.621627	0.544178	-0.17559978	0.31893012	-0.1755998	0.31893012
Rm-Rf Fiscal	0.977933972	0.077407088	12.63365	4.82E-09	0.81191228	1.143955664	0.81191228	1.14395566
RMW	-0.665976589	1.14970445	-0.57926	0.571618	-3.13184739	1.79989421	-3.1318474	1.79989421
CMA	-0.763192812	1.393982267	-0.54749	0.592663	-3.75298742	2.226601796	-3.7529874	2.2266018
ESG	0.94892566	0.102892759	9.222473	2.52E-07	0.72824264	1.169608681	0.72824264	1.16960868

Summary Output 5-Factor ESG Random Portfolio:

Regression Statistics	
Multiple R	0.94508932
R Square	0.893193823
Adjusted R Square	0.847419747
Standard Error	0.158610388
Observations	21

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	6	2.945375223	0.49089587	19.51309347	0.000004692
Residual	14	0.352201572	0.025157255		
Total	20	3.297576794			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.046057505	0.077602986	0.593501714	0.562312238	-0.120384347	0.212499358	-0.120384347	0.212499358
SMB	1.440843748	1.597458962	0.901959789	0.382333862	-1.985364968	4.867052464	-1.985364968	4.867052464
HML	0.019446681	0.180897035	0.107501378	0.91591663	-0.368538872	0.407432233	-0.368538872	0.407432233
Rm-Rf Fiscal	1.033337418	0.121460125	8.507626802	6.64385E-07	0.772831358	1.293843478	0.772831358	1.293843478
RMW	-1.79415455	1.8040111	-0.994536314	0.336841342	-5.663373542	2.075064442	-5.663373542	2.075064442
CMA	-1.69230358	2.187309514	-0.773691866	0.451980448	-6.383615908	2.999008749	-6.383615908	2.999008749
ESG	0.229182082	0.16144991	1.41952437	0.177628057	-0.117093536	0.5754577	-0.117093536	0.5754577