ESG MOMENTUM AND STOCK PERFORMANCE IN U.S. DURING 2018-2023

Does market reward companies for improving ESG scores?

Lappeenranta–Lahti University of Technology LUT

Master's thesis in Strategic Finance and Analysis

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Examiner(s): Associate Professor, Jan Stoklasa

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ABSTRACT

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Does market reward companies for improving ESG scores?

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Keywords: ESG, Momentum, Screening, CAPM, investing

The study examines ESG investing strategies on the New York Stock Exchange from 2018 to 2023. It does this by comparing the performance of a more traditional best-in-class investing strategy to an ESG momentum strategy created based on the logic of a traditional momentum strategy, focusing on constructing a portfolio of stocks achieving previous short-term success, in this case, growth in ESG scores. This study aims not only to investigate if better ESG performance leads to better returns but also to uncover broader possibilities for using ESG scores to create investment strategies.

In the empirical analysis of the study, a total of four portfolios are created to measure and compare the performance. Portfolios for each above-mentioned momentum and screening strategy, where companies with the highest ESG scores are selected for the portfolio, are used as the methods to create portfolios of 30 stocks. Portfolios of the worst-performing stocks are created for comparison purposes. Rebalancing of the portfolios is done annually, after the first half of the year, to avoid look-ahead bias by ensuring the availability of key ESG data. The performance of the portfolios is measured by absolute and risk-adjusted returns as well as pure risk metrics to ensure a comprehensive understanding of the differences between the nature of the strategies.

The results suggest that a momentum strategy slightly outperformed the screening strategy. The top ESG momentum portfolio, with a cumulative return of 92.6% and a compounded annual growth rate (CAGR) of 14.01%, surpasses the top screening portfolio's performance of 63.69% cumulative return and 10.36% CAGR. Risk-adjusted returns further emphasize the slight overperformance of the momentum strategy over the screening approach during most years of the period. However, the top screening portfolio shows lower volatility and beta, indicating a more stable, risk-averse investment option. This suggests that while the ESG momentum strategy can offer higher returns, it also comes with increased market sensitivity and potential risk, as well as higher transaction costs affecting net returns.

TIIVISTELMÄ

Lappeenrannan–Lahden teknillinen yliopisto LUT

LUT-kauppakorkeakoulu

Kauppatieteet

Niilo Helminen

ESG MOMENTUM SIJOITUSSTRATEGIA YHDYSVALLOISSA 2018-2023

Palkitseeko osakemarkkinat yrityksiä kasvavista ESG-pisteytyksistä?

Kauppatieteiden pro gradu -tutkielma

2023

60 sivua, 18 kuvaa, 8 taulukkoa ja 3 liitettä

Tarkastaja(t): Apulaisprofessori Jan Stoklasa ja Shahid Bhat

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Tutkielma tarkastelee ESG sijoitusstrategioiden menestystä New Yorkin pörssissä vuosina 2018-2023 vertaamalla perinteisen best-in-class strategian suorituskykyä ESG momentum strategiaan. ESG Momentum strategia perustuu aikaisemman lyhyen aikavälin menestyksen painottamiseen portfoliossa. Samaa logiikkaa hyödynnetään perinteisessä Momentum strategiassa. Tämän tutkielman tarkoituksena on tutkia ESG-pisteytyksen vaikusta portfolion suorituskykyyn, sekä tutkia aiempaa laajempia pisteytyksen käyttömahdollisuuksia sijoitusstrategian luomisessa.

Tutkielman empiirinen osuus koostuu neljän portfolion luomisesta. Sekä momentum, että seulonta portfoliot ovat luotu luokkansa 30 parhaiten menestyneestä osakkeesta. Vertailua varten luodut portfoliot koostuvat luokkansa huonoiten menestyvistä osakkeista. Portfolioiden tasapainotus tehtiin vuosittain. Suorituskykyä mitataan absoluttisella ja riskikorjatulla tuotolla, sekä riski mittareilla, jotta stragoiden väliset kokonaisvaltaiset erot on mahdollista havainnollistaa.

Tulokset osoittavat, että EGS-momentum strategian kumulatiivinen tuotto sekä vuosituotto (92.6%, 14.01%) ylitti best-in-class seulontastrategian tuotot (63,69%, 10,36%). Myös riskikorjattulla tuotolla mitattuna momentum strategia menestyi hieman paremmin. Seulontastrategian matalampi beta-kerroin sekä volatiliteetti viittaa kuitenkiin vakaampiin tuottoihin, jotka sijoittajan riskinottohalukkuus huomioon ottaen voivat olla houkuttavampia. Vaikka momentum strategia voi tarjota parempia tuloksia, se on myös epävakaampi ja aiheuttaa aktiivisemman tasapainottamisen takia enemmän kuluja.

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1 Introduction

Back in 2004, to support the growth of sustainable capital flows, in his initiative "Who Cares Wins," then Secretary-General of the United Nations, Kofi Annan, urged financial institutions to join the cause towards more sustainable economics. This was to happen by developing guidelines and recommendations on the integration of environmental, social, and governance issues in asset management and security brokerage. (United Nations, 2004) In more recent times, the shift towards sustainability has morphed from a mere buzzword to a core component of many investment strategies, without a clear consensus on the reliability of the metrics and their connection to real-life business practices. At the center of this shift lies the evaluation of companies based on environmental, social, and governance (ESG) metrics. With an increasing number of investors seeking to align their portfolios with their values without sacrificing returns, the above-mentioned shift has become more pronounced. This also raises questions about the reliability of ESG metrics. ESG investing in the US has grown significantly over the past decade, reflecting the global trend toward sustainable finance. A report by the US Sustainable Investment Forum found that by 2022, assets invested using sustainability approaches totalled over 8.4 trillion USD, up from 2012. (4 trillion USD). US SIF, 2023

This thesis examines the relationship between ESG momentum and stock performance, with a particular emphasis on understanding whether advancements in ESG metrics result in better stock returns for companies on the New York Stock Exchange (NYSE) from 2018 to 2023 compared to the companies that have already achieved more stable and higher status in ESG scores. The relevance of this study is underscored by the global emphasis on sustainability and the crucial role the financial market can play in directing responsible business practices. The integration of ESG factors into investment decision-making has gained momentum, arising from evidence suggesting a positive correlation between ESG performance and financial returns. (Reuters, 2022) The examination of the ESG returns on the NYSE offers a way to evaluate sustainability scores from the perspective of financial markets. This study aims not only to investigate if better ESG performance leads to better returns but also to apply a traditional momentum strategy to ESG scores for the purpose of uncovering broader possibilities of using ESG in investment strategy creation.

1.1 Background and motivation

The rise of environmental, social, and governance (ESG) investing has transformed the investment landscape. Such growth mentioned in the previous chapter on sustainable investment flows isn't merely a small trend but a shift towards sustainability-centered business practices and, therefore, investing. Regardless of the massive fund flows into ESG investments and the rapidly growing amount of research highlighting the correlation between strong ESG performance and financial success, the results are still very mixed and contradictory. (Cornell, 2021; Friede et al., 2015)

The concept of momentum in financial markets is strongly established in behavioural finance and is based on assets' tendency to maintain performance patterns. (Jegadeesh & Titman, 1993) When applied to ESG measures, the momentum method gives a different perspective. It emphasizes the importance of the direction and pace of ESG performance changes rather than concentrating exclusively on static ESG ratings. This emphasis is motivated by the idea of the market's valuation of ESG trajectories as an indicator of future performance. This thesis uses the ESG momentum strategy to investigate if the pace of change in a company's ESG profile is an indicator of its future short-term financial performance. The strategy recognizes that companies are in various stages in their sustainability efforts; thus, an improvement in ESG scores may reflect underlying operational enhancements that could translate into economic gains, while also recognizing the difficulties related to the sustainability measurement methodology. Moreover, the ESG momentum strategy aligns with the view that markets are not always efficient at processing new information. In today’s world, where sustainability awareness is on the next level and information is shared quickly, overreactions happen, leaving room for anomalies. ESG Momentum offers another, more investor-philosophy-related perspective on joining a possibly lower absolute-level ESG company on a positive trajectory, to benefit from the recent development and to further ensure the best sustainability practices in the future, from the perspective of the owner.

1.2 Contribution to literature

While the majority of existing academic literature focuses on ESG scores and more traditional ESG approaches, academic research on ESG momentum remains relatively underrepresented (Cauthorn et al., 2023). Thus, given the proven success of momentum strategies in traditional investing (Geczy & Samonov, 2016; Jegadeesh & Titman, 1993; Swinkels, 2004), this gap is noteworthy. The potential of ESG momentum methods has been recognized in studies (Khan et al., 2016; Nagy et al., 2013; Shanaev & Ghimire, 2022; Whelan et al., 2021), particularly when compared to typical ESG investment methods or compared to market returns. According to these research papers, organizations with positive trajectories in their ESG ratings outperformed either their peers with dropping ratings or the market in general. Giese et al. (2019) stated in their research that ESG momentum can be a useful financial indicator, and improvement in ESG characteristics has led to increasing valuations over time. Such results suggest a dynamic relationship between ESG ratings, their pace of change, and stock performance. Despite these preliminary findings, detailed research into the complexities of ESG momentum is sparse. The relative nature of ESG rankings and scores and their heterogeneity between different rating agencies leaves room for speculation. After all, a high ESG score may reflect a company's relative success in its sector rather than an absolute adherence to best ESG practices, and the industrial and sectorial scaling might differ between agencies.

The purpose of this thesis is to add to existing, limited literature and provide academic results for an interesting and fairly new phenomenon. This thesis hopes to provide more knowledge of ESG momentum dynamics by evaluating the ESG momentum approach and its consequences for stock returns, as well as contrasting it with established ESG traditional investment strategies. The thesis aims to discuss the noteworthy challenges and shortcomings surrounding the ESG conversation and to possibly offer practical insights for investors looking to implement ESG into their investment-related decision-making, especially in the rapidly evolving landscape of ESG investing.

1.3 Research questions

The research is formed around a set of core questions aimed at investigating and critically examining ESG investing as a phenomenon as well as the difference in results between more traditional and less-investigated newer ESG investing strategies. The thesis aims to examine the influence of ESG criteria on investment strategies and their resulting performance and risk profiles on the New York Stock Exchange from 2018 to 2023, based on Refinitiv's ESG scores. The investigation is structured around a primary question that aims to contextualize the effect of ESG integration within the broader framework of portfolio management:

I. *How does the integration of ESG criteria into portfolio construction influence investment returns on the New York Stock Exchange in 2018–2023?*

Pure ESG momentum represents the idea of capitalizing on recent improvements in a company's ESG performance, just as traditional momentum strategy capitalizes on improvements in, for example, recent stock performance. The second question investigates portfolios based on pure ESG momentum on the NYSE from 2018 to 2023. By answering this question, a so-called price tag of the momentum strategy is defined in comparison to the portfolios created by applying the more traditional screening method:

II. *How have the pure ESG momentum portfolios performed compared to the portfolios utilizing screening strategies based on risk-adjusted metrics?*

The third question aims to uncover the risk implications of adopting ESG momentum and screening strategies in portfolio construction. It will examine how these strategies perform in managing the stock market's risks, considering their exposure to market-wide changes, individual stock volatility, and other risk variables.

III. *How do the risk profiles of portfolios based on pure ESG momentum and screening strategies compare in terms of volatility, beta, and other risk metrics?*

1.4 Structure

This thesis is organized into six sections to provide a comprehensive exploration of ESG investing. In Section 2, key financial theories and models regarding modern portfolio management are covered. ESG's status, related investing strategies, scoring methods, and related challenges are discussed as well. In Section 3, the questions underlying the research are presented. In Section 4, the methodology and related data of the empirical research are presented. Findings from the analysis are discussed and presented in Section 5, providing insight into the performance of the created portfolios. The final chapter summarizes the key insights, discusses the implications of the findings, and suggests directions and potential topics for future research.

2 Literature review

As a traditional literature review would focus only on previous research on the topic, this chapter covers key financial theories such as modern portfolio theory and capital asset pricing, as well as a brief history of ESG, related investing strategies, scoring methods, and related challenges.

2.1 Efficient markets

Economist Eugene Fama's Efficient Markets Hypothesis (EMH) was introduced back in 1970. It concludes that it's nearly impossible to beat the market and create excess returns. This is due to the immediate reflection of any information available in equity prices. (Fama, 1970; CFI, 2020) Essentially, financial markets are efficient at pricing, and finding "free lunches" is extremely hard (Knüpfer & Puttonen, 2018). The efficiency of a market is placed into categories based on how much and what information is reflected through the equity prices. Weakly efficient markets form prices based only on historical information. Semi-strongly efficient markets include all publicly available information for price determination. Lastly, strongly efficient markets include not only public but also insider information, making any analysis of such information pointless because the information is already reflected by the prices. (Fama, 1970; Knüpfer & Puttonen, 2018) As in this research, the hypothesis of the efficient market is at least to some extent challenged since excess returns from momentum strategies reflect abnormal returns or a "free lunch." In Figure 1, the reaction to an efficient market is shown.

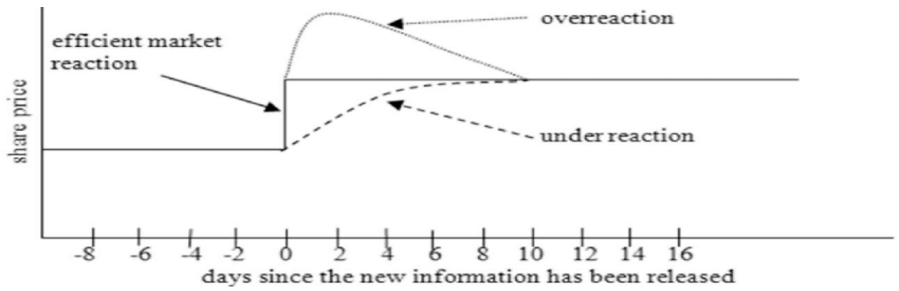


Figure 1. Price reaction to positive information on efficient / not efficient market (Jamroz, 2011, p. 73)

2.2 Modern portfolio theory

Modern Portfolio Theory (MPT), introduced by Harry Markowitz in 1952, is centered around the Efficient Frontier, a concept that identifies the highest returns of a portfolio for a specified level of risk. This theory supports diversification to mitigate unsystematic risks—risks related to specific companies or industries. By spreading investments across various assets, unsystematic risk can be significantly reduced or even eradicated, yet systematic risk, related to the broader market, cannot. (Markowitz, 1952) Efficient Frontier and MPT assume that investors avoid unnecessary risk, and therefore the portfolio is created under two conditions: minimizing the risk at a given return level and maximizing expected returns at the specified risk level (Fama & French, 2004). Due to the diminishing marginal utility of diversification, Statman (1987) suggests that a well-diversified portfolio should contain at least 30–40 different stocks, a portfolio creation parameter used in this research as well.

2.3 Capital asset pricing model

Sharpe (1964) and Lintner (1965) developed the Capital Asset Pricing Model (CAPM) from Markowitz's portfolio theory. It is a pricing model used to calculate the expected long-term return of a portfolio. Today, the CAPM is still widely used to assess the cost of capital for businesses as well as the performance of investment portfolios. It is universally used in risk and return studies, accounting for a sizable portion of investment and corporate finance textbooks (Fama & French, 2004; Levy, 2012). The CAPM, a market equilibrium model, proposes that the expected returns on investment assets should exceed the risk-free return and that expected returns increase with increasing risk. Market equilibrium is reached when a security's expected returns match the systematic risk due to the mechanism where over- or underpriced securities would either be sold or bought until the pricing-level reaches the adequate level of risk. Because diversification can eliminate unsystematic risk from a portfolio, CAPM focuses on the portion of risk that cannot be diversified. When nearly all of the portfolio's risk is systematic, the key is how the risk of a stock added to the portfolio affects the portfolio's risk, and investors earn additional returns only by bearing the systematic extra risk (Levy, 2012; Sharpe, 1964).

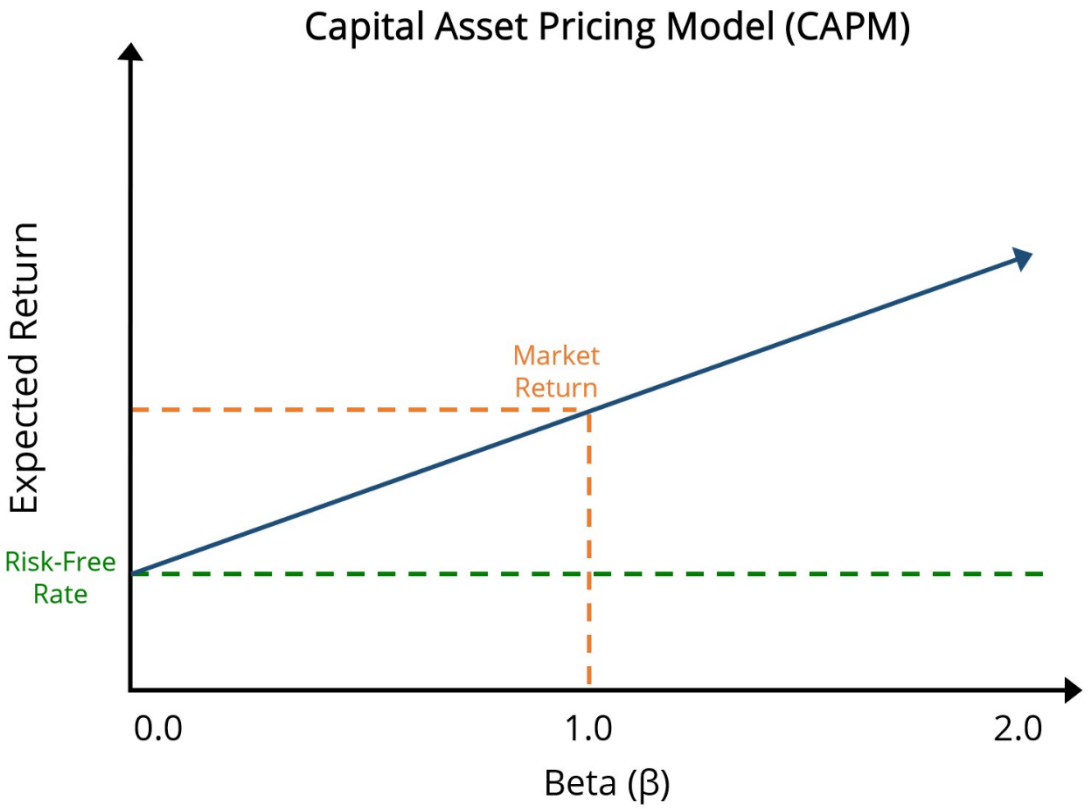


Figure 2. Capital Asset Pricing Model Graph (CAPM), (Wall Street Prep, 2023)

2.4 Brief history of ESG investing

The origins of sustainable investing can be traced back to centuries-old practices. Historically, certain religious rules prevented investments in activities that contradicted ethical or moral standards, such as alcohol production or gambling. (Morningstar, 2021) The modern embodiment of ESG investing emerged in the 1960s. During this period, socially responsible investing evolved, with investors selectively removing stocks or whole industries from their portfolios based on unethical or harmful corporate and business practices. (Forbes, 2020) Sustainable investing saw significant growth in the early twenty-first century, fueled in part by international organizations such as the United Nations. During this time, Kofi Annan, the United Nations Secretary-General, launched the Global Compact, from which the "Who Cares Wins" report derives. The phrase "ESG investing" was established at that time. The purpose of sustainable investing evolved throughout time, shifting toward specialized investments with the goal of gaining influence or making a tangible effect on issues of importance to investors. (Forbes 2020, Morningstar, 2021).

Regulatory agencies and legislators began to recognize the significance of ESG considerations. The creation of the United Nations' Principles for Responsible Investment (PRI) in 2006 marked a crucial turning point. (UN, 2006) The importance of ESG parameters in investing decisions was underlined in this framework. Numerous laws, like the European Union's Non-Financial Reporting Directive (NFRD) in 2014, the Paris Agreement (2015), and the SEC's Enforcement Task Force (2021), have required bigger corporations to publish non-financial and diversity information, pushing the ESG agenda even further.

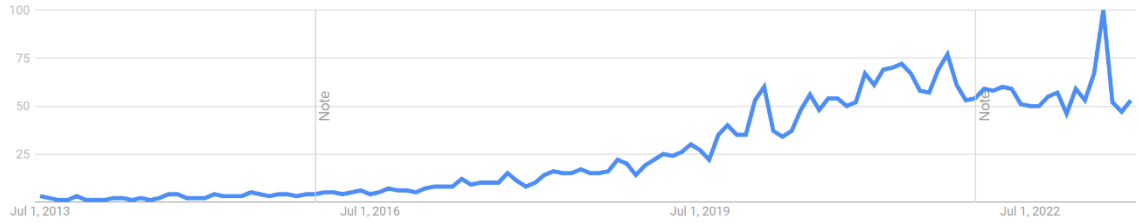


Figure 3. Google searches of "ESG investing", past 10 years. (Google Trends)

ESG investing has now moved beyond its initial status as a niche approach and has clearly established itself within the core of mainstream investment strategies, as evidenced by the fact that the percentage of mentions of ESG matters in company earnings calls increased from less than 1% in 2005–2018 to nearly 20% in 2021. (Financial Times, 2022) Individual and institutional investors alike are increasingly recognizing the inherent benefit of incorporating ESG factors into their decision-making processes. This movement is being driven not only by ethical concerns but also by a growing recognition that ESG elements may impact long-term returns and risk profiles. Furthermore, a new generation of investors who value sustainability and societal impact over financial profits is increasing the significance of ESG. With a dynamic market typified by more regulatory scrutiny, increased investor awareness, and an urgent need for long-term solutions, ESG investment aims to direct money into paths that offer more than just financial rewards but a brighter future for all. (Forbes, 2018)

While ESG investment has seen substantial development and mainstream adoption, it is not without its critics, obstacles, and uncertainties. Regulatory organizations, such as the S.E.C., have reviewed major financial companies' ESG efforts. Concerns over 'greenwashing', in other words, portraying activities or investments as more environmentally beneficial than they are, have pushed the sector to a crossroads. Some say that the ESG framework is faulty and must be fixed right away, and pushback on ESG is heard from notable players in the

financial and political sectors. (The Economist, 2022; Financial Times, 2022; The New York Times, 2022; U.S. SEC, 2021) These political and economic challenges will be further discussed together with the shortcomings of ESG from the perspective of academic research results.

2.5 ESG in investing strategies

A responsible investing strategy seeks to decrease total portfolio risk without sacrificing returns by considering the ESG aspects of firms when picking investment opportunities. This decreases the negative societal externalities of the investor's investing activity while increasing the positive benefits. (Hyrske et al., 2020) Socially responsible investing (SRI) is a difficult concept to grasp since it has changed and extended throughout time, becoming a catch-all phrase and later a trendy abbreviation, ESG, for any investments seen as responsible or evaluated as excellent according to some sustainability score. Simply put, responsible investing is (1) investing in firms that satisfy some fundamental conditions for social and environmental responsibility. (2) investing that actively seeks to commit companies to more responsible operations and establishes standards toward these goals; and (3) investing that allocates assets where economic development supports environmental and sustainability progress, with the goal of benefiting from positive changes in corporate operations. (Gay and Klaassen, 2005) Regardless of the massive fund flows into ESG investments and the rapidly growing literature on ESG investing and its financial performance, the results are still very mixed and contradictory. (Friede et al., 2015; Cornell, 2021) In the following sub-chapters, previous academic literature on different ESG strategies is presented. Similar strategies are used in the empirical analysis of the thesis, and it is therefore important to look at the previous academic results.

2.5.1 Screening

Screening can be considered the original and dominant strategy for responsible investing. As a strategy, screening refers to a method where companies are excluded or selected from the portfolio based on social and environmental responsibility criteria. (Lee et al., 2010; Schwartz, 2003) Negative screening denotes the process of removing certain investment

options from the pool of potential investments due to their irresponsible or unethical products or business models. Examples of such products might include tobacco or the weapon industry. (Simone & York, 2009) Different variations of ESG investing strategies in academic research are discussed in this chapter. With this being said, it can be stated that the momentum strategy presented in subsection 2.6.1 is also a screening strategy due to the nature of including and excluding companies based on the ESG criteria. In this thesis, the two strategies are referred to as screening and momentum to point out the difference and make the thesis easier to follow.

Pedersen et al. (2021) demonstrate the complex impact ESG ratings play in reflecting value. They argue for the CAPM-derived ESG-efficient frontier, a theoretical model representing the trade-off between ethical commitment and financial benefit. Their quantitative method, supported by extensive data research, reveals only a marginal loss in the Sharpe ratio for individuals who include ethical limitations in their portfolios, providing a more comprehensive understanding of the 'cost' of responsible investing and implying that responsible investing may not require significant compromises in returns. Adler and Kritzman (2008) use Monte Carlo simulations to introduce an alternative perspective. They emphasize the potential financial trade-offs encountered by ethically minded investors by modeling the cost of socially responsible investing. They conclude that even removing 20% of the total pool of investment opportunities for ethical concerns may result in significant opportunity costs, highlighting the need for well-calibrated ESG initiatives in the long run.

The empirical field is diverse, with research providing both positive and negative results concerning the financial efficiency of ESG screening. Lins et al. (2017) show that companies with strong corporate social responsibility intensity have considerably higher stock returns of 4–7%, illuminating the financial benefits of strong ESG standards. This positive correlation is called into question by Fabozzi's (2008) earlier research results, which show that from 1970 to 2007, sin stocks across 21 countries from six different industries—including alcohol, tobacco, weapons, biotech, gaming, and adult services—performed better than the market, with an impressive 19% average annual return. This calls into question the idea that ethical screening and financial performance are always linked. The methodologies employed across studies are as diverse as their outcomes. Kempf & Osthoff (2007) found that based on KLD’s socially responsible investing (SRI) data in 1992–2004, a simple best-in-class trading strategy of buying stocks with high SRI ratings and selling stocks with low

ratings led to high abnormal returns of up to 8.7% per year. Capelle-Blancard et al. (2014) investigate the financial effects of the intensity of ESG screening, primarily exclusionary techniques, and conclude that they do not necessarily result in superior financial outcomes. Garel and Petit-Romec (2021) investigated the impact of high ESG ratings with the best-in-class method during COVID-19, using buy-and-hold stock return as a dependent variable, previous available ESG score as an independent variable, and cash over assets, short-term debt, and long-term debt over assets as proxy control variables. They found evidence of abnormal returns leading to investor attraction, which may lead to even more inflated company prices. In contradiction to this, Demers et al. (2022) presented that not ESG but traditional accounting-based measures of the firm's financial status worked as a protection against the general market decline during that time.

The diverse effects of ESG screening in investment strategies emphasize the need for a well-balanced approach to ESG screening, one that recognizes its potential to vary depending on the investors' goals, the current market climate, and the specific nuances of the research methodologies used. There is rarely a one-size-fits-all solution in the field of ESG investment, and critical thinking is essential for navigating this dynamic environment.

2.5.2 ESG and Momentum

As noted in the preceding subsection, the importance of ESG ratings in investment processes has expanded, causing various research studies to investigate the relationship between ESG ratings and financial success. However, there has not been a lot of research on the influence of ESG rating changes on stock performance (Cauthorn, Dumrose et al., 2023). Therefore, implementing a traditional investing strategy, the momentum strategy, for ESG scores makes for an intriguing study topic. In their research, Nagy et al. (2013) presented and underlined the relevance of ESG momentum strategy in their research, using the Barra Global Equity Model (GEM3) to build optimized portfolios, highlighting the value of a company's positive trajectory in ESG ratings. This strategy demonstrated a particularly good risk-adjusted performance. Recent research (Nagy et al. 2016) questioned whether ESG issues impacted institutional investors' risk-adjusted returns. Using the same GEM3 method as in prior research, by comparing two independent global strategies supported by ESG data, it was discovered that both outperformed the MSCI World Index. Notably, the momentum strategy

outperformed the market by 2.2 percent. A large percentage of this outperformance may have been attributable to stock-specific sources that are directly connected to ESG signals. These two studies show the potential of ESG-centric strategies to not only produce higher returns but also to raise the ESG profile of investment portfolios.

Giese et al. (2019) placed a major emphasis on the concept of ESG momentum. Using the Barra Long-Term Global Equity Model (GEMLT) for their analysis, their findings underlined the financial significance of ESG momentum, as businesses with substantial positive trends in ESG ratings beat those with declining ratings on a consistent basis. Notably, this ESG momentum was revealed to be a significant predictor of stock returns, suggesting that changes in a company's ESG profile may have an impact on its price. Surprisingly, while static ESG ratings tend to stick around for a long time, their initial financial impact is minimal. In comparison, ESG momentum is more intense, but over a shorter period. Finally, ESG momentum shows up as a powerful statistic with large short-term financial ramifications, hinting that it might be a valuable tool for investors looking for above-average performance.

The implications of ESG momentum's outperformance by mapping material ESG issues, as identified by Khan et al. (2016), are supported by subsequent analyses of the ESG trajectories. Friede et al. (2015) emphasized a strong empirically founded business case for a positive relationship between ESG and corporate financial performance by combining approximately 2200 individual studies around the topic. Whelan et al. (2021) gathered evidence from multiple meta-studies, highlighting the value of ESG improvers—companies that demonstrate significant enhancements in their ESG practices. This research suggests a clear pattern: portfolios composed of firms with top-quintile improvements in ESG factors outperform those with lower ESG advancements, with an annualized difference of 3.8% against bottom-quintile ESG decliners from 2010 to 2020. This is consistent with the observations made by Shanaev and Ghimire (2022), where ESG rating improvements were associated with positive returns. Additionally, when ESG improvement is isolated in an optimized portfolio that accounts for various biases, the strategy still yields excess returns. This further substantiates the financial viability of ESG momentum, providing compelling evidence that dynamic ESG enhancements might be a solid predictor of stock performance. The research (Shanaev & Ghimire, 2022) utilized a calendar-time portfolio approach to assess the effects of ESG rating changes on the stock performance of 748 US corporations

from 2016 to 2021. While ESG rating improvements resulted in uneven positive returns, downgrades resulted in considerable negative returns. According to the research, specifically, ESG rating downgrades consistently resulted in detrimental stock outcomes, yielding statistically notable negative abnormal returns ranging from -1.0% to -1.4% monthly. The importance of ESG ratings and the informational value they provide to both institutional and individual investors was emphasized, with changes in ESG ratings having a greater impact than the ratings themselves. Cauthorn, Dumrose, et al. (2023) examined the same technique, discovering significant methodological flaws in the previous work. They developed the technique and used MSCI ESG and Vigeo Eiris ESG ratings. Their findings differed from the original, indicating that there was no significant relationship between ESG rating changes and short-term stock performance. The removal of around 28 percent of firms in Shanaev and Ghimire's research, as well as errors in portfolio returns, were significant disparities. Furthermore, the problem of ESG rating heterogeneity was addressed, underscoring that findings may differ depending on the ESG rating source used. Cauthorn and colleagues' findings support the notion that, while changes in ESG ratings may not have an immediate influence on stock performance in the short term, they may have medium- to long-term, i.e., two-year, consequences. This is supported by the findings of Berg et al. (2022a). A viewpoint by Berg et al. (2022b) and the other studies, taken together, highlight the need for the inclusion of several ESG rating providers in research to provide strong and consistent findings in the field of ESG investment. However, due to the nature of the master's thesis and the accessibility of the data, this thesis uses Refinitiv ESG ratings presented in the methodology in the later part of the thesis and justified at the end of this section.

2.6 Challenges and shortcomings of ESG

The broad landscape of ESG investing presented in previous chapters, while having the potential to benefit society and the environment as well as investment returns, does not exist without complexities that challenge its real efficiency. These challenges emerge from various dimensions, including political, economic, and methodological aspects such as sustainability metrics. These challenges can, in certain circumstances, compromise the progress and integrity of ESG initiatives and, therefore, ESG investing. It is important to consider these issues to provide a more comprehensive perspective on the landscape. The challenges and shortcomings discussed in the next sub-sections highlight the need for a more

nuanced understanding of ESG's role in investment strategies. As the prior chapters have presented methodologies and outcomes of ESG investment practices, such as screening and momentum strategies, the following discussion of the challenges emphasizes the importance of further research on the topic, such as this ESG momentum research.

2.6.1 Political and economic challenges

The connection between political influence and economic objectives tends to lead to contradictions and challenges in the ESG landscape. Puttonen & Puttonen (2021) provide a comprehensive critique of ESG metrics, pointing as an example to the problematic classification of nuclear power. While some promote nuclear energy as a low-carbon alternative that can help in the transition away from fossil fuels, the industry's general ESG status is questioned due to fear over radioactive waste and the potential for catastrophic accidents. Puttonen et al. (2021) argue for subjectivity in these judgments and point out flaws in present ESG frameworks that may fail to address such complex arguments. Hoang's (2022) findings on the corruptive effects that prevent transparent ESG disclosure, particularly among large polluters who may use political loopholes, partly validate these claims. Yang et al. (2023) add to the view that political instability can have a detrimental influence on ESG performance, highlighting the difficult balance of politics and ESG compliance.

Furthermore, McCarthy (2017) emphasizes the substantial influence of public policy and legal frameworks in the United States, implying that the ESG field may struggle to push for systemic change in the absence of legal reforms to support ESG concerns. Similarly, Costantiello and Leogrande (2023) emphasize the significance of political stability in ESG performance, suggesting a strong link between a stable government and ESG scores. Up until 2021, SEC reporting of ESG matters in the U.S. was not mandatory and only required companies to report on information that might be important to investors. After passing the ESG Disclosure Simplification Act, the aforementioned issues in legislation were considered. (United States Congress, 2021)

ESG's economic impacts are similarly complex. Pucker and King (2022) explain the misunderstanding around ESG funds, which originates from inconsistent and sometimes unregulated ESG ratings, leaving investors confused and skeptical of the real effect and

returns of ESG investment. Hartzmark and Sussman (2019) discovered that while investors appreciate sustainability and it drives fund flows, the market's reaction to sustainability ratings can be more significant than the ratings' actual impact. To make matters worse, Bhagat (2022) shows that ESG funds may not only underperform monetarily but also fail to improve compliance with labor and environmental rules. This shows a gap between ESG ratings and real business practice, which is complicated further by the idea that certain corporations may use ESG rhetoric as a smokescreen for bad financial performance, as Flugum and Souther observed (2022).

2.6.2 ESG Scores and their reliability

ESG ratings have been established as a critical instrument for investors to use to evaluate a company's non-financial features. The validity of these ratings, on the other hand, is a matter of ongoing debate that emerges from questions related to the transparency of the methodology and the consistency of the data utilized in their construction. Sahin et al. (2022) challenge the current status quo with their ESGM framework, proposing the inclusion of a 'Missing' (M) pillar that accounts for missing or unreported ESG data. Their approach, which uses Refinitiv data, indicates that transparently reporting data gaps may rebalance risk profiles. This argument is consistent with the findings of Ehlers et al. (2023), who argue for the deconstruction of existing aggregate ESG ratings to demonstrate the categorical components contained within, using the same Refinitiv scores. The argument is similar to that of Scatigna et al. (2021) and Berg et al. (2022b), who highlight the necessity for more robust and standardized ESG data to ensure that ratings truly reflect a company's sustainability efforts. This further supports the findings of Dorfleitner et al. (2015), who highlight the significant differences in the methodologies of different ESG rating providers (Refinitiv, Bloomberg, and KLD), as well as the resulting differences in ratings, notably in the social pillar. Dorfleitner and Halbritter (2015) extend this research to the relationship between ESG ratings and financial performance, arguing that differences in methodologies across rating agencies limit investors' ability to use ESG ratings to generate abnormal returns. Chatterji et al. (2016) support this view of inconsistency by reporting low convergent validity with a correlation among six SRI raters with a mean of 0.30, suggesting a low correlation. Individual correlations ranged from -0.12 to 0.67, indicating negative correlations as well. Their research, which indicates substantial variance among raters,

underlines the difficulty in developing a unified criteria for what determines responsible business operations.

To summarize, these diverse perspectives point to the same conclusion: the current state of ESG grading is characterized by inconsistencies and a lack of defined methods. Due to the number of different components measured simultaneously and then presented as a single numerical value, a comprehensive method to ensure that ESG scores properly represent the essence of business sustainability activities is almost impossible to perfect. This is not to say that ESG ratings are meaningless or cannot be used in research. In momentum investing, the pace of change is more important than the actual scores. The approach is fundamentally different from standard screening strategies, which may rely on static criteria or rankings. Momentum techniques capitalize on the direction of change, which may correlate more closely among different raters than absolute scores. This is because, even if raters disagree in their grading, they may nevertheless capture the direction and pace of development in ESG practices in a comparable way. Momentum strategies can be adaptable and regularly rebalanced, as seen in the data and methodology section, which can reduce the above-mentioned risks when compared to more static portfolios. Because momentum is based on changes over time, they can be more resistant to mistakes in any ESG rating.

In conclusion, as presented in previous chapters, ESG scoring methods are not flawless. While the ESG scores offered by Refinitiv have their undeniable limits, as does any rating agency, using the data for a momentum strategy can be justified. It is nevertheless essential to maintain a critical perspective on the data and methodologies employed. Refinitiv Eikon's ESG Scores are selected due to a couple different aspects relevant in the context of the master's thesis. The availability of the data without payment obligations through the university's resources played the biggest part in the selection process. However, the high level of coverage (see chapter 4.2.1.) of the Refinitiv scores across different companies in the dataset supports the usage of the respected rating agency. The industry-wide global acceptance of Refinitiv as a reliable data provider further justifies the selection. While acknowledging the fact that in a perfect scenario, multiple reliable rating agencies would be used in the analysis, the usage of Refinitiv's scores is justified and validated. The methodology behind the scores is presented later in the thesis.

3 Research questions

In this section, the steps required to answer the research questions are explained to provide a comprehensive understanding of the methodology. Formulas and detailed explanations behind the steps introduced in this section are discussed in Section 4. To paint a clear picture of the methodology: Four portfolios were created and rebalanced annually. For each portfolio, annual metrics were calculated for each year separately and additionally by using compounding methods for the 5-year period as well.

To answer the first question, "*How does the integration of ESG criteria into portfolio construction influence investment returns on the New York Stock Exchange in 2018–2023?*" equally weighted portfolios were created based on the ESG momentum, which is the yearly change percentage of the Refinitiv ESG scores and based on ESG score to select companies with best ESG score. Creation was done by selecting 30 best companies for each portfolio and 30 worst companies for their own comparison portfolios, ending up with a total of 4 different portfolios or strategies. Rebalancing based on the same criteria was done annually after the availability of the ESG scores could be guaranteed. Weekly returns were calculated for each stock for each week during the five separate 1-year periods. Based on these, the average return of the portfolios for each week and eventually for the respected year was calculated. The annualized return was then calculated based on the average weekly return. Cumulative returns were calculated by first obtaining a weekly growth factor (weekly return + 1) for each weekly return of the portfolio. By multiplying individual growth factors from the beginning of the period to each week until the end of the 5-year period, the cumulative return was calculated. The annual growth rate was obtained from the cumulative return by adjusting it to the annual level. These three metrics—annual returns, cumulative returns, and CAGR—were used to answer the first question.

To answer the second question, "*How have the pure ESG momentum portfolios performed compared to the portfolios utilizing screening strategies based on risk-adjusted metrics?*" Sharpe ratio, Treynor ratio, and Jensen's alpha were calculated again for each portfolio and for each five years separately, in addition to the 5-year period. These methods are described in more detail in Section 4. First, the variance of the portfolios was calculated by creating a covariance-variance matrix and multiplying it by the weights of the stocks, meaning 1/30 for

each stock in annual and 1/150 in the compounded 5-year-calculations. Then, by transposing the weights and multiplying them again by the results of the first multiplication, variance as an overall risk metric was obtained. This method accounts for not just how much each stock in the portfolio can vary but also how each stock's movement is related to the movement of every other stock in the portfolio. Volatility was derived from variance, and Sharpe ratios were calculated. The risk-free rate was calculated as an average of the weekly yield of the current year, to use more accurate figures compared to the 5-year average value. For Treynor ratio and Jensen's alpha, beta, to represent the volatility of the portfolios compared to the market (S&P 500), was calculated by defining the slope of the linear regression line of the given datasets. With this information, the Treynor ratio was calculated. Excess return, i.e., Jensen's alpha, was calculated by obtaining the annual returns of the market portfolio, calculating the expected returns at the given level of risk, and subtracting them from the returns.

To answer the third question, "*How do the risk profiles of portfolios based on pure ESG momentum and screening strategies compare in terms of volatility, beta, and other risk metrics?*" a deeper analysis of the volatility, beta, and weekly return to volatility was conducted. This was done to show the difference in the portfolio risk profiles and their natures, instead of doing the analysis from solely the perspective of the returns.

To support the three questions and the robustness of the results and analysis, a set of different steps was taken in addition to the ones directly addressed above. Transaction costs were considered by calculating the multiplier based on the portfolio turnover. Changes in the sectorial distribution were considered to further enrich the analysis. The effects of equal weighting compared to the optimization based on volatility were conducted and presented visually as part of the results. Calculations for 20 stock portfolios were done as well to ensure robustness and presented as a part of the appendix. In Section 4, a more detailed look into the methodology is done, and the limitations of the thesis are addressed.

4 Data and methodology

In this section, the data used in the empirical part of the thesis and the research methods are presented. The section also introduces the portfolios created for the thesis as well as the limitations from a data perspective. The research data has been collected using the Refinitiv Eikon Datastream application. With Datastream, both the time series data of weekly returns and the annual ESG scores of the 2168 companies listed on the New York Stock Exchange were collected. An extended list of securities, including American Depositary Receipts (ADRs), was used to better reflect the reality of the pool of investment opportunities investors investing in NYSE companies have. (U.S. Securities and Exchange Commission, 2012)

The selection of the 2018–2023 period for analysis in this thesis is justified by several factors that ensure its relevance. This period is not arbitrary but a strategically chosen interval that aligns with key aspects of financial markets. Firstly, the volatility of the S&P 500 during these years mirrors the patterns observed in similar historical periods (V-Lab, 2023). This alignment indicates that the period is a fitting representation of standard market behaviours, making the findings relevant from that perspective. This timeframe includes a series of global economic events, including the COVID-19 pandemic, changes in monetary policies globally, and geopolitical shifts. These major events provide a rich context, time- and period-wise, for examining the performance of investment strategies under varied and challenging conditions. Additionally, the recency of this period brings a perspective to the thesis from which the quickly evolving ESG landscape is in its latest phase. This is further supported by the fact that the relatively broad availability of ESG data from these years enhances the accuracy and depth of the analysis.

4.1.1 Total return index

The return data is based on the total return index (TRI) from 2018 to 2023. TRI is available for individual equities and unit trusts. TRI shows the growth in value of a stock over a specified period, assuming that dividends are reinvested to purchase additional units of the equity. This method adds an increment of 1/260th of the dividend yield to the price each

weekday. (Refinitiv, 2023) It is used to consider the differences in the dividend policies of different companies. RI on the base date = 100, then:

$$RI_t = RI_{t-1} * \left(\frac{PI_t}{PI_{t-1}}\right) * \left(1 + \left(\frac{DY_t}{100} * \frac{1}{N}\right)\right)$$

where:

RI_t is the return index on day *t*,

RI_{t-1} is the return index on the previous day,

PI_t is the price index on day *t*,

PI_{t-1} is the price index on the previous day,

DY_t is the dividend yield percentage on day *t*, and

N is the number of working days in a year, assumed to be 260.

4.1.2 ESG Score by Refinitiv

With the use of publicly available data, Refinitiv's ESG scores seek to objectively assess a company's ESG performance across ten major themes. Over 630 company-level ESG measures are used to calculate the scores, and 186 measures that are essential to the industry have a substantial impact on the assessment as a whole. Company's ESG performance is represented by its final ESG score, which is derived from these metrics and divided into three pillars: environmental, social, and corporate governance. The "governance" category weights are the same for all industries, but the "environmental" and "social" category weights differ for each industry. Below, in Figure 4, the category distribution and the 10 categories later explained in the score calculation methods are shown.

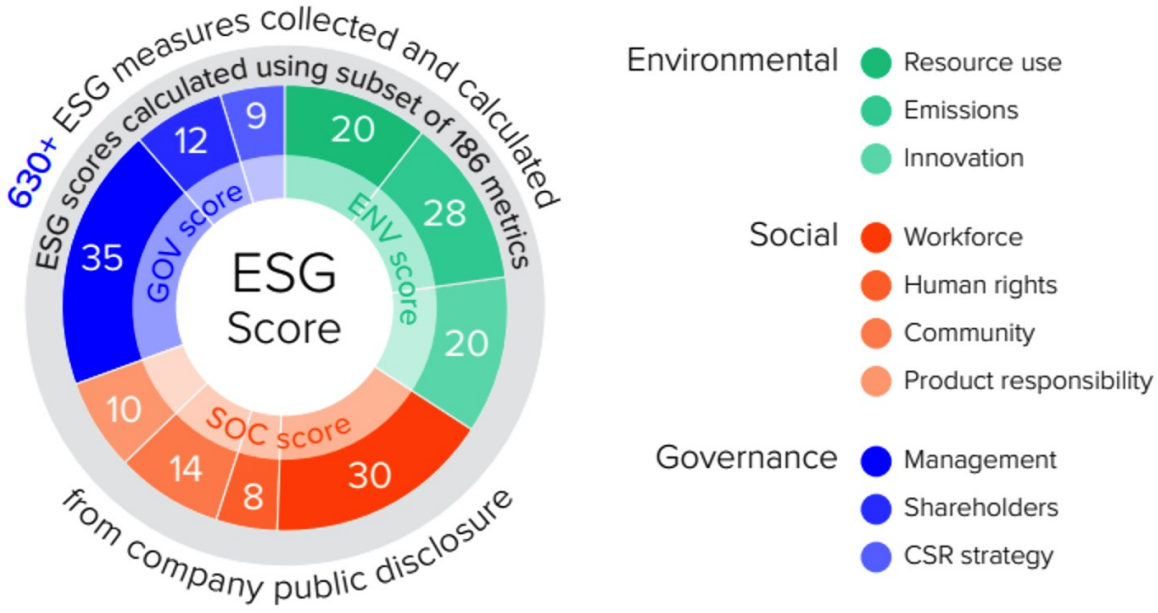


Figure 4, Category distribution of ESG Score (Refinitiv, LSEG), 2022, p. 8)

Businesses are categorized into industry groups according to their main source of revenue during the first stages of defining the ESG score. The ESG score calculation process is then broken down into multiple steps. The most relevant steps for this thesis are listed below:

1. Metric allocation to categories and category score calculations: Every metric has been assigned to one of the ten ESG categories. Important topics like emissions, innovation, human rights, and more are covered by categories.
2. Calculation of Category Scores: A company's percentile rank within its industry group is used to calculate category scores. To do this, a company's raw metric value is compared to peers in the industry.
3. Calculating the Pillar Score and Overall ESG Score: The total of the category weights, which are calculated using the Refinitiv magnitude matrix, makes up the ESG scores. Furthermore, the relative sum of the category weights is used to generate pillar scores, which stand for particular ESG factors like corporate governance, social responsibility, and the environment. (LSEG, 2022)

The Refinitiv ESG score is a relative score. It compares businesses' ESG performance to that of their peers in the industry. This means that rather than being a precise indicator of a company's ESG impact, an ESG score represents how well it performs in comparison to other businesses in the same industry. So when representing the top or bottom portfolios later in the thesis, it is important to note that they are not necessarily the actual top companies, but could be referred to as adjusted top or bottom companies due to the relative nature.

Availability of ESG Scores	2016	2017	2018	2019	2020	2021
ESG Scores	73%	81%	84%	89%	95%	94%
ESG Momentum Value	-	73%	81%	84%	89%	90%
Number of available scores	1577	1750	1821	1928	2051	2042

Table 1., Availability of ESG metrics in NYSE

The availability of sustainability-related metrics has increased significantly due to both the increased popularity of sustainability-responsible investing (SRI) and the tightening of regulatory changes and demands from policymakers. (USSIF, 2023) The above-shown Table 1 of the availability of ESG scores in the thesis data supports this, since an increase in the ability can be seen from 2016 to 2021.

4.2 Portfolio construction

Portfolios based on the analysis are created based on two different investing strategies. The behavioural finance theory suggests that investors underreact to new information, which is likely to result in trends that prevail in the short term. This phenomenon is supported by the traditional momentum investing strategy, which involves buying stocks that have performed well and selling those that have underperformed (Jegadeesh and Titman, 1993). Adapting the traditional momentum model, the Momentum ESG strategy has been utilized by implementing ESG scores into the strategy. In responsible investing, traditional screening, which is commonly regarded as its earliest and dominant approach, involves adding or removing companies from a portfolio according to their social and environmental obligations and liabilities (Lee et al., 2010; Schwartz, 2003). For these two approaches, based on the Statman (1987) suggestion of portfolio diversification, two portfolios of 30 companies each are created to represent the top and bottom-performing companies. Statman shows that the

marginal utility of diversification reduces significantly when 30 stocks and the next five, up to 35, are added to the portfolio. No specific limitations are set for the companies included in the portfolios. Companies are selected based on their ESG performance without leaving any industries or sectors outside, to once again represent the real-world pool of investment opportunities the investor would have to utilize the forementioned strategies. Companies that do not have return data for the full year in their portfolios have been excluded. Look-ahead bias is the incorrect use of data that was not available at the time of the analysis or model, which can lead to misleading conclusions. When back-testing a trading strategy, for instance, assuming quarterly earnings reports are released earlier than they are could result in a sort of look-ahead bias since the model would have access to information before it is actually available, likely overestimating performance. (CFI, 2023) In most cases, reported ESG data is updated once a year in line with companies' own ESG disclosures (Refinitiv, 2023). Therefore, the returns are calculated from July to July to be sure that the information needed for portfolio construction is really available. In the following chapters, the creation of these portfolios and their descriptive statistics are presented. For the robustness of the results, calculations were also performed with 20 stock portfolios, and the results are shown in the appendix 2.

In constructing the portfolios for this study, two different approaches were adopted concerning the weighting of individual stocks. For the overall 5-year analysis, each stock in the portfolios was assigned an equal weight of 1/150. This approach was chosen to treat the portfolio as a cumulative investment over the five-year period, where each stock, regardless of the year it was part of the portfolio, contributes equally to the outcome. This method simplifies the analysis by assuming a "time-averaged" impact of each stock, focusing on the broad effectiveness of the stock selection strategy over the entire study period. In contrast, for the annual key figures of the four portfolios, a 1/30 weighting was employed. This different weighting approach was necessary to accurately capture the performance of each portfolio on a year-by-year basis. Given that each of the four portfolios consisted of 30 companies at any given time, assigning an equal weight of 1/30 to each company for the annual analysis ensures that the yearly performance of each portfolio is assessed with equal representation from each constituent stock. Equal weighting of the portfolios is justified due to their real-life simplicity of implementation and maintenance. An equal-weighted portfolio can also be more diversified compared to one with market capitalization-based weighting. (CFI, 2023)

These weighting methodologies are needed for a comprehensive analysis with the practicality of simplification. The 1/150 weighting abstracts away from the specific annual dynamics, focusing on the long-term effectiveness of the stock-picking strategy. In contrast, the 1/30 weighting for annual key figures provides a more granular view of the portfolio's performance, acknowledging the variations and specific impacts of stocks within each yearly cycle. The differences in results between the two methods are essential to understand. For instance, the approach to calculating beta is significantly influenced by the chosen time period. Beta, a measure of a portfolio's market risk, is typically calculated using linear regression to understand how portfolio returns respond to market movements. When beta is calculated over the entire 5-year period, it integrates the collective data, offering a view that averages out annual fluctuations and highlights long-term trends in market sensitivity. On the other hand, calculating beta annually for each of the four portfolios and then calculating the average of these annual betas can produce different results. This method emphasizes the portfolio's year-to-year variability in market sensitivity, capturing the impact of specific market conditions and events that occurred in each year. Such an approach is more responsive to the immediate market environment and can highlight periods of higher or lower market risk that might be smoothed out in a 5-year aggregated analysis.

Overall, the adoption of these two distinct weighting approaches in calculating returns enhances the robustness of the study. It allows for both a broad evaluation over a five-year period and a more detailed annual analysis, each serving a purpose in understanding the impact of ESG criteria on investment returns on the New York Stock Exchange from 2018 to 2023.

4.2.1 Momentum portfolios

Portfolios of stocks with both highly positive and highly negative changes in ESG rating were constructed for the ESG Momentum strategy. The ESG momentum is defined as:

$$\left(\frac{ESG_t}{ESG_{t-1}} - 1\right) * 100$$

Where:

ESG_t = *ESG score of the year t,*

ESG_{t-1} = *ESG score of the previous year*

Based on this, the momentum factor was calculated for the NYSE companies for the four times of rebalancing and for the initial construction of the portfolio in June 2018. For the first year of investing, 2016 and 2017 ESG data were used to calculate the increase and decrease in the ESG values, and 30 companies were selected for the equally weighted portfolios. The rebalancing was done four times in total, and the last investing period ended in June 2023.

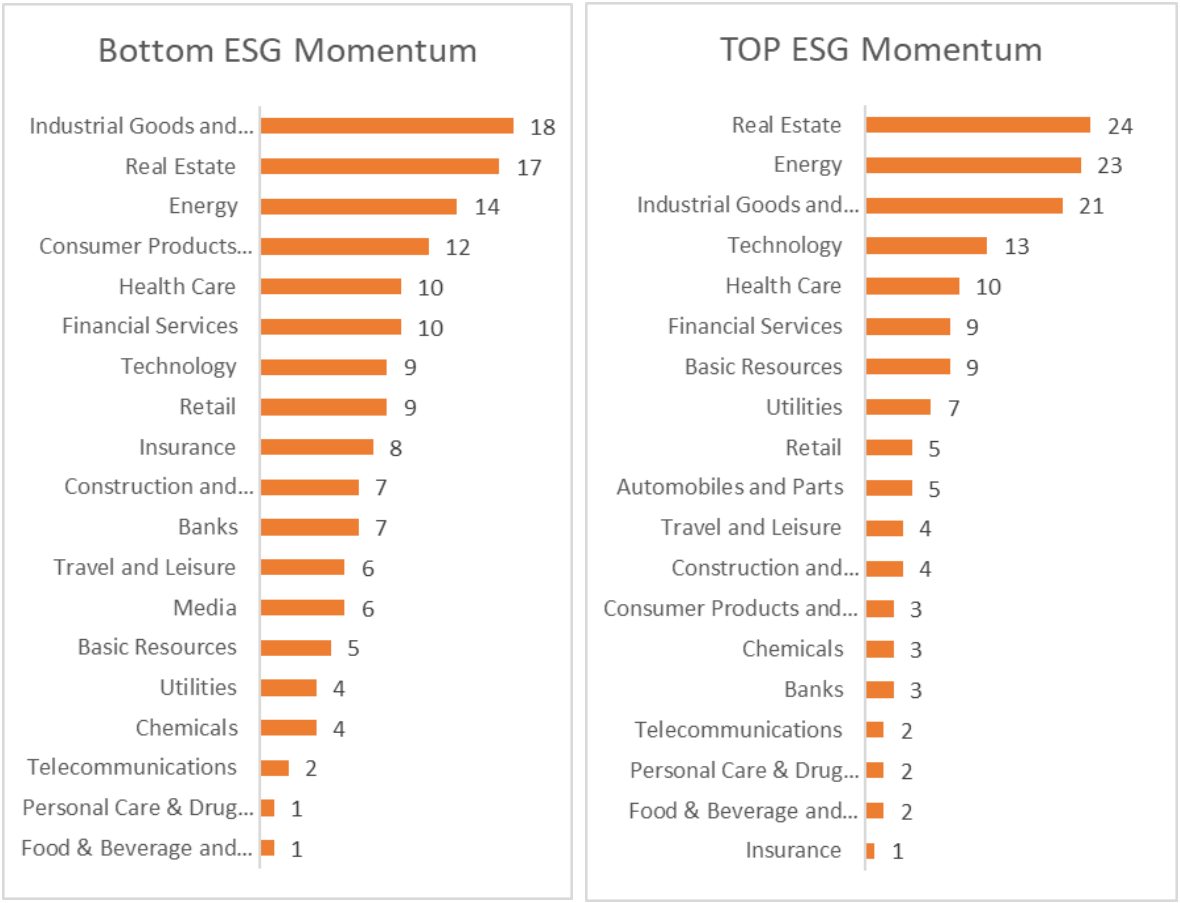


Figure 4. distribution of industries in momentum portfolios for 5 years period

4.2.2 Screening portfolios

The best-in-class screening approach places a strong emphasis on choosing companies that continuously achieve the highest standards for ESG performance. The strategy targets companies with the greatest absolute ESG scores, demonstrating a consistent commitment to environmental, social, and governance standards. This contrasts with the Momentum ESG strategy, which focuses on changes in ESG scores. The portfolios for the best and worst absolute ESG performers were created from the 30 stocks in each portfolio. The initial building of the screening portfolios was done in June 2018. 30 company portfolios were created using the 2017 ESG scores. Annual rebalancing was performed to account for changes in ESG scores. At each rebalancing period, the portfolio was evaluated to ensure it contained the top- and bottom-performing companies in terms of ESG criteria.

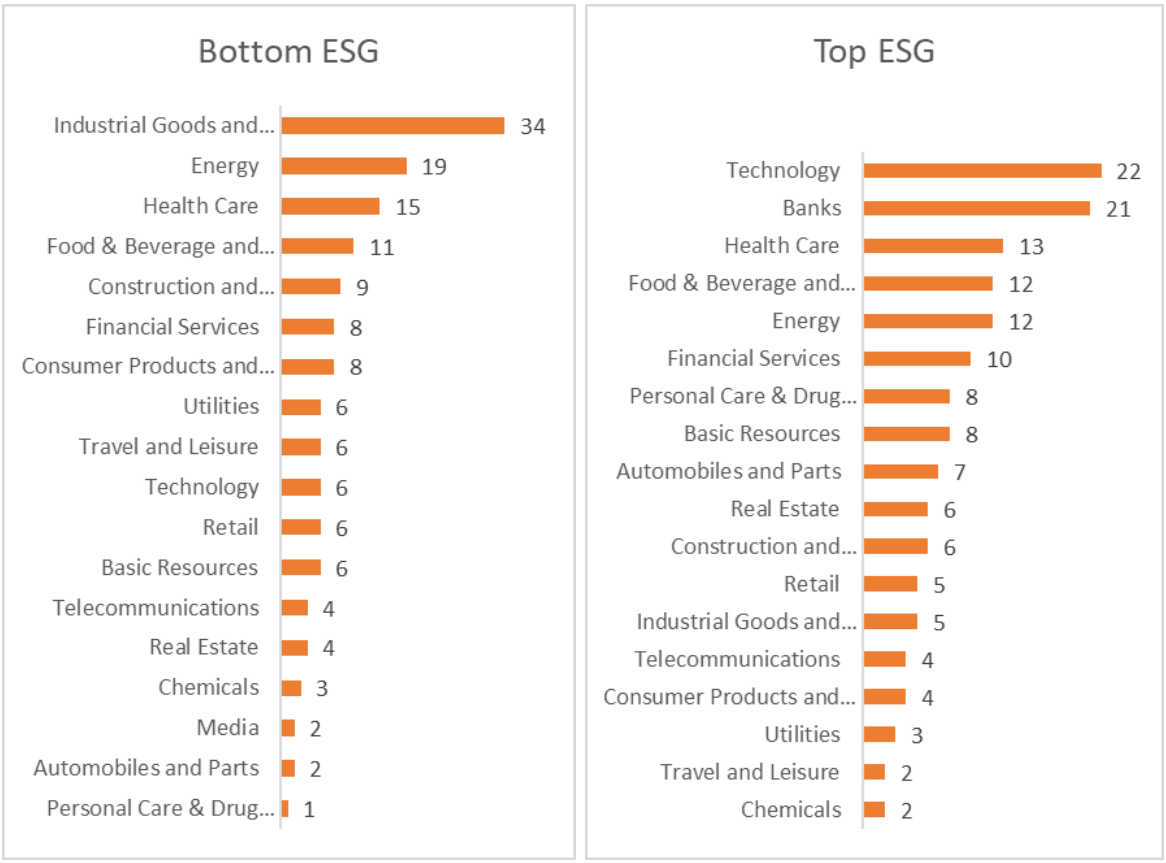


Figure 5. distribution of industries in screening portfolios for 5 years period

Figures 4 and 5 show that if a company was in a certain portfolio during the whole 5-year period, it would contribute a count of 5 to the given sector in the figure. The Momentum portfolios, both top and bottom, have a high turnover rate (93.3–100%); see Table 2. This implies that the sectors represented within these portfolios reflect short-term changes in ESG performance.

Portfolio turnover	2019-2020	2020-2021	2021-2022	2022-2023
Top ESG momentum	100%	93.3%	96.7%	100%
Bottom ESG momentum	100%	100.0%	100.0%	96.7%
Top ESG	40%	26.7%	26.7%	33.3%
Bottom ESG	43%	46.7%	56.7%	40.0%
Average of momentum	100%	97%	98%	98%
Average of screening	42%	37%	42%	37%
Transaction Cost multiplier	2.40	2.64	2.36	2.68

Table 2, Portfolio turnover and transaction costs

The presence of sectors such as energy and real estate in both top and bottom momentum portfolios can be interpreted as a sign of rapid shifts in ESG scores among companies within these sectors. The screening portfolios have a relatively lower turnover rate (26.7–56.7%). This suggests that the sectors represented, such as technology and banks in the top ESG portfolio and industrial goods and services in the bottom screening portfolio, exhibit more consistent, long-standing ESG performance. A company's repeated presence in these portfolios over multiple years indicates a sustained level of ESG performance, whether high or low, and therefore has a greater overall weight in the industrial distribution graphs above. The varied presence of sectors like real estate and energy in different portfolios suggests internal diversity in ESG practices within these sectors. For instance, while some companies in the real estate sector may be showing significant ESG improvements (reflected in the top momentum portfolio), others might be lagging (reflected in the bottom momentum portfolio). More comprehensive statistics of the sectoral distribution will be presented in the

results. The difference between these two types of portfolios is crucial for interpreting the ESG performance trends within these sectors.

In analysing investment strategies, transaction costs are a crucial factor to consider due to the need to separate gross and net returns from each other. Costs deriving from the buying and selling of stocks, due to the nature of the total return data used in the thesis, are practically impossible to implement in a way that a precise numeric value of the costs could be calculated. However, the need for transaction cost analysis is recognized, and therefore an alternative method is used in the thesis. The approach involves comparing portfolio turnover rates between two categories of portfolios: momentum and screening. Portfolio turnover is a measure of how frequently assets within a portfolio are bought and sold, which directly correlates to some extent with transaction costs. By calculating the average turnover for each category and then determining the ratio of momentum turnover divided by screening turnover, a multiplier is defined. This multiplier reflects the relative intensity of transactions needed for rebalancing in the momentum portfolios compared to the screening portfolios.

The use of a multiplier based on turnover rates is a way to address transaction costs indirectly. It's based on the idea that more active trading (as seen in higher portfolio turnover) incurs more costs. Since the data doesn't allow for a direct measurement of these costs, the method offers a reasonable measure. The resulting multiplier of 2.52 for momentum portfolios indicates they would, on average, need 2.52 times more transactions in order to do the rebalancing of the portfolios, compared to the screening portfolios. While this method provides a way to include transaction costs in the absence of direct data, it's important to acknowledge its limitations. The multiplier is an estimate and a simplification, not capturing the full complexity and variability of actual transaction costs. It assumes a direct and consistent relationship between turnover and costs, which may not always hold true in practice.

4.2.3 Descriptive statistics

The below-presented data in Table 3 on ESG portfolios reveals noteworthy tendencies over a five-year period. The average momentum of top ESG companies, with values ranging from 117 percent in 2018 to a hefty 448 percent in 2021, implies an intense era of growth and change in their sustainable practices. However, this quick ascension comes with fundamental

mathematical limits. Given the ESG scoring system's limit of 100 points, the opportunity for companies to continue such high growth rates shrinks. It's unlikely that a company will regularly increase its ESG score to the point where it will be among the top 30 performers on the NYSE, especially if it's already close to the maximum limit. This suggests that organizations with such high momentum values in previous years are more likely to see a relative slowdown in the coming years in the rise of their ESG score. It is also important to note that the ESG score is a relative score. Companies are stacked up against their peers. It is important to understand that the average momentum factor of 448 % should not be seen as a corresponding improvement of the companies' ESG practices but more as an outperformance of peers based on the particular score metric.

Momentum portfolios	**2018**	**2019**	**2020**	**2021**	**2022**
Average momentum - top	117%	121%	184%	448%	148%
Average ESG score - top	36.64	39.65	39.99	36.64	41.5
Average momentum - bottom	-28%	-31%	-31%	-26%	-21%
Average ESG score - bottom	24.79	19.04	20.34	24.41	32.58
Screening	**2018**	**2019**	**2020**	**2021**	**2022**
Average momentum - top	3%	2%	1%	2%	2%
Average ESG score - top	90.26	90.12	89.88	90.78	90.93
Average momentum - bottom	-5%	3%	1%	15%	14%
Average ESG score - bottom	8.49	7.87	8.03	9.74	11.76

Table 3. Attributes of portfolios, 2018-2023

Companies that have had negative momentum could have seen an improvement in their absolute ESG scores. This could imply that many organizations, after falling into this category, make advances that pull them out of it the following year. Other companies, on the other hand, may see their scores fall, putting them in this lower bracket for the first time. When compared to the more stable screening portfolios, the consistent high turnover in the Momentum portfolios highlights the difference in investment strategies they each represent. While momentum portfolios are characterized by their dynamism, they also have greater transaction costs due to the fees associated with purchasing and selling. Top portfolios, on the other hand, include companies that continuously demonstrate top sustainability practices,

providing a more stable investment profile in this ESG setup. It is important to note that the best performing ESG companies cannot be selected for the momentum portfolio due to their already high ESG scores and the practical impossibility of improving the score enough to qualify for the momentum portfolio. It can also be stated that the momentum portfolio can be seen as a strategy for supporting the companies on the right, improving their trajectory instead of just selecting the ones that are already performing at the top of the ladder.

4.3 Performance metrics

When measuring the performance of the portfolios, both annual, and continuous 5-year figures are calculated. This has been done to evaluate the overall effectiveness of the strategies but also to dig deeper into the annual figures in the analysis.

The study uses the total return of the S&P 500 Index as the benchmark for the created portfolios. TRI includes not only the price development of shares but also any dividends paid by the companies included in the index and is similarly used for the measurement of the created portfolios. The S&P 500 Index reflects the performance of 500 large U.S. companies and accounts for over 80 percent of the market value of all publicly traded companies in the United States. The index, fairly accurately, represents the performance of the largest companies in the United States and, by extension, the largest companies worldwide. (S&P Global, 2023; Nordnet, 2023)

The study uses the three-month U.S. Treasury Bill as a risk-free rate. A Treasury Bill is a short-term obligation issued by the U.S. government, backed by the U.S. Treasury Department, and in this case, has a maturity of 91 days. Since the yield on the three-month T-Bill has varied reasonably, as shown in Figure 6, an average of 1.62 percent based on the monthly time series data from the period of the thesis was used as a risk-free rate to calculate risk-adjusted returns for the 5-year investment period. During the period of 5 years, yearly averages varied from 0.06 to 4.2 percent. These annual averages were used in calculating yearly risk-adjusted key figures. The specifics of the averages are presented together with related results in Section 5.

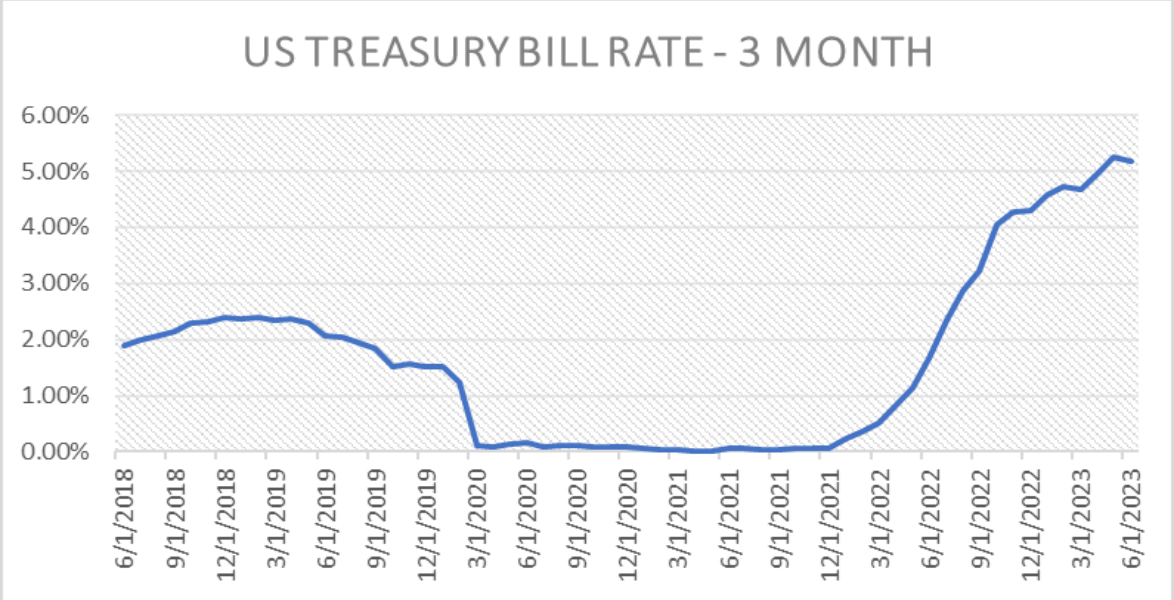


Figure 6. Risk-free rate (Refinitiv Eikon, 2023)

The research includes a variety of criteria to measure portfolio performance, including cumulative returns, compounded annual growth rates (CAGR), and annual returns. These metrics provide a general view of the portfolios' performance over the five-year period. Cumulative returns offer a broad overview of total gains, while CAGR provides insight into the average annual growth rate, capturing the effect of compounding over time. Annual returns, on the other hand, allow for a year-by-year comparison of portfolio performance.

$$Cumulative\ Return = \prod_{t=1}^{T} g_{t-1}$$

Where:

$\prod$ denotes the product over the series,

g_{t-1} = 1 + weekly average return, i.e., growth factor,

T = total number of weeks in the period.

$$Compound\ Annual\ Growth\ Rate\ (CAGR) = \left((1 + \ Cumulative\ Return)^{\frac{1}{n}}\right) - 1$$

Where:

n = number of years over which the investment is compounded.

$$Annual\ Return = (1 + \ Average\ Weekly\ Return)^n - 1$$

Where:

n = number of weekly returns over the year.

Collectively, these measures aim to address the first research question: *How does the integration of ESG criteria into portfolio construction influence investment returns on the New York Stock Exchange in 2018–2023?*

4.4 Risk-adjusted metrics

In further evaluating the impact of ESG criteria on investment portfolios, the study applies risk-adjusted metrics, critical for understanding the relationship between returns and risks. These metrics offer a comprehensive view of portfolio performance, essential for answering all three research questions. By applying these risk-adjusted metrics, such as Sharpe ratio, Treynor ratio, and Jensen's alpha, the study not only evaluates the nominal returns of ESG-integrated portfolios but also looks further into their performance in relation to the risks undertaken. This evaluation is essential for understanding ESG investing's efficacy. The Sharpe and Treynor Ratios, alongside Jensen's Alpha, collectively provide insights into whether ESG strategies yield returns that justify their risk profiles and how they compare in managing market risks. This comprehensive approach ensures a thorough analysis of the ESG criteria's impact on investment performance, directly addressing the core research questions of the study.

Sharpe (1966) introduced a performance measure for portfolios that has become known as the Sharpe ratio due to its widespread popularity and use. The Sharpe ratio is used to calculate a portfolio's risk-adjusted return per unit of risk. The portion of the return that exceeds the risk-free return is related to the portfolio's overall risk or volatility in the ratio. The higher the Sharpe ratio value, the better the portfolio's return relative to its risk. The Sharpe ratio was calculated using the formula shown below (Sharpe, 1994).

$$Sharpe\ Ratio = \frac{R_i - R_f}{\sigma_p}$$

R_i = Portfolio Return

R_f = Risk-Free Return

σ_p = Standard Deviation of portfolio i.e., volatility

Treynor (1965) introduced a portfolio performance metric that, like the Sharpe ratio, relates the portion of the portfolio return that exceeds the risk-free return to risk. The risk variable used distinguishes the Treynor Ratio from the Sharpe Ratio. The risk in the Treynor Ratio is represented by the beta coefficient, which captures market risk or the portfolio's systematic risk. As a result, the Treynor Ratio assumes that the portfolio under consideration is fully diversified. In the formula below, the formula for calculating the Treynor Ratio is shown.

$$Treynor\ Ratio = \frac{R_i - R_f}{\beta_i}$$

R_i = Portfolio Return

R_f= Risk-Free Return

β_i = Portfolio Beta

Jensen (1967) introduced a performance metric for portfolios with the goal of determining whether the return level defined by a portfolio's CAPM beta coefficient has been realized. Jensen's alpha measures potential excess returns, i.e., whether the portfolio has produced more over a period than it should for its given risk level. A positive result indicates excess returns, while a negative one suggests that the portfolio has underperformed for its risk level. If Jensen's alpha value is zero, the portfolio can be said to lie on the efficient frontier previously discussed in the study. The regression formula for calculating Jensen's alpha is presented in the following equation below.

$$Jensen's\ alpha = R_i - R_f - B_i * (R_m - R_f)$$

R_i = Portfolio Return

R_f = Risk-Free Return

R_m = Market Return

β_i = Portfolio Beta

4.5 Pure risk metrics

In addition to the risk-adjusted metrics previously discussed, this study uses pure risk measurements to further evaluate the performance of ESG-focused portfolios. These metrics, which include variance, volatility, and beta, are integral to understanding the inherent risks associated with investment strategies. This chapter outlines the formulas and methodologies used for calculating these metrics, along with their relevance to the research questions.

Variance is a measure of the dispersion of returns for a given security or portfolio. It calculates the average squared deviation from the mean return over a specified period. The formula for sample variance is:

$$\text{Variance} = \frac{1}{N-1}\sum_{i=1}^{N}(R_i - R_a)^2$$

R_i = Portfolio Return

R_a = Average Return

N = Number of Observations

Volatility, on the other hand, is the standard deviation of the returns and provides a measure of the total risk of the portfolio. It is calculated as the square root of the variance:

$$Volatility = \sqrt{variance}$$

Graphical representations of 5-year volatility for all portfolios under study are included to illustrate how volatility has fluctuated over time. This metric is crucial for understanding the stability and risk profile of each portfolio.

Beta (β) is a measure of the sensitivity of a portfolio's returns to market movements. It represents the tendency of the portfolio's returns to respond to swings in the market. A beta greater than 1 indicates higher volatility, while a beta less than 1 suggests lower volatility relative to market. The formula for beta is:

$$\beta = \frac{Cov(R_p, R_m)}{Var(R_m)}$$

$Cov(R_{p,}R_m)$ = covariance between portfolio returns and market returns

$Var(R_m)$ = variance of the market returns

A closer investigation of the betas for each portfolio provides insight into their market risk exposure. This analysis is vital for the third research question, which probes the risk profiles of portfolios based on ESG criteria.

It is acknowledged that the significance testing of the results could be considered to add to the thesis. However, in this thesis, which explores investment strategies and portfolio performance over the 2018–2023 period, the decision to not do significance testing is deliberate and supported by a few factors. The five-year period of this study and its justification in the earlier part of the thesis reduce the need for statistical validation through significance testing. This thesis is done to provide practical insights and strategic guidelines for portfolio management, especially in the rapidly evolving landscape of ESG investing. The emphasis is on deriving strategic insights and understanding the efficacy of investment strategies in the actual market environment. This real-world focus is more in line with industry practices, where investment decisions are often guided by observed trends and strategic considerations rather than purely statistical analysis. Additionally, there is support in financial research for the conscious choice of not necessarily relying on statistical significance testing (see Chong & Philips, 2016; Nagy et al., 2013, 2016). This is particularly true in analyses focusing on practical portfolio application and direct market observation. If, however, statistical significance would be tested, it could be done by, for example, a t-test

to compare the returns of, for instance, the ESG momentum and screening portfolios or by ANOVA to test the statistical significance of momentum, screening, and, for example, the market benchmark. These kinds of tests could reveal whether the differences in returns are in fact due to different strategies or to a random chance.

5 Analysis and results

The results of the study are presented in this section. Absolute returns are presented first, followed by risk-adjusted and pure risk-related results, and finally, a reflection of the limitations. In results, the main focus is on the top portfolios. Bottom portfolios are created for comparison purposes and, due to their nature, are reflected slightly less in this section. To increase the robustness of the results, calculations were done for 20 stock portfolios as well. These simplified results were mainly in line with the initial results and are presented in Appendix 2.

5.1 Absolute returns

In analysing the performance of ESG momentum and screening strategies from 2018 to 2023, the results reveal distinct patterns in investment returns and market behaviour, offering a basic understanding of ESG investing dynamics. The ESG momentum strategy demonstrated strong performance, achieving a cumulative return of 92.6% and a CAGR of 14.01%. This suggests a strong market preference for companies with improvements in ESG metrics. The bottom ESG momentum portfolio, trailing with a cumulative return of 43.41% and a CAGR of 7.48%, underperformed against the comparison group in all other categories except annual returns in 2020–2022. Cumulative returns can be seen in Figure 7 below.

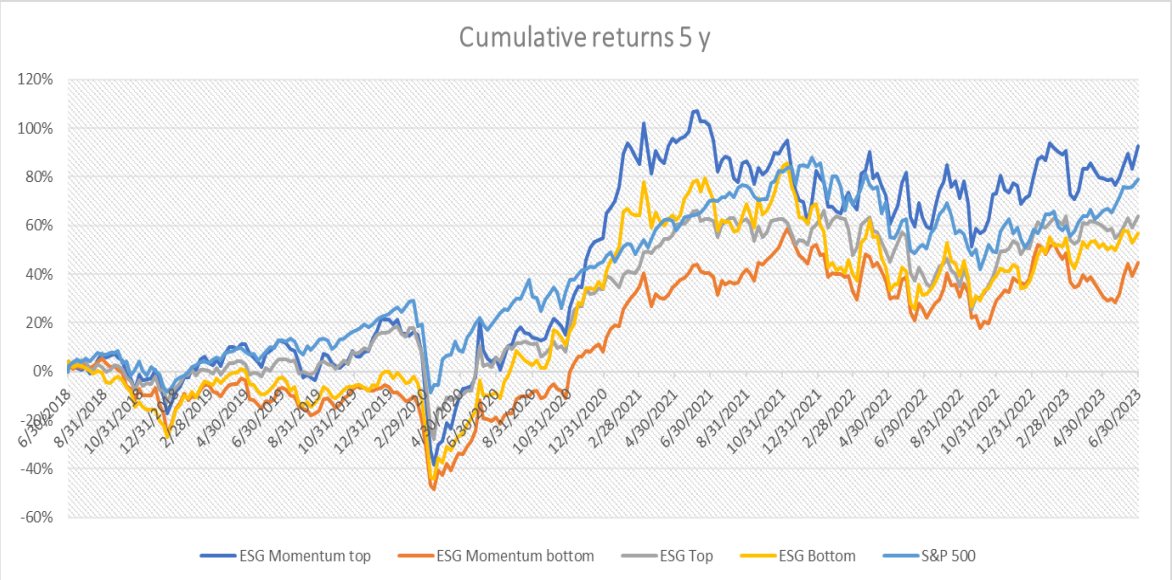


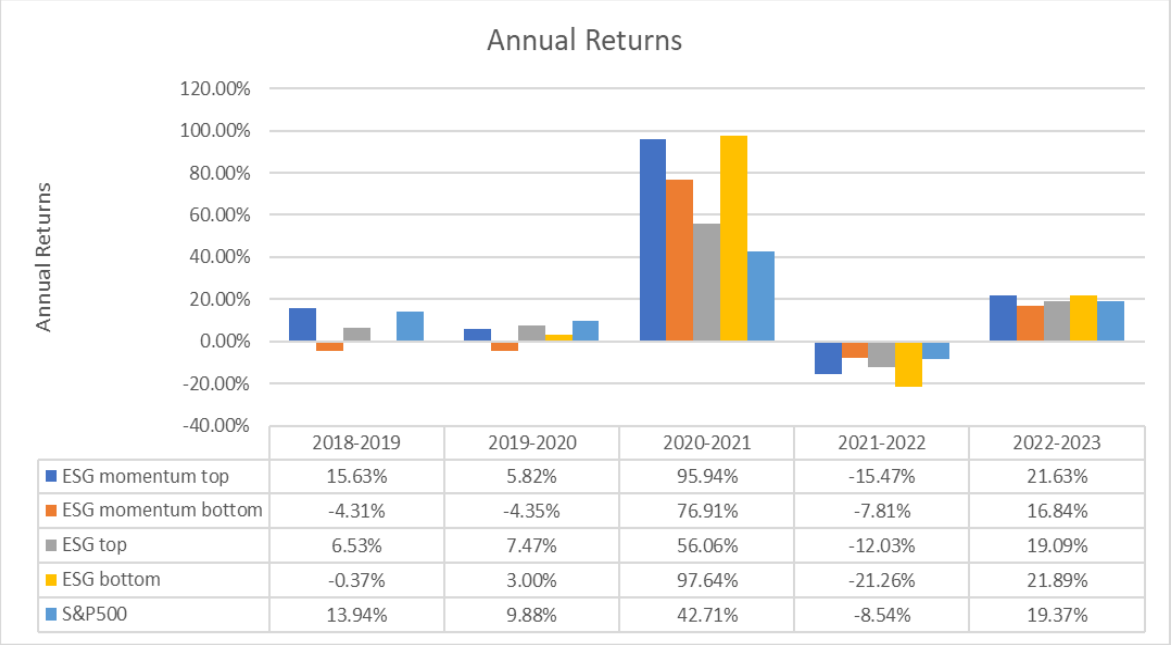
Figure 7. Cumulative returns

In contrast, the ESG screening portfolios, following a more traditional approach, presented a different narrative. The top ESG portfolio, with a cumulative return of 63.69% and a CAGR of 10.36%, and the bottom ESG portfolio's cumulative return of 56.76% and a CAGR of 9.41%, showed more stable performance. When benchmarked against the S&P 500, which recorded a cumulative return of 78.88% and a CAGR of 12.33%, the top ESG momentum strategy was the only one able to outperform the market with a relatively significant margin. This echoes the findings of Jegadeesh and Titman (1993), who underscored the potential of momentum strategies for capturing market trends. Table 4 shows the returns of the strategies.

5 years	ESG momentum top	ESG momentum bottom	ESG top	ESG bottom	S&P 500
Cumulative return	92.60%	43.41%	63.69%	56.76%	78.88%
Compounded Annual Growth	14.01%	7.48%	10.36%	9.41%	12.33%

Table 4. Returns of the portfolios

Looking into the annual returns provides more detailed information on portfolios' returns. The portfolio year 2019–2020, for instance, marked by the general decline of the stock market in April 2020 due to the COVID-19 pandemic, illustrated the varying impacts of market shocks on ESG-focused strategies.



	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023
ESG momentum top	15.63%	5.82%	95.94%	-15.47%	21.63%
ESG momentum bottom	-4.31%	-4.35%	76.91%	-7.81%	16.84%
ESG top	6.53%	7.47%	56.06%	-12.03%	19.09%
ESG bottom	-0.37%	3.00%	97.64%	-21.26%	21.89%
S&P500	13.94%	9.88%	42.71%	-8.54%	19.37%

Figure 8. Annual returns

All four portfolios experienced a significant and rapid decline during this period. The momentum-bottom portfolio experienced the slowest recovery from its lowest value during the period, suggesting that companies with declining ESG scores or lower ESG momentum were more affected by the market downturn and struggled to regain their footing. Both the bottom momentum and the bottom portfolio had the worst annual return in 2020, which partly aligns with the findings of Albuquerque et al. (2020) that companies with lower ESG ratings underperformed during the crisis. In contrast, the ESG momentum top portfolio, representing companies with rapidly improving ESG scores, not only recovered quickly but also surpassed other portfolios by late 2020. This rebound and outperformance are difficult to attribute to any single factor, but it is possible that companies with improving ESG scores may have been viewed as better positioned for long-term sustainability and therefore more valuable during the uncertain market conditions of 2020. Investors might have perceived these companies as safer or more promising investments, leading to quicker capital inflows and a more robust recovery.

The impact of transaction costs becomes an important factor when analysing net returns. The top momentum portfolio, while outperforming the other portfolios, faces bigger transaction costs. The cost multiplier of 2.52 compared to the screening strategies comes solely from the number of transactions made in annual rebalancing. This fairly significant cost factor could materially affect the net returns, at least partly diminishing the apparent outperformance when compared to the benchmark and other portfolios. Conversely, the bottom momentum portfolio, despite its lower cumulative return of 43.41% and CAGR of 7.48%, is also subject to these higher transaction costs, adding to its underperformance. ESG screening portfolios, with more stable performance and lower transaction costs, are affected differently. Their cumulative returns of 63.69% (top) and 56.76% (bottom), along with CAGRs of 10.36% and 9.41%, are more reflective of their true net performance, considering the lower costs.

The inclusion of transaction costs in any investment strategy evaluation for a more accurate performance assessment is important and cannot be ignored. However, the difference in gross returns between momentum and screening strategies is still large enough to suggest the momentum strategy as the prevailing strategy based on the absolute returns. In general, the results and findings illuminate the nature of ESG investing in this particular setup, highlighting both the high-return potential of the momentum strategy and the more stable screening approach.

5.2 Risk-adjusted returns

The top momentum portfolio's impressive performance, as evidenced in this chapter by high Sharpe and Treynor ratios and a positive Jensen's alpha, aligns well with the research of Nagy et al. (2013, 2016). These findings support the argument that ESG momentum strategies might be effective, particularly in capturing market trends and generating excess returns. This is further echoed by Giese et al. (2019), who highlighted the predictive power of ESG momentum in valuation and financial returns. In contrast, the bottom ESG momentum portfolio, with its lower performance metrics and negative Jensen's alpha, reflects the challenges faced by companies with declining ESG scores.

This is consistent with the findings of Shanaev and Ghimire (2022), who reported negative risk-adjusted returns associated with ESG rating downgrades. The CAPM graph below shows the risk-adjusted returns of the portfolios compared to the security market line, S&P500.

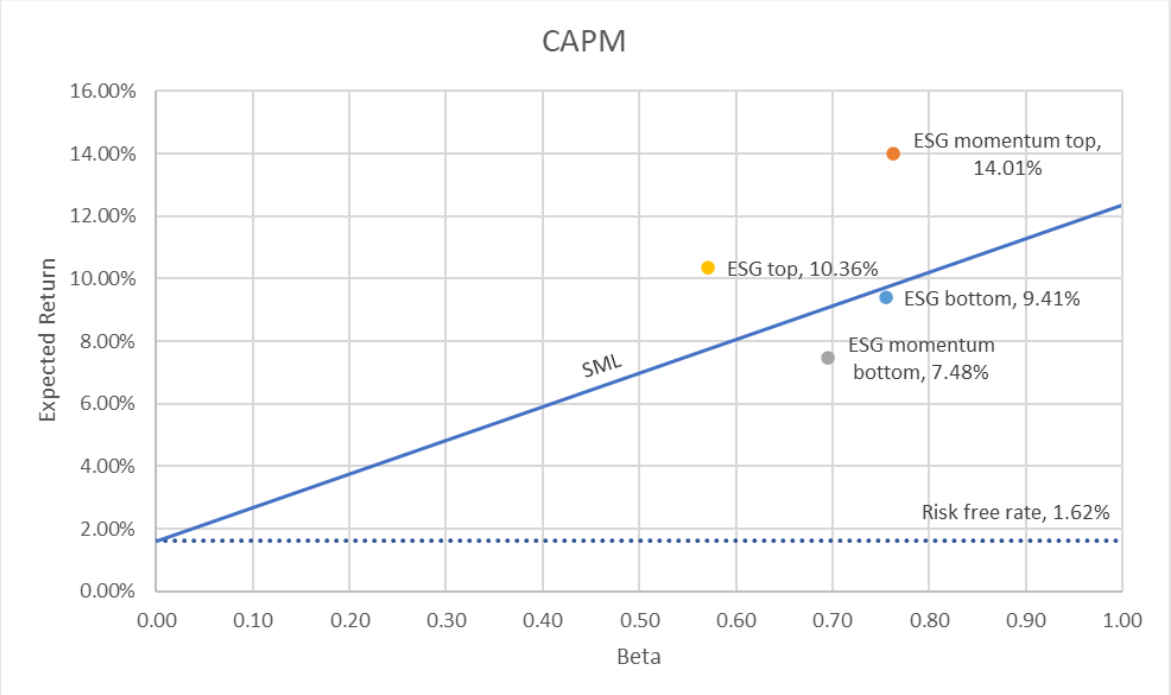


Figure 9. CAPM and security market line, 2018-2023.

The top screening portfolio shows promising results, with a risk-adjusted return higher than the S&P 500 and a positive Jensen's alpha. This suggests that strong ESG practices can yield higher returns, supporting earlier research on the abnormal returns of high ESG ratings with the best-in-class method. However, this stands in contrast to the observations of Adler & Kritzman (2008) and Fabozzi (2008), who suggested potential financial trade-offs for ethically screened investments. The bottom ESG screening portfolio, with a negative Jensen's alpha, highlights the financial risks associated with poor ESG practices, resonating with research by Capelle-Blancard et al. (2014). However, a relatively high Sharpe value of 4.92 can be seen, at least partly supported by the findings of significant returns of sin stocks in previous academic research (Fabozzi, 2008).

5 years	ESG momentum top	ESG momentum bottom	ESG top	ESG bottom	S&P 500
Sharpe	6.259	3.247	5.793	4.922	4.014
Treynor	0.162	0.084	0.153	0.103	0.107
Jensen	4.22%	-1.59%	2.62%	-0.30%	

Table 5, annual risk-adjusted returns for 5-year strategies

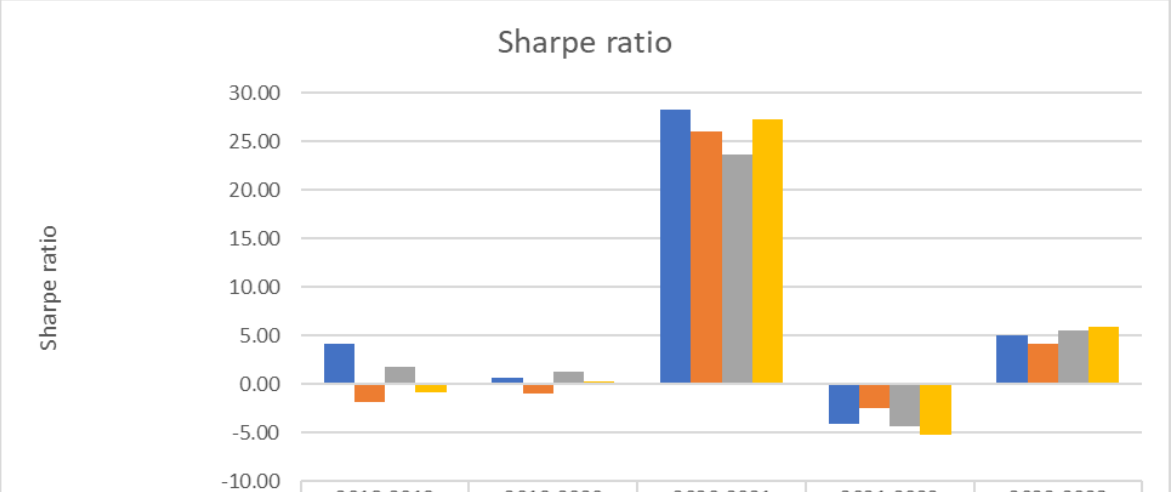
Comparatively, the top ESG momentum portfolio's outperformance over the top ESG screening portfolio, as indicated by higher risk-adjusted returns, suggests that the momentum strategy might be more effective in capturing market changes. This aligns with Giese et al. (2019), who emphasized the importance of ESG momentum. Moreover, the underperformance of the bottom portfolios in both strategies compared to their respective top portfolios shows signs that robust ESG practices could actually have a value-enhancing effect, and the potential risks associated with poor ESG performance might exist as well, aligning with the narrative in existing ESG research. However, it is important to note that the average ESG score of the companies in the momentum portfolio is not high and cannot be claimed to have robust ESG practices based on the score.

Exploring the annual risk-adjusted returns of ESG momentum and screening strategies offers a complementary view to the 5-year analysis, where the strategies are analysed as one investment period. The annual approach shows how these strategies react to short-term market shifts, which is relevant for momentum strategies where dynamics can change quickly. Annual results highlight trends that might not be visible in longer-term analyses,

making them essential for a comprehensive understanding of these investment strategies. The following analysis will investigate the annual Sharpe, Treynor, and Jensen's ratios, providing a detailed perspective on year-by-year performance.

5.2.1 Sharpe and Treynor ratio

As Figure 10 shows, the momentum top portfolio displayed a dynamic performance across the five-year period, with its and other portfolios' Sharpe ratio peaking dramatically in 2020–2021 (28.30). This peak indicates a period of exceptional risk-adjusted returns, likely driven by a strong market recovery from COVID-19, as all portfolios received significant results during that period. The biggest decline, in 2021-2022 (-4.13), highlights again the broader market reaction and the portfolio's susceptibility to market volatility. In comparison, the top screening portfolio demonstrated a more stable return, although it was generally lower than that of the momentum portfolio. This relative stability might suggest that investors in this portfolio might experience less volatility.



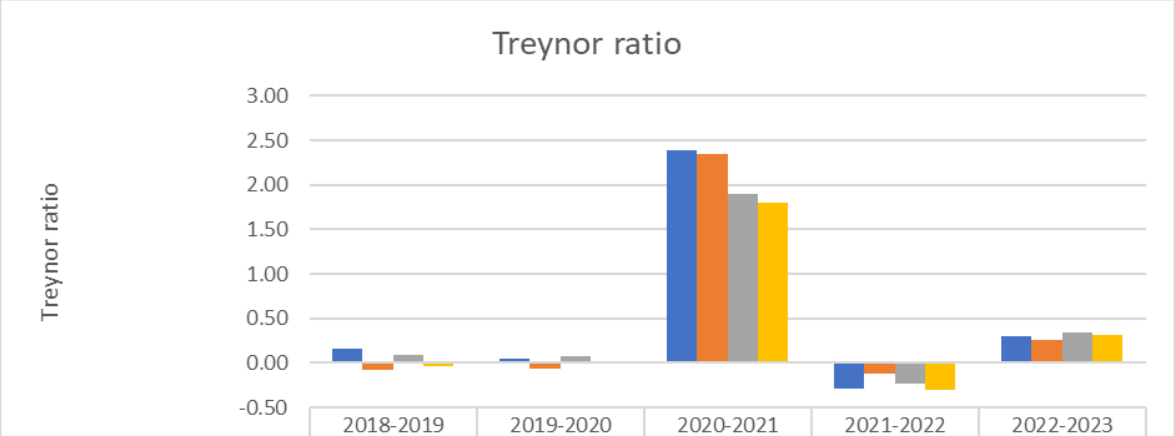
	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023
ESG momentum top	4.20	0.69	28.30	-4.13	5.01
ESG momentum bottom	-1.90	-0.98	26.00	-2.46	4.11
ESG top	1.84	1.27	23.70	-4.35	5.56
ESG bottom	-0.87	0.31	27.25	-5.24	5.97

Figure 10. Annual Sharpe ratios

While the focus is on the top portfolios, it's noteworthy that the momentum-bottom portfolio often underperforms, as seen in its consistently lower Sharpe ratios. This underscores the potential risks associated with declining ESG scores. However, both momentum and the

bottom screening portfolio, surprisingly, show occasional periods where these companies might offer unexpectedly high returns compared to other portfolios. Therefore, generalized conclusions cannot be drawn.

The Sharpe and Treynor ratios are both used to assess the risk-adjusted performance of investment portfolios, but they differ in how they measure risk. The Sharpe ratio considers the standard deviation of the portfolio's excess return over a risk-free rate, accounting for both systematic and unsystematic risk. It is useful for evaluating the performance of a portfolio relative to its total risk. In contrast, the Treynor ratio focuses solely on systematic risk, as measured by the portfolio's beta, assessing how well a portfolio performs per unit of market risk. This makes the Treynor ratio relevant for diversified portfolios where unsystematic risk is minimal.



	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023
ESG momentum top	0.17	0.04	2.38	-0.28	0.30
ESG momentum bottom	-0.08	-0.06	2.34	-0.12	0.25
ESG top	0.09	0.08	1.89	-0.24	0.34
ESG bottom	-0.04	0.02	1.80	-0.30	0.32

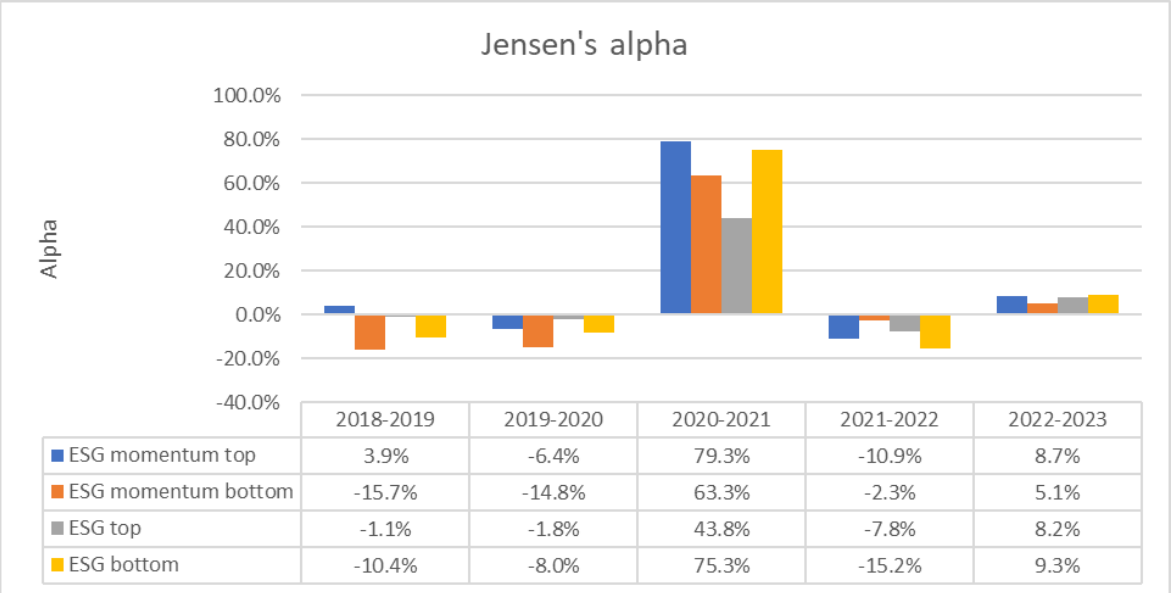
Figure 11. Annual Treynor ratios

For the momentum top portfolio, its performance does not necessarily stand out in any particular year. The results suggest an ability to create stable risk-adjusted returns. The top screening portfolio manages to create better returns compared to the momentum strategy in 3 years out of 5. The momentum bottom and bottom screening portfolios typically exhibit lower Treynor ratios throughout the period, underscoring the challenges and risks associated with either declining ESG scores or less robust ESG practices. In essence, the comparative analysis of the Treynor ratios highlights the varying strengths of the top portfolios. The choice between momentum and screening strategies may hinge on the market's phase and

the investor's preference for either capitalizing on market changes or seeking steady returns in more predictable environments. Market volatility was at its lowest during 2018–2019 and 2020–2021. During these years, the momentum strategy was dominant. Other years, during higher market volatility, screening strategies offered higher returns when measured by Treynor's ratio.

5.2.2 Jensen's alpha

Jensen's alpha, a measure of a portfolio's excess return over its expected theoretical return, provides insights into the performance of momentum and screening strategies. This metric is essential for understanding the added value of active portfolio management and, in the context of this thesis, ESG investing. For the top momentum portfolio, the annual Alpha values present results that are aligned with the previous risk-adjusted metrics. The momentum strategy offered the best returns in 2 out of 5 years during the period. However, the negative Alphas in 2019-2020 (-6.4) and 2021-2022 (-10.9) suggest periods of underperformance relative to the expected return, indicating the challenges of maintaining consistent outperformance in a more volatile market. Alpha values are presented in Figure 12. In contrast, the top screening portfolio offers more moderate returns. Although negative, the alpha in 2019–2020 (-1.8) outperforms other portfolios by a large margin. This is the year with the highest market volatility out of all the years during the 5-year period.



	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023
ESG momentum top	3.9%	-6.4%	79.3%	-10.9%	8.7%
ESG momentum bottom	-15.7%	-14.8%	63.3%	-2.3%	5.1%
ESG top	-1.1%	-1.8%	43.8%	-7.8%	8.2%
ESG bottom	-10.4%	-8.0%	75.3%	-15.2%	9.3%

Figure 12. Annual alphas

The momentum bottom and bottom screening portfolios present contrary results. The momentum portfolio generally underperforms, reflecting the inherent risks and challenges in portfolios with declining ESG scores yet being the best choice in 2021–2022. Similarly, the bottom screening portfolio generally struggles, underscoring the risks associated with poor ESG practices yet being the best out of four in 2022–2023. Considering the annual data spans from June to June, the figures for 2020–2021 do not capture the COVID-19 market crash, resulting in lower beta and higher abnormal returns for all portfolios during this period due to the timing of the market recovery. However, the first effects of the pandemic on the stock market are included in the 2019–2020 figures.

Comparing the top portfolios, the momentum portfolio demonstrates its ability to achieve significant outperformance in specific market conditions, notably during periods of lower volatility. However, its inconsistency in other years raises questions about the sustainability of such high returns over time. On the other hand, the top screening portfolio shows a more consistent performance with its Alpha values, suggesting steadier results that are suitable for investors looking to avert high risk. Though its peaks are less dramatic than the momentum portfolios, its overall results suggest a reliable outperformance in line with market expectations.

In essence, the analysis of Jensen's alpha supports the conclusions drawn from the Sharpe and Treynor ratios. The momentum portfolio succeeds in extracting value from more stable market conditions but faces challenges in maintaining this performance consistently. Meanwhile, the screening portfolio offers a balanced approach with relatively steady performance through volatile years in the 5-year period. This highlights the importance of aligning investment strategies with market conditions and investor preferences, as in any investing scenario. In understanding the dynamics of the setup of the study, it is pivotal to consider the sectoral influences that significantly impact portfolio performance. It's also important to note that the figures used in the following analysis are averages of the two respected years due to the timing of portfolio rebalancing, and the return data for 2023 represents year-to-date information as of September 30, 2023, running 3 months over the ending of the overall scenario. Sectorial returns are presented in Table 6, and the annual sectorial distribution of companies in the 4 portfolios is presented in Table 7.

Sectors	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023
Healthcare	14%	17%	6%	3%	2%
Utilities	15%	13%	9%	10%	-6%
Consumer discretionary	14%	31%	29%	-6%	-5%
IT	25%	47%	39%	3%	3%
Real Estate	13%	13%	22%	10%	-16%
Consumer staples	10%	19%	15%	9%	-3%
Communication services	10%	28%	23%	-9%	0%
Financials	10%	15%	17%	12%	-6%
Industrials	8%	20%	16%	8%	-1%
Materials	5%	23%	24%	8%	-5%
Energy	-3%	-11%	10%	60%	36%

Table 6. Average sectorial returns of S&P500 in 2018-2023. (Statista, 2023)

Technology companies exhibited exceptional performance from 2018 through 2023, being the best or second-best amongst all sectors. During this period, a large proportion of the investments in the top screening portfolio were allocated to technology stocks, followed closely by the momentum top portfolio. This allocation in technology greatly contributed to the strong performance of these portfolios, capitalizing on the sector's robust performance. Real estate, which performed solidly from 2018 to 2022, had the largest weight in the momentum-top portfolio. The sector's downturn in 2022-2023, however, negatively impacted the momentum bottom portfolio, which had the highest allocation in real estate during the year. This decline illustrates the vulnerability associated with a significant concentration in a single sector, especially in fluctuating markets. However, due to the diversification, the portfolio still managed to generate positive alpha. The energy sector's exceptional performance from 2021 to 2023 benefited the momentum top portfolio, which had the highest exposure to energy among all the portfolios during this time. In contrast, the financial sector experienced relative underperformance throughout the study period, which adversely affected the top screening portfolio due to its relatively higher allocation of financial stocks. The industrial sector delivered steady but average returns over the five years. All portfolios, except the top screening portfolio, had a significant weight in this sector.

In conclusion, this sectorial analysis is crucial for understanding the different industry impacts on ESG portfolio performance. It also makes room for consideration of different kinds of strategies utilizing sectorial inclusion or exclusion, where different megatrends could work as something to build a strategy on. These findings provide valuable insights for future ESG investment strategies, though the limitations of using averaged sectorial returns and the partial-year data for 2023 should be recognized. The analysis confirms the importance of sector awareness in optimizing ESG portfolio performance.

Years	2018-2019				2019-2020				2020-2021				2021-2022				2022-2023			
Sectors	EMT	EMB	ESGT	ESGB	EMT	EMB	ESGT	ESGB	EMT	EMB	ESGT	ESGB	EMT	EMB	ESGT	ESGN	EMT	EMB	ESGT	ESGB
Health Care	10%	10%	3%	10%	3%	13%	7%	20%	10%	-	10%	10%	3%	7%	10%	3%	7%	3%	13%	7%
Energy	13%	13%	10%	23%	13%	7%	3%	7%	20%	13%	7%	10%	13%	3%	10%	10%	17%	10%	10%	13%
Real Estate	27%	7%	3%	-	23%	10%	3%	7%	10%	10%	7%	-	20%	10%	3%	-	-	20%	3%	7%
Financial Services	3%	-	3%	7%	3%	3%	10%	3%	3%	10%	7%	7%	13%	17%	10%	7%	7%	3%	3%	3%
Consumer Products and Services	3%	7%	-	3%	-	17%	3%	7%	-	3%	3%	7%	-	7%	3%	3%	7%	7%	3%	7%
Industrial Goods and Services	17%	17%	3%	17%	10%	13%	3%	30%	20%	10%	3%	30%	20%	10%	3%	20%	3%	10%	3%	17%
Banks	3%	7%	20%	-	7%	3%	13%	-	-	-	13%	-	-	10%	13%	-	-	3%	10%	-
Automobiles and Parts	3%	-	7%	-	-	-	3%	-	-	-	3%	-	7%	-	7%	7%	7%	-	3%	-
Chemicals	3%	7%	-	3%	3%	-	-	-	-	3%	-	-	3%	-	-	3%	-	3%	7%	3%
Technology	3%	-	20%	3%	7%	3%	20%	7%	10%	3%	10%	3%	3%	10%	10%	3%	20%	13%	13%	3%
Basic Resources	3%	3%	3%	3%	10%	7%	3%	-	3%	-	7%	-	3%	-	3%	7%	10%	7%	10%	10%
Telecommunications	3%	-	3%	3%	3%	3%	3%	-	-	3%	3%	3%	-	-	3%	3%	-	-	-	3%
Utilities	3%	-	3%	-	10%	3%	3%	3%	-	3%	3%	3%	3%	3%	-	7%	7%	3%	-	7%
Retail	-	7%	3%	3%	7%	-	7%	-	10%	17%	3%	3%	-	7%	3%	7%	-	-	-	7%
Travel and Leisure	3%	7%	-	3%	-	3%	-	-	7%	3%	-	3%	3%	3%	3%	7%	-	3%	3%	7%
Construction and Materials	-	7%	7%	10%	-	7%	3%	7%	7%	3%	3%	10%	3%	3%	3%	3%	3%	3%	3%	-
Food & Beverage and Tobacco	-	-	3%	7%	-	-	10%	7%	-	3%	13%	7%	3%	-	7%	10%	3%	-	7%	7%
Personal Care & Drug and Grocery Stores	-	-	7%	-	-	-	3%	-	-	-	3%	3%	-	-	7%	-	7%	3%	7%	-
Insurance	-	7%	-	-	-	3%	-	-	-	10%	-	-	-	3%	-	-	3%	3%	-	-
Media	-	3%	-	3%		3%	-	3%		3%	-	-		7%	-	-	-	3%	-	-
	100%	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 7. annual sectorial distribution of companies. In this table, the annual distribution of the sectors in the portfolios are presented. The table is presented here due to its relevance to the results. Table is referred in multiple parts of the results and therefore the logical placing for it is here. For the easier interpretation, portfolios are named in the table as follows: EMT = ESG Momentum top, EMB, ESG Momentum bottom, ESGT = ESG Top (screening), ESGB = ESG Bottom (screening)

5.3 Risk metrics

In the context of ESG investing, understanding the risk metrics, particularly beta and volatility, is essential for a comprehensive assessment of portfolio performance. Beta, a measure of a portfolio's volatility relative to the market, and volatility, indicating the degree of variation in a portfolio's returns, are key indicators of risk.

5 years	ESG momentum top	ESG momentum bottom	ESG top	ESG bottom
Variance	0.04%	0.03%	0.02%	0.03%
Volatility	1.98%	1.80%	1.51%	1.58%
Covariance	0.05%	0.05%	0.04%	0.05%
Beta	0.76	0.69	0.57	0.75

Table 8. Average weekly risk-metrics for 5-year period

The annual beta figures in Table 8 and Figure 13 show market sensitivities across the four portfolios. Momentum Top Portfolio has the highest annual beta of all portfolios in 2019–2020, reflecting a greater sensitivity to market movements during the year. In contrast, the top screening portfolio showed the lowest betas across all years, indicating a more stable, less market-sensitive investment strategy, aligning with earlier results.

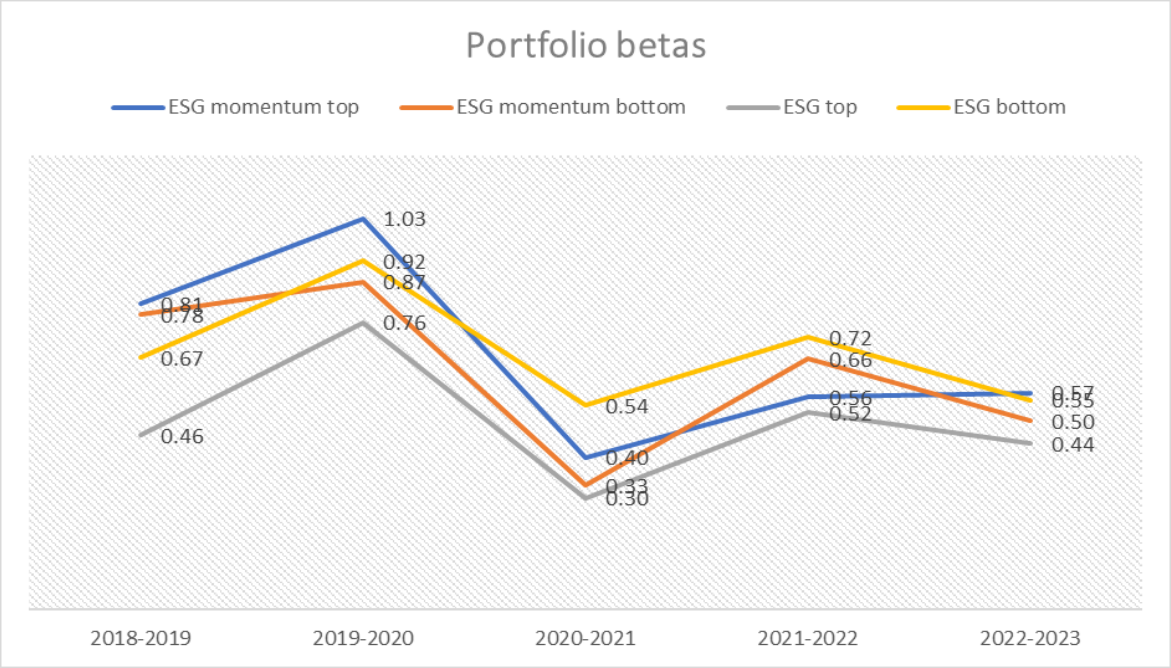
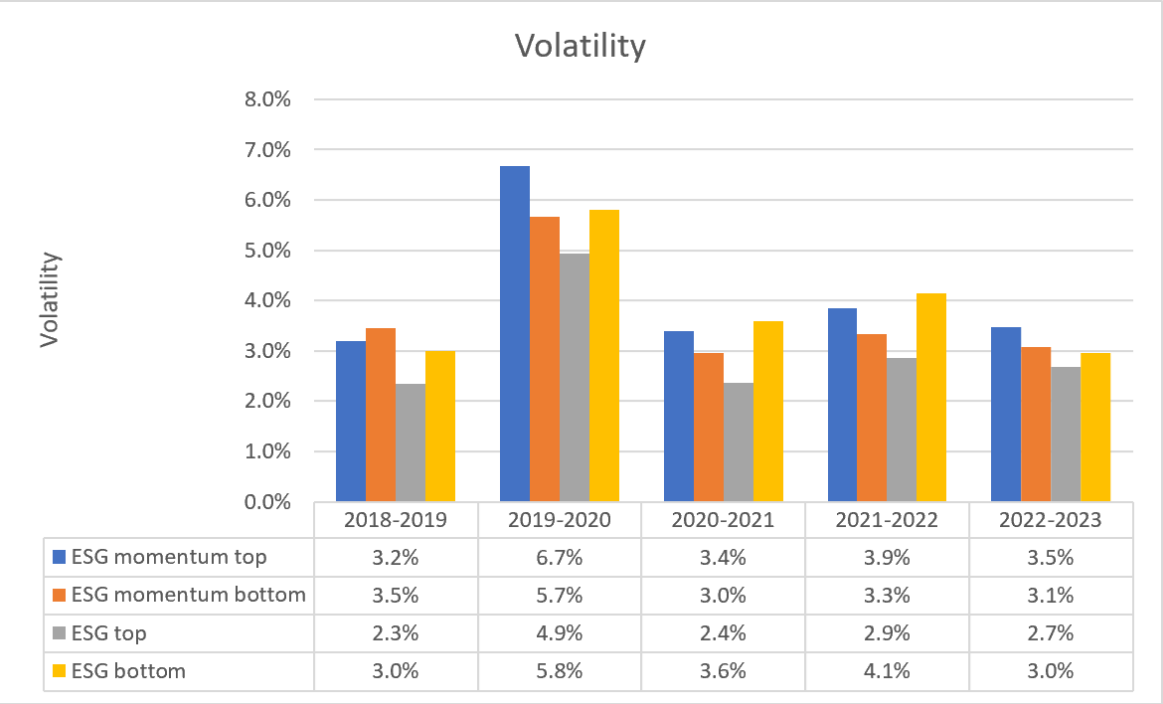


Figure 13. Annual betas

The bottom portfolios demonstrated moderate betas, with the screening portfolio showing the highest betas from 2021 to 2023. The consistently low betas across all portfolios can be attributed to effective diversification, which typically reduces exposure to individual stock volatility and market-specific risks. The annual weekly volatility figures reveal insights into the internal fluctuations of the portfolios. The momentum top portfolio experienced a notable spike in volatility in 2019–2020, aligning with its higher beta during this period. The portfolio's returns were more sensitive to market movements during the most volatile year in the market overall, leading to greater fluctuations in its weekly returns.



	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023
ESG momentum top	3.2%	6.7%	3.4%	3.9%	3.5%
ESG momentum bottom	3.5%	5.7%	3.0%	3.3%	3.1%
ESG top	2.3%	4.9%	2.4%	2.9%	2.7%
ESG bottom	3.0%	5.8%	3.6%	4.1%	3.0%

Figure 14. Annual volatilities

The momentum bottom portfolio, while starting with higher volatility in the initial years, demonstrated a weak decreasing trend in volatility. The top screening portfolio's consistent low volatility and lower betas, observed across all years, indicate that the screening strategy not only targets responsible investments but also inadvertently contributes to portfolio stability. Lastly, the bottom screening portfolio volatility pattern is somewhat irregular, with fluctuations across the years. Relatively high volatility is present during the whole 5-year period.

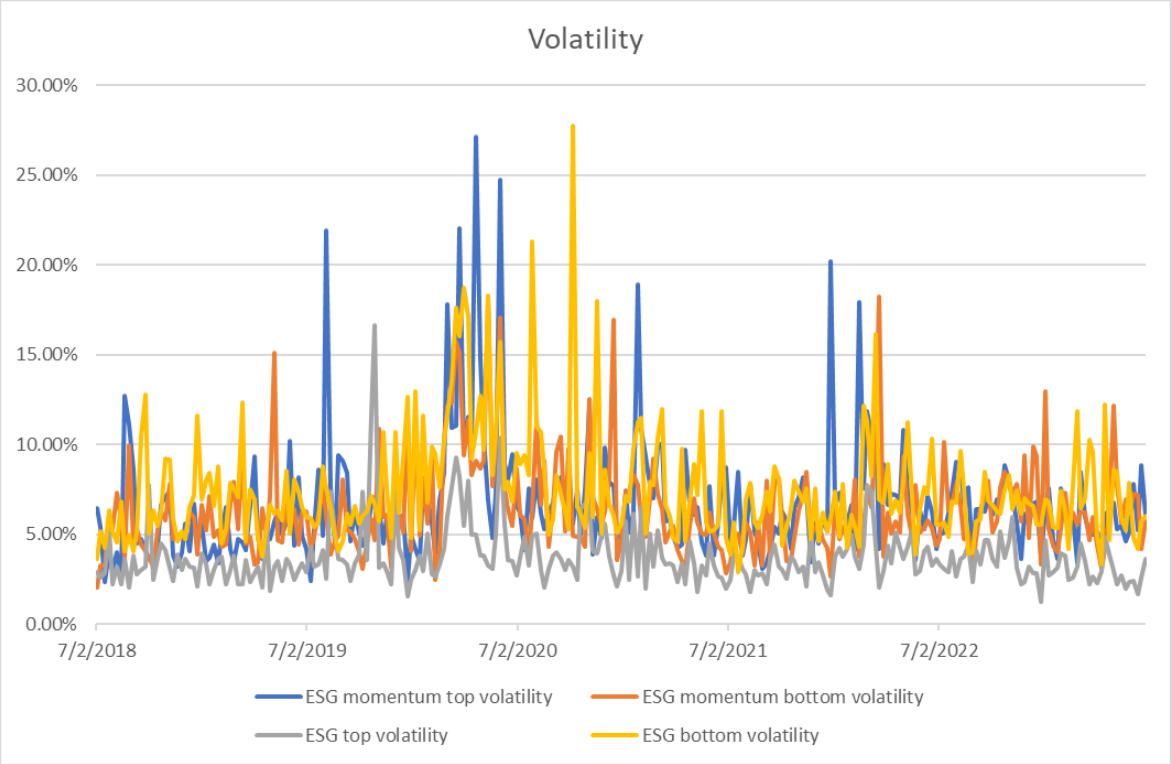


Figure 15. Weekly volatility for 5-year period

In examining the volatility figure above, it becomes evident that the momentum top and bottom screening portfolios experienced the highest weekly volatility values during the five-year period. Notably, these were the only portfolios whose single-week values of 20% or higher were observed. The momentum-top portfolio stands out in this respect, with over 70% of these values exceeding the 20% threshold. The two before-mentioned portfolios also recorded the highest individual volatility values, with peaks surpassing 27%. This significant level of volatility underscores the heightened market sensitivity and potential for 'high risk-high return', which can be seen in the returns from 2019–2021. This is an important characteristic that investors should consider in the context of their risk tolerance and investment objectives. As stated before, the top screening portfolio demonstrated low volatility, which is easy to observe from the graph. Its lowest recorded weekly volatility was 1.25%, significantly less than the lowest volatility levels of the other portfolios. Furthermore, an overwhelming majority of its weekly volatility values, nearly 90%, were below 3%. This consistently low volatility once again supports the finding that the respected portfolio is the least risky among the strategies analysed. Its performance indicates a stable investment option with minimal fluctuations in returns, making it an attractive choice for investors prioritizing risk minimization in their investment strategy.

After the risk-adjusted and pure-risk results, Figure 16 of a short-term, simplified version of the weekly Sharpe Ratio is presented for all portfolios, simply calculated by dividing weekly returns by volatility. The graph shows how much return the portfolios have generated per unit of risk in all weeks for 5 years. Higher results can therefore be seen as favourable. A momentum-top portfolio can be seen as a portfolio with a relatively high level of variance in the returns during the period, if a trend line is drawn. Momentum bottoms can be seen regularly between 0.5 and -0.5, with a weak downward trend. The top screening portfolio has a few high and low spikes and a lot of variance in general. Lower overall volatility can make relative changes in the ratio more visible and stronger. When the base volatility is low, even small fluctuations in returns can appear significant in a return-to-volatility ratio. The bottom screening portfolio produces lower returns during the whole period, which can be visibly observed from the graph.

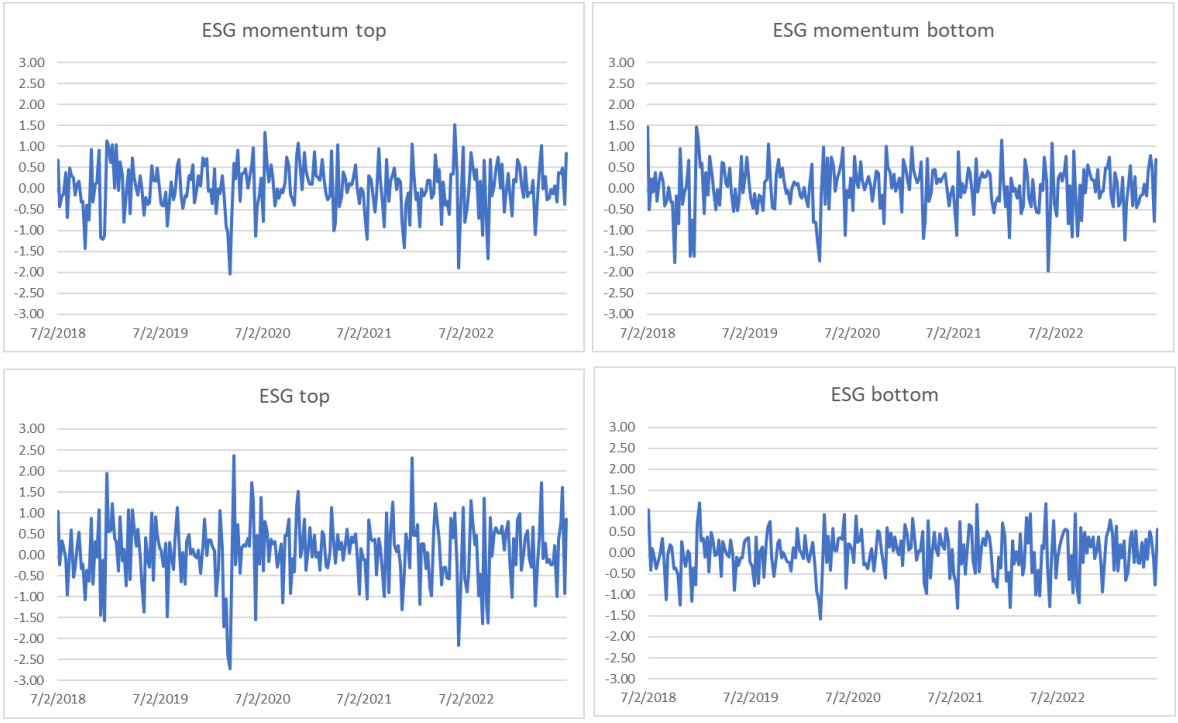


Figure 16. Weekly return to volatility for 5 year-period

In summary, the analysis of beta and volatility underscores the differing risk profiles of the ESG portfolios. The momentum top portfolio, with its higher beta and volatility, is more sensitive to market changes but offers the potential for higher returns, as earlier results prove. In contrast, the top screening portfolio's lower beta and volatility reflect low risk and consistency. The varying levels of market sensitivity and internal fluctuation in the bottom portfolios highlight the possibility of high risk attached to bad ESG practices. This risk analysis is integral to understanding the comprehensive performance of ESG portfolios, especially in the context of their alignment with investor risk preferences and market conditions.

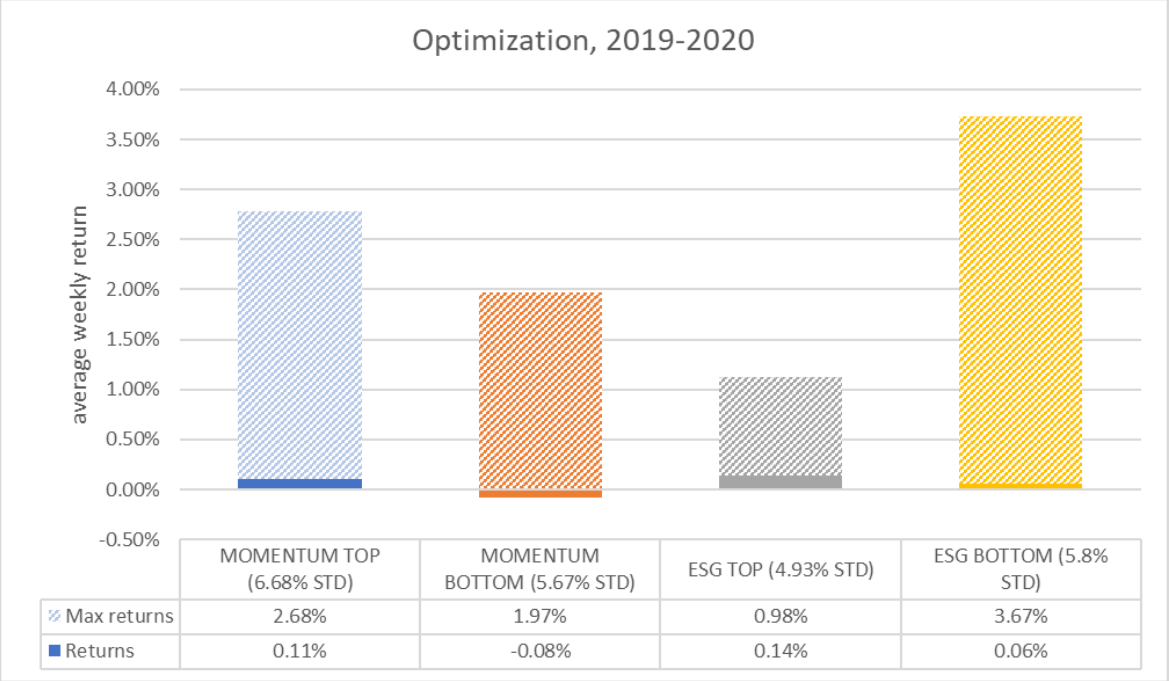


Figure 17. Optimization of the returns based on volatility. 2019-2020

The additional analysis of portfolio performance across different market conditions from 2019 to 2021 shows the actual returns of equally weighted portfolios against their theoretical maximum returns at given levels of standard deviation, offering an understanding of potential gains through active management or optimization. These two years were selected since 2019–2020 was the most volatile year and 2020–2021 was the least volatile, based on S&P 500 returns. Portfolio optimization was done with constraints set for stock weights to be greater than or equal to zero, ensuring a realistic, long-only investment scenario. This approach effectively simulated real-world investment strategies by restricting short selling based on negative weights.

During the high-volatility period of 2019–2020, the results indicate a substantial gap between the actual and optimized returns for all portfolios. (Figure 17) This suggests that in volatile market conditions, strategic adjustments in portfolio weights instead of equal weights could potentially yield significantly higher returns. In contrast, the low-volatility period of 2020–2021 presented a different scenario. (Figure 18) The gap between actual and optimized returns was notably narrower. This period demonstrated that in more stable market conditions, the benefits of more active portfolio rebalancing and weighting might be less significant.

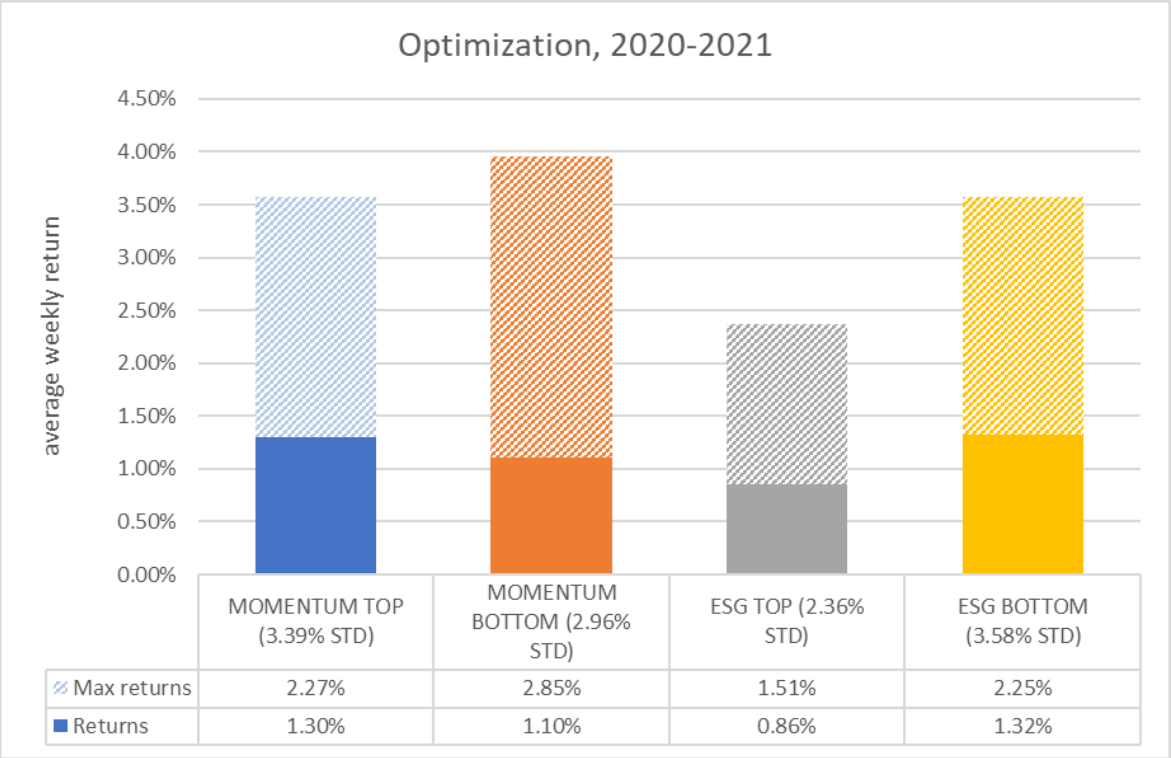


Figure 18. Optimization of the returns based on volatility. 2020-2021

It is interesting to note that during both years, the top screening portfolio performed significantly closer to its theoretical optimum compared to the other portfolios. Speculatively, it could be said that this aligns with the earlier findings of the study by suggesting a consistent performance of the top ESG companies.

5.4 Limitations of the study

This study, while offering valuable insights into ESG investing through momentum and screening strategies, is subject to several limitations that are important to acknowledge for a comprehensive understanding of its findings.

The reliance on Refinitiv ESG scores as the sole basis for evaluating corporate sustainability practices presents a limitation. Given the varying methodologies and potential inconsistencies highlighted in ESG ratings, as discussed in Section 2.6.2, these scores may not fully capture the "true ESG performance" of companies. This fact limits the generalization of the findings of the study.

The construction of portfolios based on the top and bottom ESG scores, while methodologically sound for this research, may not accurately reflect the diversity of ESG investing practices in real-world scenarios. This isn't necessarily a limitation, but an important fact to remember when assessing the meaning and importance of the findings. The availability of ESG data is an important limitation to consider. Although the availability of the data during the period was 73–94%, which can be seen as decent or good, the tendency of ESG scores to be more commonly reported by larger companies, as indicated in previous studies, might have led to an underrepresentation of small-cap firms in the portfolios. This could have affected the results, given that the performance and risk profiles of smaller companies can differ significantly from larger ones.

The approach to estimating transaction costs, as mentioned in the methodology, involves simplifications that do not capture the full complexity and variability of real transaction costs. This could affect the accuracy of net returns and the compared differences between the portfolios with different turnover rates in the study.

The study periods of 2019–2020 and 2020–2021 are calculated from July to July, as stated in the study. The COVID-19 pandemic and the resulting quick market crash and subsequent robust recovery affect the results in such a way that the spring 2020 is included in the 2019–2020 portfolio and the recovery period is included in the 2020–2021 portfolio. This is not a limitation, but an important fact to consider when interpreting the results of the respected periods of the study.

A notable limitation of this study is the impact of sectorial distribution within the portfolios on performance outcomes. Given the significant influence that sector-specific trends can have on investment returns, it is clear that the results observed in this study are at least partly influenced by these sectorial dynamics rather than being solely attributable to ESG factors. This consideration highlights the challenge of isolating the effects of ESG criteria from other influential market forces. However, this study aims to investigate the performance of investing strategies rather than specific correlations. In addition to this, the relative nature of the scores makes the sectorial comparability of the ESG scores difficult due to the fact that the scores are partly based on the comparisons within industry groups rather than across them. As an example, a tech company's environmental impact is different from that of a manufacturing company, and the weight given to certain metrics varies across industries. A fair evaluation is included, but it complicates cross-industry comparisons. This means that the companies in top and bottom portfolios are top and bottom companies in relation to their industry peers, rather than in absolute terms across the market.

The chosen period of 5 years can be seen as a limitation, especially in the case of this thesis, where significance testing is not done. However, both the justification of the period and the conscious decision not to conduct significance testing are explained in the thesis.

The top 30 and bottom 30 companies are chosen based on the efficient diversification of the risk in the portfolio. For robustness, calculations were conducted for 20 stock portfolios as well. However, a percentile approach, where portfolios would be created based on, for example, the top 10%, top 20%, top 30%, etc., could be a better and more reliable way to investigate the relationship between momentum, screening, and respected returns.

Momentum in this thesis is defined as a change in the rating between the two prior years. Two years is a relatively short period of time, especially when the Refinitiv ESG score is released annually, i.e., two times. This provides a narrow view of a company's ESG trajectory. A broader timeframe would allow for more consistent and stable trajectories, which is, after all, something that some investors could seek instead of quicker, stronger fluctuations.

In conclusion, while this study provides important insights into ESG momentum and screening strategies, these limitations suggest caution in generalizing the findings beyond the specific context of this research. They also underscore the need for further studies that might address these limitations, perhaps by incorporating broader ESG scoring methodologies, diverse market contexts, and more nuanced approaches to portfolio construction.

6 Summary and conclusions

This thesis examined the relationship between ESG momentum and stock performance, with a particular emphasis on understanding whether advancements in ESG metrics result in better stock returns for companies on the New York Stock Exchange (NYSE) from 2018 to 2023 and how these results compare to a more traditional best-in-class screening strategy.

Previous academic research has found a positive correlation between ESG ratings and financial value (Kempf & Osthoff, 2007; Lins et al. 2017). This does not mean, however, that no coinciding research results exist. Regardless of the rapidly growing amount of academic literature, the results are still very mixed and contradictory. While the amount of academic literature has grown, there has not been a lot of research on the influence of ESG rating changes on stock performance, nor has there been a lot of research suggesting the implementation of traditional investing strategies, such as momentum strategies, for ESG scores. The primary question in the study aimed to contextualize the effect of ESG integration within the broader framework of portfolio management: *"How does the integration of ESG criteria into portfolio construction influence investment returns on the New York Stock Exchange in 2018–2023?"* It can be stated that the integration of the ESG criteria into portfolio construction has had a notable impact on investment returns, although this influence is complex and multifaceted. The research findings indicate a positive relationship between ESG integration and investment performance, being in line with earlier academic literature (see Kempf & Osthoff 2007; Lins et al. 2017).

So far, the focus of academic research in ESG has been mostly on screening strategies. However, promising results on ESG momentum have been proven by various studies (see Giese et al. 2019; Khan et al. 2016; Nagy et al. 2016; Whelan et al. 2021), challenging the traditional idea of best-in-class screening. By answering this second question, *"How have the portfolios based on pure ESG momentum performed compared to the portfolios utilizing screening strategies?"* a so-called price tag for the momentum strategy was attempted to be defined in comparison to the portfolios created by applying a more traditional screening method. Outperformance of the top ESG momentum portfolio in absolute returns (cumulative return of 92.6% and a CAGR of 14.01% vs. cumulative return of 63.69% and a CAGR of 10.36%) as well as in risk-adjusted returns at the annual and 5-year levels gives it

a slight edge over the top screening portfolio. However, considering the higher transaction costs of the momentum portfolio in addition to the fact that, based on the risk-adjusted returns, momentum outperformed screening in 3 years while screening outperformed momentum in 2, the price tag is yet undefined. To be able to make a difference between these strategies, an answer to the third and final question, "*How do the risk profiles of portfolios based on pure ESG momentum and screening strategies compare, in terms of volatility, beta?"* is needed. In addressing this final question, it can be stated that the analysis of the risk profiles of the portfolios reveals significant differences. The momentum strategy, while capable of achieving higher returns, also carries a higher risk profile, characterized by greater sensitivity to market fluctuations. On the other hand, the top ESG screening portfolio displays a contrasting risk profile with consistently lower beta values, indicating a more stable and less market-sensitive investment strategy. This stability is further supported by the portfolio's low volatility, which suggests that it offers a more predictable and lower-risk investment option.

Therefore, the comparison of these investment strategies can be concluded by asking: high risk, high reward, or stable and predictable? meaning that ultimately, this choice comes down to the risk preferences of the potential investors. Whether they are risk-seeking and ready for more uncertainty or if they are risk-averse by appreciating stable returns is not for this study to determine. Therefore, a combination of these two strategies, to some extent, could be something to consider. Taking the middle road by combining more volatile momentum with more stable screening portfolios could lead to even better performance and could be a topic of future research as well.

While this study contributes to existing literature on a fairly new topic, ESG momentum, it also recognizes the need for a more diverse approach to ESG investing. Future research should explore the impact of ESG criteria in different market conditions by obtaining a longer time period and expanding to different geographical locations. More long-term studies would provide deeper insights into the strategy. Additionally, analysing a broader range of ESG rating sources could offer a more comprehensive and reliable understanding of ESG integration's influence on investment strategies.

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Appendix 1. Wide result tables for 30 stock portfolios.

ESG momentum top	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023
Annual return	15.63%	5.82%	95.94%	-15.47%	21.63%
Variance	0.001014025	0.004464159	0.001147974	0.001482624	0.001208888
Volatility	3.18%	6.68%	3.39%	3.85%	3.48%
Coveriance	0.00034158	0.001341476	0.000171676	0.000453004	0.000322316
Beta	0.81	1.03	0.40	0.56	0.57
Portfolio mean	0.000000	0.001067	0.013019	-0.003226	0.003772
Risk free	2.24%	1.21%	0.06%	0.42%	4.20%
SP500	13.94%	11.83%	41.19%	-8.54%	19.37%
Sharpe	4.203	0.689	28.296	-4.126	5.012
Treynor	0.165	0.045	2.381	-0.283	0.304
Jensen	3.92%	-6.37%	79.31%	-10.85%	8.73%

ESG top	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023
Annual return	6.53%	7.47%	56.06%	-12.03%	19.09%
Variance	0.000544198	0.002433908	0.000558095	0.000818116	0.000717287
Volatility	2.33%	4.93%	2.36%	2.86%	2.68%
Coveriance	0.000194761	0.000985435	0.000126136	0.000420276	0.000247006
Beta	0.46	0.76	0.30	0.52	0.44
Portfolio mean	0.001217	0.001361	0.008596	-0.002462	0.003365
Risk free	2.24%	1.21%	0.06%	0.42%	4.20%
SP500	13.94%	11.83%	41.19%	-8.54%	19.37%
Sharpe	1.839	1.269	23.702	-4.353	5.557
Treynor	0.093	0.082	1.893	-0.239	0.339
Jensen	-1.11%	-1.80%	43.83%	-7.78%	8.22%

ESG momentum bottom	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023
Annual return	-4.31%	-4.35%	76.91%	-7.81%	16.84%
Variance	0.001193032	0.003210583	0.000873868	0.001114338	0.000947069
Volatility	3.45%	5.67%	2.96%	3.34%	3.08%
Coveriance	0.000329568	0.001123675	0.000140032	0.000534155	0.00027624
Beta	0.78	0.87	0.33	0.66	0.50
Portfolio mean	-0.000847	-0.000839	0.011031	-0.001562	0.002998
Risk free	2.24%	1.21%	0.06%	0.42%	4.20%
SP500	13.94%	11.83%	41.19%	-8.54%	19.37%
Sharpe	-1.897	-0.982	25.997	-2.464	4.108
Treynor	-0.084	-0.064	2.340	-0.124	0.254
Jensen	-15.69%	-14.75%	63.34%	-2.29%	5.08%

ESG bottom	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023
Annual return	-0.37%	3.00%	97.64%	-21.26%	21.89%
Variance	0.000894987	0.003362975	0.00128231	0.001713854	0.000878106
Volatility	2.99%	5.80%	3.58%	4.14%	2.96%
Coveriance	0.000281637	0.001194959	0.000230509	0.000580202	0.000311936
Beta	0.67	0.92	0.54	0.72	0.55
Portfolio mean	-0.000071	0.000557	0.013187	-0.004587	0.003814
Risk free	2.24%	1.21%	0.06%	0.42%	4.20%
SP500	13.94%	11.83%	41.19%	-8.54%	19.37%
Sharpe	-0.872	0.308	27.248	-5.238	5.970
Treynor	-0.039	0.019	1.805	-0.301	0.319
Jensen	-10.42%	-7.99%	75.34%	-15.23%	9.27%

5 years	ESG momentum top	ESG momentum bottom	ESG top	ESG bottom
Cumulative return	92.60%	43.41%	63.69%	56.76%
Compounded Annual Growth	14.01%	7.48%	10.36%	9.41%
Variance	0.000391594	0.000325216	0.000227443	0.000250259
Volatility	1.98%	1.80%	1.51%	1.58%
Coveriance	0.000542906	0.000494858	0.000406451	0.000537613
Beta	0.76	0.69	0.57	0.75
Portfolio mean	0.003485686	0.002156377	0.002415342	0.002580262
Risk free	1.62%	1.62%	1.62%	1.62%
SP500	12.33%	12.33%	12.33%	12.33%
Sharpe	6.259	3.247	5.793	4.922
Treynor	0.162	0.084	0.153	0.103
Jensen	4.22%	-1.59%	2.62%	-0.30%

Appendix 2. Returns of 20 stock portfolios.

ESG momentum top	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023
Annual return	18.37%	9.21%	101.81%	-25.22%	16.06%
Beta	0.84	0.99	0.45	0.73	0.68
Jensen	6.33%	-2.54%	83.21%	-19.09%	1.57%
ESG momentum bottom	**2018-2019**	**2019-2020**	**2020-2021**	**2021-2022**	**2022-2023**
Annual return	-0.06%	6.38%	68.45%	-4.65%	11.12%
Beta	0.66	0.92	0.25	0.72	0.51
Jensen	-9.99%	-4.62%	57.92%	1.34%	-0.76%
ESG top	**2018-2019**	**2019-2020**	**2020-2021**	**2021-2022**	**2022-2023**
Annual return	8.15%	1.69%	47.07%	-3.25%	23.50%
Beta	0.45	0.85	0.24	0.45	0.49
Jensen	0.66%	-8.54%	37.11%	0.39%	11.90%
ESG bottom	**2018-2019**	**2019-2020**	**2020-2021**	**2021-2022**	**2022-2023**
Annual return	-1.24%	-9.08%	95.76%	-20.95%	25.07%
Beta	0.64	0.83	0.49	0.8	0.57
Jensen	-11.01%	-19.06%	75.38%	-14.23%	12.19%

5 years	ESG momentum top 20 stock	ESG momentum bottom 20	ESG top 20 stocks	ESG bottom 20 stocks
Cumulative return	73.56%	55.31%	66.96%	38.46%
Compounded Annual Growth	11.66%	9.20%	10.80%	6.72%
Beta	0.81	0.70	0.59	0.73
Jensen	1.31%	0.05%	2.91%	-2.73%

Appendix 3. Market returns and risk-free rate.

S&P 500	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023
Weekly retuns	0.3%	0.2%	0.7%	-0.2%	0.3%
Annual returns	13.9%	9.9%	42.7%	-8.5%	19.4%
Variance	0.0%	0.1%	0.0%	0.1%	0.1%
Volatility	2.1%	3.6%	2.1%	2.8%	2.4%
Risk Free	2.24%	1.21%	0.06%	0.42%	4.20%