Performance comparison of green, brown and sin stock portfolios: The US evidence 2009-2022

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ABSTRACT

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The purpose of this thesis is to examine the performance of responsible investment strategies compared to irresponsible investment strategies in the U.S. stock market during the period from 2009 to 2022. Three portfolios are constructed in the study, which are compared with each other and against the market index. The Green portfolio consists of companies that annually receive the highest ESG (Environmental, Social, Governance) scores. The first irresponsible portfolio, referred to as the Brown portfolio, is formed each year from companies that generate the highest CO2 emissions. The second irresponsible portfolio, termed the Sin portfolio, is constructed based on industry classification, specifically from companies within so-called sin industries. The Green and Brown portfolios are managed actively by updating their constituent stocks annually. In contrast, the Sin portfolio is a passive buy-and-hold portfolio due to the limited number of companies operating within sin industries. The performance of the portfolios is evaluated in terms of total return, risk-adjusted returns, and the Fama-French 6-factor alphas.

The results of the thesis indicate that the Green portfolio generated better risk-adjusted returns compared to the irresponsible portfolios and the market. However, the Sin portfolio earned the highest total return during the sample period. The Brown portfolio performed the worst in terms of both total return and risk-adjusted returns. The 6-factor regression analysis reveals that the return variability of all the examined three portfolios is explained by multiple factors, whose significance varies across the portfolios. Expectedly, the market excess return factor has clearly the highest explanatory power on the return variability for all three portfolios.

TIIVISTELMÄ

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Kauppatieteet

Jyri Inkilä

Vihreiden, ruskeiden ja epäeettisten osakkeiden portfoliotuottovertailu Yhdysvaltain osakemarkkinoilla 2009–2022

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Tämän tutkielman tarkoituksena on selvittää vastuullisen sijoitusstrategian suoriutumista verrattuna ei-vastuullisiin sijoitusstrategioihin Yhdysvaltojen osakemarkkinoilla vuosien 2009–2022 aikana. Tutkielmassa muodostetaan kolme portfoliota, joita verrataan keskenään sekä markkinaindeksiin. Vihreä osakesalkku koostuu vuosittain yhtiöstä, jotka ovat saaneet korkeimmat ESG-pisteet (Enviromental, Social, Governance). Ensimmäinen ei-vastuullinen salkku, ns. Ruskea portfolio, muodostetaan vuosittain yrityksistä, jotka aiheuttavat korkeimmat CO2-päästöt. Toinen ei-vastuullinen salkku, epäeettinen portfolio, muodostetaan toimialapohjaisesti niin sanottujen ”syntitoimialojen” yhtiöistä. Korkean ESG-pisteytyksen ja korkeiden päästöjen salkku ovat aktiivisesti hoidettuja, joissa portfoliot päivitetään vuosittain. Epäeettinen portfolio on puolestaan passiivinen salkku, koska syntitoimialoilla toimivia yrityksiä on rajallinen määrä. Portfolioiden suoriutumista vertaillaan kokonaistuoton, riskikorjatun tuoton mittareiden sekä Fama-French 6-faktori-mallin perusteella.

Tutkielman tulokset osoittavat, että Vihreä portfoliolla on saatu parempaa riskikorjattua tuottoa ei-vastuullisiin salkkuihin ja markkinaan verrattuna, vaikkakin epäeettisen portfolion kokonaistuotto on ollut tutkimusaineiston korkein. Ruskea portfolion suoriutuminen on ollut heikointa sekä kokonaistuotolla että riskikorjatuilla tuotoilla mitattuna. 6-faktoriregressioiden perusteella kaikkien portfolioiden tuottojen vaihtelu selittyy useammalla kuin yhdellä faktorilla, jotka vaihtelevat portfoliokohtaisesti, vaikkakin markkinaylituottofaktori on näistä odotetusti kaikissa tapauksissa selvästi selitysvoimaisin.

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1 Introduction

Today, responsible investing is not a strategy of choice, to be followed if you want to. Any individual investor can and should invest in companies or investment instruments of their choice, but almost all investment instruments offered by financial institutions are built on ESG or sustainability. The loans offered by financial institutions have become more and more focused on green loans every year. Most Western stock exchanges produce extensive ESG reports to highlight corporate responsibility. Sustainability and ESG are everywhere in the investment and financial sector. The social and political climate favours sustainability and green investing, and the general idea is that responsible investing outperforms other strategies. This is why responsible investment has been the subject of so much research by economists. There has been a desire to find out whether responsible investing generates excess returns.

1.1 Background and reason to study

Today, responsible equity investing simply means investing in stocks with a high ESG score. The aim of ESG investing is to get a good return on invested assets, as with any other investment strategy. However, ESG investing today has other purposes than just increasing the value of shareholders. By investing according to ESG principles, the aim is to improve the position of employees, the surrounding nature and society, and the position of other stakeholders and customers of the company. (Deloitte 2024) Clichéd to say that responsible investing is about making the world a better place for everyone, but many studies have shown that responsible strategies can generate positive abnormal returns.

One of the first pieces of evidence of excess returns from a responsible strategy comes from a study by Moskovits in 1972. The number of studies on sustainability has only increased over the decades, and it is notable that the number of studies has increased over time. Over time, many studies have shown that responsible investing can generate positive abnormal returns (Kempf and Osthoff, 2007; Nagy, Kassam, Lee 2016; Badía, G. et al., 2020; Priem & Gabellone, 2024). But there are also studies that find no evidence of market beating, but the strategy does reduce portfolio risk when risk is measured by volatility (Bodhanwala &

Bodhanwala, 2020). ESG investing has not only been studied through returns from investment markets. It has been found that with a high ESG score, a firm's cost of capital decreases, especially if the firm has invested in the Governance pillar (Priem, 2024) At the same time, studies have been conducted that find that unsustainable investments can beat the market. A carbon premium has been observed, where excess returns are obtained by investing in companies with high carbon emissions or in companies operating in morally and ethically questionable sectors.

As sustainability, carbon neutrality and concern for the state of the world has become a major social phenomenon, the political agendas of individual investors and governments alike have seen large investments in industries that are classified as responsible. For example, the European Union launched the largest ever stimulus package in 2020, aimed at reviving the European economy in the aftermath of the COVID-19 crisis. The stimulus money is to be used to make Europe greener, more digital and more resilient (European Commission 2024). The United States also has ambitious targets for reducing greenhouse gas emissions, for example. The aim is to reduce greenhouse gas emissions from 2005 levels by 50-52% by 2030.

If almost all Western countries have set targets that benefit certain sectors and constrain others, the question of whether political and social trends have affected or will affect the returns of responsible investment strategies can be thoroughly asked. For example, if policy decisions are taken to direct stimulus funds to certain sectors, or the cost of capital is lowered by proper sustainability reporting. At the same time, sin industries are made more difficult to operate, for example through higher taxes, or companies with high greenhouse gas emissions are restricted through emissions trading. In such a setting, it is perfectly understandable if responsible investment generates excess returns.

The study is important and significant because there have been many studies in history comparing responsible companies with irresponsible companies, but most of the studies have been based solely on ESG scores. Although the ESG score is an important and widely used measure for comparing corporate responsibility, it has shortcomings because it is mostly compiled from responsibility reports and communications. In this case, the financial investment in communication and reporting has a major impact on the ESG score. In the time covered by this study, every year the 30 most responsible companies in the US included companies that were among the largest greenhouse gas emitters in the country or companies whose business is not in line with ethical investing. Since the fundamental idea of responsible investing is to reduce the harm that companies cause to the environment, communities and individuals, the paper has sought to draw the clearest possible distinction between responsible and traditionally no responsible portfolios. In this way, the study will provide a clearer answer on the merits of responsible and irresponsible investment strategies.

Three portfolios will be created in the thesis. The first is the responsible portfolio, which describes the success of responsible investment. The portfolio is called the Green Portfolio. In each year, the portfolio consists of 30 stocks, selected according to the ESG scores of the previous year. The study uses a "best in class" methodology, selecting the 30 best scoring companies for the portfolio. The first portfolio against responsible investment strategy is formed from the most polluting companies in the US and is called the Brown portfolio. Pollution is measured by total CO_2 emissions, and the selection method is a reverse "best in class" model with the largest polluters. The Brown portfolio is also an actively managed portfolio of 30 stocks per year. Another portfolio that is not in line with the responsible investment strategy is called the Sin portfolio. The Sin portfolio is made up of companies selected on an industry basis, contrary to the basic idea of responsible investment. The sinful industries are alcohol, tobacco, gambling, adult entertainment, guns and cannabis.

The aim of the master's thesis is to answer the question: has it been possible to make excess returns in the United States through responsible investing, compared to the market and to the strategies against responsible investing in the post-financial crisis period? To provide sufficiently broad and thorough answers to the thesis, the following five sub-research questions have been developed to answer the problem. Since the definition of scapegoats in certain situations is a moral issue, especially in the arms segment, companies whose main activity is the manufacture of arms and ammunition, or the manufacture of products sold to the defence industry (posing a risk to human health) have had to be selected for the portfolio. The benchmark index used is the S&P 500 index. The LSEG Refinitiv workspace has been used as a source for stock and index price data, ESG scores and total CO_2 emissions. The study does not consider real-world transaction costs such as trading costs, other management costs or taxes. These may have a potential impact on the results.

The traditional benchmark methods used in the study are total portfolio return over the study period, annual geometric return and volatility. Investment strategies are also compared using the traditional Sharpe ratio and the Sharpe ratio that considers skewness and volatility. The statistical significance of risk-adjusted returns is also examined. Finally, a six-factor analysis is carried out, for each portfolio, showing the existence and statistical significance of potential excess returns.

Question 1. *"Is it possible for investment strategies to outperform the market index in terms of total return and risk-adjusted returns?*

Question 2. *"Does the green portfolio outperform the brown portfolio?"*

Question 3. *"Has the social and political climate boosted returns on responsible stocks and depressed returns on sin stocks?"*

Question 4. *"Does a responsible portfolio outperform irresponsible portfolios with risk-adjusted returns?"*

Question 5. *"Do the portfolios show statistically significant deviations over the course of sample period?"*

1.2 Structure of thesis

The first section of the thesis discusses the thesis in general terms and gives the background to the motives for writing the thesis. The second section provides a theoretical background on ESG and financial theory. This is followed by a more detailed look at the research on responsible investment, the returns on sin stocks and the carbon premium. Studies that would explain excess returns or lack thereof are also reviewed. The fourth section focuses on the data analysis and portfolio construction, followed by an introduction to the research methods used. Section 6 focuses on the results obtained from the data using the research methods outlined in Section 5. The final chapter summarizes the results and answers the research questions.

2 Theoretical background

In this section, we will introduce the theoretical background of the thesis, in terms of responsible investment and financial theory, to make it easier to understand and connect the dots. The history and current state of responsible investing, ESG scoring and investment strategies most used in responsible investing are discussed. The most relevant financial theories for this thesis will be reviewed to provide the reader with an understanding of the basic assumptions.

2.1 ESG

2.1.1 Responsible investment

Alongside Socially Responsible Investing (SRI), many people are familiar with the acronym ESG (Enviromental, Social, Governance). These letters encapsulate the idea of responsible investing, where the investor takes into account not only financial issues, but also environmental issues, social responsibility and good governance (Silvola & Landau, 2019). As this way of investing has become a very popular investment strategy, the variety of ways to invest responsibly has increased a lot. Investors can invest in direct stock picking, or they can invest in responsible funds such as those run by financial institutions. The UN developed the Principles for Responsible Investment (PRI), which address the ESG issues mentioned above (PRI, 2024). Hyrske (2020) explains that the term responsible investment replaced the term ethical investment in 2006, when the UN developed the Principles for Responsible Investment.

As noted earlier, the term responsible investing or ESG investing used to be ethical investing. Ethical investing means making an investment decision from one's own ethical perspective. This has been done for a very long time throughout history, but the first modern ethical investment choices were made in the 17th century, when the military and slave trade was refrained from. Later, the Christian Pioneer Fund was the first action to stop investing in 'sin stocks' (Puaschunder, 2019) In the United States in the 1960s, for example, the Vietnam War vassal movement drove some institutional investors to sell shares in companies involved in the production of napalm (Biller, 2007). Historically, various movements and activism around different social and environmental issues have sensitised companies to corporate social responsibility (Renneboog et al., 2007). Over the last two to three decades, social and governance-related forms of responsibility have gained momentum. Human rights, governance, corruption and the independence of governments and other stakeholders have become as important criteria as environmental factors for responsible investors (Tucker, 2020).

As can be seen, there is no easy or simple timeline for the emergence of responsible investing, how and on what basis investors have made responsible investment choices. A different investor might have made the same moral or ethical choices four decades ago without the idea of responsible investing, while today the same or opposite ideas and moral and ethical understanding of investing have been given a name and standardisation around it. The same event may also have been linked to place rather than time. Sandberg et.al (2009) noted that cultural and ideological differences have been influential in the development of responsible investment terminology.

The rapid growth of responsible investing can be seen around the world. This growth is driven by investors' ever-increasing awareness of ESG issues, climate change efforts and initiatives by Western governments to promote responsible investing. As all the above reasons and actions are not forgotten or diminished, it is expected that responsible investing will continue to grow (Renneboog, 2008). As responsible investing has only increased and become more popular, for example, responsible funds have become much more common, and all financial institutions have their own responsible funds. According to Camilleri (2021), responsible investment indices have become much more widespread thanks to easier access to information. Smartphones are a good example of the ease of access to information. For example, they allow you to follow current news and trade on the stock exchange. The ease and volume of information brought by technology is forcing investors and analysts to make better and more reliable indices to add value to even the most informed investors.

Many investors have embraced responsible investing as a good way to make a good return, but many investors engage in responsible investing because they are genuinely concerned about grievances and want to make a positive contribution to nature or society. (Camilleri, 2021) While Camilleri (2021) divided the motives of responsible investing into profit and responsible investment behaviour, Bruno et al. (2021) divided the motives of responsible investing into four pillars, the first of which is investing according to one's own morals and ethics. The second pillar is to achieve social impact through investment (active ownership). The third pillar is to manage the risks associated with failing to act responsibly and the potential retrospective consequences, for example in the form of litigation. The last pillar, as identified by Bruno et al. (2021), is the excess returns of an ESG investment strategy. As Camilleri and Bruno et al. noted, one key reason to implement an ESG strategy is the potential excess returns it can generate, so in this paper we do not focus on investors' motives or moral perceptions, but rather we investigate whether 2009-2022 responsible investing can generate excess returns and outperform portfolios that do not follow an ESG strategy.

In academic circles, there are two main paradigms of responsible investment: ethical investment and economic return. According to the ethical paradigm, responsible investment seeks to influence the way companies operate by investing in responsible companies. The economic paradigm means that investors and investment providers want a return on their money. Therefore, the profit motive may distract from the basic idea of responsible investment, which is to change companies more responsible. (Widyawati, 2020) The problem of the economic paradigm can only be influenced by each investor. To put it simply, if one feels that responsible investment is important and wants to invest in accordance with responsible values, one must overlook the potential returns. This problem was also highlighted by Renneboog (2008), who argued that when portfolio managers strive to make financial returns and achieve sustainability objectives, financial efficiency may suffer due to multitasking. This is reflected in risk-adjusted returns and agent costs.

2.1.2 ESG-score

If the ESG score does not correctly measure corporate responsibility, there is a risk that investors' money will be diverted to companies that are not as sustainable as the score suggests. Therefore, variables such as measures of changes in greenhouse gas emissions must also be considered to ensure that the ESG score is a true measure of corporate sustainability (Drempetic, 2019). Drempetic et al. (2019) and Widyawati (2020) consider why the debate on ESG measurement revolves around the returns from responsible investment rather than the reliability of ESG measurement. They also raised the question of how much larger and better ESG resources of large companies matter for ESG scores by outsiders. Drempetic et al. (2020) provided evidence that ESG scores are positively affected by firm size, available ESG resources, and the availability of ESG data. Firm balance sheet information has also been found to have a clear positive relationship with ESG scores of regularly traded firms. (D'Amato, 2022) Drempetic et al. (2020) therefore ask whether the ESG score measure allows large companies to raise their own ESG score with large resources, when investors do not have similar resources to access information about the company and the rating agency. Researching ESG scoring is difficult because there is not yet a standardised taxonomy for defining ESG factors, investors and researchers are dependent on commercial data providers, which also lack a uniform standardisation (Priem, 2024). D'Amato et al. (2022) noted that their study is also based on the assumption that they have reliable information on ESG ratings. It can be argued that ESG data are subject to risks, especially in terms of completeness and quality, which means that ESG scoring can be used for so-called greenwashing. For example, in the absence of clear standardisation, companies operating in sinful sectors such as tobacco, alcohol and gambling may start to publish information on their corporate social responsibility and in this way raise their own ESG score, even though the products of the industry cause problems for individuals as well as societies (Garcia, 2017). Similar standardisation problems and data reliability problems do not exist in traditional valuation based on accounting data (Bertolotti, 2020).

In the US, one of the biggest risks to responsible investment is the voluntary disclosure of ESG information and the lack of standards. As a result, investors are demanding better ESG reporting and greater transparency of information from companies. (Bertolotti, 2020) Fallan (2009) argue for voluntary disclosure through market forces. Companies report ESG data voluntarily because they want to be legitimate actors for investors and stakeholders. When ESG data are open and widely produced, it is easier for third parties to continue to produce higher quality ESG analyses and scores. The main problems with ESG metrics are lack of transparency and consistency. The lack of transparency arises from a lack of published information on the processes and methodologies of ESG data providers and rating agencies, or on the quality of the data used to produce the indicators. This lack of consistency is reflected in the different ratings given by rating agencies. This is due to differences in data collection and analysis methods. For example, ESG scores published by several major rating agencies are not consistent (Widawati, 2020).

2.2 Strategies for responsible investment

Responsible investment can be implemented through a wide range of strategies and approaches. As responsible investment is a recent phenomenon, the strategies are not yet well-established, so not everyone refers to them by the same name or classifies them in the same way. Classification has also changed over time. (Runyon, 2023), Silvola & Landau (2019) and Hyrske et al. (2020) roughly divide responsible investing into six strategies: ESG integration, thematic or thematic investing, favouritism, exclusion, active ownership and impact investing. Previously, strategies have been divided into three categories: social screening, active ownership and community investing (Schueth, 2003). Renneboog (2008) has also divided responsible investment strategies into the three categories mentioned above. In this thesis, responsible investment strategies are simply divided into screening, active ownership, ESG integration and impact investing. This is due to the partial overlap of strategies and the possibility for investors to implement several different strategies simultaneously when making decisions (Silvola & Landau, 2019).

2.2.1 Screening

The screening is divided into two main strategies. Exclusion, or negative screening, is the process of screening out companies that should not be invested in because they do not comply with ESG values. This is often influenced by the sector in which the company operates. For example, the alcohol and tobacco industries are two such sectors that are subject to negative screening (Renneboog, 2008). Exclusion also takes into account the sustainability of the products or services produced by the company and its practices. When assessing the goods and practices produced by a company, consideration is given to whether they are irresponsible, unethical or otherwise contrary to the principles of responsible investment (Hyrske, 2020).

Positive screening, or favouritism, is the opposite of negative screening. (Hyrske, 2020) When screening companies for investment, the most common focus is on corporate governance, labour relations, sustainability of the investment, the operating environment and the promotion of cultural diversity. Preference is also strongly linked to a 'best in class' approach. This means that companies are ranked according to ESG criteria. In this way, the most responsible companies from different sectors can be selected (Renneboog, 2008).

2.2.2 ESG integration

ESG integration means that investment analysis is integrated alongside traditional economic measures and sustainability criteria (Hyrske, 2020). The aim is to use ESG information to inform analysis and decisions, as ESG information is expected to influence returns and risk over the long term. As there are no standardised definitions of ESG integration, each investor can implement the integration of ESG factors into traditional financial metrics at their own discretion (Silvola & Landau, 2019). Private investors can analyse company figures such as turnover and financial results. ESG factors such as future demand for the product can be integrated into this analysis. For example, if a product is unethically produced and has a negative impact on climate change, it can be assumed that demand for the product will dwindle in the future. (Hyrske, 2020) Institutional investors are increasingly buying ESG analysis and ratings from external service providers, which can be used to support other analyses when making decisions (Silvola & Landau, 2019).

2.2.3 Active ownership and Impact investing

Shareholder activism means that an investor owns shares in a company, i.e. a stake in the company, with the aim of influencing its activities. As the investor has the right to participate, vote and speak at the general meeting of shareholders under the Companies Act, the influence is directly directed at the company's management and decision-making (Hyrske, 2020). A responsible investor seeks to engage in dialogue with the company's management whenever possible, so that he or she can influence any perceived grievances and monitor progress towards ESG goals. An investor can take active ownership from within the board of a company, allowing the investor's expertise to be used directly by the company's management (Silvola & Landau, 2019).

Impact investing, unlike other investment strategies, is based on the premise that an investment must have a measurable positive social or environmental impact (Hyrske, 2020). The purpose of investing is to achieve measurable change in some aspect of social or environmental issues Such issues may include investments in public transport, construction, energy efficiency, homelessness and exclusion prevention. The most important criterion for investment is the reduction of emissions and social problems (Silvola & Landau, 2019).

2.3 Financial theory

This section reviews the financial theories that underpin the research methods used in the thesis and the conclusions to be drawn. The theories discussed are portfolio theory, efficient market theory and the CAPM model and related ratios. Portfolio theory provides the rationale for portfolio diversification. The efficient market theory provides the basis for the basic assumption of the thesis that a single investment strategy cannot generate consistent excess returns, and the CAPM model provides the basis for the six-factor model and the risk-adjusted return measures presented in chapter five.

2.3.1 Portfolio theory

Modern portfolio theory can be considered to have been born in 1952, the year Harry Markowitz published his book "Portfolio selection". In his work, Markowitz describes the benefits of diversification to optimise portfolio returns. The influence of modern portfolio theory is still significant when discussing investment theory. Since all investors want the best possible return on their invested capital with the lowest possible risk, modern portfolio theory is also essential for responsible investing. Markowitz was awarded the Nobel Prize in 1990 for his portfolio theory.

One of the most important ideas of portfolio theory is diversification. Since investors want to reduce the risk of their portfolio as much as possible, they must invest their wealth in different types of assets, such as stocks, real estate or bonds (Markowitz, 1952). For example, capital can be allocated by buying shares in companies in different sectors. Diversification can also be achieved by allocating capital geographically. According to portfolio theory, risk is reduced by diversifying into assets with the lowest possible correlation between them, so that a potential disaster, technological change or social/political pressure does not affect all the assets in which one has invested.

According to portfolio theory, it is possible for an investor to construct an optimal portfolio with the highest possible expected return and the lowest possible risks. This theory, known as the efficient front, assumes that risk and expected return go hand in hand. The higher the risk, the higher the expected return. According to the efficient frontier, the investor chooses the portfolio with the highest expected return from those with the same level of risk, or the portfolio with the lowest expected return from those with the same level of risk (Markowitz, 1952).

Portfolio risk consists of two types of risk. The first is asymmetric risk and the second is market risk (systematic risk). Asymmetric risk can be eliminated by diversification, leaving only systematic risk (market risk). Systematic risk cannot be eliminated, i.e. there will always be risks in investments. The first ten stocks have the greatest diversification benefits of all. With this number of stocks in the portfolio, it is possible to weed out most of the asymmetric risk (Allen, Breatley and Myers, 2011, 169).

2.3.2 Efficient market hypothesis

Efficient market hypothesis has been widely used in financial market research. An efficient capital market is a situation in which all available information about a firm is directly reflected in the price of that firm's stock. When this happens, the theory suggests that the stock price is always correct. When the market is efficient, the information is immediately reflected in the stock price at the time of publication. (Fama, 1970) When the market is efficient, no investment strategy can generate excess returns.

The basis for the efficient market theory is provided by the three conditions for an efficient market defined by Fama (1970); investors in the market should be rational, there should be no transaction costs in the market and information about firms should be available to all. Market efficiency can be divided into three categories; weak conditions, medium conditions and strong conditions, based on how the conditions are met (Fama, 1970.) When market conditions are weakly met, security prices are only affected by historical information. When conditions are partially met, security prices reflect all public information in addition to historical information. When all existing information, public as well as private and historical, is reflected in the security price, the conditions are strongly met (Nikkinen, Rothovius & Sahlström 2002).

Although Efficient Market Hypothesis is widely used as a basis for financial market research, several studies have shown that different investment strategies have produced non-market returns. Although ESG investing does not yet have a classical position in the financial world such as EMH, ESG strategies challenge efficient market theory in terms of the studies advocating excess returns. (See, e.g., Borovkova & Wu 2020; Bose, Shams, Ali, & Mihret 2021) Investor rationality has also been studied, and efficient market theory has been challenged by the lack of investor rationality (De BONDT & THALER 1985; Kahneman & Tversky 1979). Lo (2004) argues that investors are not rational, and that market efficiency is not stable but varies from time to time. The assumption of the paper is still based on Fama's (1970) theory that if the conditions are strongly met, it must be assumed that a responsible investment strategy cannot beat the market.

2.3.3 CAPM model

The CAPM model (Capital Asset Pricing Model) was developed from the portfolio theory developed by Markowitz (1959), a few years later with the contribution of several different economists such as Willian Sharpe, Jan Mossin and John V. Lintner. The model is still very widely used to assess portfolio performance, i.e. to calculate the expected return on securities. The basic assumption of the model is that there is a linear relationship between stock returns and market returns. The idea behind the CAP model, in line with portfolio theory, is that investors want to minimise risk, i.e. eliminate non-systematic risk by diversification, leaving only systematic risk. In this case, according to the CAP model, the return requirements for equities consist of the return requirement for a risk-free investment and a risk premium. The risk premium consists of the systematic risk of the market portfolio multiplied by the beta coefficient (Knüpfer and Puttonen, 2018).

Although the model has indeed been used in theoretical modelling, the empirical results of the model are poor, which may be due to the simplifying assumptions of the model or to the difficulty to conduct tests according to the model. For example, the model uses the variable market portfolio return expectation, where market portfolio is a fuzzy concept. It is not known whether the market portfolio includes only equities or whether it should include all assets globally, even if the asset under study is equities. (Fama and French, 2004) Another problem with the CAPM is the single beta coefficient, which does not consider differences in, for example, the size of firms, the amount of investment or the value of the assets (Fama and French, 2006).

$$E(r_i) = r_f + \beta_i[E(r_m) - r_f]$$

With,

$E(r_i)$ = Expected return on investment i

r_f = The return on the risk-free asset

$E(r_m)$ = Expected return on the market portfolio

The beta (β) coefficient is an integral part of the CAPM model, since beta measures the sensitivity of a single stock to market changes, it is essential to include it as a systematic risk factor (Knüpfer and Puttonen, 2018). For a beta of 1, the stock price moves in line with the market portfolio. For a coefficient of 2, the return on the stock varies twice as much as the market portfolio. A higher Beta coefficient is also considered as an increased risk. In turn, if the beta is less than 1, the returns fluctuate less than the market portfolio and thus the risk is less than the risk of the market portfolio. The formula for beta is as follows:

$$\beta_{im} = \frac{COV(R_i, R_m)}{\sigma^2(R_m)}$$

With,

R_i = Return on investment i

R_m = Market portfolio return

σ^2 = Variance of market return

Volatility is a measure of risk in the stock market. Volatility is the standard deviation that measures the variation in stock returns over a given period, reflecting the uncertainty in the stock market about future price movements. The volatility formula is shown follows:

$$\sigma = \frac{\sigma_{SD}}{\sqrt{T}}$$

With,

σ = Volatility

σ_{SD} = Standard deviation of returns

T = Time

3 Literature review

The literature review discusses previous studies related to the topic of this thesis. An attempt has been made to deal with the studies in chronological order, as far as possible. Research has been sought on responsible investment performance, the existence of a carbon premium and the success of sin shares. The literature review has also highlighted studies that take a view on the reasons why and how different strategies have been successful historically.

3.1 Performance of responsible and non-responsible investment strategies

Several articles have shown that responsible investing has the potential to generate excess returns compared to the market. Kempf and Osthoff (2007) came to the same conclusion in their study that over the period 1992-2004, investors using best-in-class strategies have been able to generate significant excess returns. The best-in-class strategy works best when using several different sustainability screens and favouring stocks with a high ESG score. While several studies from the same era support the results of Kempf and Osthoff's study, there are studies from the same era that show that it has been possible to generate excess returns by investing in companies operating in generally unethical and ESG-unfriendly sectors. These sectors include alcohol, tobacco and gambling. Companies operating in these sectors outperformed the market in the first fourteen years of the 2000s (Bozkurt, 2016). Although companies operating in these sectors have been frowned upon by responsible investors and even governments, Hong and Kacperczyk (2009) analyse the performance of companies operating in unethical sectors from 1965 to 2006. They find that investing in companies operating in unethical industries has allowed for excess returns over this period.

As responsible investing is a new phenomenon, it should be noted that it is a new phenomenon that changes much more in a short period of time than older trends. The previous studies date back in part to the previous millennium, when responsible investing was not a strategy commonly used by all investors and financial institutions. In 2012, Guenster published an article in which he explained that in the past, responsible investing may have generated excess returns, but market efficiency suggests that responsible investors underperform the market because they miss out on returns from sin stocks. The market for responsible investing has grown tremendously over the past decade. This growth has led to a lot of new research and knowledge on the subject. Halbritter and Dorfleitner (2015) present results in their study showing that there are no significant differences in returns between high and low ESG scoring companies, although Kempf and Osthoff (2007) find the opposite. Halbritter and Dorfleitner's (2015) study shows that it does not matter whether one looks at the overall score or at the individual pillar of sustainability. Even when ESG scores were examined by sector, high scores did not produce abnormal returns. In Germany, brown stocks have been found to outperform the market, but this can be explained by the free access to financial services in the study by Oestreich & Tsiakas (2015). But they raise the carbon risk factor, which says that higher co2 total emissions increase risk, so investors expect more return because of the increased risk. A similar idea has been raised about sin stocks, which have historically delivered excess returns. If scapegoats are seen as higher-risk investments, a premium for increased risk is required. However, the excess returns of sinful stocks can be explained by high exposure to the profitability and investment factors of the Fama & French five factor model, thus negating the idea of a risk premium (Blitz, 2017).

When companies with high ESG ratings were compared to a stock market index, it was found that in the US, responsible investing yielded significantly higher returns than investing according to a market index. In the UK and Australia, investing in companies with a high ESG score did not produce better returns on average relative to the market index. In developing countries, investing in companies with high ESG scores yielded worse returns than the market index (Bodhanwala & Bodhanwala, 2020). Duque-Grisales and Aguilera-Caracuel (2019) also find that multinationals from Latin America have a negative relationship between ESG score and financial performance. However, it can be argued that a portfolio of companies with high ESG scores has lower volatility than the market index. Responsible investment can therefore reduce risk (Bodhanwala and Bodhanwala, 2020).

Economists have also compared scapegoats with high ESG scores, although such studies have played a smaller role. Paradis & Schiehll (2021) compared scapegoats to companies in other industries in their study. They obtain clear results that scapegoats perform worse on all three pillars of the ESG measure. The largest underperformance occurs in Pillar G. As a hypothetical explanation for poor performance in the G-pillar, Cayón and Gutierrez (2021) propose "social cleansing". Since scapegoats operate in socially and ethically questionable sectors, it is unwise for them to invest in governance because social and ethical issues do not go away. However, Cayo and Gutierrez argue that companies operating in sin sectors can invest in E and S pillars, as they allow companies to increase ESG scores and reduce reputational risk, for example. It has also been observed that lobbying can increase the annual returns of synergistic stocks, and these lobbied synergistic stocks outperform the benchmark index. When comparing scapegoats and high responsibility stocks, it is also found that financial investment in lobbying only has a positive impact on the market returns of scapegoats, but not on the market returns of responsible companies. Responsible companies need to invest in corporate social responsibility activities that have an impact on the market returns of these companies. (Ghouma, 2019) Both in the responsible, polluting and sin sectors, it has been found that disclosure of corporate responsibility has a positive relationship with firm assets and financial leverage (Alareeni, 2020). It can be argued that the more assets a company has and the more financial debt it has, the better the company's sustainability report. Badía (2021) reports that by investing globally in a portfolio of the 100 most responsible companies in the world or in the S&P Global 100 index, there is no difference in the returns of these investments in any market situation. And that S&P Global 100 Index includes some of the largest and best-known companies in the world.

When investing responsibly, the geographical location of the companies in the portfolio has an impact on portfolio returns, for example, companies with high ESG scores in the EU perform better than those with low scores (Badía, 2020).A study conducted a couple of years later, says that companies operating in sin sectors have maintained healthy profits and profitability has not suffered, despite governments squeezing sin sectors and general social pressure against them (Anon, 2022). While companies with high ESG scores have been found to achieve superior returns, companies in polluting sectors, in addition to those in sin stocks that are not responsible investments, have had good returns. Bolton and Kacperczyk (2020) examined carbon premiums in Asia, the US and Canada, and Europe, and found then having increased recently in all of the above regions.

The results have been mixed, and researchers have not found an answer to whether responsible investing can generate excess returns. However, according to researchers and analysts, ESG reporting by companies is becoming more and more valued as stakeholders are increasingly interested in responsible companies. Prompt publication of sustainability information is essential for companies' financial performance, as it is the most visible and appreciated by stakeholders. This will improve the market value and profitability of the firm in the long run. (Imlak, 2022) Sinha Ray and Goel (2024) showed that ESG disclosure has a positive relationship with the annual returns of the firm in the long run in India. They found that investing in ESG reporting is reflected in firm returns with a lag. In countries where, for example, legislation, contract and trade law, judicial practices and institutions do not operate at the same level as in Nordic countries or the US, ESG scores have a significant impact on a firm's cost of capital. When companies invest in governance rather than environmental and social factors, the cost of capital of the company decreases (Priem, 2024).

There is a carbon premium, and it is clearly visible. However, the carbon premium disappears if the amount of CO2 emissions relative to the size of the company and the source of CO2 emissions are considered. If the co2 figure used is the number of emissions estimated by the data provider, a carbon premium occurs, but the carbon premium does not occur if the pollution is measured using unscaled figures reported by the company. (Aswani, 2024) Bolton and Kacperczyk (2024) were along the same lines in their study, believing that absolute co2 emissions are more relevant to investors than scaled emissions. Moreover, Bolton and Kacperczyk (2024) show that green stocks have outperformed brown stocks in the G7, despite an increase in the carbon premium since the Paris climate agreement, as they noted four years earlier (Bolton, 2020). They also found that during the energy crisis, brown stocks outperformed green stocks in terms of returns.

4 Data and methodology

This chapter discusses the empirical data used in the thesis, the data collection and the portfolios, how those are constructed.

4.1 Data collection

The thesis has been carried out as a quantitative study. The study compared the performance of three portfolios against the market index and against each other, from the beginning of January 2009 until the last day of December 2022. All data used in the thesis were obtained from the Refinitiv workspace and from the Kenneth French data library, where the data were used to run the regressions. Data processing for the thesis was carried out using Microsoft Excel software. The calculation of the significant figures has been carried out using Microsoft Excel and the regressions have been carried out using Stata. The regressions in Stata are performed with Newey-West standard errors. The Newey test considers any heteroskedasticity and autocorrelation in the regression and handles any related automatically (Stata 2024).

4.2 Risk free return

The risk-free interest rate used in this paper is taken from the Kenneth French Data Library. The risk-free rate used is the 1-month U.S. Treasury bill (figure 1), which is also risk-free rate in the Fama & Franch factor model. Assets that offer risk-free returns are generally considered to be treasury notes issued by highly rated sovereigns, as it is assumed that the sovereigns will be able to repay the capital they have borrowed. A risk-free rate of return describes the rate of return, which is the maximum return that can be earned on securities without the risk of default. The risk-free rate is used as a benchmark in economic and financial market studies. In this thesis, the risk-free rate is needed to calculate the ratios and regressions presented in the next section on excess returns.

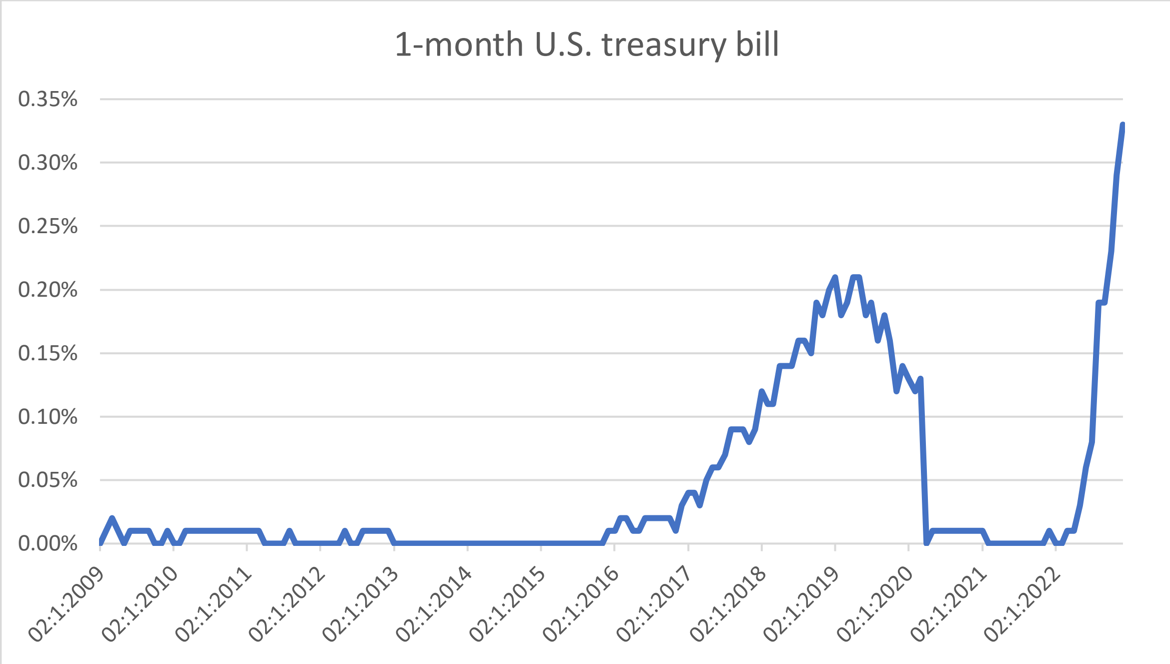

Figure 1. Risk-free rate from 1-month U.S. treasury bill.

4.3 Construction of portfolios

This section discusses how all three portfolios Green, Brown and Sin were constructed. It also describes exceptional cases where the numerical criteria for constructing the Green and Brown portfolios have been relaxed because moral choices have had to be made to respect the original idea of sustainability and ESG investing.

The portfolios are actively managed, with a rotation of stocks according to defined numerical criteria each year. Stocks are selected for the portfolios according to the scores of the previous financial year and the monthly returns on the stocks over the sample period have been used to construct the total portfolio return for the study period. Given the large size of the US market, the number of stocks in the portfolios could be increased to 30 to minimize asymmetric risk through a broad diversification.

4.3.1 Green portfolio

The Green portfolio is constructed based on ESG scores. This portfolio includes the 30 companies with the highest ESG scores, headquartered in the United States. As the companies are selected based on ESG scores, a "best in class" screening strategy has been applied. As the study is building two other portfolios with a basis that is not in line with responsible investment, the Green portfolio has also had to use an ESG integration methodology. The ESG integration method has been used in situations where the company clearly belongs more to the Brown or Sin portfolio, such as oil companies or tobacco companies. The portfolios are constructed according to the ESG score of the previous year. The portfolio is actively managed, so the Best in Class and ESG integration methods have been used each year to ensure that the portfolio meets the criteria set for it. The weighting of the companies in the portfolio is evenly distributed, i.e. each stock has a weight of 3.33% in the portfolio. The equal weighting of the stocks is based on the idea of diversification in portfolio theory in order to remove as much as possible unsystematic risk from the portfolios.

The ESG score is derived from the Refinitiv workspace. LSEG uses over 750 ESG metrics to generate ESG scores. These metrics are manually reviewed by analysts and algorithms for each company. These metrics go through a thorough process to standardize the data, make it comparable with other companies and ensure that the data quality is as close to 100% as possible. The scoring is made up of three main pillars: environment, society and governance. The pillars are weighted by sector, so they are normalized into percentages that make up a company's ESG performance, i.e. a score from 0 to 100. The LSEG uses only publicly available data, so the ESG score reflects the performance and efficiency of the company based on publicly available data. A company with a score of 0 < score <= 25 has a poor relative ESG performance and insufficient transparency in ESG reporting. With a score of 25 < score <= 50, transparency in ESG disclosure is moderate and relative ESG performance is satisfactory. ESG performance is good, and transparency is above average when the company's ESG score is between 50 < score <= 75. With a score of 75 < score <= 100, the company shows high transparency on ESG information and excellent performance (LSEG, 2024).

Table 1 shows the average ESG scores of the Green portfolio by year. The table shows that the average ESG score of the portfolio has increased year on year. The increase has not been linear, but the rise in scores suggests that companies have been investing more in sustainability. During the period under review, the lowest ESG score was 73.24 in 2008, while the highest score was 95.16 in 2011.

Average ESG score Per year	
Year	**ESG score**
2008	80,29
2009	82,27
2010	82,78
2011	83,98
2012	82,21
2013	83,19
2014	82,89
2015	84,53
2016	85,18
2017	86,58
2018	86,72
2019	86,39
2020	88,22
2021	87,92

Table 1. Green portfolios average ESG score by years.

4.3.2 Brown portfolio

The Brown portfolio is based on total CO2 emissions. The 30 most polluting public companies in the United States are selected for the portfolio. The portfolio was constructed using a "best in class" methodology and an ESG integration methodology, but in reverse to find the most appropriate stocks for the metrics identified. ESG integration is used in cases where the company belongs to the Sin portfolio based on its sector of activity or where, from an environmental point of view, the pollution of the company is a lesser evil than if the sector did not exist (waste management). As in the Green portfolio, the weights of this portfolio are evenly distributed among the stocks each year.

Pollutant emissions are measured in this study by total CO2 Equivalent Emissions. Total CO2 Emissions includes direct emissions (scope 1) and indirect emissions (scope 2). Scope 1 refers to direct GHG emissions from a company's operations, while scope 2 refers to indirect emissions from a company's operations (LSEG, 2024). (LSEG, 2024) Scope 2 emissions are caused by a company's energy purchases, which are produced by another company (EPA, 2024). The measured greenhouse gas emissions are carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCS), perfluorinated compound (PFCS), sulfur hexafluoride (SF6), nitrogen trifluoride (NF3). Data from the Refinitive workspace follow the GHG protocol for all emission classifications by type (LSEG, 2024).

Table 2 shows the average of the portfolio's annual total CO2 emissions. The table shows that CO2 emissions have increased over the study period. The average total emissions have increased by 5 716 689,29 tonnes over the study period. The largest single polluting company produced CO2 emissions of 143 000 000,00 tonnes. The least polluting company in the portfolio produced total CO2 emissions of 1 442 379,00 tonnes in 2008.

CO2 Equivalent Emissions Total.	
Year	**Tonnes**
2008	18 940 613,86
2009	18 999 373,03
2010	21 192 721,90
2011	21 157 467,72
2012	21 266 628,83
2013	22 859 016,80
2014	21 138 325,37
2015	21 949 703,83
2016	21 604 920,03
2017	23 919 907,83
2018	26 997 723,01
2019	26 894 129,57
2020	25 696 814,62
2021	24 657 303,15

Table 2. Brown portfolios total CO2 equivalent emissions by years.

4.3.3 Sin portfolio

As in previous portfolios, the Sin portfolio will not be constructed using numerical indicators, but in a way that runs counter to the original idea of responsible investing. The portfolio will include companies active in sectors such as alcohol, tobacco, gambling, firearms/defense, adult entertainment and cannabis. The portfolio was constructed using the "negative screening" strategy of responsible investing, to identify stocks that one would want to invest in a way that goes against responsible investing. This portfolio had to be made passive and the target of 30 stocks could not be collected. For the period 2009-2013, only 19 companies were included in the portfolio. In 2014, 2019 and 2020, one stock was added to the portfolio. In total, there are 22 stocks in the portfolio. When selecting companies, moral/ethical choices have to be made, for example in the firearms/defense sector. No companies have been selected for the portfolio whose sector better reflects the hunting/outdoor sector.

5 Portfolio performance metrics

This chapter discusses the theoretical framework of the thesis. The creation of a theoretical framework and the opening of its background make it easier to follow and understand the results. The research methods used in the thesis, regression and risk-adjusted returns, are explained in this chapter.

The paper uses the 6-factor model extended by Fama and French (2018), which considers a wide range of market activities compared to the traditional CAPM. The second measure of risk-adjusted return used is the Sharpe ratio and the Skewness and Kurtosis adjusted Sharpe ratio (SKASR), which is an extended version of the traditional Sharpe ratio.

5.1 Fama-French 6-factor alpha

As discussed in Chapter 2, the CAPM is one of the most popular and widely used methods for studying the financial world. Since CAPM assumes a linear relationship between return and risk and takes into account only one sensitivity factor (beta), it does not adequately capture the functioning of the market. Thus, the 3-factor model, developed in 1992 by Fama and French, considers the beta, size and value factors when predicting portfolio returns. The size factor is called the SMB (small-minus-big) factor, which refers to the assumption that small firms generally outperform larger firms. A second addition to the factor model, the value factor, called the HML (high-minus-low) factor, considers the different book-to-market multiples of firms, since in the long-term firms with high multiples have on average performed better than firms with low book-to-market multiples. (Fama & French 1992) The formula for the 3-factor model is as follows:

$$R_p - R_f = \alpha_p + \beta_p\left(R_m - R_f\right) + S_p SMB + h_p HML + e_i$$

With,

$R_p - R_f$ = Portfolio excess return over the risk-free rate

α_p = Overall excess return explained by model

$R_m - R_f$ = Market excess return

β_p, S_p, H_p = Sensitivity of the Market-, SMB-and HML factors

SMB = Small-minus-big factors excess return

HML = High-minus-low factors excess return

e_i = Error term

In 2015, Fama and French make an extension to the previous 3-factor model, adding two sensitivity factors to the model. The factors are CMA (conservative-minus-aggressive) and RMW (robust-minus-weak). The CMA factor takes into account the investment levels of firms when comparing returns, thus comparing the differences in returns between high and low investing firms. The RMW factor, on the other hand, takes into account the profitability levels of firms, comparing returns between highly profitable and less profitable firms. After adding two additional measures of sensitivity to the 3-factor model, a new regression method, the 5-factor model, was created. (Fama and French 2015) The formula for the 5-factor model follows:

$$R_p - R_f = \alpha_p + \beta_p\left(R_m - R_f\right) + S_pSMB + H_pHML + R_pRMW + C_pCMA + e_i$$

With,

R_p, C_p = Sensitivity of the RMW and CMA factors

RMW = Robust-minus-weak factors excess return

CMA = Conservative-minus-aggressive factors excess return

The 5-factor model was extended in 2018 when Fama and French added the momentum factor (MOM), transforming the model into a 6-factor model. The momentum factor was already used in 1997 by Carhart, when the 4-factor model was used. The MOM factor is used to describe the difference in returns between firms that have done well in the past and those that have done badly in the past. The formula for the six-factor model is as follows:

$$R_p - R_f = \alpha_p + \beta_p(R_m - R_f) + S_pSMB + H_pHML + R_pRMW + C_pCMA + M_pMOM + e_i$$

With,

M_p = Sensitivity of the MOM factor

MOM = Momentum factors excess return

The regression model is includes the alpha (α_p) intercept. When alpha is statistically significant and positive, the portfolio has generated excess returns that can not be explained by other factors. If the alpha is negative, the portfolio has underperformed the market. If alpha is not statistically significant, the return is explained by the model.

5.2 Sharpe ratio and SKASR

5.2.1 Sharpe ratio

Developed by Sharpe (1966) and named after him, the Sharpe ratio measures the risk-adjusted rate of return, capturing the relationship between portfolio returns and volatility. In other words, it assesses how well a portfolio has performed relative to its risk (Sharpe, 1966). More specifically, the excess return from unsystematic risk is related to volatility (Vaihekoski, 2004). Excess return is the difference between the portfolio return and the risk-free return. The higher the Sharpe ratio, the better the portfolio has performed in terms of risk-adjusted return (Kallunki et al. 2019, p. 333). A higher number means a lower risk, so you can achieve the same return as a market portfolio, but with lower risk. The Sharpe ratio is calculated using the following formula:

$$\text{Sharpe Ratio} = \frac{R_p - R_f}{\sigma_p}$$

With,

R_p = Return of the portfolio

R_f = Risk free rate

σ_p = Standard deviation of the portfolios excess return

The size of the Sharpe ratio is heavily influenced by the risk-free rate and volatility. The higher the risk-free rate, the lower the excess return, and this greatly affects the Sharpe ratio (Bodie et al, 2017). The magnitude of the standard deviation also has an impact on the final value. Standard deviation as a measure of risk may oversimplify the risk-adjusted return (Pätäri, 2011). Since standard deviation is calculated on the basis of an outcomes, it also considers positive outcomes, i.e. increases in value, which is not a risk-increasing element for the investor. The Sharpe ratio has therefore been criticised as a measure of risk-adjusted return because it does not consider the skewness of standard deviations (Pätäri 2008). It can also be questioned whether volatility is the right measure of risk, as it is based on the behaviour of investors in the market.

5.2.2 SKASR

Although the Sharpe ratio has been widely used as a measure of risk-adjusted return for more than 50 years (Pätäri 2011), its extension (Skewness and Kurtosis adjusted Sharpe ratio) has become an important measure of risk-adjusted return alongside the traditional Sharpe ratio. Since the traditional Sharpe ratio does not take into account the shape of the distribution of returns, but assumes that it follows a normal distribution, the results may be misleading. Since the Sharpe ratio penalises the portfolio for high positive returns, the SKASR formula presented by Pätäri (2011) also takes into account possible asymmetries in the return distribution. The SKASR does not penalize the portfolio for positive returns that deviate from the mean. The calculation of the SKASR values starts with an estimating of the approximate critical probability value based on the actual distribution. The estimation formula is as follows:

$$Z_{CF} = Z_C + \frac{1}{6}(Z_C^2 - 1)S + \frac{1}{24}(Z_C^3 - 3Z_C)K - \frac{1}{36}(2Z_C^3 - 5Z_C)S^2$$

With,

Z_C = The critical probability value based on nominal distribution

S = Skewness

K = Kurtosis

In order to proceed with the calculation of SKASR, the next step is to calculate Skewness and kurtosis for critical probability value formula, which have the following formulas:

$$S = \frac{1}{N}\sum_{i=1}^{N}\left(\frac{R_{it} - \bar{R}_i}{\sigma}\right)^3$$

$$K = \frac{1}{N}\sum_{i=1}^{N}\left(\frac{R_{it} - \bar{R}_i}{\sigma}\right)^4 - 3$$

With,

N = Number of outcomes

$\bar{R}_i =$ average return

Once we know the skewness and kurtosis, we calculate their deviation SKAD (skewness and kurtosis adjusted deviation), whose formula is as follows:

$$\text{SKAD} = \sigma \frac{z_{CF}}{z_C}$$

With,

$\sigma =$ Volatility

Once the SKAD is calculated, it can be used in the Sharpe ratio formula in place of volatility. This gives the formula for SKASR. This formula eliminates the problem of measuring negative excess returns that occurs in the traditional Sharpe ratio (Israelsen 2005).

$$\text{SKASR} = \frac{R_p - R_f}{SKAD_p^{(\frac{ER}{|ER|})}}$$

With,

R_p = Return of the portfolio

R_f = Risk free rate

SKAD = Skewness and Kurtosis-Adjusted Deviation of portfolio's monthly excess returns

ER = Average excess return of portfolio

When the standard deviation is replaced by SKAD, the new formula also takes into account the distribution of returns. If the distribution is skewed to the right, i.e. there are more positive months, the portfolio may be performing better than the Sharpe ratio suggests (Pätäri 2011). In this case, the SKASR takes on a higher value than the Sharpe ratio. If SKASR and Sharpe ratio have the same value, returns are normally distributed.

Statistical differences between the Sharpe ratios of portfolios can be examined using the Z-test developed by Jobson-Korkie (1981) and modified by Memmel (2003) into the following formula:

$$\text{Z} = \frac{\hat{S}h_i - \hat{S}h_n}{\sqrt{\hat{V}}} = Z_{JK}$$

With,

$\hat{S}h_i$ *and* $\hat{S}h_n$ = Sharpe ratios of portfolios n and n

$\hat{V}$ = Asymptotic variance of sharpen ratio difference

$\hat{V}$ is calculated as follow:

$$\hat{V} = \frac{1}{T}\left[2 - 2\rho_{in} + \frac{1}{2}(Sh_i^2 + Sh_n^2 - Sh_i Sh_n \rho_{in}^2)\right]$$

With,

T = Number of periodic returns within a sample period

ρ_{in} = correlation of the portfolio returns

ρ_{in} is calculated as follow:

$$\rho_{in} = \frac{\sigma_{in}}{\sigma_i \sigma_n}$$

6 Results

This section examines the results obtained. The results are examined using three different investment strategies. First, the total returns of all portfolios over the period are examined. Portfolio returns are compared with each other and with the S&P 500 index. Finally, the total returns are examined by looking at a fiqures showing how the portfolios have behaved during a major global event (COVID-19). Next, investment strategies are compared using annual geometric returns and volatility. The portfolios are then compared using risk-adjusted returns. Finally, Fama & French 6-factor regressions are estimated for the portfolios.

6.1 Total returns

Figure 2 shows the evolution of the Green portfolio over the period under review, starting from 1,000 USD investment. The benchmark is the total return of the S&P 500 index over the same period. The Green portfolio has outperformed its benchmark index throughout the period. Looking at the total return curve, it is evident that the Green portfolio closely follows the curve of the S&P 500. For example, the Green portfolio clearly shows larger changes during the COVID-19 decline in 2020 and the sharp rise thereafter. The total return on the S&P 500 over the 14-year period has been 5628,46 USD (462.85%). The total return of the Green portfolio at the end of 2022 was 8061,06 USD (706.11%), outperforming the benchmark index by 243.26 percentage points. During the period under review, both the Green portfolio and the S&P 500 index were below 1,000 USD at the beginning of 2009. The Green portfolio was below starting investment for only the first three months, and the S&P 500 for the first four months.

The Green portfolio rose very steadily from the beginning of the period under review until mid-2015, followed by a six-month period of flat growth. Since then, the rise has been steeper than before. There was a slight decline in 2018, and the total return record was only broken in February 2019. In December 2019, the Green portfolio and the S&P 500 made their review period records, just before the COVID-19 crisis. Between 2020 and 2022, the portfolio reached a new peak point of 8532,00 USD, after which it experienced another significant drop to 6850,00 USD. This was followed by a sharp rise, bringing the final total return of the portfolio for the period under review to 8061,06 USD.

Figure 2. Cumulative return of one-thousand-dollar investment in the Green portfolio between 2009-2022

Figure 3 shows the performance of the Brown portfolio and compares it to the S&P 500 index from a starting value of one thousand USD. The figure indicates that the Brown portfolio has underperformed the S&P 500 index over the period under review. The total return curve also does not track the index as closely as the Green portfolio does. However, the Brown portfolio is not countercyclical to the index. While the S&P 500 index had a total return of 5628,46 USD (462.85%) at the end of 2022, the Brown portfolio had a total return of 5118,35 USD (411.84%), thus losing was 51.01 percentage points to the S&P 500 index. The Brown portfolio was below one thousand USD for the first three months of the period under review, as was the Green portfolio.

Looking at the total return curve in figure 3 for the Brown portfolio, we see that the portfolio slightly outperformed the index for the first 6.5 years, until the total return of the portfolio fell below that of the S&P 500. The Brown portfolio outperformed the index from December 2016 to September 2018, after which the S&P 500 index has outperformed the Brown portfolio. The beginning of 2019 saw a 13-month period where the Brown portfolio performed countercyclically to the S&P 500 index. The S&P 500 rose from early 2019 to early 2020, while the Brown portfolio fell over the same period. In March 2020, the Brown portfolio experienced a significant decline, bringing its total return to 1828,00 USD which corresponds to a total return of 82.80%, making the review period 11 years and 2 months. After the Covid-19 crisis began, the Brown portfolio made a substantial increase to the end of the review period, with the portfolio reaching 5118,00 USD. This means portfolios the total return increased by 329.04 percentage points, a 397.29% increase over 21 months.

Figure 3. Cumulative return of one-thousand-dollar investment in the Brown portfolio between 2009-2022

The total returns of the Sin portfolio and the S&P 500 in terms of index points are shown in Figure 4. The figure illustrates that the Sin portfolio has outperformed the S&P 500 index over the period under review. Like the Green and Brown portfolios, the Sin portfolio had a return of less than invested one thousand USD during the first three months, but the total return over the rest of the period has been positive. Throughout the period under review, the Sin portfolio has consistently outperformed the benchmark index. For the first 14 months, the difference between the total returns of the portfolio and the index was low, but thereafter, the difference has been significant, as shown in Figure 3. The total return of the portfolio at the end of 2022 was 9249,43 USD (834.94%). The difference between the Sin portfolio's total return and that of the S&P 500 index is 372.09 percentage points.

By comparing the changes in the curves in Figure 4, we can see that the Sin portfolio does not track the S&P 500 index as closely as the Green portfolio does. The curve also shows that the Sin portfolio has experienced larger changes in total return, indicating more volatility than the benchmark index. This volatility has increased from 2018 onwards. After the fall following the COVID-19 crisis in March 2020, the Sin portfolio rose by 7145,92 USD over 15 months, reaching a peak performance of 12378,80 USD over the period under review. Over the same period, the S&P 500 rose by 2528,00 USD. The Sin portfolio increased by 136.58% over 15 months, while the S&P 500 increased by 69.72%. When comparing the peak performance of the portfolio and the S&P 500 over the period under review, it is observed that the final total return compared to the peak is clearly lower for the Sin portfolio than for the benchmark index.

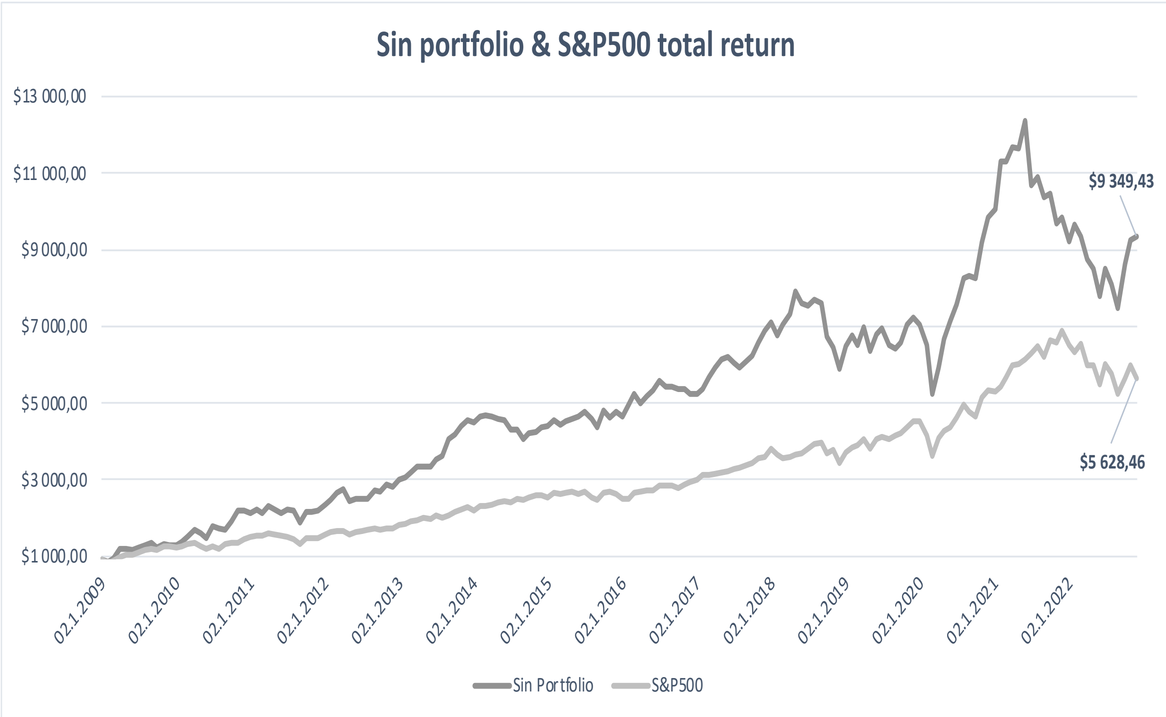

Figure 4. Cumulative return of one-thousand-dollar investment in the Sin portfolio between 2009-2022

Figure 5 shows the total returns for the Green, Brown, and Sin portfolios starting from 1,000 index points in January 2009. The curves move very steadily upwards until mid-2011, after which the gap between the Sin portfolio and the other portfolios increases. The Green and Brown portfolios rise at a very similar pace until mid-2018, after which the total return on the Brown portfolio falls and the total return on the Green portfolio rises. In the same year, the Sin portfolio shows a clear decline, after which the portfolio index score remains between 6000,00 and 7000,00 USD. The deepest fall of the COVID-19 crisis in March 2020 brought the total return of the Sin portfolio close to that of the Green portfolio. All portfolios recovered quickly from the decline, but the total return of the Brown portfolio remained much lower than the total returns of the Sin and Green portfolios. After the start of the Ukraine war in February 2022, the Brown and Green portfolios showed a clear decline in the uptrend, but the Sin portfolio was already in a significant decline before the war started.

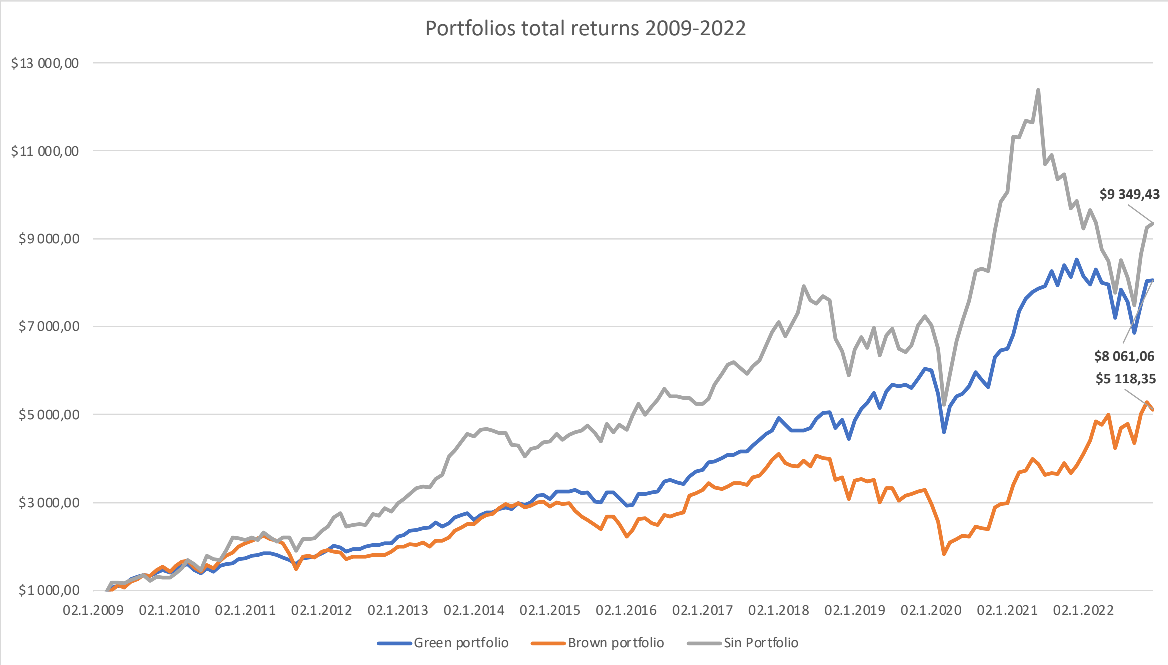

Figure 5. Cumulative return of one-thousand-dollar investment in the Green-, Brown- and Sin portfolios between 2009-2022

Table 1 shows the annualized total returns for all portfolios and the S&P 500 index over the period from 2009 to 2022. The Sin portfolio's total return has outperformed the other portfolios and the benchmark index. The Sin portfolio has had a total return of 834.94% and an annualized return of 17.31%, more than double the return of the Brown portfolio and almost double the return of the S&P 500 index. The volatility of the Sin portfolio is much higher than the S&P500 index, but slightly lower than the Brown portfolio. The difference between Sin and the S&P500 is 7,12 percentage points, compared to 2,0 percentage points for the Brown portfolio. The Green portfolio has a total return of 706.11% and an annualized return of 16.08%, significantly better than both the Brown portfolio and the S&P 500. While the Green portfolio has clearly outperformed the benchmark index, its total return has underperformed the Sin portfolio by 128.83 percentage points. The volatility difference between the Green portfolio and the benchmark index is 1,31 percentage points, which is close to the benchmark index given the much higher total returns. The volatility difference between the Green and Brown portfolios is a large 7,81 percentage points, especially when the return differential is taken into account. The Brown portfolio's total return over the 14-year period was 411.84%, with an annualized return of 12.37% per annum. Although the

Brown portfolio has performed well in a historical context, it has underperformed both the Sin and Green portfolios by a wide margin and underperformed the benchmark index, which has a total return of 462.85% and an annualized return of 13.14%. The Brown portfolio has the highest volatility in the benchmark group, which means it can be considered the riskiest portfolio. Given the portfolio's performance against its peers, it can be said to have high volatility.

Annual	Green	Brown	Sin	S&P500
Total return	706,11 %	411,84 %	834,94 %	462,85 %
Average Return	16,08 %	12,37 %	17,31 %	13,14 %
Volatility	16,70 %	24,51 %	22,51 %	15,39 %

Table 3. Returns and risks of all portfolios and benchmark index.

When comparing the portfolios in terms of total return, the so-called raw return, the following observations can be made. The Sin portfolio has significantly outperformed the other portfolios over the period under review. The Sin portfolio also shows the most volatility in the second half of the period. Due to this high volatility, it can be said that the Sin portfolio appears to be the riskiest in terms. But during the survey period, the volatility of the Sin portfolio has not been the highest. The Green portfolio also has a high raw return, but it fluctuates much less than the Sin portfolio. Although the Green portfolio has a lower return, it can be considered the least risky in terms. The Brown portfolio's total return is below the benchmark index and underperforms the previous two portfolios. The Brown portfolio is also more volatile than the Green and Sin portfolio, so based on raw return, the Brown portfolio can be considered the worst performing and most risky.

6.2 Sharpe ratio

This chapter examines the risk-adjusted returns on portfolios in the thesis. The risk-adjusted return measures used are the Sharpen ratio and the SKASR, which is an improved version of the traditional Sharpen ratio.

6.2.1 Sharpe ratio

Table 4 shows the Sharpe ratios and SKASR (Skewness and Kurtosis Adjusted Sharpe Ratio) for all portfolios and the benchmark index. Looking at the Sharpe ratios, it can be seen that the Green portfolio is the best performer in terms of risk-adjusted returns. The Green portfolio has a Sharpe ratio of 0.952, only slightly higher than the benchmark S&P 500, which has a Sharpe ratio of 0.940, only 0.012 higher. According to risk-adjusted returns, investing in the Green portfolio would have given the investor a better return compared to investing in the S&P 500 index. The best-performing Sin portfolio in terms of total return did not match the Green portfolio, nor the benchmark index, in terms of Sharpe ratios due to its high volatility. With a risk-adjusted return ratio of 0.803, the Sin portfolio underperformed the benchmark index by 0.137. This means that a higher return requires a higher risk tolerance than investing in the Green portfolio or the S&P 500 index. The worst-performing Brown portfolio in terms of total return also clearly underperformed the other portfolios in terms of risk-adjusted return. The Brown portfolio has a Sharpe ratio of 0.583, which is well below those of the other benchmark portfolios and the index. The lower return of the Brown portfolio, combined with high volatility, further reduces the risk-adjusted return. Even with the Sharpe ratio, investors in the Brown portfolio have to tolerate a higher level of risk compared to the benchmark index and the other portfolios. Although there are relatively large differences between the portfolios, all Sharpe ratios are positive, suggesting that it would have been worth taking the risk by investing in these portfolios compared to risk-free investments.

Annual	Green	Brown	Sin	S&P500
Sharpen	0,952	0,583	0,803	0,940
SKASR	0,872	0,503	0,812	0,856
signif.	0,426	0,056	0,968	

Table 4. Risk-adjusted metrics of all portfolios and benchmark index.

6.2.2 SKASR

Table 2 above shows the SKASR figures for the portfolios and the benchmark index. Note that the SKASR values are lower than the Sharpe values for all but the Sin portfolio, whose SKASR value is 1.12% higher than its Sharpe value. The difference in portfolio performance compared to the market is not statistically significant, as the significance level is 96.8 %. With a SKASR higher than the Sharpe figure, the Sin portfolio can be expected to offer a better risk-adjusted return than the Sharpe figure suggests. The higher SKASR for the Sin portfolio means that the monthly returns are more likely to be higher. However, the difference is very small.

The Green portfolio's SKASR is 9.17% lower than its Sharpe figure, and the benchmark S&P 500 index has dropped by 9.81%. The Green portfolio's significance level against the market is 42.6%. This exceeds the 5% and 10% significance levels. Statistically, there is no significant difference in performance between the Green portfolio and the market.

The difference between the Sharpe figure and the SKASR for the Brown portfolio is 15.9%, which is the largest relative difference. Since the Green and Brown portfolios' SKASR values are lower than their Sharpe numbers, it means that the distribution of monthly returns is negatively skewed, i.e., there are more large loss months in the observations. The significance level for the Brown portfolio is 5.6% against S&P 500 index, which is very close to the 5% threshold. However, it cannot be said that the difference in performance of the Brown portfolio versus market returns is statistically significant, but if the 10% significance level is used, it can be said to be statistically significant. Since the Brown portfolio has had a larger decline, it means that the Brown portfolio has more large loss months than the Green portfolio. The lower the SKASR relative to the Sharpe ratio, the higher the investor's risk relative to the expected return.

The pairwise differences in performance between the Green and Sin portfolios and between Brown and Sin portfolios are not statistically significant, whereas that between the Brown portfolio and the Green portfolio is significant at the 5% risk level.

Because the relative drops in SKASR for the Green portfolio and the S&P 500 have been very close, as have the Sharpe ratios themselves and the SKASRs, it can be said that the Green portfolio's risk-adjusted returns are very close to those of the benchmark index. By investing in the Green portfolio, the investor has to tolerate higher volatility for higher total returns.

6.3 Results of the 6-factor regressions

Table 5 shows the results of the regression of the Fama-French-Carhart 6-Factor model for the Green portfolio and the R-squared for the entire period under review. The regression of the Green portfolio resulted in a significant alpha at the 5% significance level with a p-value of 0.03. The alpha of the portfolio is also positive (0.00195). When the alpha receives a positive coefficient value and is statistically significant, the portfolio outperforms against the employed asset pricing model. The 6-Factor model also yields statistically significant p-values for the MktRf, HML, and RMW factors. The slope of the market risk factor is very close to 1 (0.962028), which means that the portfolio moves almost in line with the market risk factor. The coefficients of the HML factor and the RMW factor are 0.1049016 and 0.2014825, respectively, which are clearly positive. The R-squared of the Green portfolio is 0.9265, which means that the explanatory power of the model is very high, explain about 93% of the portfolio's volatility.

The regression run on the Brown portfolio using the 6-Factor model can be seen in table 5. The alpha for the Brown portfolio is not statistically significant, as it was assigned a p-value of 0.681. Since the alpha is not statistically significant, it means that the portfolio has not outperformed against the employed asset pricing model according to the model's predictions based on the model's factors. The MktRf, SMB, HML, and Mom factors in the model had statistically significant p-values. The coefficient of the market risk factor is 1.126156, which means that as the market risk factor increases, the portfolio rises slightly more in relative terms. The coefficients of the SMB and HML factors are also positive, indicating that the slope is increasing, and these factors also affected portfolio movements. The slope of the momentum factor is negative, which means that on average, the portfolio's return has moved in the opposite direction to the momentum factor. The R-squared is 0.824, so the explanatory power is good, and the model can explain about 82% of the portfolio's variation.

The Sin portfolio also receives an insignificant alpha in table 5, as the p-value is 0.138, suggesting that, according to the model's factor forecast, the portfolio would not have outperformed against the employed asset pricing model over the period considered. The regression model gives statistically significant p-values for only two factors, but they are strongly significant. MktRf has a p-value of 0 and a coefficient of 0.9069436, and SMB has a p-value of 0.001 and a coefficient of 0.6082316. The portfolio has moved very similarly to the market risk factor, as its slope is close to one. The model's explanatory power, or R-squared, is 0.5997, which is clearly lower than the other portfolios. Since the model can only explain about 60% of the portfolio's variation, it can be said that the model does not fit the portfolio data as well as it has fit previous portfolios.

**** = Statistically significant at 99 %*
*** = Statistically significant at 95 %.*
**= Statistically significant at 90 %*

6 Factor-Model			
Regression with Newey-West standard errors			
	Green	Brown	Sin
Factors	Coefficient		
Alpha	0,002 **	-0,001	0,004
MktRf	0,962 ***	1,126 ***	0,907 ***
SMB	0,025	0,327 ***	0,608 ***
HML	0,105 **	0,459 ***	-0,085
RMW	0,201 **	0,124	0,189
CMA	0,130	0,232	0,093
Mom	-0,059	-0,122 **	-0,084
Adjusted R-squared	0.9238	0,8174	0,5848

Table 5. Fama & French 6-factor regression models result for all portfolios.

The regressions show that the green portfolio has clearly been the most successful, when observing the statistical significance of alpha, and the 6-factor model has been the best predictor of its movement and has had the best explanatory power. In absolute alpha terms, the sin portfolio has performed best. The Brown portfolio's movement is well explained by the regression model, and the data fits the model much better than the Sin portfolio, for which the explanatory power of the model is lowest. When comparing the results of the portfolio regressions and the total portfolio returns to the S&P 500, it can be said that the results for the Green and Brown portfolios are in the same direction, but the regression for the Sin portfolio provides a different picture of the portfolio's performance over the period under review.

7 Conclusions

This chapter reviews the research questions set out in the first chapter and answers the questions of how the portfolios have performed, based on the results of the thesis. A summary based on the null hypothesis of the thesis is also presented. Finally, the thesis is discussed from a critical perspective and further research proposals are presented.

The thesis was based on a comparison of three investment strategies from a responsible investing perspective, with an active portfolio of high ESG scores that was actively managed, with each year containing the thirty best performing US companies in terms of ESG scores in the previous year. To compare sustainability, we wanted to construct two non-responsible portfolios to make the contrast as stark as possible.

7.1 Answers to research questions

Question 1. Is it possible for investment strategies to outperform the market index in terms of total return and risk-adjusted returns?

The answer to the first research question on the Green Portfolio is yes. At the end of the study period, the portfolio had clearly outperformed the benchmark S&P 500. The Green portfolio outperformed the benchmark index for most of the study period. For the first non-responsible portfolio, the answer to the research question is negative. The Brown portfolio yielded less than the benchmark index during the sample period. The portfolio did not significantly outperform the benchmark index over the long term. The Sin portfolio clearly outperformed the benchmark index in terms of total return throughout the study period. However, all the active portfolios had higher volatilities than the benchmark index. Investors in non-responsible portfolios would have had to endure significantly higher volatility of their investments. The Green portfolio is the only one with risk-adjusted returns above the benchmark index, but not significantly so. It can be said that the green portfolio has not outperformed in terms of risk-adjusted returns, but has narrowly outperformed the benchmark index, so it can be said that a high ESG scoring strategy does not underperform the market.

Question 2. Does the green portfolio outperform the brown portfolio?

The Green portfolio clearly outperformed the Brown portfolio in terms of total return. The portfolios' returns were very similar until 2014, with only one major difference in returns in 2011, when the Brown portfolio briefly exceeded the Green portfolio's return. Since 2014, the green portfolio has significantly outperformed the Brown portfolio. After 2019, the total return gap widened substantially and by the end of the sample period, the green portfolio had returned USD 2942.71 more than the Brown portfolio with an initial investment of USD 1,000.

Question 3. Has the social and political climate boosted returns on responsible stocks and depressed returns on sin stocks?

As the third chapter of the thesis shows, the world has moved in a more responsible direction, and the social and political climate is morally very judgmental towards companies operating in sin industries. Despite this, in terms of total return, the Sin portfolio has outperformed the Green portfolio throughout the period. Towards the end of the sample period, the total returns of the portfolios were close, but by the end, the Sin portfolio had a total return of $1,288.37 higher, with an initial investment of $1,000.

Question 4. Does a responsible portfolio outperform irresponsible portfolios with risk-adjusted returns?

Responsible investing has provided a risk-adjusted return over the sample period, and the risk-adjusted return was very similar to the benchmark index. However, the risk-adjusted return of the responsible portfolio was clearly higher than the risk-adjusted return of the Brown and Sin portfolios. The risk-adjusted return of the Brown portfolio was clearly lower than that of the Responsible portfolio. Although the risk-adjusted return of the Sin portfolio has also been less than that of the Green portfolio, the difference is not nearly as large as between the Brown and Green portfolios. A high total return does not always mean a good risk-adjusted return.

Question 5. Does the portfolio show statistically significant deviations over the course of the study?

Responsible and non-responsible investing strategies were first compared on total returns and risk-adjusted returns, then the performance of the portfolios was further examined using the Fama & French 6- factor model to examine the factor positions of the portfolios.

The Green portfolio is the only portfolio with a significant alpha at 3% risk level. However, this level of significance is not academically significant. The alpha is close to zero anyway, so it can be said that the green portfolio has not produced abnormal returns. The market risk factors for all portfolios were statistically significant, and all portfolios follow closely the market risk factor. For the Green portfolio, the RMW factor was statistically significant and positive, but only slightly, so the relative impact on returns is small. For the Brown portfolio, in addition to the market risk factor, the SMB (Small Minus Big) factor and the HML (High Minus Low) factor had a statistically significant effect. Movements in these factors have a clear positive impact on portfolio movements. The MOM (Momentum) Factor was slightly negative for all portfolios, but the Brown portfolio is the only one with a significant result, but the significance is not sufficient for academic research. The regression of the Sin portfolio yielded the least statistically significant factors across the sample period. As mentioned above, the portfolio tracks movements in the market risk factor closely. In addition, portfolio movements are also significantly affected by the SMB factor, which was statistically significant.

7.2 The validity of the null hypothesis

H_0: *"The markets are efficient, and thus ESG or irresponsible investing strategies cannot provide abnormal returns for an investor."*

For the Green portfolio and the Sin portfolio, it can be said that the zero hypothesis does not hold for total return. In terms of risk-adjusted returns, the null hypothesis remains valid because the portfolios have not produced abnormal returns compared to the market index and both returns are strongly linked to the market risk factor. When looking at total return and risk-adjusted returns, the Brown portfolio has underperformed the benchmark index, so the null hypothesis does hold. Over the 2009-2022 period, investing in stocks with high ESG scores has allowed to outperform the market, but has had to endure more severe risk. Investing in sin stocks has also allowed for outperformance of the market in terms of total return at a higher risk, so this portfolio cannot be said to have produced abnormal returns either. By investing in the most polluting companies, the investor may have received negative carbon premiums, as the total return and risk-adjusted return have been well below the market.

7.3 Research criticality and future research

The time period used in the study is 14 years, starting in January 2009, as this is the point at which the economy has almost returned to its most normal level since the 2008 financial crisis, January and February 2009, however, were negative months after the crisis. The time period of the study could be considered in several parts, in addition to the whole, because the Covid-19 crisis and the beginning of the Energy crisis coincide with the study period and these crises may have had a clear impact on the sectors of origin and on the energy sector, which is one of the most polluting industries. However, it is reasonable to question whether it is justified from a research perspective to focus the investment strategy study on a short time period where one investment strategy gains a competitive advantage due to an ongoing crisis, as the energy sector did during the energy crisis. It might be justified to study the same investment strategies from 2009 to the end of 2019, before the Covid-19 crisis.

Of the three portfolios formed in the study, 2 have been actively managed and one passive due to the small size of the sectors. This introduces a bias in the diversification of the portfolios, as the portfolio constructed using ESG scoring contained about ten times more companies throughout the study period than the passive sin portfolio.

As discussed in chapter 2 of the thesis, there are gaps in the standardization of responsible investment and there is no clear definition of how responsible investment should be studied. Although sustainability is a clear concept to many, it is not entirely certain how sustainability has been studied and thus how the research is comparable. In the study, companies were pruned from the green portfolio for moral reasons, even though the companies had high ESG scores, but the sectors did not meet the definition of responsible investing. The question can be asked how reliable ESG scores are. If a similar study is conducted but no moral choices are made, the results will be different, and the question can also be raised whether the studies are comparable.

As noted in the literature review, there are many different results on responsible investment and irresponsible investment. The study suggests that further research is needed to determine the merits of a responsible investment strategy, if the reason for ESG scores is to be determined. Is it possible that high returns are not the result of sustainability and high ESG scores, but high ESG scores are the result of good reporting achieved with good returns. When comparing a responsible investment strategy with an irresponsible investment strategy, it is important to remember that portfolio and stock returns are not mutually exclusive, and that morally conflicting industries or companies can thrive at the same time.

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APPENDIX

Appendix 1. Regression results Fama & French 6-factor model of Sin portfolio

Source	SS	df	MS			
Model	.423902809	6	.070650468	Number of obs	=	168
Residual	.282942211	161	.001757405	F(6, 161)	=	40.20
Total	.706845019	167	.004232605	Prob > F	=	0.0000
				R-squared	=	0.5997
				Adj R-squared	=	0.5848
				Root MSE	=	.04192

Sin	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
MktRF	.9069436	.0812917	11.16	0.000	.7464081	1.067479
SMB	.6082316	.148844	4.09	0.000	.3142934	.9021699
HML	-.0849537	.1412504	-0.60	0.548	-.363896	.1939887
RMW	.1887907	.1818662	1.04	0.301	-.1703602	.5479417
CMA	.0926344	.220546	0.42	0.675	-.3429016	.5281704
Mom	-.0838711	.0830307	-1.01	0.314	-.2478408	.0800986
_cons	.0040071	.0034262	1.17	0.244	-.002759	.0107732

Regression with Newey-West standard errors	Number of obs	=	168
Maximum lag = 3	F(6, 161)	=	59.05
	Prob > F	=	0.0000

Sin	Coefficient	Newey-West std. err.	t	P>|t|	[95% conf.	interval]
MktRF	.9069436	.0687853	13.19	0.000	.7711057	1.042781
SMB	.6082316	.1859059	3.27	0.001	.2411033	.97536
HML	-.0849537	.1218876	-0.70	0.487	-.3256583	.1557509
RMW	.1887907	.2410096	0.78	0.435	-.2871569	.6647384
CMA	.0926344	.2175956	0.43	0.671	-.3370751	.5223439
Mom	-.0838711	.1234726	-0.68	0.498	-.3277058	.1599635
_cons	.0040071	.0026862	1.49	0.138	-.0012977	.0093119

Appendix 2. Regression results Fama & French 6-factor model of Brown portfolio

Source	SS	df	MS
Model	.691109074	6	.115184846
Residual	.147617723	161	.00091688
Total	.838726797	167	.005022316

Number of obs	=	168
F(6, 161)	=	125.63
Prob > F	=	0.0000
R-squared	=	0.8240
Adj R-squared	=	0.8174
Root MSE	=	.03028

Brown	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
MktRF	1.126156	.0587173	19.18	0.000	1.0102	1.242111
SMB	.3273191	.1075107	3.04	0.003	.1150061	.5396321
HML	.4593715	.1020258	4.50	0.000	.2578902	.6608529
RMW	.1236515	.1313628	0.94	0.348	-.1357649	.3830679
CMA	.2323894	.1593014	1.46	0.147	-.0822003	.546979
Mom	-.1219318	.0599735	-2.03	0.044	-.2403679	-.0034957
_cons	-.0011506	.0024748	-0.46	0.643	-.0060377	.0037366

Regression with Newey-West standard errors
Maximum lag = **3**

Number of obs	=	168
F(6, 161)	=	98.80
Prob > F	=	0.0000

Brown	Coefficient	Newey-West std. err.	t	P>|t|	[95% conf.	interval]
MktRF	1.126156	.0660929	17.04	0.000	.9956352	1.256677
SMB	.3273191	.1131593	2.89	0.004	.1038513	.5507869
HML	.4593715	.1320161	3.48	0.001	.198665	.720078
RMW	.1236515	.1760131	0.70	0.483	-.2239406	.4712436
CMA	.2323894	.2050272	1.13	0.259	-.1724999	.6372787
Mom	-.1219318	.0562022	-2.17	0.032	-.2329203	-.0109432
_cons	-.0011506	.002791	-0.41	0.681	-.0066622	.004361

Appendix 3. Regression results Fama & French 6-factor model of Green portfolio

Source	SS	df	MS			
				Number of obs	=	168
				F(6, 161)	=	338.28
Model	.360288718	6	.06004812	Prob > F	=	0.0000
Residual	.028578861	161	.000177508	R-squared	=	0.9265
				Adj R-squared	=	0.9238
Total	.388867579	167	.002328548	Root MSE	=	.01332

Green	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
MktRF	.962018	.0258357	37.24	0.000	.9109976	1.013039
SMB	.0251031	.0473048	0.53	0.596	-.0683147	.1185209
HML	.1049016	.0448914	2.34	0.021	.0162497	.1935535
RMW	.2014825	.0577997	3.49	0.001	.0873391	.3156258
CMA	.1298811	.0700927	1.85	0.066	-.0085385	.2683007
Mom	-.0591891	.0263884	-2.24	0.026	-.1113011	-.0070772
_cons	.0019512	.0010889	1.79	0.075	-.0001992	.0041015

Regression with Newey-West standard errors	Number of obs	=	168
Maximum lag = 3	F(6, 161)	=	347.53
	Prob > F	=	0.0000

Green	Coefficient	Newey-West std. err.	t	P>|t|	[95% conf.	interval]
MktRF	.962018	.0259257	37.11	0.000	.9108197	1.013216
SMB	.0251031	.0432278	0.58	0.562	-.0602635	.1104697
HML	.1049016	.041416	2.53	0.012	.0231129	.1866903
RMW	.2014825	.0628709	3.20	0.002	.0773244	.3256405
CMA	.1298811	.0742656	1.75	0.082	-.0167793	.2765415
Mom	-.0591891	.0475398	-1.25	0.215	-.1530712	.0346929
_cons	.0019512	.0008911	2.19	0.030	.0001914	.003711