The Performance of European Low Carbon Mutual Funds:
Evidence from Sweden, Finland, and Denmark

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I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration.

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Resumo

Esta dissertação tem como objetivo investigar o desempenho dos fundos de investimento europeus socialmente responsáveis, nomeadamente os de baixo carbono, com foco nos seus retornos financeiros e conformidade com objetivos ambientais. Para tal foram selecionados fundos domiciliados na Finlândia, Suécia e Dinamarca, que investem globalmente. Desta seleção resultou uma amostra de 251 fundos. Cada fundo foi, então, categorizado consoante as suas emissões, nisto resultaram três carteiras – baixa, com 161 fundos, média, 77 fundos e alta, 13 fundos. O desempenho destas carteiras foi avaliado usando o modelo de cinco fatores de Fama and French (2015), no seu modo incondicional e condicional, o modelo de *timing* e seletividade de Treynor e Mazuy (1966) foi utilizado para avaliar a capacidade de seleção dos gerentes. Adicionalmente, analisamos o desempenho dos fundos para dois estados da economia (contração e expansão). Para tal, incluímos uma variável *dummy* no modelo de cinco fatores de Fama and French (2015), para distinguir entre os estados. A análise dos fundos é feita para o período de fevereiro de 2010 a junho de 2022.

Os resultados mostram que os fundos de baixo carbono têm um desempenho neutro ou negativo relativamente ao mercado, mas têm um desempenho semelhante aos fundos de alto carbono. Os resultados do desempenho não evidenciam que os gestores de fundos tenham capacidades de *timing* e seletividade. Adicionalmente, observa-se que os resultados não são afetados por diferentes condições de mercado da indústria do petróleo.

Palavras-chave: Avaliação de desempenho; Baixo carbono; Emissões; Europa; Investimentos Socialmente Responsáveis

Abstract

This dissertation aims to investigate the performance of European socially responsible mutual funds, specifically focusing on low carbon funds, with regards to their financial returns and environmental objectives compliance. To achieve this, funds domiciled in Finland, Sweden, and Denmark that have global investments were selected, resulting in a sample of 251 funds. Each fund was then categorized based on their carbon emissions, resulting in three portfolios - low (161 funds), medium (77 funds), and high (13 funds). The performance of these portfolios was evaluated using the Fama and French (2015) five-factor model, both in its unconditional and conditional forms. The Treynor and Mazuy (1966) timing and selectivity model was used to assess the managers' selection ability. Additionally, the performance of the funds during two economic states (contraction and expansion) was analysed by including a dummy variable in the Fama and French (2015) five-factor model to differentiate between the states. The fund analysis covers the period from February 2010 to June 2022.

The results show that low carbon funds either underperform the global market or show a neutral performance. Yet, there is no statistically significant difference between the performance of low carbon funds and their high carbon counterparts. We find no evidence of fund timing and selectivity capabilities. Furthermore, the fund performance does not significantly change in response to market fluctuations in the oil industry.

Keywords: Performance evaluation; Low carbon; Emissions; Europe; Socially responsible investments

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1. Introduction

Climate change is a key challenge of our time. The increasing awareness of the harmful effects of global warming has led, by mid-2000s, to a general international consensus on the urgency of mitigating climate change (Baiardi & Morana, 2021). The Paris Agreement, in 2015, represents an important milestone in this process, with 196 countries expressing their commitment to limiting the increase in global average temperature, below 2°C (ideally below 1.5°) pre-industrial levels and to 'making finance flows consistent with a pathway toward low greenhouse gas emissions and climate-resilient development[1]. Meeting these objectives requires decarbonizing the economy and accelerating investments in low-carbon technologies (Roberts et al., 2018). Because of this, policymakers and regulators increasingly recognize the potential role of financial markets in either accelerating a smooth transition to a lower-carbon economy or, by contrast, amplifying the systemic risks of climate change (Ceccarelli et al., 2023).

Although there has been an increase in government incentives to decarbonize, private investment has gradually been gaining ground as a source of capital. In this context, many investors wish to integrate sustainability criteria in their investments. This approach to investing - Socially Responsible Investment (SRI) - is generally defined as an investment approach that considers environmental, social, and corporate governance criteria in order to yield long-term competitive financial utility, as well as favourable societal effects (Ibikunle & Steffen, 2017). Low-carbon investments can be defined as a subset of SRI. Companies and enterprises that qualify as low carbon directly contribute to decarbonization and therefore produce low levels of greenhouse gas emissions.

A popular way to invest with sustainability criteria is through SRI funds. The offering of SRI funds has attracted many investors in the last years. According to the Global Sustainable Investment Alliance[2], at the start of 2020, global sustainable investment reached US$35.3 trillion in five major markets, a 15% increase since 2018. Furthermore, SRI funds have been following the decarbonization trend, since their exposure to black industries has fallen over time, according to

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[1] https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

[2] http://www.gsi-alliance.org/

the Global Fossil Fuel Disinvestment Commitments Database[3]. In fact, as of 2022, the divestment movement has mobilized divestment commitments of approximately US$40.77 trillion (value of institutions divesting), especially driven by divestment from fossil fuel industries (Muñoz, 2021). The growing concerns within the mutual fund industry regarding the impact of climate risks on corporations, particularly physical and transitional risks (Carney, 2015), have led many institutional asset managers to take actions to reduce the carbon footprint of their portfolios, as documented by Krueger et al. (2020). Decarbonization and climate change present new challenges for investors, portfolio managers, and academics. An ongoing discussion revolves around whether investors face a trade-off between minimizing climate risk exposure and maximizing the risk benefits of portfolio diversification in a world that has not yet fully transitioned to a low-carbon economy (Ceccarelli et al., 2023).

The concept of portfolio diversification, as outlined in modern portfolio theory, suggests that investors can optimize risk and return by spreading their investments across various assets with low correlations (Markowitz, 1952). However, when considering the integration of sustainability criteria, such as low carbon or environmental considerations, into investment strategies, concerns arise regarding potential limitations in achieving the proper level of diversification and risk management. SRI investments may appear to be less diversified compared to traditional investment approaches due to the exclusion of certain industries or companies that do not meet specific sustainability criteria (Derwall et al., 2005). Ceccarelli et al. (2023) address this trade-off between climate risk exposure and portfolio diversification. They analyse the impact of climate change on portfolio performance and highlight the challenges faced by investors in balancing risk management and sustainability goals. Their research findings contribute to the understanding of how climate risks and investment decisions interact in a not-yet-low-carbon world.

Besides the diversification issue, another argument supporting the underperformance of sustainable portfolios stems from the equilibrium theory of Pástor and Stambaugh (2021). The theory predicts that investors' preferences for green assets combined with the risk-hedging effect of such assets will result in a lower expected return.

However, despite the potential trade-off between SRI and portfolio diversification, the popularity of SRI investment products suggests that investors are still eager to generate financial

[3] https://divestmentdatabase.org/

returns while aligning their investments with their environmental and social values (Ibikunle & Steffen, 2017), and that there is a growing demand for investment opportunities that not only consider financial gains but also address sustainability concerns. Notably, the outperformance hypothesIs is not precluded by Pástor and Stambaugh (2021). In fact, even though their model anticipates the underperformance of green assets in a static setting, it also predicts that green assets can outperform brown assets when there are unexpected changes in consumers' and investors' towards greenness.

Therefore, the performance evaluation of low carbon mutual funds is crucial for several reasons. Firstly, it provides insights into the effectiveness of sustainable investment strategies in generating favourable returns. This information is valuable for investors seeking to balance financial gains with their environmental and social objectives. Additionally, it contributes to the broader understanding of the financial performance of low carbon investments, further promoting sustainable finance as a viable investment approach (Serafeim et al., 2018). In this context, this research aims to evaluate the performance of European low-carbon mutual funds, with a specific emphasis on funds based in Sweden, Finland, and Denmark. We also aim to investigate whether these funds exhibit market timing abilities and whether fund performance depends on the conditions of the oil industry.

The inclusion of Swedish, Finnish, and Danish funds in this analysis is motivated by the notable commitment of these countries to sustainability and renewable energy development. Sweden, Finland, and Denmark have consistently ranked among the global leaders in renewable energy generation and greenhouse gas emissions reduction efforts[4]. Consequently, the low carbon mutual funds in these countries are likely to exhibit unique characteristics and performance attributes, warranting a dedicated examination.

The primary objective of this dissertation is to assess the financial performance of low carbon mutual funds in Sweden, Finland, and Denmark. By conducting an analysis of the performance of these funds, we aim to determine whether low carbon investment strategies in these countries have the potential to generate competitive financial returns.

[4] https://ec.europa.eu/eurostat/web/products-eurostat-news/w/DDN-20230119-1

Although there are many studies on the performance of SRI funds, the literature is still sparse on the performance of funds with a low carbon footprint. For that reason, the research will cover a database of mutual funds that invest in low-carbon industries and evaluate their returns for a period of 12 years.

2. Literature Review

In this section, we will explore and analyse the existing research on Socially Responsible Investing, with a specific focus on Low Carbon Mutual Funds. We will delve into the definition and objectives of SRI, understanding its underlying principles and the motivations behind its adoption. Additionally, we will examine the concept and characteristics of Low Carbon Mutual Funds, exploring how these funds contribute to sustainable investing and the potential benefits they offer to investors.

Furthermore, this review aims to provide a comprehensive overview of the empirical studies conducted on SRI funds, with a particular emphasis on their performance, timing abilities and selectivity. Additionally, we will explore the extent to which SRI fund managers exhibit market timing abilities and stock-picking skills.

2.1. Definition of Socially Responsible Investing and low carbon mutual funds

SRI, also known as sustainable or ethical investments, refers to an investment approach that integrates environmental, social, and governance (ESG) factors into the investment decision-making process (Renneboog et al., 2008a). Although the conceptual origins SRI can be traced back to the early history of civilization, its modern roots can be found in the movements of the 1960s (Schueth, 2003).

One of the key objectives of SRI is to generate financial returns while simultaneously considering the social and environmental impacts of investments. This approach acknowledges that companies with strong ESG practices and responsible business models can outperform their peers in the long run (Clark et al., 2019). By incorporating ESG factors into investment analysis, SRI investors seek to identify companies that demonstrate strong financial performance alongside responsible business practices.

As for investors' motivations, Chatzitheodorou et al. (2019) find that, from an economic perspective, investors are primarily driven by the financial opportunities presented by environmental and social issues, rather than solely moral incentives. This perspective challenges the notion that investments in these areas are solely driven by ethical considerations. However, the authors also note that there are investors who genuinely prioritize the protection of society and the environment. This commitment is often reflected in their investment choices, such as implementing negative screening strategies that exclude specific business sectors like tobacco companies or the weapon industry (van Dijk-de Groot & Nijhof, 2015). The existence of investors with different motivations is also explored by Derwall et al (2011), who distinguish between values-driven and profit-driven investors. Notably, a stream of the literature documents investors' willingness to pay, consistent with investors being willing to pay a price for sustainable financial investments (e.g., Gutsche & Ziegler, 2019; Anderson & Robinson, 2022).

In line with societal concerns about climate change and the need to foster the transition to a climate-neutral economy, the mutual fund industry has launched mutual funds that prioritize investing in companies or assets with a low carbon footprint. Low carbon mutual recognize the importance of addressing climate change and transitioning to a low carbon economy and seek to align their portfolios accordingly (Soler-Domínguez et al., 2021) by minimizing exposure to companies involved in activities that contribute to greenhouse gas emissions. Thus, these funds cater to investors who wish to support companies with a reduced environmental impact. Recognizing this trend and investors' need for salient signals indicating whether funds are indeed committed to reducing their carbon footprint, Morningstar introduced, in 2018, the Low Carbon Designation (LCD) label (Soler-Domínguez et al., 2021; Ceccarelli et al., 2023). This designation indicates that the companies included in a portfolio are generally aligned with the transition towards a low-carbon economy. Portfolios receiving the LCD are assessed based on their low carbon risk and limited exposure to fossil fuels, providing investors with a clearer understanding of their environmental sustainability and their efforts to mitigate carbon-related risks (Morningstar, 2018).

2.2. Empirical Studies on SRI Funds

There is an extensive literature on the performance of SRI mutual funds. A subset of studies addresses green funds (e.g., Climent & Soriano, 2011; Silva & Cortez, 2016; Ibikunle & Steffan, 2017) to assess the impact of integrating environmental criteria in the investment process. As to the performance of fossil-fuel free or low-carbon funds, there are arguments that can support a positive or a negative impact of divested mutual funds. Considering portfolio theory, excluding any sector will lead to diversification losses. Furthermore, assuming that shunned stocks yield abnormal returns (Hong & Kacperzyk, 2009), excluding them would also penalize performance. Considering investors demand for green assets, the equilibrium model of Pástor and Stambaugh (2021) is also in line with the underperformance hypothesis.

There are, however, contrasting arguments that support a positive effect of divestment. The growing concerns about the effects of energy production and use of fossil fuels on global warming, climate change, and the implied risks to portfolios may generate investment opportunities in energy efficiency and renewable energy projects for managers and investors (Marti-Ballester, 2019a). Resorting to divestment as a way to address climate risks can reinforce the institutional investors' environmental stance (Bassen et al., 2021) and be perceived by capital markets as a competitive advantage. Riedl and Smeets (2017) observed a similar pattern among investors highlighting their tendency to prioritize their personal social values when investing in sustainable mutual funds. Besides, it can be value-enhancing for the divesting institution and funds can benefit from a better post-transition performance, particularly in terms of the risk-adjusted returns, and their exposure to systematic risk factors (Guo et al., 2022). Furthermore, the transition risk associated to oil sector companies are considerable. As mentioned previously, to meet the targets set by the Paris Agreement one third of oil reserves, half of gas reserves and over 80 percent of current coal reserves should remain unused from 2010 to 2050 (McGlade & Ekins, 2015). Since there is not yet a way to capture and store carbon, we are left with the necessity of significantly phasing out fossil fuels. Doing so would stop investments in new fossil fuel projects and decommission most existing projects, generating stranded assets worth trillions of dollars (Rempel & Gupta, 2021). The outperformance hypothesis is also addressed by Pástor and Stambaugh (2021), who anticipate that green assets can outperform in times when there is an unexpected shift towards greenness.

In terms of empirical results, a set of studies explore the performance of renewable energy funds. Reboredo et al., (2017) finds that renewable funds performed worse than conventional and SRI funds in terms of Jensen's alpha, which were negative (Reboredo et al., 2017). Marti-Ballester (2019b) finds that 32.1% of renewable mutual funds perform significantly better than the S&P Clean Energy market benchmark. However, none of them are able to beat the fossil fuel energy (S&P Global 1200 Energy Index) or conventional market benchmarks (S&P Global 1200 Index)

(Marti-Ballester, 2019b). Marti-Ballester (2019a) also noted that, according to stakeholder theory (Freeman, 2010), companies operating in the green energy sector have the potential to outperform companies in the black energy sector. This performance differential arises from the potential advantages that green energy firms may enjoy, such as lower costs and higher profits, in the long run compared to their black energy counterparts (Reboredo et al., 2017).

Studies that investigate the performance of fossil fuel-free funds are scarce. However, research on energy transition has shown that investors can opt for low-carbon firms, without compromising on their investment targets. Soler-Domínguez et al. (2021) investigate the relationship between funds' Low Carbon Designation label and their financial performance. The results indicate that, in general, funds with greater sustainability intensity obtain better financial performance, which would imply tilting the balance in favour of sustainable investment (Soler-Domínguez et al., 2021). In fact, Hartzmark and Sussman (2019) found that the implementation of the Morningstar sustainability rating in 2016 had a substantial impact on the US mutual fund market. Following the introduction of this rating system, funds categorized as unsustainable experienced significant outflows as investors showed a preference for more sustainable option. As a result, mutual funds face increasing pressure from investors to improve their sustainability practices and decrease their Weighted Average Carbon Intensity (WACI) (Ceccarelli et al., 2023).

2.3. Timing and Selectivity

Treynor and Mazuy (1966) introduced the concept of timing and selectivity in the context of evaluating the performance of investment strategies. While their original work focused on general investment strategies, their framework can be applied to the analysis of socially responsible investing (SRI) and low carbon mutual funds as well.

Leite and Cortez (2014) examine the timing and selectivity abilities of SRI and conventional funds. The results indicate that no statistically significant differences in timing abilities between SRI and conventional funds. However, the study did find differences in stock picking skills between SRI and conventional funds specifically focused on the European market. This suggests that while the timing abilities may be similar, SRI and conventional funds may differ in terms of their stock selection strategies and performance in the European market. Renneboog et al. (2008b), in line with previous studies on conventional mutual funds employ the Treynor and Mazuy (1966) measure by adding the quadratic term of the market premium to the conditional four-factor model, and fund that SRI fund managers in the UK, US, and continental Europe have limited ability to time the market. This finding indicates that they are not able to consistently predict and capitalize on short-term market movements. Another international SRI performance study was conducted by Schroder (2004), who examines 30 US funds and 16 German and Swiss ones. Based on the significance level of the timing coefficients, the findings indicate that only a small proportion of the examined funds, specifically 5 out of the total 46 funds, demonstrate positive timing ability. Conversely, the analysis reveals that 7 fund managers exhibit market timing in the wrong direction, with 6 of them being German and Swiss fund managers.

Lastly, Martí-Ballester (2019a) investigate the selectivity ability of renewable energy funds and observe, using specialized global market benchmark, that the selectivity estimates are significantly positive for renewable energy funds, but insignificant for black energy and conventional funds. Nevertheless, the selectivity ability of renewable energy funds becomes insignificant when a broad-based index is used as a benchmark. This suggests that, while fund managers specializing in renewable energy can identify top-performing stocks within the sector, their investment universe limitations prevent them from capitalizing on opportunities in other economic sectors where corporate financial performance may be higher. This observation aligns with the principles of modern portfolio theory (Markowitz, 1952) and neoclassical economic theory (Friedman, 1970).

2.4. SRI fund performance on different time states

Several studies have examined the performance of portfolios in different time states, shedding light on the dynamics of performance across various market conditions. Leite and Cortez (2015) focus on the performance of European socially responsible funds during market crises, specifically in France. They find that, while these funds may underperform during non-crisis periods, they demonstrate resilience and the ability to match the performance of conventional funds during market downturns. Silva and Cortez (2016) and Nofsinger and Varma (2014) reach a similar conclusion. SRI funds underperform conventional funds during non-crisis periods. However, during market crisis periods, SRI funds outperform conventional funds. The authors conclude that investors may be attracted to SRI funds during market crises due to their potential for downside protection. Furthermore, research suggests that fund managers demonstrate a greater ability to deliver superior performance during challenging market conditions compared to favourable market conditions (Glode, 2011).

In line with these results, Muñoz et al. (2014) find that US SRI funds have statistically insignificant performance during crisis periods but underperformed relative to the market during normal periods. On the other hand, European SRI funds exhibit statistically insignificant performance regardless of market conditions. This means that the performance of European SRI funds did not significantly differ between crisis and normal periods.

However, there is scarce literature on how low carbon funds perform in different market states. Even though Silva and Cortez (2016) focus on green funds, and a new stream of studies following the COVID-19 crisis, which is considered an economic shock, focuses on ESG stocks (Albuquerque et al., 2020; Ferriani & Natoli, 2021) and different ESG ratings (Döttling and Kim, 2020), there the issue of howlow carbon mutual fund performance during different time states is largely unexplored.

3. Methodology

This section provides an overview of the methodology used in this dissertation. In this study, in order to evaluate funds' financial performance, we will use the Fama and French (2015) five-factor model both in an unconditional and a conditional setting, allowing for alphas and betas to vary linearly over time. Furthermore, the model proposed by Treynor and Mazuy (1966) will be used to assess market timing ability.

It is worth noting that fund performance will be assessed at the individual fund level and at the aggregate level by evaluating portfolios of funds. In fact, equally weighted and value weighted portfolios were created for three categories of funds: low emissions, medium emissions, and high emissions funds. Additionally, a difference portfolio was created to assess the difference between low emissions and high emissions portfolios.

Through the application of these models, we aim to gain insights into various aspects of performance evaluation. The Fama and French (2015) five-factor model allows us to examine the risk-adjusted returns and factor exposures of the funds under consideration, providing a comprehensive assessment of their performance in relation to risk factors.

The Treynor and Mazuy (1966) timing and selectivity model enables us to explore the timing abilities and stock selection skills of the fund managers, shedding light on their ability to capitalize on market trends and make effective investment decisions.

Additionally, the conditional Fama and French Five-Factor model takes into account the dynamic nature of the market by incorporating time-varying risk factors, allowing us to assess performance under changing market conditions.

3.1. The Fama and French (2015) five-factor model

To assess performance, we build on the standard alpha approach based on a multifactor model. We will use Fama and French (2015) five-factor model, that includes the market factor, SMB (small minus big), HML (high minus low), RMW (robust minus weak) and CMA (conservative minus aggressive). This model adds two factors – profitability and investment – to the well-known three-factor model of Fama and French (1993). The choice of the five-factor model is motivated by Plantinga and Scholtens (2021) and Cortez et al. (2022), who show the usefulness of the profitability and investment factors to explain the returns of portfolios of fossil fuel and non-green stocks. The regression model is the following:

$$r_{i,t} - r_{f,t} = \alpha_i + \beta_{i1}(r_{m,t} - r_{f,t}) + \beta_{i2}(SMB_t) + \beta_{i3}(HML_t) + \beta_{i4}(RMW_t) + \beta_{i5}(CMA_t) + \varepsilon_{i,t} \quad (1)$$

Where $r_{i,t} - r_{f,t}$ is the excess return on fund i over the risk-free asset in period t, $(r_{m,t} - r_{f,t})$ is the excess return of the market, (SMB_t) corresponds to the difference in returns between a portfolio of small firms and big large firms, (HML_t) is the difference in returns between a portfolio of high book-to-market stocks and a portfolio of low book-to-market stocks, (RMW_t) is the profitability factor assessing the difference between the returns on diversified portfolios of stocks with robust and weak profitability, (CMA_t) is the investment factor, which is the difference between the returns on diversified portfolios of the stocks of low and high investment firms, $\beta_{i1}, \beta_{i2}, \beta_{i3}, \beta_{i4}$ and β_{i5} are the factor loadings of the five investment style factors - market, SMB, HML, RMW and CMA, respectively and $\varepsilon_{i,t}$ is the stochastic error term.

3.2. Timing and Selectivity

To evaluate timing and selectivity, the model used will be the one proposed by Treynor and Mazuy (1966), which adds a squared term to the market factor. The formula is the following:

$$r_{i,t} - r_{f,t} = \alpha_i + \beta_{i1}(r_{m,t} - rf_{,t}) + \beta_{i2}(r_{m,t} - r_{f,t})^2 + \varepsilon_{i,t} \quad (2)$$

A statistically significant positive alpha indicates a superior performance of the fund in relation to the market. A statistically significant negative alpha indicates the reversal. A statistically significant positive coefficient of the squared term indicates that managers have successful market timing ability, while a negative and significant coefficient denotes poor market timing ability.

3.3. Conditional Fama and French (2015) Five-Factor Model

Since, conditional models of performance evaluation are currently considered more robust than unconditional models, we also apply the five-factor model in a conditional setting that allows for alphas and betas to vary linearly over time as a function of a vector of conditioning information (Ferson & Schadt, 1996; Christopherson et al., 1998).

$$\begin{aligned} r_{i,t} - r_{f,t} = {} & \alpha_i + A'_i z_{t-1} + \beta_{i1}(r_{m,t} - r_{f,t}) + \beta_{i1}'[z_{t-1}(r_{m,t} - r_{f,t})] + \beta_{i2}(SMB_t) \\ & + \beta_{i2}'(z_{t-1}SMB_t) + \beta_{i3}(HML_t) + \beta_{i3}'(z_{t-1}HML_t) + \beta_{i4}(RMW_t) \\ & + \beta_{i4}'(z_{t-1}RMW_t) + \beta_{i5}(CMA_t) + \beta_{i5}'(z_{t-1}CMA_t) + \varepsilon_{i,t} \end{aligned} \quad (3)$$

Where α is the average conditional alpha, $z_{t-1} = Z_{t-1} - E(Z)$ represents the vector of deviations of the public information variables Z_{t-1} from their unconditional average values, $\beta_{i1}, \beta_{i2}, \beta_{i3}, \beta_{i4}, \beta_{i5}$ are the average betas, $\beta_{i1}', \beta_{i2}', \beta_{i3}', \beta_{i4}', \beta_{i5}'$ are the vectors that measure sensitivity of conditional betas to the information variables Z_{t-1}, A'_i is a vector that measures the response of the conditional alpha to the information variables. The public information variables to be included in these models are the short-term rate and the dividend yield, as in Ferson and Warther (1996) and Cortez et al. (2012). Based on the same study, the Wald test will be applied to the conditional models to see if the conditional variables are jointly significant, in the sense that they add something to the model. Regarding heteroscedasticity and autocorrelation of errors, the Newey and West (1987) correction method will be used.

3.4. Performance during times of contraction and expansion

To compare the performance of funds during times of contraction and expansion in the oil industry, we adopt a similar approach to Areal et al. (2013), Leite and Cortez (2015), and Silva and Cortez (2016), by incorporating a dummy variable into the Fama and French (2015) five-factor model. This model incorporates the dummy variable into both the alpha term and the risk factors, allowing to capture potential changes not only in performance but also in the risk profile of the portfolios during different market conditions.

Adding the dummy variable to the Fama and French (2015) five-factor model results in the following expression:

$$\begin{aligned} r_{i,t} - r_{f,t} = {} & \alpha_i + \alpha_{C,i} D_{C,t} + \beta_{i1}(r_{m,t} - r_{f,t}) + \beta_{C,i1}[(r_{m,t} - r_{f,t}) D_{C,t}] \\ & + \beta_{i2}(SMB_t) + \beta_{C,i2}(SMB_t D_{C,t}) + \beta_{i3}(HML_t) \\ & + \beta_{C,i3}(HML_t D_{C,t}) + \beta_{i4}(RMW_t) + \beta_{C,i4}(RMW_t D_{C,t}) \\ & + \beta_{i5}(CMA_t) + \beta_{C,i5}(CMA_t D_{C,t}) + \varepsilon_{i,t} \end{aligned} \tag{4}$$

Where $D_{C,t}$ is the dummy that takes the value of one in periods of contraction and zero in periods of expansion. Accordingly, $\alpha_{C,i} D_{C,t}$ represents the differential abnormal return of fund i in times of contraction.

4. Data

In this section, we present the data used in this dissertation, including its sources and the selection process. We begin by describing the dataset of mutual funds examined in this study, outlining the criteria employed to categorize the funds into three groups based on their emission scores (high, medium, and low). Additionally, we discuss the dataset of the risk factors used in the analysis. Finally, we present a summary of the descriptive statistics derived from the data.

4.1. Fund data

For the identification of the mutual funds and their corresponding emission scores we used the Refinitiv Eikon Fund Screener, selecting funds domiciled in Denmark, Finland, and Sweden. We only considered equity funds with a “global” geographical focus. Furthermore, we applied the “primary flag” in the “Fund Screener” to identify the primary classes of funds. In order to avoid survivorship bias, we included both active and inactive funds. Additionally, we excluded funds with less than 36 monthly observations and funds that didn’t report their Emissions scores. These criteria resulted in a dataset of 251 funds.

The emissions scores of the funds were retrieved from Refinitiv Eikon, which assigns scores ranging from 0 to 100 based on verifiable data publicly available[5]. The scores are divided into quartiles, with a range of 0-25 indicating poor ESG performance (first quartile), 25-50 denoting satisfactory ESG performance (second quartile), 50-75 representing relatively good ESG performance (third quartile), and 75-100 indicating excellent ESG performance (fourth quartile)[6]. The emissions score falls within the environmental pillar, which is a subset of the broader ESG framework. Using the above criteria, we applied the same methodology to assess and classify each fund accordingly. As none of the funds in our sample fall into the first quantile, we categorize the funds based on the second, third, and fourth quantiles. Specifically, we label funds in the second quantile as "High"

[5] https://www.refinitiv.com/content/dam/marketing/en_us/documents/fact-sheets/lipper-fund-esg-scores.pdf

[6] https://www.refinitiv.com/en/sustainable-finance/esg-scores

emissions, funds in the third quantile as "Medium" emissions and funds in the fourth quantile as "Low" emissions. Funds in the latter category correspond to low carbon funds. Table 1 shows the number of funds in each category.

Table 1. Categorization of Funds based on Emissions Scores

	Low	Medium	High	TOTAL
Number	161	77	13	**251**
%	64%	31%	5%	**100%**

This table describes the sample of the 251 funds among three emission scores levels (High; Medium and Low emissions).

For each fund category, we created two portfolios: an equally weighted portfolio and a value weighted portfolio. The equally weighted portfolio was constructed by taking the average monthly returns of each fund in the category, while the value weighted portfolio considered not only returns but also the size of each fund, measured by the Total Net Assets. A third portfolio was created to access the difference between the low and high emissions portfolios.

To examine fund performance, we collected monthly returns and monthly Total Net Assets (TNA) of funds from January 2010 to June 2022. The data was retrieved in US dollars from Refinitiv Eikon. The funds' returns were computed in a discrete way.

4.2. Risk factors, benchmark, and public information variables

For the analysis of fund performance, we sourced the monthly risk factors from the Kenneth French data library[7]. The Fama and French (2015) five-factor model uses the SMB, HML, RMW and CMA factors. SMB is the average return on the nine small stock portfolios minus the average return on the nine big stock portfolios, HML is the average return on the two value portfolios minus the average return on the two growth portfolios, RMW is the average return on the two robust operating profitability portfolios minus the average return on the two weak operating profitability

[7] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html#Developed

portfolios, and CMA, is the average return on the two conservative investment portfolios minus the average return on the two aggressive investment portfolios. The risk-free rate was also obtained from this website, and it is proxied by the US one-month Treasury bill rate. The data is denominated in US dollars. Since we selected the "global" in the geographical focus, we extracted the global factors "Developed Markets Factors and Returns" from the Kenneth French data library.

In relation to the public information variables, we used two lagged variables to include in the conditional factor models. The variables chosen were the Dividend Yield (DY) and the Short-Term Rate (STR), as in Ferson and Warther (1996) and Cortez et al. (2012). For the short-term rate, the yield on a 3-month US Treasury Bill was used while the dividend yield is based on the STOXX Europe 600 Index, and both were collected from Refinitiv Eikon.

To ensure data quality and address certain statistical issues, we employed the stochastic detrending procedure proposed by Ferson et al. (2003) in our analysis. This procedure involved subtracting the 12-month moving average from each variable, which helps eliminate any underlying trend or systematic biases. Additionally, we applied a mean-zero adjustment to the variables using the method outlined by Bernhardt and Jung (1979), which further enhances comparability and eliminates potential scale effects. By implementing these preprocessing steps, we were able to mitigate issues related to autocorrelation and improve the reliability of the results. Furthermore, we lagged the variables by one month to account for the time delay in investors' decision-making process, as past information often influences their investment choices.

4.3. Periods of contraction and expansion in the oil industry

To assess performance in different market states, most studies discussed in section 2.4. use indicators such as the NBER economic cycles or the time series historic values of stock price indices to define periods of expansion/non-crisis versus periods of recession/crisis. However, we use a different criteria, motivated by Plantinga and Scholtens (2021), who claim that the issue of how high emissions portfolios perform in different market states should consider periods of contraction and expansion of the fossil fuel industry. In this context, we follow Plantinga and Scholtens (2021) we use the growth and decline in the number of oil rigs in operation, as reported by Baker Hughes[8], to identify scenarios of contraction and expansion in the oil industry. Specifically, we use the twelve-month trailing growth rate of global oil rigs to categorize months with a negative growth rate as contraction periods and months with a positive growth rate as expansion periods. In the period under analysis, February 2010 to June 2022, we identified three periods of contraction: August 2012 to November 2013; January 2015 to December 2016 and July 2019 April 2021. As mentioned previously, to perform the evaluation, we used a dummy variable that assumes the value of one in contraction periods and zero otherwise.

4.4. Summary Statistics

Table 2 presents some summary statistics for the portfolios under analysis, for risk factors and for the public information variables. The period covered goes from February 2010 to June 2022.

Regarding the portfolios, when looking at the average excess return, we note that both the equally weighted portfolios and the value weighted portfolios show positive average excess returns. The High emissions portfolios (equally weighted and value weighted) are the ones that present both the highest and lowest value of excess return. All the portfolios show negative skewness, with values ranging from approximately -0.31 to -0.79, indicating a slight departure from symmetry, with a longer tail on the left side of the distributions. The magnitude of skewness is however relatively small, implying that the departure from symmetry is not substantial. The excess kurtosis values range from approximately -1.90 to 0.53. Most of the values are negative, indicating a tendency towards lighter tails compared to a normal distribution. This suggests that extreme values or outliers are less likely to occur in the distribution, resulting in a relatively less peaked shape. However, there is an observation with an excess kurtosis value of 0.53, indicating a slightly heavier tail and a more peaked distribution. To further evaluate the departure from normality, the Jarque-Bera test has been conducted. This statistical test combines measures of skewness and excess kurtosis to determine whether the sample data significantly deviates from a normal distribution (Jarque & Bera, 1987; Jarque, 2011). The small p-values obtained suggest strong evidence against

[8] https://rigcount.bakerhughes.com/intl-rig-count

the null hypothesis that the returns follow a normal distribution. In fact, we can almost always reject the null hypothesis for the usual levels of significance – 10%, 5% and 1% (except for the Low value weighted Portfolio, where we reject only at a 10% and 5% significance levels). This supports the use of conditional models (Adcock et al., 2012).

In what regards the risk factors, in terms of average returns, only the SMB and HML present negative values. The market has the highest standard deviation (4.24%) and, not surprisingly, exhibits both the highest and lowest value of the returns. When looking at the skewness levels we observe that both the market and SMB have negative skewness, close to zero, indicating that, as mentioned previously, these series are almost symmetric but with the left tail longer than the right tail. The HML, RMW and CMA factors have positive skewness, meaning that the data is skewed to the right, with the right tail longer than the left tail. By analysing the excess kurtosis, we note that the market, the SMB and the RMW factors have a negative excess kurtosis or platykurtic distribution. The HML and CMA factors present a positive excess kurtosis or leptokurtic distribution. Since all the factors present p-values very close to zero, we can reject the null hypotheses that the series follow a normal distribution.

Table 2. Descriptive statistics of the Equally and Value Weighted portfolios and risk factors

		Observations	Mean	Standard Deviation	Maximum	Minimum	Skewness	Excess Kurtosis	Jarque Bera Test	p-value
Equally Weighted Portfolio	**Low**	149	0.6172	4.3111	0.1352	-0.1246	-0.3077	-1.9019	24.8083	0.0000
	Medium	149	0.5961	4.5667	0.1331	-0.1452	-0.3496	-1.8065	23.2967	0.0000
	High	149	0.6028	5.1441	0.1482	-0.1933	-0.6289	-0.8081	13.8759	0.0010
Value weighted Portfolio	**Low**	149	0.3925	3.3330	0.1234	-0.1274	-0.5224	0.1908	7.0026	0.0302
	Medium	149	0.6724	4.4771	0.1326	-0.1404	-0.4059	-1.7326	22.7270	0.0000
	High	149	0.5239	4.7445	0.1572	-0.1968	-0.7930	0.5262	17.3335	0.0002
Five Factors	**Mkt-Rf**	149	0.7748	4.2422	0.1334	-0.1377	-0.4053	-1.8951	26.3758	0.0000
	SMB	149	-0.0902	1.4336	0.0396	-0.0444	-0.0673	-2.9644	54.6692	0.0000
	HML	149	-0.1330	2.5523	0.1196	-0.0924	0.7857	0.7917	19.2192	0.0001
	RMW	149	0.3179	1.2823	0.0459	-0.0291	0.0762	-2.4244	36.6357	0.0000
	CMA	149	0.0737	1.5270	0.0809	-0.0318	1.5528	2.9709	114.6739	0.0000

This table presents the descriptive statistics for the monthly returns of the equally and value weighted portfolios. The table also presents the summary statistics for all risk factors – the monthly excess returns of the MKT, SMB, HML, RMW and CMA. The portfolios are constructed the sample of 251 mutual funds. The descriptive statistics presented are the number of observations, mean, standard deviation, maximum, minimum, skewness, excess kurtosis, the Jarque Bera test for normality and its corresponding p-value. The period of analysis starts at February 2010 and ends in June 2022.

5. Empirical Results

This section presents the findings and analysis based on the utilization of different models to evaluate performance. Specifically, the three models employed in this study: the Fama and French (2015) five-factor model, the Treynor and Mazuy (1966) timing and selectivity model, the conditional Fama and French (2015) five-factor model and the Fama and French (2015) five-factor model for different market conditions. The performance evaluation covers the time period from February 2010 to June 2022.

It is important to notice that all results were corrected for autocorrelation and heteroscedasticity using the Newey and West (1987) method.

5.1. Performance based on the Fama and French (2015) Five-Factor model

Table 3 reports the results of the Fama and French (2015) five-factor model using data from February 2010 to June 2022. The table shows the performance of Low, Medium, and High emissions portfolios, as well as of the difference between Low and High portfolios. Two weighting methods are employed: equally weighted and value weighted.

In this study, the primary focus is to evaluate the financial performance of low carbon portfolios. To accomplish this, particular attention is given to the constant term (α) in the analysis. The constant term represents the expected return of the portfolio or fund when all five factors, namely market risk premium, size, value, profitability, and investment, are assumed to be zero. By examining the constant term, we gain insights into the baseline performance of the portfolios and can assess how they deviate from the expected return under the absence of any systematic factors.

Starting with the Low emissions portfolio, both the equally weighted and value weighted approaches show negative and statistically significant alphas, although only the alpha of the equally weighted portfolio is statistically significant at conventional levels, i.e., at least at the 5% level. The difference in the alpha estimates between the equal and value weighted portfolios suggests that the negative performance is mainly driven by small funds. At the individual fund level, most individual funds exhibit neutral performance. The beta coefficients for the market factor (MKT) are positive and statistically significant (1% level), suggesting a positive relationship with market returns. The other factor betas (SMB, HML, RMW, CMA) vary across the portfolios, but they are generally close to zero or have small magnitudes. It is also of note that only the beta for the RMW factor of the value weighted portfolio is statistically significant (5% level), suggesting that large funds are more exposed to the profitability factors. As for the adjusted explanatory power (adj. R^2), all portfolios report high values, showing that the index used is a good fit for the model.

In the Medium emissions portfolio, similar patterns are observed, with a negative alpha for the equally weighted portfolio and positive beta coefficients for the market factor. The majority of individual funds present neutral performance. In addition, the market betas are greater than 1 for both weighting methods, indicating a higher sensitivity to market returns. Once again, the alpha for the value weighted portfolio is not statistically significant. None of the remaining factors (SMB, HML, RMW, CMA) betas are statistically significant. Finally, the adj. R^2 values remain high, indicating a significant portion of the portfolio returns explained by the factors.

The High emissions portfolio exhibits neutral alphas. The beta coefficients for the market factor are again positive and statistically significant. The SMB factor beta shows a significant coefficient (1% level) in the case of the equally weighted portfolio. The adj. R^2 values indicate a relatively high explanatory power of the factors for the portfolio returns.

When examining the difference between the Low and High portfolios, both the equally weighted approach the value weighted approach shows non-significant and close to zero alpha coefficients, indicating no statistically significant differences between the performance of Low and High emissions portfolios. The differences portfolios also show a significant negative beta coefficient for the market factor, indicating that the High emissions portfolio has more systematic risk than its Low emissions counterpart. Furthermore, the results also show that the Low emissions portfolio is more exposed to large companies that the High emissions portfolio. The difference portfolio also documents a difference in exposure to the CMA factor, as the equally weighted Low carbon portfolio is more exposed towards companies that exhibit more caution and prudence in their investment decisions.

The SMB (Small Minus Big) factor is positive and significant, for the High emissions equally weighted portfolio (suggesting that small-cap stocks have outperformed large-cap stocks during the evaluation period.

When looking at the RMW factor across the portfolios, we can observe that it is positive for the Low and High emissions portfolios and negative for the Medium one. However, it is only significant (at a 5% level) in the case of the value weighted Low emissions portfolio. A positive coefficient suggests that there is a positive relationship between a company's profitability and its investment.

Finally, the CMA factor is positive and significant when we analyse the Low minus High emissions portfolio using the equal weighted approach. A positive CMA coefficient indicates exposure to companies with conservative investment and financing policies.

Table 3. Fund performance using the Fama and French (2015) five-factor model

Portfolios	α	βMKT	βSMB	βHML	βRMW	βCMA	Adj. R^2 (%)
			Low				
Equal. Weighted	-0.002***	1.0023***	-0.0494	-0.1004	0.0396	0.0764	95.03
Value Weighted	-0.0025*	0.7133***	0.1085	0.0951	0.4088**	-0.2273	83.67
N+	37[4]	161[161]	75[7]	38[8]	88[23]	114[39]	-
N-	124[44]	0	86[14]	123[49]	73[9]	47[7]	-
			Medium				
Equal. Weighted	-0.002**	1.041***	0.1092	-0.1281	-0.0563	0.0081	94.44
Value Weighted	-0.0009	1.0073***	0.1205	-0.1703	-0.0716	-0.0404	93.17
N+	23[2]	77[76]	56[18]	19[0]	31[7]	42[10]	-
N-	54[9]	0	21[1]	58[21]	46[11]	35[2]	-
			High				
Equal. Weighted	-0.0024*	1.1283***	0,4173***	-0.0502	0.0501	-0.2338	92.7
Value Weighted	-0.0019	0.9535***	0.3313	-0.0153	0.1301	-0.5096	82.07
N+	6[1]	13[13]	13[7]	5[0]	8[2]	2[0]	-
N-	7[1]	0	0	8[3]	5[1]	11[2]	-
			Low minus High				
Equal. Weighted	0.0004	-0.126***	-0.4667***	-0.0502	-0.0105	0.3102**	46.87
Value Weighted	-0.0006	-0.2402***	-0.2228	0.1104	0.2787	0.2824	45.01

This table reports the regression estimates of the Fama and French (2015) five-factor model for the Low, Medium, and High emissions portfolios of mutual funds, as well as difference between the Low and High portfolios, for the time period between February 2010 to June 2022. The table describes abnormal returns (α), the betas of the risk factors (Mkt, SMB, HML, RMW and CMA) and the adjusted coefficient of determination (adj. R^2). Standard errors are estimated using the Newey and West (1987) procedure to correct the autocorrelation and the heteroskedasticity, the number of lags is determined by the rule of thumb: $\sqrt[4]{N}$, where N is the number of observations. ***,**,* represent the level of significance of 1%, 5%, 10%, respectively. N+ and N- indicate the number of individuals mutual funds that have positive and negative estimates, respectively. Between brackets, the number of mutual funds that are statistically significant at the significance level of 5%.

5.2. Performance based on the Treynor and Mazuy (1966) Timing and Selectivity model

The results of the regression analysis based on the Treynor and Mazuy (1966) Timing and Selectivity model, reported on table 4, provide valuable insights into the performance of the portfolios across different categories and weighting approaches.

Starting with the Low emissions portfolios, both portfolios exhibit insignificant alphas (at conventional levels of significance), indicating neutral performance. Consistent with the portfolio results, most individual funds also exhibit neutral performance. The statistically significant positive beta coefficients for market movements suggest a positive systematic risk exposure to the market. When the overall market performs well, these portfolios tend to experience positive returns, and vice versa. The statistically significant nature of the beta coefficients implies that this relationship is not due to chance but reflects a systematic pattern. However, the beta coefficient for market movements squared is not statistically significant, indicating a lack of nonlinear relationship between market movements and portfolio returns and suggesting there is no evidence of market timing ability. At the individual fund level, 10 funds show evidence of market timing, while 5 funds show evidence of negative (or perverse) timing. The adj. R^2 values suggest that the included factors explain a substantial portion of the portfolio's return variation.

Moving to the Medium emissions portfolio category, similar patterns emerge, with both portfolios and most individual funds presenting a neutral performance. The beta coefficients for market movements remain positive, significant and, this time, above one. Once again, there is no evidence of market timing. The adj. R^2 values for the Medium portfolios indicate a high percentage of the portfolio's return variation explained by the factors.

In the High emissions portfolio category, the picture is similar, with both the equally weighted and value weighted portfolios presenting a performance that is comparable to the market. As to the beta coefficients, they are positive and statistically significant, indicating a positive systematic risk exposure to market movements. The coefficients of the squared market factor do not show any evidence of market timing. The adj. R^2 values indicate a relatively high explanatory power of the systematic risk factors.

Comparing the performance difference between the Low and High emissions portfolios, both approaches show non-significant alpha estimates suggesting, once again, no statistically significant differences in performance between both portfolios. The beta coefficient for the market factor is negative and statistically significant at the 1% level, indicating that the Low emissions portfolio has a lower systematic risk than its High emissions counterpart. As for the market factor squared, both portfolios present a positive beta, even though only the value in the equally weighted approach is statistically significant at level 5%, suggesting that the equal weighted portfolio of Low emissions funds has more market timing abilities than their High emission peers. In conclusion, the results of the regression analysis for the difference between the Low and High portfolios do not provide strong evidence of a significant performance difference or systematic risk exposure difference between the two portfolios. This suggests that the Low and High portfolios do not exhibit a significant divergence in their financial performance.

Overall, the analysis suggests that the evaluated portfolio managers have not consistently demonstrated superior timing and selectivity abilities. The negative or non-significant alpha coefficients indicate a lack of skill in generating excess returns beyond systematic risk factors.

Table 4. Fund Performance based on the Treynor and Mazuy (1966) Timing and Selectivity model

Portfolios	α	βMKT	βMKT^2	Adj. R^2 (%)
		Low		
Equal. Weighted	-0.0019*	0.9903***	0.2348	94.85
Value Weighted	-0.0009	0.7099***	-0.3791	81.63
N+	51[2]	161[161]	95[10]	-
N-	110[20]	0	66[5]	-
		Medium		
Equal. Weighted	-0.0023*	1.0446***	0.0966	94.06
Value Weighted	-0.0012	1.014***	0.0495	92.19
N+	28[1]	77[77]	36[1]	-
N-	49[5]	0	41[1]	-
		High		
Equal. Weighted	-0.0016	1.1547***	-0.7004	90.89
Value Weighted	-0.0003	0.9894***	-1.1516	78.8
N+	5[0]	13[13]	3[0]	-
N-	8[0]	0	10[3]	-
		Low minus High		
Equal. Weighted	-0.0003	-0.1644***	0.9351**	24.4
Value Weighted	-0.0006	-0.2796***	0.7725	34.58

This table reports the regression estimates of the Treynor and Mazuy (1966) Timing and Selectivity model for the Low, Medium, and High portfolios of mutual funds, and the difference between the Low and High portfolios, for the time period between February 2010 to June 2022. The table describes abnormal returns (α), the betas of the risk factors (market and market squared) and the adjusted coefficient of determination (adj. R^2). Standard errors are estimated using the Newey and West (1987) procedure to correct the autocorrelation and the heteroskedasticity, the number of lags is determined by the rule of thumb: $\sqrt[4]{N}$, where N is the number of observations. ***,**,* represent the level of significance of 1%, 5%, 10%, respectively. N+ and N- indicate the number of individuals mutual funds that have positive and negative estimates, respectively. Between brackets, the number of mutual funds that are statistically significant at the significance level of 5%.

5.3. Performance based on the conditional Fama and French (2015) five-factor model

The analysis of the portfolios' performance using the conditional Fama and French (2015) five-factor model provides valuable insights into the performance and factor exposures of these portfolios. The results reveal significant factor exposures, including market risk (MKT), size (SMB), value (HML), profitability (RMW), and investment (CMA), which have varying impacts on the portfolio returns. The public information variables used in the models are the short-term rate (STR) and the dividend yield (DY). To test if the inclusion of these variables represents an improvement in the model (are not equal to zero), a Wald test was implemented in all models. The results of the regression are reported in tables 5 and 6.

Starting with the Low emissions portfolio, we observe that both the equally weighted portfolios underperform the market, while the value weighted portfolio's performance is neutral. The beta coefficients for the market factor (MKT) are positive and statistically significant, at 1% level, indicating a strong sensitivity of the portfolio returns to overall market movements. Overall, the integration of the public information variables (PIV) with the market factor does not provide significant coefficients, indicating no significant interaction effects. Significance is shown when the investment factor (CMA) is associated with the PIV STR, for the value weighted portfolio, but only at the 10% level. The negative coefficient indicates that the portfolio is negatively affected by increases in interest rates. As for the adj. R^2 the high values indicate a high degree of explanatory power of the factors in the models.

Moving to the Medium emissions portfolio, the results follow a similar pattern to the Low portfolio, but with some differences in the coefficients and their significance. Concerning the alphas, we observe that for the equally weighted approach the value is negative and statistically significant, at a 5% level. The value weighted approach shows a positive alpha, however, like in the Low portfolio, it is not significant. Once again, the beta coefficients for the market factor (MKT) are positive and significant at a 1% level. It is important to note that almost all the factors have insignificant coefficients except for the interaction between the size (SMB) and the PIV DY. The coefficient is positive and significant at a 5% level, indicating that the portfolio is positively affected by increases in dividend yields.

Table 5. Performance based on the conditional Fama and French (2015) five-factor model – Low and Medium portfolios

	Low				Medium			
Parameters	**Equal. Weighted**	**Value Weighted**	**N+**	**N-**	**Equal. Weighted**	**Value Weighted**	**N+**	**N-**
α	-0.0020**	-0.0016	60[6]	101[22]	-0.0023**	0.0008	30[2]	47[7]
αSTR	0.0029	-0.0026	87[4]	74[0]	0.0028	0.0005	41([1]	36[1]
αDY	-0.004	0.0001	63[0]	98[4]	-0.0063	-0.0032	27[0]	50[2]
βMKT	1.0078***	0.6631***	161[161]	0	1.0539***	1.0000***	77[77]	0
βMKT*STR	-0.058	-0.0052	78[11]	83[7]	-0.0839	-0.0736	39[10]	38[5]
βMKT*DY	0.1185	-0.0344	113[30]	48[3]	0.0733	0.0968	53[8]	24[3]
βSMB	-0.0245	0.0051	89[12]	72[8]	0.1413	0.1087	60[21]	17[1]
βSMB*STR	-0.983	0.2946	135[14]	26[0]	-0.5462	-0.3385	64[7]	13[0]
βSMB*DY	1.2085	-1.9498	107[17]	54[[0]	2.4034**	0.6567	48[6]	29[1]
βHML	-0.0549	-0.0036	42[5]	119[34]	-0.071	-0.1632	23[2]	54[19]
βHML*STR	0.2864	-0.2373	41[1]	120[18]	0.2793	0.1224	23[2]	54[13]
βHML*DY	0.0085	0.2653	120[17]	41[1]	-0.0283	0.0195	65[10]	12[0]
βRMW	0.0660	0.1938	72[16]	89[6]	-0.0240	-0.1113	25[4]	52[8]
βRMW*STR	-0.0015	-0.4506	47[2]	114[23]	0.1989	-0.0438	36[4]	41[9]
βRMW*DY	0.0581	0.0478	131[36]	30[1]	-0.0041	0.0094	66[20]	11[0]
βCMA	0.0295	-0.1560	98[35]	63[13]	-0.0489	-0.0565	29[6]	48[6]
βCMA*STR	0.0679	-1.3817*	119[18]	42[2]	0.3146	-0.1497	66[15]	11[0]
βCMA*DY	0.1761	0.6466	49[4]	112[5]	0.2246	0.2907	17[0]	60[12]
Adj. R² (%)	95.01	85.24	-	-	94.55	92.79	-	-
W_1	0.4245	0.8849	-	-	0.1732	0.6921	-	-
W_2	0.1842	0.0525	-	-	0.0015	0.3274	-	-
W_3	0.1604	0.0720	-	-	0.0024	0.3716	-	-

This table reports the regression estimates of the conditional Fama and French (2015) Five-Factor model for the Low and Medium portfolios of mutual funds, for the time period between February 2010 to June 2022. The table describes the abnormal return (α), the conditional α coefficients (αSTR, αDY) the systematic risk (βMKT), the adjusted coefficient of determination (adj. R^2), the factors of the regressions namely, size (SMB), book-to-market (HML), profitability (RMW), investment (CMA) and the conditional betas coefficients (βMKT*STR, βMKT*DY, βSMB*STR, βSMB*DY, βHML*STR, βHML*DY, βRMW*STR, βRMW*DY, βCMA*STR, βCMA*DY). Standard errors are estimated using the Newey and West (1987) procedure to correct the autocorrelation and the heteroskedasticity, the number of lags is determined by the rule of thumb: $\sqrt[4]{N}$, where N is the number of observations. ***,**,* represent the level of significance of 1%, 5%, 10%, respectively. N+ and N- indicate the number of individuals mutual funds that have positive and negative estimates, respectively. Between brackets, the number of mutual funds that are statistically significant at the significance level of 5%. W1, W2 and W3 correspond to p values of Wald tests on the null hypothesis of no time-varying alphas, no time-varying betas and no time-varying alphas and betas, respectively.

The results for the High emissions portfolio continue to show the same pattern. The portfolio alphas are neutral. The beta coefficients for the market factor (MKT) are positive and significant at a 1% level. In the equally weighted approach two factors stand out for being statistically significant. The size factor (SMB) shows a positive and significant (1% level) coefficient suggesting exposure towards small-cap stocks. The interaction between the SMB and the PIV DY also shows a positive and significant (5% level) coefficient, suggesting that the portfolio is positively affected by increases in dividend yields.

Moving to the difference between the Low and High portfolios, the difference in the abnormal returns is very low and not statistically significant. Although there are no performance differentials, there are some differences in investment style. In fact, the SMB factor is negative and significant (at 1% level), indicating that low carbon portfolios are more exposed to large cap stocks than their high carbon peers. The difference in the CMA factor is less evident, as its significance is only at the 10% level.

Looking at the results shown for the adj. R^2, it appears that these are in line with the ones previously achieved for the same model but in its unconditional form, indicating that the inclusion of the public information variables doesn't significantly affect the explanatory power of the regressions.

Overall, the results of the Wald tests show that the joint hypothesis of no time-varying alphas cannot be rejected at conventional levels of significance. However, the joint hypotheses of no time-varying betas, and alphas and betas can be rejected, suggesting that allowing for time varying risk is indeed relevant when evaluating performance evaluation.

Table 6. Performance based on the conditional Fama and French (2015) five-factor model – High and difference between the Low and High

	High				Low minus High	
Parameters	**Equal. Weighted**	**Value Weighted**	**N+**	**N-**	**Equal. Weighted**	**Value Weighted**
α	-0.0024*	-0.001	8[0]	5[1]	0.0005	-0.0005
αSTR	-0.0011	-0.0034	6[0]	7[0]	0.0041	0.0008
αDY	-0.0074	-0.0036	5[0]	8[0]	0.0034	0.0035
βMKT	1.1317***	0.8970***	13[13]	0	-0.1239***	-0.2340***
βMKT*STR	-0.0594	-0.0668	10[2]	3[0]	0.0014	0.0616
βMKT*DY	0.0966	0.104	10[3]	3[0]	0.0219	-0.1384
βSMB	0.4360***	0.1973	13[8]	0	-0.4604***	-0.1923
βSMB*STR	-0.4333	-0.1788	12[0]	1[0]	-0.5496	0.4735
βSMB*DY	3.1816**	-0.3894	4[1]	9[0]	-1.9731	-1.5604
βHML	-0.0239	-0.1075	3[1]	10[2]	-0.0310	0.1038
βHML*STR	0.2107	-0.1611	2[0]	11[5]	0.0757	-0.0762
βHML*DY	-0.2276	-0.3652	11[1]	2[0]	0.2361	0.6305*
βRMW	0.0622	-0.0371	4[0]	9[1]	0.0039	0.2309
βRMW*STR	-0.0069	-0.7678	5[0]	8(3]	0.0669	0.3172
βRMW*DY	-0.1124	-0.1353	12[4]	1[0]	0.1705	0.1831
βCMA	-0.2348	-0.3999	4[0]	9[2]	0.2644*	0.2438
βCMA*STR	-0.1783	-1.6048	12[6]	1[0]	0.2462	0.2231
βCMA*DY	0.1170	-0.1917	12[0]	1[1]	0.0590	0.8383*
Adj. R^2 (%)	92.91	81.64	-	-	47.02	47.42
W_1	0.2644	0.7006	-	-	0.3419	0.7228
W_2	0.0007	0.5372	-	-	0.0311	0.0792
W_3	0.0002	0.6974	-	-	0.0409	0.0735

This table reports the regression estimates of the conditional Fama and French (2015) Five-Factor model for the High and the difference between the Low and High portfolios of mutual funds, for the time period between February 2010 to June 2022. The table describes the abnormal return (α), the conditional α coefficients (αSTR, αDY) the systematic risk (βMKT), the adjusted coefficient of determination (adj. R^2), the factors of the regressions namely, size (SMB), book-to-market (HML), profitability (RMW), investment (CMA) and the conditional betas coefficients (βMKT*STR, βMKT*DY, βSMB*STR, βSMB*DY, βHML*STR, βHML*DY, βRMW*STR, βRMW*DY, βCMA*STR, βCMA*DY). Standard errors are estimated using the Newey and West (1987) procedure to correct the autocorrelation and the heteroskedasticity, the number of lags is determined by the rule of thumb: $\sqrt[4]{N}$, where N is the number of observations. ***,**,* represent the level of significance of 1%, 5%, 10%, respectively. N+ and N- indicate the number of individuals mutual funds that have positive and negative estimates, respectively. Between brackets, the number of mutual funds that are statistically significant at the significance level of 5%. W1, W2 and W3 correspond to p values of Wald tests on the null hypothesis of no time-varying alphas, no time-varying betas and no time-varying alphas and betas, respectively.

5.4. Performance during times of contraction and expansion

Table 7 shows the results for Fama and French (2015) five-factor model when using a dummy to account for different market conditions, as in Leite and Cortez (2015) and Silva and Cortez (2016). Following Plantinga and Scholtens (2021), market conditions are related to the oil industry. [9]

Looking at the abnormal returns for the period of expansion, most of the portfolios show a negative and statistically significant alpha at the 5% level. This suggests that the portfolios, on average, underperform the Benchmark. The interaction term between alpha and the dummy variable (α*D) represents the differential performance in times of contraction. The results indicate that the effect of the dummy variable is small and statistically insignificant. This implies that oil market conditions do not have a significant impact on the differential abnormal returns across these portfolios. This finding is consistent with the findings of Muñoz et al. (2014), who conclude that European socially responsible funds exhibit statistically insignificant performance regardless of the prevailing market conditions, including both crisis and normal periods.

Looking at the market factor, most of the portfolios show, in times of expansion, a positive and statistically significant market coefficient close to one, at the 1% level. In regard to the approach, it is interesting to note that equally weighted portfolios have a beta higher than one, and value weighted portfolios have a beta lower than one, larger firms have lower market betas. In times of contraction, in the Low emissions value weighted portfolio (experiences a significant increase in market beta.

Regarding the remaining risk factors, across the three main portfolios, all values are neutral, and most of them do not show significant changes in different conditions of the oil industry.

Looking at the difference portfolio, we note that in times of contraction, Low emissions portfolios decrease systematic risk more than their High emissions counterparts. The SMB coefficient of the equally weighted difference portfolio is negative and statistically significant, indicating that this portfolio becomes more exposed to large firms than its high emission

[9] In this analysis, we do not report the results of fund performance at the individual level. Considering the results of the previous sections, we expect that the results at the individual level are, overall, consistent with those at the aggregate level.

counterpart in periods of contraction in the oil industry. There is evidence of positive and statistically significant RMW and CMA factors at the 5% levels in expansion periods, indicating that the Low emissions portfolio becomes more exposed to robust profitability and conservative investment firms more than high emissions portfolio.

Table 7. Performance based on the Fama and French (2015) five-factor model in different market conditions

	Low		Medium		High		Low minus High	
Parameters	**Equal. Weighted**	**Value Weighted**	**Equal. Weighted**	**Value Weighted**	**Equal. Weighted**	**Value Weighted**	**Equal. Weighted**	**Value Weighted**
α	-0.0020**	-0.0030**	-0.0027**	-0.00106	-0.0030**	0.0009	0.0011	-0.0021
α*D	-0.0002	0.0003	0.0011	-0.0006	0.0020	-0.0316	-0.0021	0.0030
βMKT	1.0026***	0.5968***	1.0619***	0.9869***	1.1731***	0.,8371***	-0.1704***	-0.2403**
βMKT*D	0.0004	0.2546**	-0.0606	0.0414	-0.1249	0.2407	0,1253**	0.0138
βSMB	-0.0423	-0.1129	0.8736	0.3861	0.4242	0.1214	-0.4665***	-0.2343
βSMB*D	-0.0201	0.2632	0.7201	0.1478	0.0444	0.2532	-0.0645	0.0100
βHML	-0.1405	-0.1110	-0.1911	-0.2366	-0.1058	-0.3147	-0.0347	0.2037
βHML*D	0.5894	0.1462	0.1293	0.0509	0.1541	0.3195	-0.0952	-0.1734
βRMW	0.5135	0.1958	-0.0204	-0.0870	0.0542	-0.1986	-0.0028	0.3944**
βRMW*D	-0.0375	0.1700	-0.0295	-0.0513	0.1021	0.4151	-0.1396	-0.2451
βCMA	0.1360	-0.0858	0.1459	0.0416	-0.2056	-0.3607	0.3417**	0.2749
βCMA*D	-0.1123	-0.0021	-0.3476	-0.1074	-0.0203	0.0688	-0.0920	-0.0709
Adj.R2(%)	94.83	85.99	94.36	93.03	92.72	82.97	49.03	44.35

This table reports the regression estimates of the conditional Fama and French (2015) Five-Factor in different market conditions for the Low, Medium, and High portfolios of mutual funds, and the difference between the Low and High portfolios, for the time period between February 2010 to June 2022. The table describes the abnormal return (α), the returns differential in times of crisis (α*D), the systematic risk (βMKT), the adjusted coefficient of determination (adj. R^2), the factors of the regressions namely, size (SMB), book-to-market (HML), profitability (RMW), investment (CMA) and for times of recession (MKT*D, SMB*D, HML*D, RMW*D CMA*D). Standard errors are estimated using the Newey and West (1987) procedure to correct the autocorrelation and the heteroskedasticity, the number of lags is determined by the rule of thumb: $\sqrt[4]{N}$, where N is the number of observations. ***,**,* represent the level of significance of 1%, 5%, 10%, respectively.

6. Conclusions

This dissertation explores the performance of European SRI funds, with a specific focus on low carbon funds, and their alignment with environmental objectives. The analysis focuses on a dataset of of 251 funds domiciled in Finland, Sweden, and Denmark, with global investment strategies. Fund performance is evaluated with the Fama and French (2015) five-factor model, in its unconditional and conditional form, and the Treynor and Mazuy (1966) timing and selectivity model. Fund performance was evaluated for the overall period, February 2010 to June 2022, and in periods of different conditions of the oil industry. Besides, fund performance was evaluated at the aggregate level, by creating value and equally weighted portfolios of funds, as well as at the individual fund level. For the identification of the mutual funds and their corresponding emission scores we used the Refinitiv Eikon Fund Screener and classify each fund according to their emission score. We sourced the monthly risk factors and risk-free rate from the Kenneth French data library. The data is denominated in US dollars. Lastly, to address the performance low carbon funds in different market conditions, a dummy variable to account for contraction periods was included in the Fama and French (2015) five-factor model, not only in the alpha term but also in the risk factors, as in Areal et al. (2013), Leite and Cortez (2015), and Silva and Cortez (2016).

The results show that, for the overall period, funds underperform the benchmark after adjusting for the risk factors, with the High emissions portfolio presenting the lowest performance. This portfolio, on the other hand, has a higher market sensitivity when compared to the Low emissions portfolio. Looking at the difference between the Low and High portfolios, we do not find statistically significant differences between their performance. The risk factors included in the models (market, size, value, profitability, and investment) explain a significant portion of the portfolios' performance, as indicated by the high adjusted R-squared values. Despite no performance differentials in terms of performance between the three portfolios, our findings show some differences in terms of their investment style. In fact, the Low emissions portfolio tends to perform better when there is a higher return on stocks with robust profitability compared to stocks with weak profitability, and the High portfolio tilts towards stocks with more conservative investment profiles.

In terms of fund managerial abilities, one can conclude that portfolio managers have not consistently exhibited superior timing and selectivity skills. The presence of negative or non-significant alpha coefficients suggests a lack of expertise in generating excess returns beyond the influence of systematic risk factors. This finding in line with the empirical literature on timing.

Regarding the evaluation of fund performance across different market conditions of the oil industry, the results show that oil market conditions do not significantly influence the variation in fund abnormal returns across portfolios. This finding is consistent with the findings of Muñoz (2014), who conclude that European socially responsible funds exhibit statistically insignificant performance regardless of the prevailing market conditions, including both crisis and normal periods. Once again, the difference between the Low and High emissions portfolios is also insignificant in what regards performance.

Overall, this research shows that, in general, there are no financial gains nor penalties in investing in Low emissions funds compared to their High emissions peers. Although we note that low carbon mutual funds still slightly outperform high carbon mutual funds. These results hold in different market conditions of the oil industry.

Some of the limitations of this research are the low number of funds used in the dataset and the information available regarding funds' emissions scores. Specifically, for the larger dataset, the Emission scores of many funds was missing. In fact, we could not find funds in the 0-25 range (poor ESG performance) which might mean that the funds we categorized as "High emissions" might not exactly be those with the most pollutant firms. Also, we did not have access to the funds' time series of Emission scores. Therefore, we are assuming the most recent scores available on Refinitiv Eikon Lipper Fund hold for the whole period under analyses. The number of funds that we qualify as "High" is also a significant limitation, especially when comparing to the size of the Low emissions portfolio, 161 to 13.

Overall, these findings contribute to the existing body of knowledge on the performance of socially responsible investment funds, specifically in the context of low carbon strategies in Europe. The results suggest that further research with a larger dataset of funds with emissions scores is needed to better understand the factors influencing the performance of low carbon funds versus their high carbon counterparts in times when climate change concerns are heightened and there is international pressure to transition to a low carbon economy.

Further investigation could also delve into the role of ESG ratings and their impact on fund performance. Additionally, studying the persistence of performance over longer time periods and considering different market conditions may provide valuable insights into the performance of low-carbon funds. Finally, expanding the geographical scope of the study to include other regions and comparing the performance of low-carbon funds across different markets would contribute to a more comprehensive analysis of their financial performance.

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