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On the role of Sustainability in European Fund Pricing using Morningstar Ratings

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On the Role of Sustainability in European Fund Pricing using Morningstar Ratings ®

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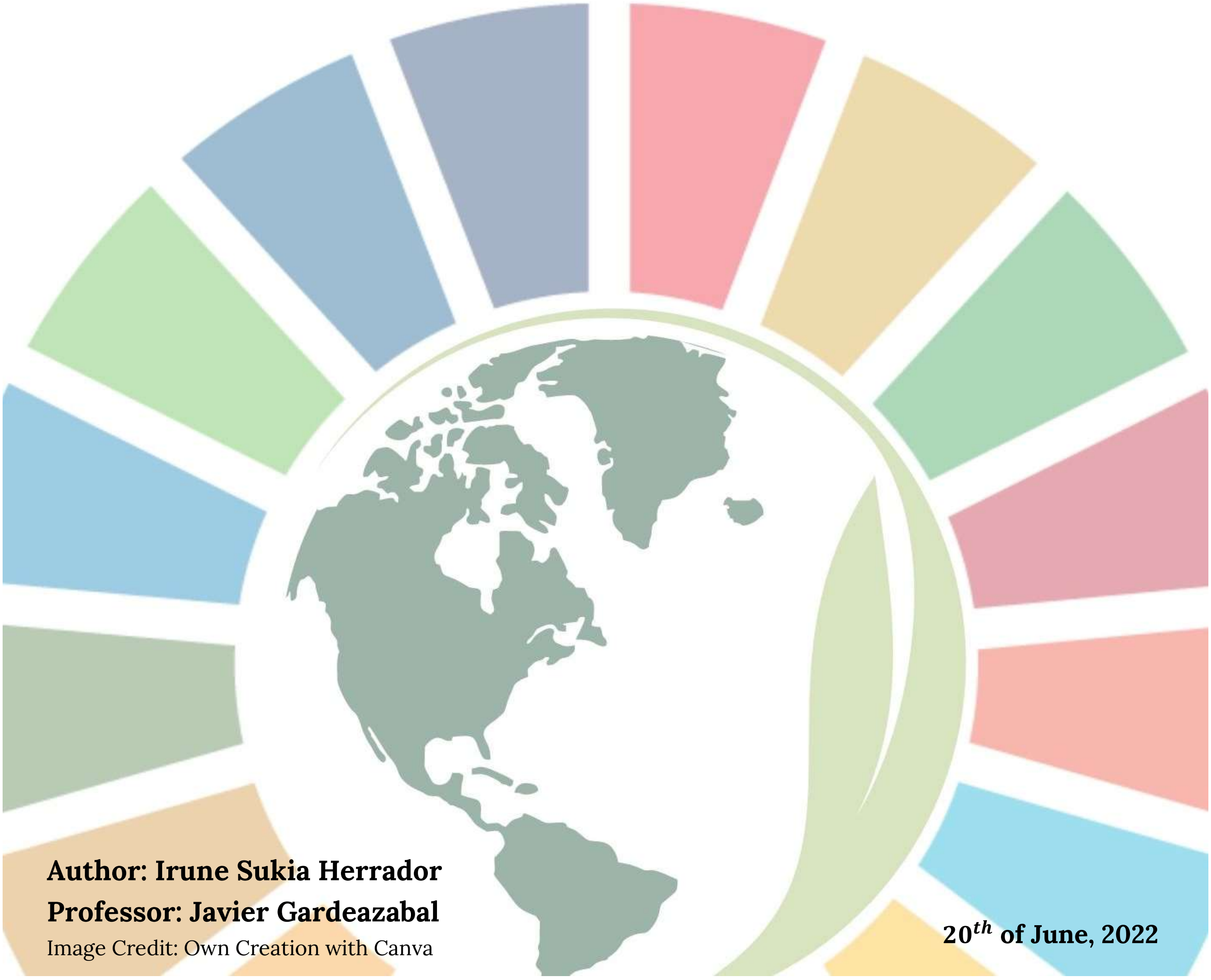

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ABSTRACT

This paper tests whether introducing the sustainable investment effect may be considered an additional variable for both Fama & French's three-factor model and Carhart's four-factor model so that the performance of asset pricing models can be improved. The sustainable investment effect is captured by a newly created sustainability factor, which is constructed using European open-ended mutual funds data from October 2018 to January 2022, rated by the Morningstar Sustainability Rating (MSR). The results indicate that (1) Green labelled funds outperform the returns of red labelled (unsustainable) funds on average. (2) Socially responsible mutual funds outperform regular funds during market decline, but underperform traditional funds during economic booms. (3) Investing is transitioning away from red-labelled funds toward green-labelled ones. (4) The Fama & French's three-factor model acquires a higher explanatory power than the CAPM. (5) Carhart's model does not suppose a major increase in performance over the Fama & French's three-factor model results. (6) Sustainable investment effect introduction in both Fama and French's three-factor model and Carhart's four-factor model merely increases the efficacy of expected returns estimation. However, its major impact on expected fund returns must be underlined. (7) Its significance, loading and sing vary among MSR fund groups. Red labelled funds are the ones with a negative, highest in absolute value and significant sustainability beta, whereas green labelled funds are the ones with a positive, lowest in absolute value and insignificant sustainability beta.

1. INTRODUCTION

The word "sustainable" has been on everyone's lips in the last few years. Meeting the needs of current generations without compromising the needs of our subsequent has become a challenge for today's society, while we try to ensure the balance between economic growth, environmental respect and social welfare. These objectives have also been transferred to the finance world, where an increasing number of companies are committing to environmental protection, enhancing Sustainable Investment.

US Forum for Sustainable and Responsible Investment (SIF) defines Socially Responsible Investment (SRI) as "an investment discipline that considers Environmental, Social and Corporate Governance (ESG) criteria to generate long-term competitive financial returns and positive societal impact".

This new investment approach renders Sharpe's (1964), Linter's (1965) and Black's (1972) Capital Asset Pricing Model (CAPM) obsolete, as one of its major assumptions, the investor's only concern for returns, is no longer valid.

Added to that, Stattman (1980), Banz (1981), Reinganum (1981), Blume & Stambaugh (1983), Brown, Kleidon, & Marsh (1983), Basu (1983), Rosenberg, Reid, & Lanstein (1985), Bhandari (1988), Lakonishok & Shapiro (1986), Chan, Hamao, & Lakonishok (1991), Bartholdy & Peare (2004) and Karp (2017) concluded that the unrealistic assumptions of CAPM inhibit it from explaining the accurate expected returns of funds. Hence, Fama & French (1992) revamped the model and summarised the evidence on its empirical failings to create a new three-factor asset pricing model.

Even though Griffin (2002), Ajili (2005), Bundoo (2008), Blanco (2012) and Chaudhary (2017) tested the efficacy of the F&F three-factor model, for different time periods and markets, authors in reference such as Nartea & Djajadikert (2005), Ziegler, Schöder, Schulz, & Stehle (2007), Bartholdy & Peare (2004) and Karp (2017) suggested that the three-factor model was not as good as expected.

Carhart (1997) added a new variable in the hopes of getting a better estimate of stock and portfolio returns whose accuracy was tested by L'Her, Masmoudi, & Suret (2004), Connor, Hagmann, & Linton (2012) and many more, concluding its effectiveness. But, as with the other models, Chen & Fang (2009) found no evidence of improvement over Fama & French's (1992) model.

Authors such as Chan & Faff (2005), Connor, Hagmann, & Linton (2012), Fama & French (2015), Hou, Chen Xue, & Zhang (2015) and López Garcia, Trinidad Segovia, Sánchez Granero, & Pouchkarev (2021) have also augmented the aforementioned models in the hope of finding new explanatory variables that better explain the expected fund returns. Following the same research line, I have augmented Fama & French's three-factor model and Carhart's four-factor model by introducing a new factor that captures the broadening concerns of 21st century investors; Sustainability.

For instance, Renneboog, Horst, & Zhang (2008), Xiao, Faff, Gharghori, & Lee (2013) and Walker, Lopatta, & Kaspereit (2014) attempted to incorporate the influence of sustainability by expanding the previously mentioned frameworks. The various findings in studies incorporating the sustainable component led me and other researchers to assume that the outcomes could be temporal and market dependent.This necessitates the inclusion of an additional sustainability element in performance evaluation methodologies to counteract the disruptions caused by sustainability in conventional approaches. Hence, the main objective of this study is to investigate whether the sustainable investment effect may be considered an additional variable for both Fama & French's and Carhart's models, so that the performance of asset pricing models can be improved. The sustainable investment effect is captured by a new created Green Minus Red (GMR) portfolio that is based on funds that follow ESG criteria.

The remainder of this paper is laid out as follows. In **Section 2**, I define what a Sustainable & Responsible Investment is based on and what may have been the factors that have caused its increase in the last few years. **Section 3** describes how Morningstar Sustainability Rating is constructed. In **Section 4** I describe different asset pricing models and review the related literature for each one of them. I also explain the proposed augmented asset pricing models. **Section 5** describes the data used for the study, its descriptive analytics and the formation of the GMR portfolio. In **Section 6** I analyse the obtained results and in **Section 7** the split sample test and the most robust results are calculated. In **Section 8** conclusions are stated. Finally, in **Section 9**, I present the weaknesses the proposed models may bring with them.

2. SUSTAINABLE INVESTMENT

Eurosif reported in 2021 that Sustainable & Responsible Investment is "a long-term-oriented investment approach that integrates Environmental, Social and Governance (ESG) factors in the research, analysis and selection process of securities within an investment portfolio". It combines basic research and involvement with an assessment of ESG aspects in order to maximize long-term returns for investors while also benefiting society by influencing corporate behaviour.

On the one hand, environmental criteria take into account corporate climate policy, energy consumption, waste, pollution, natural resource conservation and animal care among other aspects. The criteria may also be used to assess any environmental hazards that a firm may have and how those risks are being managed. On the other hand, the company's ties with stakeholders are examined using social criteria. Employee relations and diversity, working conditions, including child labour & slavery, health & safety etc. are all taken into account. Finally, ESG governance principles guarantee that a firm follows accurate and transparent accounting practices, selects leadership with integrity and diversity, and is responsible to shareholders. Some factors considered include tax strategy, CEO salaries, contributions and political lobbying, corruption and bribery, board diversity etc.

According to the Global Sustainable Investment Review of 2020, at the beginning of that year, Europe, the United States, Canada, Australia and Japan, all together, totalled USD35,3 trillion in global sustainable investment, which represented a 15% increase within the last two years (2018-2020). Europe is considered to be the second region behind the United States with the highest number of sustainable assets. This could be due to the influence of regulatory and policy forces, alongside industry, customer and market drivers over socially responsible investment. The European Union Sustainable Finance Action Plan implemented in 2018, and in particular, the Sustainable Finance Disclosure Regulation (SFDR), were some of the main regulatory drivers that increased ESG investing across Europe, as well as the Corporate Sustainability Reporting Directive proposal and the EU Taxonomy Regulation.

Both industry and customer drives have shed light on sustainable investment. The introduction of voluntary sustainable fund labels, the creation of both FinDatEx and Net Zero Asset Owner Alliance (NZAOA) and the new MiFID II amendments are some of those responsible for the increase in sustainable investment.

Finally, market drivers have helped investors evaluate portfolios on ESG factors such as Morningstar Research, that with the introduction of the Morningstar Sustainability Rating (MSR) in 2016 has helped investors measure the financially material ESG risk of a fund when compared with similar ones.

Table 1 shows the above mentioned regulatory, industry, customer and market driver's definitions.

Table 1
Regulatory, industry, customer and market drivers' definitions

The Sustainable Finance Disclosure Regulation (SFDR)	SFDR requires institutional investors, asset managers and advisers to report how they integrate sustainability risks and adverse impacts at entity level, and to classify and report their ESG products' sustainability risks and adverse impacts.
Corporate Sustainability Reporting Directive proposal	This proposal demands large corporations produce frequent reports on their social and environmental implications.
EU Taxonomy Regulation	This regulation entered into force in 2020. It sets four overarching conditions that an economic activity has to meet in order to qualify as environmentally sustainable.
Sustainable Fund Labels	SRI fund labels strive to provide minimal parameters for sustainable funds while providing openness for interpretation by investors. They demonstrate the ESG credentials of the fund to end investors.
FinDatEx (Financial Data Exchange Templates)	It is a joint structure formed by representatives from the European financial services sector with the goal of coordinating, organizing, and carrying out standardisation work to make data exchange between stakeholders easier in the context of European financial markets legislation such as MiFID II.
Net Zero Asset Owner Alliance (NZAOA)	It is an international organisation of 71 institutional investors committed to achieving net-zero greenhouse gas emissions in their investment portfolios by 2050. The UNEP's Finance Initiative and the Principles for Responsible Investment have brought together the Alliance (PRI) which was founded by the United Nations.
MiFID II amendments	The European Union (EU) established MiFID II as a legal framework to regulate financial markets in the bloc and increase investor safeguards. Its goal is to standardize processes across the EU and restore business trust. The new amendments urge financial advisers to enquire about each client's "sustainable preferences" and recommend relevant products.

Source: Eurosif (2021) report

Due to the recent change in investors-preferences over investment decisions and the effect the above-mentioned regulatory & policy, industry, customer and market drivers have had on the market, a boom in sustainable investment has occurred. This new trend has been perceived by lots of experts, and they have tried to answer three major questions regarding ESG investment approach, (1) how do SRI proclaimed mutual funds perform with respect to unsustainable funds?, (2) how do sustainable funds flow vary in comparison with unsustainable funds? and (3) how does the Value of Risk vary among green and conventional funds.[1]

On the one hand, answering the first enquiry, Mallin, Saadouni, & Briston (1995) and Luther, Matatko, & Corner (1992) concluded that socially responsible funds were able to beat market indices, at least in the UK, which is where both of them focused their studies. Friede, Busch, & Bassen (2015) also backed up the notion that there was a positive correlation between ESG factors and financial performance regarding the meta-analysis of about 2200

[1] The Value at risk (VaR) describes the expected maximum loss over a target horizon within a given confidence level. VaR is an essential tool for communicating downside risk" (Durán Santomil, Otero González, Correia Domingues, & Reboredo, 2019).

unique primary empirical studies used. However, the more traditional idea holds that SRI mutual funds have the same return as other funds, and writers such as Kreander, Gray, Power & Sinclair (2005), Bauer, Derwall & Otten (2007), Humphrey, Warren & Boon (2016), Syed & Jeffers (2018) and many more, support this theory. Added to that, Junkus & Berry (2015) remarked that "the results are highly dependent on model specification, time period, benchmark and other characteristics of the study". Also, the lack of clearly defined criteria for identifying mutual funds as "socially responsible" makes measuring the success of SRIs challenging, as concluded by booth Statman & Glushkov (2016) and Durán Santomil, Otero González, Correia Domingues, & Reboredo (2019).

On the other hand, trying to address the second issue, Ammann, Bauer, Fischer, & Müller (2019) uncovered compelling evidence that "retail investors were shifting money away from low-rated funds and into high-rated ones". Nofsinger & Varma (2014) came to the same conclusion a few years before, when they found out that assets under management for SRI mutual funds climbed by more than 13%, while conventional funds stayed relatively steady during 2007-2009. They also revealed that one of the differences between funds following ESG criteria and conventional funds is determined by market conditions. Socially Responsible mutual funds outperform conventional funds during market crises, but underperform traditional funds during an economic boom.

Finally, Reboredo, Quintela, & Otero (2017) as well as Durán Santomil, Otero González, Correia Domingues, & Reboredo (2019) among others, researched the impact of SRI funds over the value of risk. They concluded that "the level of sustainability is negatively and significantly related to the VaR of the fund, supporting that higher scored mutual fund better protect against extreme losses. This result could mean that SRI mutual fund managers base their decisions on a deeper analysis resulting in a significant reduction in the risk of their investment decisions" Durán Santomil, Otero González, Correia Domingues, & Reboredo (2019).

3. MORNINGSTAR SUSTAINABILITY RATING

Morningstar's Research department provides unbiased research of individual securities, managed investments, portfolios, and markets. Alongside one of the global providers of ESG and corporate governance products and services called Sustainalytics, they have constructed a Sustainability Rating which assists investors in evaluating the relative environmental, social and governance risks within a portfolio.

Any fund that qualifies for a MSR will receive a number of "globes" ranging from one to five, with a larger number of globes indicating reduced ESG risk. This evaluation has been done for each global category, which means that a fund might have a higher ESG risk than another but yet receive a better rating if they are in different global categories.[2]

In order to construct the MSR, Sustainalytics' ESG Risk Ratings and Sustainalytics' Country Risk Ratings are used to calculate corporate and sovereign issuers. On the one hand,

[2] The Morningstar Global Category system groups investment vehicles across the globe that invest in similar asset classes (Barr, Doman, & Redensek, 2021).

the ESG Risk Rating measures the magnitude of a company's unmanaged ESG risk. Management gap and unmanageable risk are taken into account to calculate unmanaged risk. Corporate organizations are classified into one of five ESG risk categories based on their Unmanaged Risk Scores: Negligible, Low, Medium, High and Severe. On the other hand, wealth and ESG Performance scores are used to determine the Country Risk Rating. Wealth is a measure of a country's vulnerability to ESG hazards, which is represented by the value of assets within a country, as calculated by the World Bank. ESG Performance "is an assessment of how well a country is managing key environmental, social and governance factors" (Barr, Doman, & Redensek, 2021) which is determined using socioeconomic indicators, analysis of trends and assessments of any significant events that have occurred within the country. Sovereign issuers are classified into one of five ESG risk categories based on their total risk scores: Negligible, Low, Medium, High and Severe. The construction of both Sustainalytics' ESG Risk Ratings and Sustainalytics' Country Risk Ratings is summarized in table 2.

Table 2

Sustainalytics' Risk Ratings formation

<table>
<tr><th></th><th>Sustainalytics' ESG Risk Ratings</th><th colspan="2">Sustainalytics' Country Risk Ratings</th></tr>
<tr><td>It is used to calculate</td><td>Corporate issuers</td><td colspan="2">Sovereign issuers</td></tr>
<tr><td>It measures</td><td>Company's unmanaged ESG risk</td><td colspan="2">Country's vulnerability to ESG hazards</td></tr>
<tr><td>It takes into account</td><td>Unmanaged risk</td><td>Wealth</td><td>Country's ESG Performance scores</td></tr>
<tr><td>Calculation</td><td>Unmanaged risk</td><td>Value of assets within a country, as calculated by the World Bank</td><td>Using socioeconomic indicators, analysis of trends and assessments of events occurred within the country.</td></tr>
</table>

Source: Own creation based on Morningstar Research Sustainalytics' Methodology & Portfolio Research

Five steps are followed to calculate the Morningstar Sustainability Rating:

1. *Suitability of the rating*

In this first stage, Morningstar evaluates whether or not the fund is suitable for the rating. For each fund, holdings are classified depending on their ESG risk exposure into qualified and non-qualified groups. Holdings that are considered in scope for a potential ESG assessment, the ones in the qualified group, are once again filtered to see if they are eligible to contribute a measure of risk under Corporate or Sovereign Risk Ratings. Table 3 shows the classification of the holdings within a fund. "Once the portion of Qualified Holdings and Eligible Holdings in the fund is determined, the value of Eligible Holdings is divided by the value of Qualified Holdings, with a requirement that at least 67% of the fund's Qualified Holdings are eligible to be rated" (Barr, Doman, & Redensek, 2021). Before calculating the exposure to corporate and sovereign ESG risk, all eligible and qualified holdings are rescaled to 100%.

Table 3

Suitability of the Rating

<table>
<tr><th colspan="3">TOTAL NUMBER OF HOLDINGS</th><th></th></tr>
<tr><td colspan="3">QUALIFIED
Include: Equities, fixed-income instruments, commodities, real estate, and alternatives.</td><td rowspan="3">NON-QUALIFIED
Short positions, cash and currency, derivatives and synthetic holdings.</td></tr>
<tr><td>Corporate ESG Risk
Include: Equities, fixed-income securities issued by corporate entities, select securitized debt, and supranational entities.</td><td>Sovereign ESG Risk
Include: Fixed-income securities issued by government entities and select securitized debt.</td><td>Others
Include: Municipal bonds, commodities, real estate, alternative investment types, and any other securities considered to carry intrinsic ESG risks which are not already classified as corporate or sovereign.</td></tr>
<tr><td colspan="2">ELEGIBLE</td><td>NON-ELEGIBLE</td></tr>
</table>

Source: Own creation based on Morningstar Research Sustainalytics Methodology & Portfolio Research

2. *Portfolio Corporate Sustainability Score and Portfolio Sovereign Sustainability Score*

In the second stage, the Portfolio Corporate Sustainability Scores [1] and Portfolio Sovereign Sustainability Scores [2] are calculated. They are asset-weighted average of Sustainalytics' company-level ESG Risk Rating and Sustainalytics' Country Risk Rating respectively:

[1]

$$Portfolio\ Corporate\ Sustainability\ Score = PCSS = \sum_{i=1}^{n} ESG\ Risk_i \times Rescaled\ Holdings\ Weight_i$$

[2]

$$Portfolio\ Sovereign\ Sustainability\ Score = PSSS = \sum_{i=1}^{n} Country\ Risk_i \times Rescaled\ Holdings\ Weight_i$$

$Where,$

$i = 1, 2, \ldots, n\ number\ of\ holdings$

$And\ for\ holdings\ 1\ to\ n\ where\ RescaledHoldingWeight\ is\ not\ null$

In order to calculate the Corporate Sustainability Score, 67% of the assets in the portfolio holdings identified as corporate ESG risk need to have company ESG Risk Ratings. Similarly, Sovereign Sustainability Score is calculated if 67% of assets in such portfolio have country ESG Risk Ratings.

3. *Historical Corporate Sustainability Score and Historical Sovereign Sustainability Score*

The Historical Corporate Sustainability Scores [3] and Historical Sovereign Sustainability Scores [4] are calculated in the third stage. These scores are weighted averages of Portfolio Corporate and Sovereign Sustainability Scores for the previous 12 months. Recent portfolios are given a higher weighting than older portfolios.[3]

[3]

$$Historical\ Corporate\ Sustainability\ Score = HCSS_t = \frac{\sum_{i=0}^{11}(12-i) \times PCSS_{t-i}}{78}$$

[4]

$$Historical\ Sovereign\ Sustainability\ Score = HSSS_t = \frac{\sum_{i=0}^{11}(12-i) \times PSSS_{t-i}}{78}$$

$Where,$

$$i = number\ of\ months\ from\ present$$

4. *Portfolio Corporate Sustainability Rating and Portfolio Sovereign Sustainability Rating*

Previously calculated Historical Corporate Sustainability Scores and Historical Sovereign Sustainability Scores are ranked from 1 to 5 as stated in **table 4** within a Morningstar's Global Category. There must be at least 30 portfolios with respective HCSS or HSSS so that they can receive a score. Higher Sustainability Ratings will reflect a lower ESG risk. "The minimum difference between the median score and each subsequent breakpoint is set to 0,25 for sovereigns and 0,40 for corporates" (Barr, Doman, & Redensek, 2021).

Table 4
Summary of Corporate and Sovereign Sustainability Ratings Distribution

Distribution	Ratings
Best 10% (Lower Risk)	5
Next 22,5%	4
Next 35%	3
Next 22,5%	2
Worst 10% (Higher Risk)	1

Source: Morningstar Research Sustainalytics' Methodology & Portfolio Research

5. *Morningstar Sustainability Rating*

Finally, the Morningstar Sustainability Rating is computed by averaging the Portfolio Corporate and Sovereign Sustainability Ratings proportional to the respective contribution

[3] "In cases where 12 months of consecutive data are not available, a historical score will still be derived based on the most recent consecutive history of available Portfolio Corporate and Sovereign Sustainability Scores" (Barr, Doman, & Redensek, 2021).

of its long corporate and sovereign positions. This calculation can be seen in the following equation [5].

[5]

$$MSR = (Corporate\ Sustainability\ Rating\ \times Corporate\ Contribution\ Percent) + (Sovereign\ Sustainability\ Rating\ \times Sovereign\ Contribution\ Percent)$$

$$Where,$$

$$Contribution\ Percent = percentage\ between\ the\ corporate\ and\ sovereign\ portions\ of\ a\ portfolio$$

In order to receive a Morningstar Sustainability Rating the fund must have both a Portfolio Corporate and Sovereign Rating. If that's not the case, only the funds with less than 5% of corporate or sovereign qualified holdings will receive a MSR.

In comparison to its comparable group, a fund with a higher Morningstar Sustainability Rating will have a reduced ESG risk. **Table 5** shows MSR's 5 different categories.

Table 5
Morningstar Sustainability Rating Categories

Combined Corporate and Sovereign Rating	Rating Categories
≥ 4,5	5
< 4,5 and ≥ 3,5	4
< 3,5 and ≥ 2,5	3
< 2,5 and ≥ 1,5	2
< 1,5	1

Source: Morningstar Research Sustainalytics' Methodology & Portfolio Research

4. FAMA & FRENCH MODEL: ITS ANCESTORS AND DESCENDANTS

The well-known Fama and French's Three-Factor Model is a 1993 asset pricing model that extends on the Capital Assets Pricing Model (CAPM) by adding size-risk and value-risk elements to the market risk factor in CAPM. [4]

[4] The market risk factor, also known as undiversifiable risk, refers to the uncertainty associated with any investment decision. This kind of risk affects all asset classes and is unpredictable.

The CAPM model, constructed by Sharpe (1964), Linter (1965) and Black (1972), was designed to solve the question proposed by Markowitz (1952) of how to price one asset while taking into account the risk and return the security entails. According to CAPM, assets are priced in such a way that the projected profits pay investors for the predicted risks.

In Markowitz's approach, an investor chooses a portfolio at time $t-1$ that will provide a stochastic return at time t. The model assumes that investors are risk-averse and that when deciding between portfolios, they are solely concerned with the mean and variance of their one-period investment return. As a result, investors prefer "mean-variance efficient" portfolios, which (1) “reduce portfolio return variance given anticipated return” and (2) “maximize expected return given variance” (Fama & French, 2004). In other words, the optimal portfolio has the lowest degree of risk conceivable in relation to its level of return. As a result, the Markowitz technique is frequently referred to as a "mean-variance model."

In order to find the mean-variance efficient portfolio, Sharpe (1964) and Lintner (1965) added two major assumptions to the previously mentioned model that turned the algebraic statement into a testable prediction about the relationship between risk and return. (1) Complete agreement. “Given market-clearing asset prices at time $t-1$, investors agree on the joint distribution of asset returns from time $t-1$ to time t” (Fama & French, 2004). (2) Borrowing and lending at a risk-free rate are unrestricted.

Hence, the key assumptions of the CAPM models are as follows. (1) There are no taxes or transaction costs, hence, there is a perfect capital market. (2) All investors are risk-averse individuals who try to maximize their wealth by choosing a portfolio based solely on its mean and variance. (3) They all have homogeneous expectations. (3) All investors can borrow and lend at a risk-free interest rate.

These assumptions imply that the market portfolio must be on the minimum variance frontier if the asset market is to clear.[5] The relationship between the expected return and risk of investing in a security was described as followed in equation [6]:

[6]

$$E[R_i] = r_f + \beta_i \times E\left[R_{Mkt} - r_f\right], \quad i = 1, \dots, N$$

$$Where,$$

$$\beta_i = \frac{Cov\ (R_i, R_{Mkt})}{Var\ (R_{Mkt})}$$

In words, the expected return on any asset i is equal to the risk-free interest rate, r_f, plus a risk premium, which is the asset’s market beta multiplied by the market excess return. The beta of the security, β_i, represents the sensitivity of the stock to market risk. This means that according to the model, the success of a portfolio is mostly explained by the performance of the market as a whole.

[5] The efficient frontier contains the set of optimal portfolios that offer the lowest level of risk for a given level of return, not taking into account the risk-free rate of return.

Black (1972) replaced the unrealistic assumption of unrestricted risk-free borrowing and lending by allowing unrestricted short sales of assets to investors instead.[6]

The implications of the CAPM model are based on three main elements. (1) All asset's anticipated returns are linearly correlated to their betas, and no other variable has marginal scientific validity. (2) The expected return of the market portfolio is higher than the asset's anticipated return while these returns are uncorrelated, as the beta premium is positive. (3) Uncorrelated assets have expected returns equal to the risk-free interest rate, hence, the stock beta will be equal to the excess market return.

Many time-series regressions have been done to test the implications and the effectiveness of the Sharpe-Lintner model. The linear regression is the statistical technique that identifies the Security Market Line or best-fitting line through a set of points. This regression represents the relationship between the risk and the required return of an investment, which can be seen in equation [7].

[7]

$$R_i - r_f = \alpha + \beta_i^{Mkt} \times \left[R_{Mkt} - r_f\right] + \varepsilon_i$$

$Where,$

$R_i - r_f = Excess\ Asset's\ return$

$R_{Mkt} - r_f = Excess\ Market\ Return$

$\varepsilon_i = \ Error\ term$

$\alpha = E[R_i] - R_i$

According to the Security Market Line, Jensen's Alpha, α, measures the historical performance of a security relative to the required return. Sharpe's (1964) and Lintner's (1965) model suggests that the required return of an asset must be equal to its expected return, hence, the value of alpha must be zero.

Black, Jensen, & Scholes (1972) and Fama & MacBeth (1976) find that, as predicted by CAMP, there was a positive and linear relationship between the average returns of NYSE assets and market β during 1926 and 1968.[7] However, most studies carried out to test the efficacy of CAPM have concluded its inadequacy. Fama & French (1992) extended the previously mentioned study, analysing the years between 1963 and 1990, and discovered that the relation between the beta and market return disappeared. Reinganum's (1981) and Lakonishok & Shapiro's (1986) studies came to the same conclusion years earlier. Added to that, many studies have been able to identify other variables that influence average returns.

On the one hand, Banz (1981) documented the size effect: when equities are classified by market size or capitalization, average returns on small stocks outperform CAPM predictions. Hence, he found that there is a negative relation between expected returns and

[6] A short sale is the selling of an asset or stock in which the seller has no ownership. In general, it is a transaction in which an investor sells borrowed securities in expectation of a price decrease; the seller is then compelled to return an equivalent number of shares at a later date.

[7] NYSE: New York Stock Exchange.

firm size. Later on, using US data Blume & Stambaugh (1983) validated the size impact, as did Brown, Kleidon, & Marsh (1983) using Australian data.

On the other hand, according to Bhandari (1988), average returns are positively related to leverage. That is, high debt-equity ratios are associated with returns that are excessively high in comparison to their market betas. [8]

Added to that, Stattman (1980) and Rosenberg, Reid, & Lanstein (1985) revealed a strong correlation between average return and book-to-market equity for U.S stocks. Chan, Hamao, & Lakonishok (1991) came up with the same result for Japanese Stocks. [9] Basu (1983) did also find the same relation between average returns and price-to-earnings ratio, including in his test the size and market betas as well. [10]

Variables like size, leverage, book-to-market and price-to-earnings are all scaled versions of a firm's stock price. "These ratios involving stock prices have information about the expected returns missed by the market betas" (Fama & French, 2004).

The above-mentioned Fama & French (1992) research provided an update and synthesis of the evidence on the CAPM's empirical failings. They confirm, using a cross-sectional regression approach, that size, earnings-to-price, debt-equity, and book-to-market ratios contribute to the explanation of projected stock returns offered by market beta. [11]

The combination of the market excess return, size and book-to-market ratio absorbs the effects of earnings-to-price and leverage obtaining as a consequence an expanded three-factor version of the CAPM, outlined by [8].

[8]

$$E[R_i] = r_f + \beta_i^{Mkt} \times E\left[R_{Mkt} - r_f\right] + \beta_i^{SMB} \times E[R_{SMB}] + \beta_i^{HML} \times E[R_{HML}]$$

$Where,$

$E[R_i] = Expected\ rate\ of\ return$

$R_{Mkt} - r_f = Excess\ Market\ Return$

$r_f = Risk\ Free\ Interest\ Rate$

$\beta_i = Factor'scoefficient\ or\ sensitivity$

$E[R_{SMB}] = Small\ Minus\ Big\ portfolio\ Expected\ Return$

$E[R_{HML}] = High\ Minus\ Low\ portfolio\ Expected\ Return$

The Fama-French model seeks to characterize stock returns by focusing on three factors: (1) Market risk, (2) outperformance of small-capitalization businesses relative to large-capitalization companies and (3) outperformance of high book-to-market value companies against low B/M firms. The approach is based on the fact that high-value and small-cap firms consistently beat the overall market.

[8] The debt-equity ratio is a measure of leverage which is calculated by dividing the book value of debt with the market value of equity.

[9] The book-to-market ratio identifies stocks that are undervalued or overpriced by diving the book value by the market value. The ratio determines a company's market value in relation to its true worth.

[10] The P/E ratio compares the share price of a firm to its earnings per share.

[11] Cross sectional: A collection of data from many different subjects at the one point or period of time.

The added factors were “constructed using six value-weight portfolios formed on size and book-to-market equity” (Fama & French, 1993). [12]

In order to construct the portfolios, at the end of each June, the authors sort stocks in a region into two market capitalization and three book-to-market equity (B/M) groups. On the one hand, stocks were sorted by size. Assets in the top 10% are considered big-cap stocks (B) and the bottom 10% are considered to be small-cap stocks (S). On the other hand, the 30th and 70th percentiles of B/M for the region’s large stocks are considered the book-to-market equity breakpoints. Low, average and high B/M stocks are denoted as growth (G), neutral (N) and value (V) respectively.

Taking into account the value-weighted portfolios, on the one hand, the Small Minus Big portfolio return is formed by subtracting the average return on the three big portfolios from the average return on the three small portfolios, as seen in equation [9]:

[9]

$$R_{SMB} = \frac{1}{3}\left(R_{\frac{S}{V}} + R_{\frac{S}{N}} + R_{\frac{S}{G}}\right) - \frac{1}{3}\left(R_{\frac{B}{V}} + R_{\frac{B}{N}} + R_{\frac{B}{G}}\right)$$

On the other hand, the High Minus Low portfolio return calculation is shown in equation [10]. It is the result of the deduction of the two low B/M equity stocks from the two value portfolios.

[10]

$$R_{HML} = \frac{1}{2}\left(R_{\frac{S}{V}} + R_{\frac{B}{V}}\right) - \frac{1}{2}\left(R_{\frac{S}{G}} + R_{\frac{B}{G}}\right)$$

Several studies have been carried out to test the effectiveness of the Fama & French’s three-factor model when calculating cross-section average returns. Authors such as Ajili (2005), Bundoo (2008), Blanco (2012) and Chaudhary (2017) have concluded that the three-factor model poses a higher explanatory power than the Sharpe-Lintner model, at least for the French market, Mauritius stock exchange market, American NYSE market and Indian capital markets respectively. Griffin (2002) proposed that practical implementations of Fama & French’s model are best undertaken on a country-specific basis. He used data for 1521 companies in Japan, 1234 in the United Kingdom, and 631 in Canada from January 1981 to December 1995 to conclude that “domestic factor models explain much more time-series variation in returns” (Griffin, 2002).

Nevertheless, not all the studies done until now have found proof of the improvement in the estimation of portfolio returns. Using data from New Zealand, Nartea & Djajadikert (2005) discovered a large size impact and a mild book-to-market effect, hence according to them, the three-factor model is not as good as expected. Ziegler, Schöder, Schulz, & Stehle (2007) came to the same conclusion analysing the German market. Added to that, authors in reference, Bartholdy & Peare (2004) and Karp (2017), suggested the inaccuracy of both CAPM and the extended three-factor model.

In the hope of obtaining a better estimation of stock and portfolio returns, Carhart (1997) introduced a new variable, a cross-sectional momentum factor, to the Fama & French’s

[12] Six value weighted portfolios: (1) Small Growth S/G, (2) Small Neutral S/N, (3) Small Value S/V, (4) Big Growth B/G, (5) Big Neutral B/N, (6) Big Value B/V.

three-factor model, as depicted in equation [11]. The momentum effect was first discovered by Jegadeesh & Titman (1993), and its introduction in the multifactor regression was able to improve the explanatory power of the former model considerably.

[11]

$$E[R_i] = r_f + \beta_i^{Mkt} \times E[R_{Mkt} - r_f] + \beta_i^{SMB} \times E[R_{SMB}] + \beta_i^{HML} \times E[R_{HML}] + \beta_i^{WML} \times E[R_{WML}]$$

$Where,$

$$i = 1, \dots, n \; number \; of \; funds$$

$$E[R_{WML}] = Winners \; Minus \; Losers \; portfolio \; Expected \; Return$$

The momentum effect is the tendency of stocks to exhibit persistence in performance, that is to say, stocks that performed well in the recent past, denoted as winners, on average outperform other stocks in the subsequent period, whereas loser stocks with bad returns do the reverse. The trading strategy of constructing a zero-investment portfolio by buying recent winners and selling recent losers is proved to be uncorrelated to undiversifiable risk. [13]

This constructed portfolio, usually called Winners Minus Losers (WML) is built using six value-weighted portfolios based on size and historical two to twelve-month performances.[14] The median NYSE market equity serves as the monthly size breakpoint. The 30th and 70th NYSE percentiles are the monthly preceding (2-12) return breakpoints where winner (W), tie (T) and looser (L) stocks can be identified. The WML portfolio return is the average return on the two portfolios with high past returns minus the average return on the two portfolios with poor prior returns as can be seen in equation [12].

[12]

$$R_{WML} = \frac{1}{2}\left(R_{\frac{S}{W}} + R_{\frac{B}{W}}\right) - \frac{1}{2}\left(R_{\frac{S}{L}} + R_{\frac{B}{L}}\right)$$

Carhart's four-factor model's accuracy has been tested not only in the US market by Carhart (1997) and Connor, Hagmann, & Linton (2012), but also by L'Her, Masmoudi, & Suret (2004) in the Canadian stock market. However, Chen & Fang (2009) found that the three-factor model outperforms the CAPM in the Pacific Basin markets, but they couldn't uncover any evidence for Carhart's four-factor model's momentum impact. The three-factor model performed as well as, if not slightly better than, the four-factor model, according to their findings.

More recent studies have been carried out extending both the Fama & French and Carhart models. López Garcia, Trinidad Segovia, Sánchez Granero, & Pouchkarev (2021) introduced the long-term memory factor whose significance level was found to be similar to the SMB and HML portfolios, and even higher comparing it to the WML portfolio significance level. Before this research was done, the liquidity-augmented F&F three-factor model was developed by Chan & Faff (2005) while Connor, Hagmann, & Linton (2012) developed a five-factor extension of Carhart's four-factor model that included an own-volatility element.

[13] A zero-investment portfolio is formed by a group of stocks that have a net value of zero.

[14] The six value weighted portfolios: (1) Small Winner S/W, (2) Small Tie S/T, (3) Small Looser S/L, (4) Big Winner B/W, (5) Big Tie B/T, (6) Big Looser B/L

Fama & French (2015) beat their initial three-factor model after proposing a 5-factor model oriented at value, size, profitability, and investment patterns in average stock returns. After that, based on data from the US market, the Q-factor model of Hou, Chen Xue, & Zhang (2015) beat the F&F five-factor model.

Authors such as Renneboog, Horst, & Zhang (2008), Xiao, Faff, Gharghori, & Lee (2013) and Walker, Lopatta, & Kaspereit (2014) tried to determine if corporate sustainability is an important factor in multifactor asset pricing models. The former, augmented Carhart's four-factor model by introducing a new factor based on a simple long-short strategy in the FTSE4Good sustainability index. Xiao et al. (2013) augmented the Fama and French three-factor model introducing their constructed sustainable factor which was based on SAM (Sustainable Asset Management) raking. The latter used yearly data from the MSCI KLD database to construct the Green Minus Unsustainable (GMU) portfolio and introduce it to Carhart's model. All three models concluded that the sustainability component does not influence predicted returns, at least for the markets and periods analysed.

Following the aforementioned authors' research line, and with the purpose of finding a significant variable that may explain part of a portfolio's expected returns, this study augments Fama and French's Three-Factor Model and Carhart's Four-Factor Model by introducing the effect of sustainable investment.

Nowadays, a growing number of people are not choosing investment opportunities purely based on their capacity to create financial returns. They seek long-term solutions that reflect their values and contribute to the issues they care about, such as the environment or nature preservation, fair and ethical social basis or governance criteria. This change in perspective renders the CAPM model outdated, as one of its main assumptions is no longer sustained, the investor's unique concern about returns.

The introduction of the new factor, GMR, or the Green Minus Red portfolio is intended to reflect the broadening concerns of 21st century investors, creating a portfolio based on funds that follow ESG criteria. These kinds of funds generate benefits such as integration, equity, gender inclusion, the fight against climate change, innovation in financial instruments for sustainability, and even contribute to dialogue networks between regions and companies.

By expanding the previously mentioned models, I seek to characterize stock returns by focusing not only on the market risk, size, value and momentum factors but also on the out-performance of high sustainable funds relative to the low sustainable funds. This is assumed and tested by different authors mentioned before. Sustainable investment involves high control and transparency, which translates into an increase in the quality of the investments and a reduction in risks. The fact of obtaining a social benefit, besides the economic one revaluates them.

The main objective of this study is to investigate whether the sustainable investment effect captured by the GMR portfolio can be considered an additional factor for both Fama & French's and Carhart's models so that the performance of asset pricing models for the European Mutual Fund Industry between October 2018 and January 2022 can be improved.

The augmented Fama & French's model [13] and the augmented Carhart's model [14] are defined as follows:

[13]

$$E[R_i] = r_f + \beta_i^{Mkt} \times E[R_{Mkt} - r_f] + \beta_i^{SMB} \times E[R_{SMB}] + \beta_i^{HML} \times E[R_{HML}] + \beta_i^{\text{GMR}} \times E[R_{\text{GMR}}]$$

[14]

$$E[R_i] = r_f + \beta_i^{Mkt} \times E[R_{Mkt} - r_f] + \beta_i^{SMB} \times E[R_{SMB}] + \beta_i^{HML} \times E[R_{HML}] + \beta_i^{WML} \times E[R_{WML}] + \beta_i^{\text{GMR}} \times E[R_{\text{GMR}}]$$

$Where,$

$i = 1, \dots, n \; number\ of\ Europena\ open - enden\ mutual\ funds$

$E[R_{GMR}] = Grenn\ Minus\ Red\ portfolio\ Expected\ Return$

[13] $represents\ the\ augmented\ Fama\ \&\ French\ Three\ Factor\ Model$

[14] $represents\ the\ augmented\ Carhart\ Four\ Factor\ Model$

The hypothesis behind this study is that the added factor will improve the estimation of expected fund returns. I believe this will happen not only because it considers the broadening concerns of investors, but also because it reflects the idea that they beat the market.

5. DATA AND DESCRIPTIVE ANALYTICS

In order to construct the new factor, information from Morningstar Direct has been downloaded. This database contains a sum of 159.581 European open-ended mutual funds registered on it, from which only 22.455 or the 14,07% of funds contain continuous monthly data between October 1, 2018 and January 31, 2022 on:

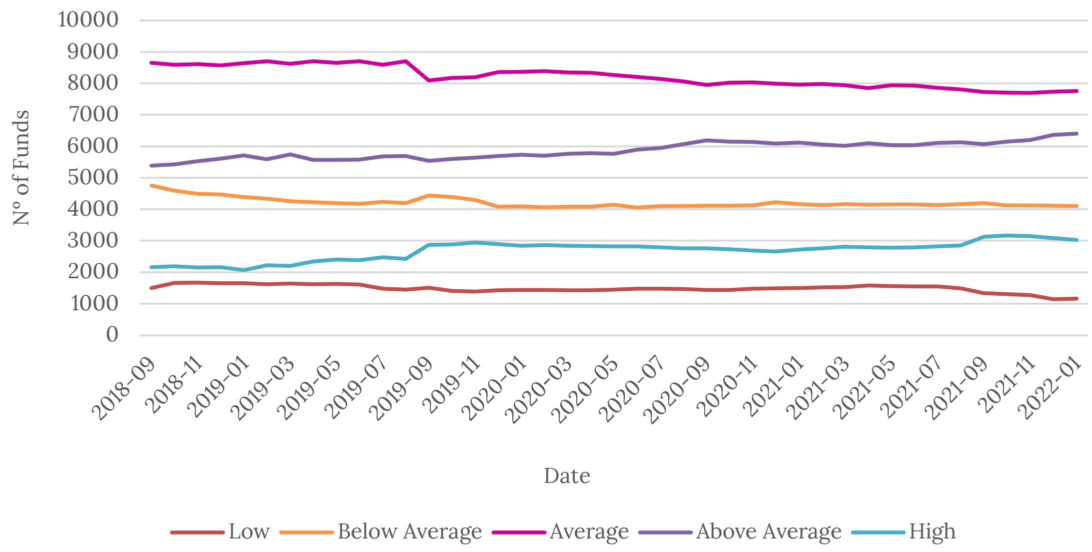
- *Morningstar Sustainability Rating*
- *Net Return*
- *Gross Return*
- *Fund size or market capitalization*

These funds also contain information about their inception date and global broad category group which summary statistics are shown below.

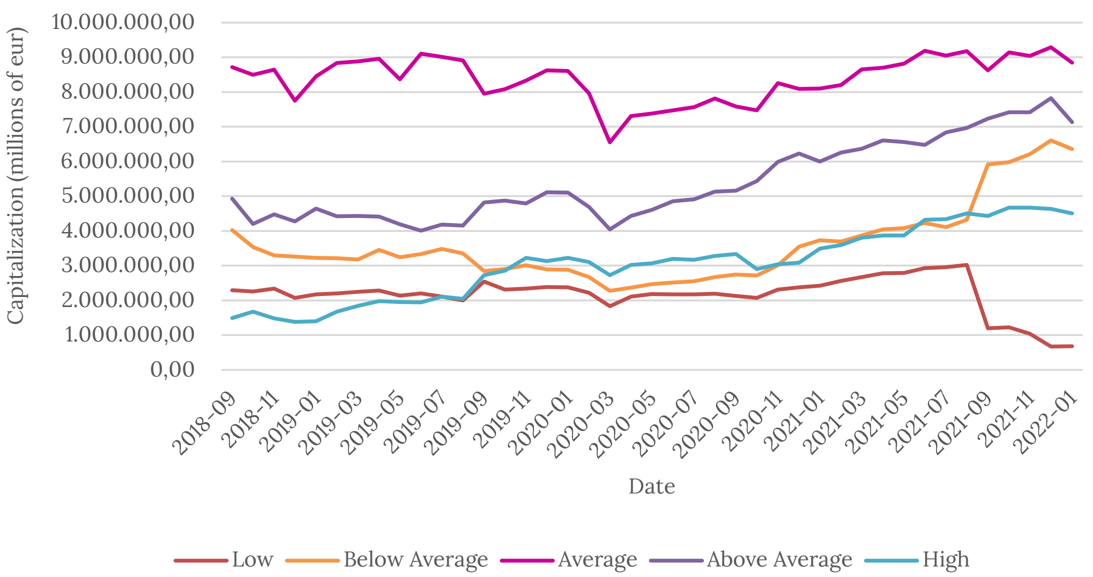
Figure 1, panel A illustrates the monthly-time series plot of the number of European open-ended mutual funds based on MSR from October 2018 to January 2022. Even though the number of average MSR funds has decreased by 10,28% these 41 months, they remain the representative majority. Green funds, the ones ranked as above average or high, have had an increase of around 25%, which compared to the red or unsustainable funds, ranked below average or with low calcifications, had noticed an increase of over 40,5%.

Figure 1
Monthly number of funds and capitalization of the European Open-Ended mutual funds based on MSR

Panel A: *Monthly Number of Funds*



Panel B: *Monthly Capitalization in millions of euros*



Note: Data table is shown in ***appendix 1*** *and* **2**
Source: *Own Creation*

As far as market capitalization is concerned, it is worth noting in **figure 1, panel B,** the increase in capitalization of highly rated funds. Their size has increased more than double since October 2018, even though the number of funds among this category has remained stable. Funds rated as below or above average have also noticed an increase in capitalization of 57,91% and 44,69% respectively during the period analysed. It is also noticeable the drop of 70,31% among low sustainable funds. According to Nofsinger and Varma (2014), socially responsible mutual funds outperform conventional funds during market declines but underperform traditional funds during economic expansions. We can use this explanation to argue that due to the COVID-19 crisis the European market suffered a decline in capitalization which fostered sustainable funds capitalization and lowered non-sustainable ones.

Regarding funds age, we can observe in **table 6** that the mean lifetime of average labelled European mutual funds was about 15 years, not that different from funds labelled as green and red.

Table 6

Funds Age Summary Statistics based on MSR

	Low	Below Average	Average	Above Average	High
Mean	12	14	15	14	14
	(149)	(162)	(174)	(173)	(167)
Median	10	11	12	12	11
	(117)	(133)	(148)	(143)	(135)
Maximum	74	68	86	85	72
	(885)	(816)	(1036)	(1022)	(868)
Minimum	3	3	3	3	2
	(40)	(41)	(39)	(41)	(25)

Note: Funds age has been calculated using a reference year which is the 31st of January of 2022. Hence, the fund's age, represented in years (months), is the difference between January 31st, 2022 and its inception date according to Morningstar Direct.

Source: Own Creation

Finally, **table 7** shows the number of funds classified both with the Global Broad Category Group and MSR. The Morningstar Global Category assignments were created in 2010 to assist investors in their search for comparable assets domiciled throughout the world.

Morningstar offers worldwide categories, which are divided into nine global broad category groupings (Equity, Allocation, Convertibles, Alternative, Commodities, Fixed Income, Money Market, Property, and Miscellaneous). When designating Global categories, Morningstar research teams employ a mosaic technique. Many variables influence their selection: "familiarity with the strategy of the portfolio managers and fund family, the fund's Morningstar Retail category assignment, and a desire to portray the most accurate picture of economic exposure possible" (Morningstar, 2018).

Equity funds form the majority of the selection, accounting 87,18% of all funds. Equity green funds sum up a total of 7.156 funds, whereas red funds sum up to 4.776. This kind of funds invest mainly in stocks, which are categorized according to the market capitalization, the investment style of the holding in the portfolio and geography. Funds classified as fixed income and allocation form together the remaining 11,44% of the fund selection. On the one hand, fixed income refers to financial securities that pay fixed interest or dividend payments to investors until the maturity date. Investors are refunded the principal amount they invested at maturity. The most prevalent fixed-income instruments are government and corporate bonds. On the other hand, asset allocation funds are a mix of the previously mentioned two categories. It is a fund that invests in a broad portfolio of assets across several asset classes, meaning it can be held to specific percentages of asset classes or permitted to be overweighted on others depending on market circumstances.

Table 7

Number of funds based on Global Broad Category Group & MSR

	Low	Below Average	Average	Above Average	High	TOTAL
Equity	1196	3580	7645	4879	2277	**19577**
Fixed Income	96	269	565	265	87	**1282**
Allocation	124	72	338	415	339	**1288**
Convertibles	2	41	140	68	25	**276**
Alternative	-	2	10	-	3	**15**
Miscellaneous	-	-	-	5	10	**15**
Money Market	-	2	-	-	-	**2**
TOTAL	**1418**	**3966**	**8698**	**5632**	**2741**	**22455**
Percentage	**6%**	**18%**	**39%**	**25%**	**12%**	

Source: Own Creation

Regarding the construction of the new factor, 22.455 European open-ended mutual funds have been classified each month from October 2019 to January 2022 by the MSR and market capitalization. On the one hand, stocks are sorted depending on their MSR mark. Hence, three different groups are formed with funds labelled as red (R), average (A) and green (G). On the other hand, stocks have been sorted by size. Funds with a capitalization above the 70th percentile of the overall 22.455 funds capitalization are classified as big (B), those with a capitalization below the 30th percentile are classified as small (S) and the remaining funds are named as medium (M) capitalization funds.

Nine value-weighted portfolios are formed each month taking into account their capitalization as a share of the market capitalization of the selected portfolio. [15]
Equation [15] shows how GMR portfolio returns have been constructed. It is the difference between green classified and red classified portfolios' average returns.

[15]

$$R_{GMR} = \frac{1}{3}\left(R_{\frac{G}{S}} + R_{\frac{G}{M}} + R_{\frac{G}{B}}\right) - \frac{1}{3}\left(R_{\frac{R}{S}} + R_{\frac{R}{M}} + R_{\frac{R}{B}}\right)$$

Note: Portfolios with average MSR have not been considered to calculate the GMR portfolio returns, as we wanted to quantify the impact of sustainable and non-sustainable funds clearly classified in one of the MRS groups.

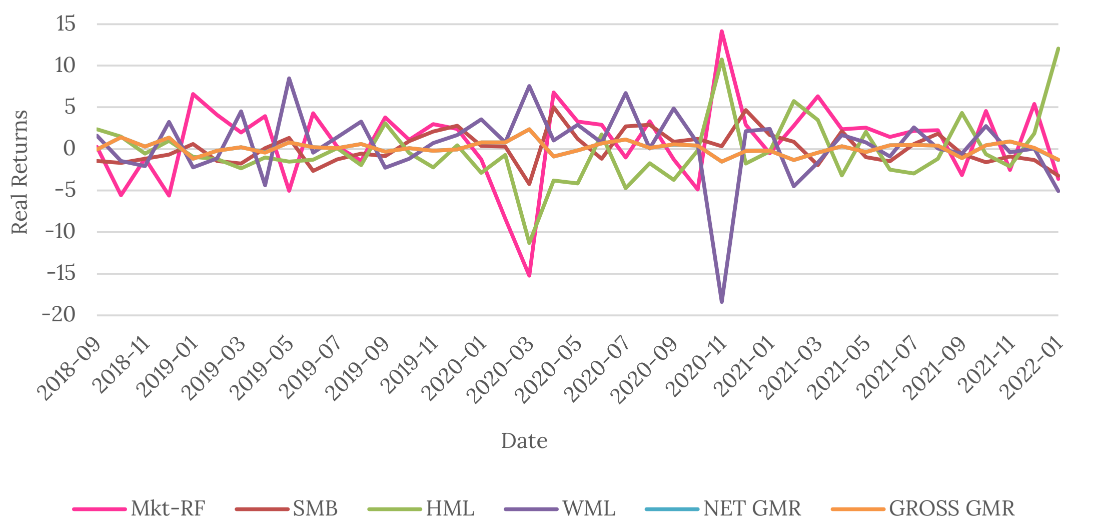
[15] Nine value weighted portfolios: (1) Green Small G/S, (2) Green Medium G/M, (3) Green Big G/B, (4) Average Small A/S, (5) Average Medium A/M, (6) Average Big A/B, (7) Red Small R/S, (8) Red Medium R/M, (9) Red Big R/B

In order to build the model and verify whether the new factor improves the asset pricing models, Small Minus Big (SMB), High Minus Low (HML) and Winners Minus Losers (WML) portfolio returns have been gathered from the Kenneth R. French official web page databases (Kenneth R. French - Data Library (dartmouth.edu)). On the contrary, the market excess return has been constructed using Morningstar database information about MSCI Europe IMI net returns and the monthly Euribor data as a proxy of market return and risk-free interest rate for the European market respectively.

On the one hand, the MSCI Europe Investable Market Index (IMI) includes big, mid, and small size stocks from 15 European Developed Markets. The index represents about 99 per cent of the free float-adjusted market capitalisation throughout the Developed Markets nations of Europe, with 1,479 components. On the other hand, the Euro Interbank Provide Rate, or Euribor, is a reference rate calculated using the average interest rate at which eurozone banks offer unsecured short-term loans on the interbank market. Euribor is calculated using loans with maturities ranging from one week to one year, in this study, I have used the 1-month Euribor monthly returns.

Figure 2

Monthly factor real returns



Note: Data table shown in ***appendix 3***

Source: Own Creation

Regarding **figure 2** and analysing **table 8**, we can see that the newly added factors, net and gross GMR factors, are the most stable over the years analysed, both having a standard deviation of 0,7936% and a mean return of 0,1059% and 0,1077% respectively. These positive values indicate that, on average, funds with high or above-average sustainable Morningstar ratings tend to achieve higher returns than stocks labelled as red. Seeing that European open-ended mutual funds classified as green outperform on average the returns of the red ones during October 2018 and January 2022, the previously mentioned hypothesis is fulfilled. This result reinforces the conclusions reached by Luther, Matatko, & Corner (1992) and Friede, Busch, & Bassen (2015).

The most volatile variable is the market risk factor, 4,8896%, which also has the highest average returns, 0,8263%, with respect to the other factors, followed by the WML portfolio, with an average return and volatility of 0,4685% and 4,2343% respectively. HML portfolio is the one with the lowest mean return, -0,2749%, and a 3,9248% standard deviation. Finally, SMB portfolio's volatility and average returns are 3,9392% and 0,0780% respectively.

Table 8
Summary Statistics

	Mkt-RF	SMB	HML	WML	NET GMR	GROSS GMR
Average returns	0,8263	0,0780	-0,2749	0,4685	0,1059	0,1077
Median	2,1558	0,1000	-0,9500	0,7500	0,1244	0,1274
Variance	23,9084	3,9392	15,4038	17,9296	0,6298	0,6297
Standard deviation	4,8896	1,9847	3,9248	4,2343	0,7936	0,7936
Maximum	14,1427	5,0400	12,0900	8,5000	2,3604	2,3656
Minimum	-15,2091	-4,2200	-11,3000	-18,3900	-1,5233	-1,5193

Source: *Own Creation*

Table 9
Variance, Covariance and Correlation matrix

Panel A: *Variance and Covariance matrix*

	Mkt-RF	SMB	HML	WML	NET GMR	GROSS GMR
Mkt-RF	23,90845	2,73206	6,61704	-11,52287	-2,61710	-2,61745
SMB		3,93922	-1,56283	0,83237	-0,33492	-0,33388
HML			15,40378	-12,15898	-2,04637	2,19220
WML				17,92957	2,19298	2,19220
NET GMR					0,62981	0,62976
GROSS GMR						0,62974

Panel B: *Correlation matrix*

	Mkt-RF	SMB	HML	WML	NET GMR	GROSS GMR
Mkt-RF	1	0,28152	0,34481	-0,55654	-0,67443	-0,67456
SMB		1	-0,20063	0,09904	-0,21263	-0,21198
HML			1	-0,73164	-0,65700	-0,65653
WML				1	0,65260	0,65240
NET GMR					1	0,99998
GROSS GMR						1

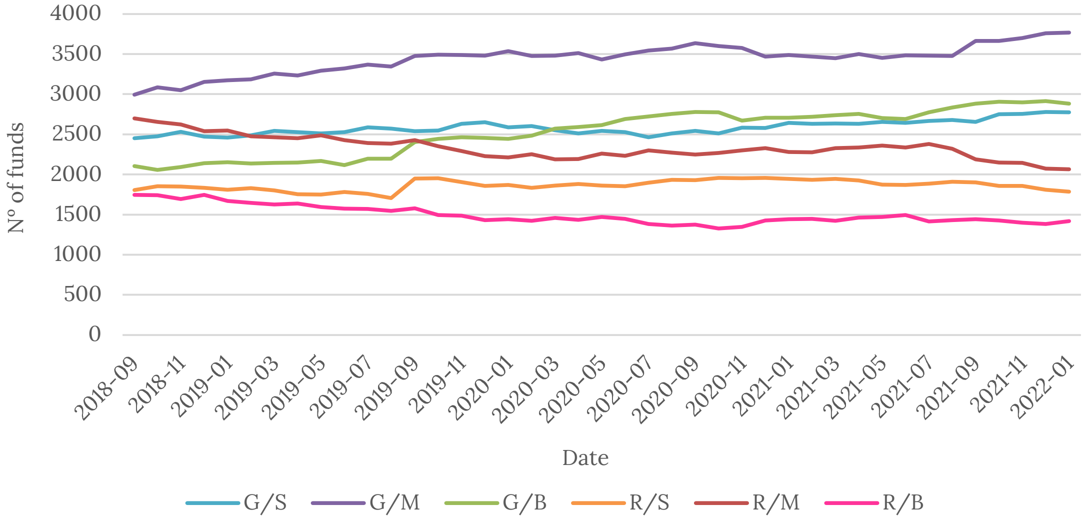
Source: *Own Creation*

The newly added factors are strongly correlated with the market and move in the opposite direction, as it is noticeable in **table 9**. This confirms the conclusion drawn by the authors in reference Nofsinger & Varma (2014), which is that socially responsible mutual funds outperform regular funds during market downturns but underperform traditional funds during economic booms.

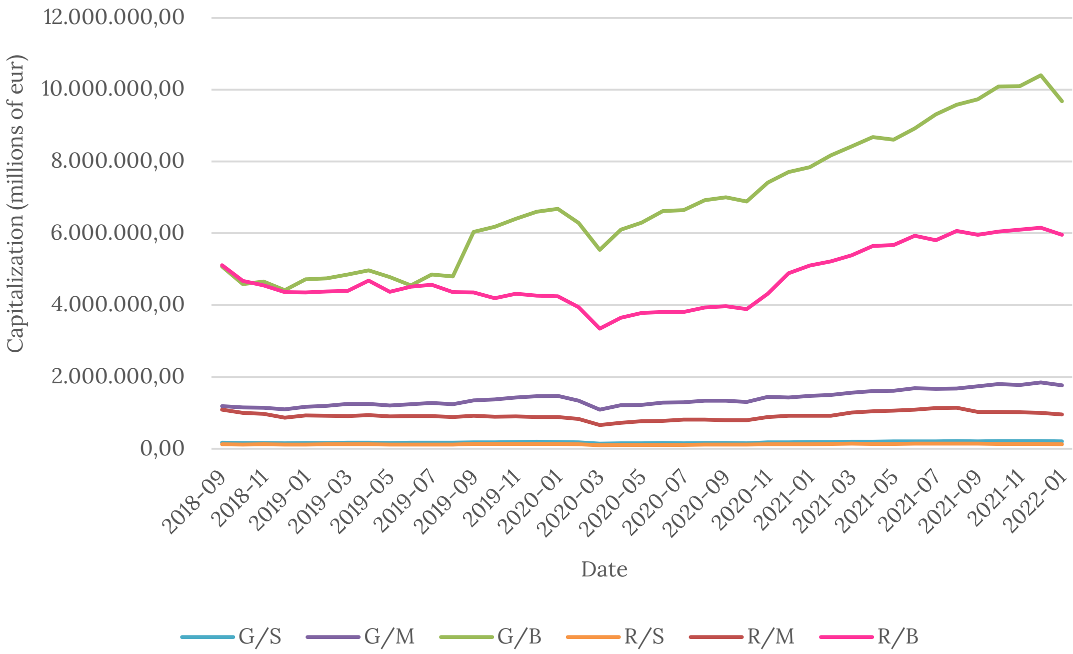
Figure 3

Monthly number of funds and capitalization of the nine value-weighted portfolios

Panel A: *Monthly number of funds*



Panel B: *Monthly capitalization in millions of euros*



Note: Data table shown in ***appendix 4*** *and* ***5***

Source: Own Creation

Analysing a bit more the construction of the GMR portfolio, figure 3 confirms the above Ammann, Bauer, Fischer, & Müller (2019) and Nofsinger & Varma (2014) study results: Investors are shifting money away from red labelled funds to green labelled funds. Especially, the G/B portfolio experiences a 36,03% increase in the number of funds over the 41 months, followed by the G/M and G/S portfolios whose number of funds increased by 25,83% and 13,09% respectively. The R/M portfolio has suffered the major decrease in the number of funds, followed by the R/B and R/S portfolios. The number of funds decreased by 23,45%, 18,82% and 1,16% respectively during the observed period. These shifts in the number of funds forming green and red labelled portfolios have caused a substantial increase in their capitalization, especially for G/B portfolio, which in the observed period has suffered an increase of 19,23%.

6. RESULTS

Table 10, panel A shows the results of the 3 asset pricing models by OLS. CAPM, Fama and French's three-factor model and Carhart's four-factor model results are calculated using the data collected from Morningstar and Kenneth R. French's official web page databases about European open-ended mutual funds, risk-free interest rate, European market-return proxy and risk factors between October 2018 and January 2022.

It should be noted that the coefficients on excess market return, R_{SMB}, R_{HML} and R_{WML} are all significant among all three models, which means that they are sufficient in explaining the variation of fund returns. The systematic risk is the highest beta among all three models. This means that one percent increase in the excess market return will increase the fund's expected excess net return by 0,847848% (CAPM), 0,833268% (F&F) or 0,822826% (Carhart). The coefficient of SMB portfolio return, β^{SMB} , is the second highest risk-factor after the market beta, however, its variations in percentage terms does not have an excessive impact over excess net returns. One percent increase in the R_{SMB} will provoke an expected increase of around 0,27% for both F&F (0,27236%) and Carhart (0,278401%) models. R_{HML} and R_{WML} coefficients have both negative sings, which means they move in opposite directions compared with the funds net excess return. However, their variations are merely noticeable over expected fund excess returns ($\beta_{FF}^{HML} = -0{,}0597733, \beta_{CAR}^{HML} = -0{,}0796616$ and $\beta^{WML} = -0{,}0316550$).

It is worth mentioning that the introduction of the SMB and HML portfolios has greatly improved the estimation of the excess returns over CAPM. The determination coefficient, R^2, has increased by 2,287% ($R_{CAPM}^2 = 0{,}617302$ and $R_{FF}^2 = 0{,}631420$), which is a relatively high increase given the low impact the added variables return change provoke over the expected excess net returns of the funds. This result confirms the above-mentioned study results done by Griffin (2002), Ajili (2005), Bundoo (2008), Blanco (2012) and Chaudhary (2017). Nevertheless, the introduction of the momentum factor does not create an excessive improvement in R^2 ($R_{CAR}^2 = 0{,}631647$) which supports Chen & Fang (2009) findings.

Table 10

Results of the different Asset Pricing Models

Panel A: CAPM [7], *Fama & French [16] and Carhart Model [17] results*

[7]

$$R_i - r_f = \alpha + \beta_i^{Mkt} \times [R_{Mkt} - r_f] + \varepsilon_i$$

[16]

$$R_i - r_f = \alpha + \beta_i^{Mkt} \times [R_{Mkt} - r_f] + \beta_i^{SMB} \times R_{SMB} + \beta_i^{HML} \times R_{HML} + \varepsilon_i$$

[17]

$$R_i - r_f = \alpha + \beta_i^{Mkt} \times [R_{Mkt} - r_f] + \beta_i^{SMB} \times R_{SMB} + \beta_i^{HML} \times R_{HML} + \beta_i^{WML} \times R_{WML} + \varepsilon_i$$

	α	β^{Mkt}	β^{SMB}	β^{HML}	β^{WML}	R^2
CAPM	0,129388***	0,847848***				0,617302
	(0,00340901)	(0,00069574)				
FF	0,103748***	0,833268***	0,27236***	−0,0597733***		0,63142
	(0,00338188)	(0,000786867)	(0,00185741)	(0,000960185)		
CARHART	0,12127***	0,822826***	0,278401***	−0,0796616***	−0,0316550***	0,631647
	(0,00345966)	(0,000900146)	(0,00187401)	(0,00127122)	(0,00132653)	

Panel B: *Augmented Fama & French [18] and Carhart's [19] Model results*

[18]

$$R_i - r_f = \alpha + \beta_i^{Mkt} \times [R_{Mkt} - r_f] + \beta_i^{SMB} \times R_{SMB} + \beta_i^{HML} \times R_{HML} + \beta_i^{GMR} \times R_{GMR} + \varepsilon_i$$

[19]

$$R_i - r_f = \alpha + \beta_i^{Mkt} \times [R_{Mkt} - r_f] + \beta_i^{SMB} \times R_{SMB} + \beta_i^{HML} \times R_{HML} + \beta_i^{WML} \times R_{WML} + \beta_i^{GMR} \times R_{GMR} + \varepsilon_i$$

	α	β^{Mkt}	β^{SMB}	β^{HML}	β^{GMR}	β^{WML}	R^2
ISH_FF	0,219046***	0,775702***	0,205175***	-0,152031***	-0,829294***		0,63619
	(0,00351977)	(0,0009409)	(0,0019439)	(0,00127052)	(0,0075432)		
ISH_CAR	0,227467***	0,770551***	0,209350***	−0,162049 ***	−0,819424***	−0,0176914***	0,63626
	(0,00357545)	(0,00101678)	(0,00196869)	(0,00147524)	(0,00757858)	(0,0013245)	

Note: *** *indicates statistical significance at the 10% level. ( ) Standard deviations are given in parentheses.*
ISH_FF and ISH_CAR notation refers to the augmented Fama and French's three-factor model and Carhart's four-factor model respectively.
All returns are expressed in percentages and have been calculated using net data.

Source: *Own Creation*

As shown in **table 10, panel B**, the introduction of the sustainable investment factor in the model decreases the market beta to 0,77 in both models ($\beta_{ISH\_FF}^{Mkt} = 0{,}775702$ and $\beta_{ISH\_CAR}^{Mkt} = 0{,}770551$), and the GMR factor turns out to have the highest beta in absolute value ($\beta_{ISH\_FF}^{GMR} = -0{,}829294$ and $\beta_{ISH\_CAR}^{GMR} = -0{,}819424$). 1% increase in the GMR portfolio returns, will provoke a reduction of 0,829294% (ISH_FF) or 0,819424% (ISH_CAR) in the expected excess net fund returns. The negative sign of the new added factor's beta indicates that the excess portfolio returns and GMR portfolio returns are moving in opposite directions. This may happen because although 37,2879% of the sample is classified as green funds, an increase in their returns may mean a major reduction in red labelled fund return, thus causing an overall negative effect over expected excess fund net returns. An alternative explanation could be that the sustainability factor is mostly driven by returns on "red" funds and therefore the beta is negative.

Another noticeable change in the estimation of model that includes the GMR factor is the decrease in the HML factor coefficient of around 100-150% depending on the model, with resulting negative betas of 0,152031 (ISH_FF) or 0,162049 (ISH_CAR) respectively. This could be due to the negative and strong correlation between the variables ($Correlation_{GMR_{net},\ HML} = -0{,}65700$). However, these changes have not influenced the determination coefficient, as only the 63,6% of the funds excess net returns variability can be explained by the factors included in both models.

7. SPLIT SAMPLE TEST

Based on Walker, Lopatta, & Kaspereit's (2014) study, European open-ended mutual funds have been classified into 4 different groups between October 2018 and January 2022 in order to analyse the impact of the newly added factor over specific MSR groups.[16] The value-weighted returns of these 4 differently rated funds are regressed on the common factors from Fama and French's three-factor model, Carhart's four-factor model and the sustainability factor.

In line with the hypotheses that Walker, Lopatta, & Kaspereit (2014) mentioned in their work, I expect (1) a significant and large factor loading $\boldsymbol{\beta}_{i,Rtn}^{\mathbf{GMR}}$ which will be (2) negative for lower sustainable rated funds and positive for higly rated ones, (3) higher adjusted R^2 and (4) less significant intercepts or alphas in the augmented model results with respect to the original ones.

On the one hand, **table 11, panels A** and **B** present the results for the time series regression of the different sustainable level fund weighted returns on the factors from Fama and French's three-factor model and Carhart´s four-factor model. On the other hand, **table 11, panels C** and **D** indicate the extended model results for both Fama & French and Carhart's models.

Looking at the results obtained for both Fama and French's and Carhart's non-augmented models, it is noticeable that all variables are significant in explaining the variation of differently rated fund returns except WML portfolio returns and the intercept. The latter is statistically significant only for green-rated funds. The former β^{WML}, is never significant, perhaps because the sample period is so short that there is not much time for the momentum to fluctuate. Hence, introducing this variable hardly increases the determination coefficient in Carhart's model, being its value most of the time lower than in the Fama & French model.

[16] The classification of the 4 different groups: Low, below average, above average and high sustainability rated funds.

Table 11

Results of Capital Asset Pricing Models for each MSR groups

Panel A: *Fama and French's Three-Factor Model [16] Results*

	α	β^{Mkt}	β^{SMB}	β^{HML}	R^2
Low	0,19377	0,759987***	0,311067**	−0,110436*	0,877841
	(0,153943)	(0,0644086)	(0,128752)	(0,0618981)	
Below Average	0,105569	0,859948***	0,328787**	−0,0882333***	0,91596
	(0,131708)	(0,0610504)	(0,131903)	(0,0402795)	
Above Average	0,204757*	0,789145***	0,226486**	−0,178021***	0,920993
	(0,120434)	(0,0423013)	(0,111503)	(0,0307662)	
High	0,395071 ***	0,790588***	0,175444*	−0,229717***	0,933462
	(0,136313)	(0,039839)	(0,0953286)	(0,0278901)	

Panel B: *Carhart's Four-Factor Model [17] Results*

	α	β^{Mkt}	β^{SMB}	β^{HML}	β^{WML}	R^2
Low	0,250935	0,72592***	0,330775**	−0,175322**	−0,103274	0,881882
	(0,154659)	(0,0637974)	(0,123612)	(0,0853116)	(0,077377)	
Below Average	0,144475	0,836762 ***	0,342200 **	−0,132393**	−0,0702866	0,917479
	(0,138475)	(0,0650543)	(0,128895)	(0,0643417)	(−0,0702866)	
Above Average	0,239124*	0,768663***	0,238334**	−0,217030 ***	−0,0620882	0,92251
	(0,128888)	(0,0478961)	(0,107257)	(0,0601307)	(0,0692964)	
High	0,407266**	0,783320***	0,179648*	−0,243559***	−0,0220315	0,933661
	(0,152327)	(0,0549239)	(0,0933201)	(0,0525509)	(0,0628868)	

Panel C: *Augmented Fama and French's Three-Factor Model [18] Results*

	α	β^{Mkt}	β^{SMB}	β^{HML}	β^{GMR}	R^2
Low	0,413618***	0,650222***	0,182959	−0,286352 ***	−1,58128***	0,906778
	(0,15044)	(0,0435165)	(0,130245)	(0,0548931)	(0,426047)	
Below Average	0,277103*	0,774304***	0,228832*	−0,225490***	−1,23378***	0,930256
	(0,145491)	(0,0507014)	(0,121562)	(0,052262)	(0,278749)	
Above Average	0,263412 *	0,759860***	0,192307	−0,224955 ***	−0,421883	0,923132
	(0,13236)	(0,0412831)	(0,114195)	(0,0533467)	(0,311518)	
High	0,389568***	0,793335***	0,178650*	−0,225314 ***	0,0395773	0,933481
	(0,13972)	(0,04212)	(0,0943229)	(0,0333588)	(0,225176)	

Panel D: *Augmented Carhart's Four-Factor Model [19] Results*

	α	β^{Mkt}	β^{SMB}	β^{HML}	β^{GMR}	β^{WML}	R^2
Low	0,450296***	0,627786***	0,201148	−0,329985 ***	−1,53829***	−0,0770608	0,909007
	(0,14981)	(0,0595367)	(0,125336)	(0,0872881)	(0,436285)	(0,0696164)	
Below Average	0,300775 *	0,759824***	0,240571**	−0,253651***	−1,20603***	−0,0497349	0,931009
	(0,156195)	(0,0654899)	(0,117436)	(0,0800954)	(0,28861)	(0,0708477)	
Above Average	0,290790**	0,775469***	0,201361	−0,239515***	−0,713917 **	−0,0348547	0,924328
	0,130852	0,0494503	0,119222	0,0687248	0,314995	0,0606613	
High	0,400479**	0,786661 ***	0,184061*	−0,238294***	0,0523667	−0,0229239	0,933696
	(0,153813)	(0,0564017)	(0,0917493)	(0,0558166)	(0,227195)	(0,0621137)	

*Note: *** indicates statistical significance at the 10% level, ** indicates statistical significance at the 5% level and * indicates statistical significance at the 1% level.*
( ) Standard deviations are given in parentheses.
All returns are expressed in percentages and have been calculated using net data.
The robust standard errors approach was used to estimate the coefficients in order to minimize the standard errors of OLS coefficients in the presence of heteroscedasticity.
Rtn = Low, Below Average, Average, Above Average or High rated funds
Source: *Own Creation*

As far as the expanded model results are concerned, the coefficients of the excess market return and HML portfolio returns are substantial at 10% for all 4 differently rated fund groups. WML portfolio net returns beta remains insignificant and negative, whereas SMB, which was formerly substantial, is now not always significant. Added to that, the intercept is now substantial for all MSR funds. Hence, hypothesis (4) is rejected, which results in the reduction of the explanatory power of the new added sustainable factor.

Regarding the GMR portfolio return's coefficient, its significance level varies across red and green-labelled funds. Poorly rated funds have a significant β^{GMR}, whereas green-labelled ones do not. These findings show that the first hypothesis has been refuted.

Added to that, GMR portfolio returns coefficient's value is negative for red labeled funds and positive for highly rated ones. This result is consistent with the second hypothesis stated before. Portfolios formed of low-sustainability funds are adversely exposed to the sustainability factor, whereas portfolios composed of highly sustainable funds are positively exposed. This is because Green labelled funds outperform the returns of red labelled funds on average, proved by Luther, Matatko, & Corner (1992) and Friede, Busch, & Bassen (2015).

As for loadings, β^{GMR} is the highest in absolute value among red labelled funds, however, excess market return's coefficient outstrips its value for those funds that are highly rated.

Finally, if we compare the coefficient of determination between the base and augmented models, it has increased by around 3% for low rated funds, while the increase is merely significant for highly rated funds. Hence, the third hypothesis is partially sustained.

As previously stated, the GMR portfolio was built using funds graded as red and green by Morningstar. Hence, funds with low, below average, above average and high sustainability ratings share return patterns that can be captured with the new sustainability factor. There may be a concern that the results shown until now are biased since the new factor is defined as the difference in return between portfolios of funds with above and below average MSR ratings, whereas the test portfolios are based on the same scores. The only approach to avoid the possible bias caused by portfolio overlaps is to completely separate the funds used in the factor calculation from the funds used to compute the test portfolio returns.

To this end, I have used the European open-ended mutual funds from October 2018 to January 2022 rated as "Average" by MSR to construct the test portfolio since these funds have been excluded to construct the GMR portfolio.

Table 12

Results of Capital Asset Pricing Models for "Average" MSR group

Panel A: *Fama & French's [16] and Carhart's [17] Model Results*

	α	β^{Mkt}	β^{SMB}	β^{HML}	β^{WML}	R^2
FF	0,17224	0,836523***	0,252547*	−0,138194 ***		0,928017
	(0,107727)	(0,0465592)	(0,125326)	(0,0325082)		
CARHART	0,198268	0,821012***	0,261520 **	−0,167736 ***	−0,0470204	0,928781
	(0,118899)	(0,0476193)	(0,123732)	(0,053729)	(0,0650041)	

Panel B: *Augmented Fama & French's [18] and Carhart's [19] Model Results*

	α	β^{Mkt}	β^{SMB}	β^{HML}	β^{GMR}	β^{WML}	R^2
FF_ISH	0,274201**	0,785617 ***	0,193134	−0,219780 ***	−0,733362**		0,933691
	(0,1202)	(0,0400038)	(0,122385)	(0,0482633)	(0,309762)		
CAR_ISH	0,290790**	0,775469***	0,201361	−0,239515***	−0,713917 **	−0,0348547	0,934106
	(0,130852)	(0,0494503)	(0,119222)	(0,0687248)	(0,314995)	(0,0606613)	

*Note: *** indicates statistical significance at the 10% level, ** indicates statistical significance at the 5% level and * indicates statistical significance at the 1% level. ( ) Standard deviations are given in parentheses.*
All returns are expressed in percentages and have been calculated using net data.
The robust standard errors approach was utilized to estimate the coefficients in order to minimize the standard errors of OLS coefficients in the presence of heteroscedasticity.

Source: *Own Creation*

Table 12, panel A show the results of Fama & French's and Carhart's models using the average rated fund net returns as the test portfolio. It should be noted that the coefficients on excess market return, R_{SMB} and R_{HML} are all significant among both models, this suggests that they are adequate for explaining the variation in fund performance. The systematic risk is the highest beta among all three models. This means that one percent increase in the excess market return will increase the fund's expected excess net return by 0,836523% (F&F) or 0,821012% (Carhart). The SMB portfolio return coefficient, β^{SMB}, is the second most important risk factor after the excess market beta; nonetheless, fluctuations in percentage terms have little influence on average fund excess net returns. One percent increase in the R_{SMB} will provoke an expected increase of around 0,26% for both the F&F (0,252527%) and Carhart (0,261520%) models. Both R_{HML} and R_{WML} coefficients have negative sings, which means average funds net excess returns move in opposite directions compared with them. However, their variations are merely noticeable over expected average fund excess returns. Hence, no differences have been found in the determination coefficient between Fama & French's model and Carhart's model ($R^2_{A,FF} = 0{,}928017, R^2_{A,CAR} = 0{,}928781$). The variations in the explanatory variables express around 92,8% of the variation in the average excess fund returns.

As shown in **table 12, panel B**, the introduction of the sustainable investment factor in both models provokes the reduction of the β^{Mkt} loading. Nevertheless, and contrary to what we have seen in the full sample test, excess market return beta continues to be the coefficient with the highest value among all coefficients in absolute value. As mentioned before, the negative sign of the new added factor's beta indicates that the excess average rated portfolio returns and GMR portfolio returns are moving in opposite directions. This may happen because an increase in green labelled fund returns may mean a major reduction in red labelled fund return, thus causing an overall negative effect over expected excess average fund net returns.

A noticeable change between the full sample test results and the split sample test results is the determination coefficient's loading. In the full sample test, the determination coefficient was 63,3%. However, using the average fund returns as the test portfolio, 93,4% of the variability of these funds can be explained by the factors included in the model.

8. CONCLUSION

Through this study, I have sought to provide evidence on whether the introduction of the sustainable investment effect, captured by the Green Minus Red portfolio, in different asset pricing models, is a relevant factor in explaining the excess fund returns. I have used the regression methods to calculate the impact of GMR portfolio returns on expected excess returns of European open-ended mutual funds between October 2018 and January 2022. The results have not only partially proved the hypothesis behind this study, but they have reinforced the results of other above-mentioned studies.

On the one hand, this study reinforces the following conclusions: (1) Green labelled funds outperform the returns of red labelled funds on average. This result backs up Luther, Matatko, & Corner (1992) and Friede, Busch, & Bassen's (2015) study conclusions. More specifically, (2) Socially responsible mutual funds outperform regular funds during market decline but underperform traditional funds during economic booms, as first stated by Nofsinger & Varma (2014). (3) Investing is transitioning away from red-labelled funds toward green-labelled ones, previously concluded by Ammann, Bauer, Fischer, & Müller (2019) and Nofsinger & Varma (2014). (4) The Fama & French's three-factor model acquires a higher explanatory power than the CAPM, also agreed on by Griffin (2002), Ajili (2005), Bundoo (2008), Blanco (2012) and Chaudhary (2017), however, (5) WML portfolio introduction does not suppose a major increase in the performance over F&F three-factor model.

On the other hand, the main hypothesis of this study is merely confirmed. The determination coefficient has increased due to the introduction of the GMR portfolio return ($R^2_{A,ISH\_FF} = 0{,}933691$ and $R^2_{A,ISH\_CAR} = 0{,}934106$). However, its improvement is limited and insignificant if we compare it with the non-augment models R^2 ($R^2_{A,FF} = 0{,}928017$ and $R^2_{A,CAR} = 0{,}928781$).

Nevertheless, the introduction of the sustainable factor has reduced the value of the market-risk beta, β^{Mkt}, and increase the HLM factor coefficient's negative effect, β^{HML}. Added to that, SMB and WML portfolio returns are not sufficient in explaining the variation of fund returns. Hence, taking into account the non biased split sample results, β^{Mkt} remains the variable with the highest loading in absolute value, closelly followed by the GMR portfolio return's coeffcient ($\beta^{Mkt}_{A,ISH\_FF} = 0{,}785617^{***} > |\beta^{GMR}_{A,ISH\_FF}| = 0{,}733362^{***}$ and $\beta^{Mkt}_{A,ISH\_CAR} = 0{,}775469^{***} > |\beta^{GMR}_{A,ISH\_CAR}| = 0{,}713917^{***}$).

First, as a new significant variable has been introduced in the model, changes in the loadings could occur. Second, the omission of a relevant variable in a model would lead to bias and inconsistency in the non-augemented model estimates. This should explain why the significance level of SMB portfolio return's coefficient changes from being significant to non-significant. Lastly, the negative sign of β^{GMR} could be explained as follows: It may be that some of the factors causing the increase in the returns of funds classified as green, provoked at the same time a larger reduction in the red labelled fund returns. This would lead to an overall negative effect on expected average fund excess net returns. An alternative explanation could be that the sustainability factor is mostly driven by returns on "red" funds and therefore the beta is negative.

Regarding the impact of the new factor among the different MSR groups, it is worth mentioning that (1) the significance level of the factor varies among MSR groups, being significant for red labelled funds and irrelevant for green labelled ones, which goes against what we expected. (2) β^{GMR}'s value is negative for red labelled funds and positive for highly-rated funds, this result goes in line with Walker, Lopatta, & Kasperei's (2014) study and reinforces the study results of Luther, Matatko, & Corner (1992) and Friede, Busch, & Bassen (2015). (3) β^{GMR} loading is the highest in absolute value among red labelled funds, however, excess market return's coefficient outstrips its value for those highly rated ones. (4) The intercept is substantial among low, below average, above average and highly rated funds; however, it is insignificant for average fund net returns which is the more robust result among all. Hence, we could say that our last hypothesis is partially sustained.

9. DISCUSSION

Authors in reference such as, Fama & French (1992), Reinganum (1981) and Lakonishok & Shapiro (1986), have tested the ineffectiveness of the CAPM model, which may be due to its "unrealistic assumption, including complete agreement and either unrestricted risk-free borrowing and lending or unrestricted short selling of risky assets" (Fama & French, 2004) or the lack of significant variables such as SMB, HML, WML portfolio returns in the linear regression tested by Banz (1981), Blume & Stambaugh (1983), Brown, Kleidon, & Marsh (1983), Bhandari (1988), Stattman (1980), Rosenberg, Reid, & Lanstein (1985), Chan, Hamao, &

Lakonishok (1991) and Basu (1983). Nevertheless, the majority if not all economic models include unrealistic simplifications, hence they must be evaluated against evidence.

CAPM has not been the only model criticised by experts, Fama and French's three-factor model is said to be incomplete as much of the diversity in average returns related to profitability and investment is missed by its three variables. This was concluded by Novy-Marx (2013) and Titman, Wei, & Xie (2004) among others. The same faults could be drawn from Carhart's four-factor model.

In addition to the criticism of Fama & French's and Carhart's models, this study may be incomplete as the construction of the GMR portfolio could not be constructed with a representative group of funds to the market. As mentioned before, only 14,07% of European open-ended mutual funds were selected to form the GMR portfolio as the remaining funds registered in Morningstar did not have continuous monthly data about the MSR and their returns. However, in a few years, when Morningstar possesses additional funds and its data to review and assign a MSR to them, the method outlined in this study could be used to construct a representative GMR portfolio.

As mentioned before, all portfolio and fund returns have been calculated using net data. While it would have been better to use gross returns to calculate fund excess returns before fees, Morningstar's platform did not contain information on MSCI Europe IMI gross returns, so possible estimation errors caused by these commissions could not be avoided. However, net and gross GMR portfolio returns are highly correlated and there is not much variation between the two variables between October 2018 and January 2022. Hence, I believe no significant estimation errors will arise.

Regarding the results obtained in the augmented Fama & French's and Carhart's models, as mentioned before, the fact that the beta of the GMR portfolio return is higher than that of the excess market, SMB, HLM and WML portfolio returns coefficients could be because the GMR portfolio was built using the same European open-ended mutual funds data that was eventually used to calculate the expected returns of both the augmented F&F and Carhart models. To avoid biased results due to portfolio overlaps, I have completely separated the funds used in the factor calculation from the funds used to compute the test portfolio net returns, using as test portfolio average rated funds. However, as Walker, Lopatta, & Kaspereit (2014) stated in their work, "the shortcoming of this approach is the arbitrary split algorithm. If a random assignment is applied, there is no guarantee that the first random draw will produce a representative sample of the population, either with respect to the factor and or test portfolio calculation".

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11. APPENDIX

Appendix 1

Monthly Number of funds based on MSR

	Low	Below Average	Average	Above Average	High
2018-09	1495	4759	8648	5391	2162
2018-10	1658	4589	8587	5428	2193
2018-11	1675	4489	8617	5530	2144
2018-12	1651	4467	8570	5608	2159
2019-01	1645	4383	8642	5715	2070
2019-02	1615	4333	8699	5591	2217
2019-03	1640	4251	8621	5740	2203
2019-04	1621	4224	8701	5572	2337
2019-05	1633	4197	8652	5566	2407
2019-06	1606	4173	8713	5578	2385
2019-07	1481	4239	8587	5678	2470
2019-08	1443	4192	8707	5686	2427
2019-09	1511	4438	8090	5541	2875
2019-10	1408	4390	8176	5596	2885
2019-11	1384	4298	8191	5641	2941
2019-12	1424	4087	8357	5695	2892
2020-01	1431	4092	8363	5730	2839
2020-02	1441	4066	8388	5701	2859
2020-03	1427	4079	8350	5762	2837
2020-04	1424	4080	8338	5784	2829
2020-05	1447	4147	8271	5767	2823
2020-06	1476	4057	8210	5893	2819
2020-07	1474	4105	8145	5945	2786
2020-08	1465	4100	8058	6072	2760
2020-09	1440	4109	7953	6189	2764
2020-10	1437	4115	8017	6153	2733
2020-11	1474	4125	8028	6140	2688
2020-12	1490	4220	7992	6092	2661
2021-01	1497	4166	7956	6119	2717
2021-02	1520	4136	7980	6060	2759
2021-03	1529	4166	7940	6014	2806
2021-04	1582	4141	7848	6099	2785
2021-05	1555	4150	7940	6032	2778
2021-06	1543	4156	7935	6036	2785
2021-07	1547	4133	7854	6104	2817
2021-08	1491	4169	7810	6132	2853
2021-09	1334	4197	7729	6067	3128
2021-10	1306	4127	7705	6148	3169
2021-11	1276	4126	7704	6201	3148
2021-12	1149	4115	7735	6367	3089
2022-01	1163	4108	7759	6406	3019

Source: Own Creation

Appendix 2

Monthly Capitalization in Millions of euros based on MSR

	Low	Below Average	Average	Above Average	High
2018-09	2.293.516,82	4.025.147,73	8.713.392,47	4.931.947,45	1.494.309,88
2018-10	2.252.913,46	3.536.855,59	8.497.375,87	4.206.344,26	1.680.868,40
2018-11	2.344.498,60	3.297.114,24	8.641.508,48	4.479.503,56	1.480.496,35
2018-12	2.070.507,06	3.263.648,55	7.753.199,07	4.275.132,10	1.387.117,51
2019-01	2.172.059,79	3.222.602,98	8.446.436,62	4.644.970,59	1.396.555,24
2019-02	2.199.965,50	3.219.158,92	8.839.641,10	4.423.981,62	1.677.645,63
2019-03	2.251.013,33	3.175.705,33	8.881.815,86	4.431.152,74	1.842.612,78
2019-04	2.285.121,40	3.450.990,88	8.958.866,71	4.411.631,50	1.979.950,46
2019-05	2.137.183,56	3.242.466,88	8.371.543,09	4.192.245,82	1.949.410,27
2019-06	2.205.120,58	3.339.988,06	9.101.280,74	4.013.518,74	1.940.570,84
2019-07	2.108.533,48	3.478.859,00	9.009.007,36	4.180.040,61	2.111.356,06
2019-08	2.003.755,57	3.356.052,49	8.910.110,98	4.152.860,05	2.046.884,94
2019-09	2.547.344,55	2.851.051,70	7.953.862,12	4.823.633,26	2.730.040,44
2019-10	2.316.441,58	2.898.635,83	8.081.584,26	4.871.236,92	2.858.295,47
2019-11	2.338.404,08	3.015.088,08	8.333.359,56	4.787.358,61	3.226.802,46
2019-12	2.386.886,13	2.891.677,16	8.629.538,67	5.117.203,75	3.134.611,24
2020-01	2.375.833,62	2.883.338,39	8.611.389,92	5.106.816,41	3.228.847,63
2020-02	2.220.708,47	2.671.482,34	7.965.351,47	4.693.523,75	3.103.822,92
2020-03	1.834.234,25	2.276.320,69	6.554.958,36	4.044.560,12	2.727.687,38
2020-04	2.106.610,97	2.369.812,67	7.304.349,27	4.435.941,22	3.026.685,75
2020-05	2.179.885,18	2.473.497,91	7.382.405,61	4.604.711,52	3.066.030,77
2020-06	2.178.381,11	2.512.868,95	7.473.797,36	4.859.974,98	3.197.159,27
2020-07	2.176.151,08	2.550.106,68	7.566.904,51	4.911.972,47	3.172.793,82
2020-08	2.191.185,99	2.669.010,35	7.814.482,69	5.134.014,01	3.283.409,84
2020-09	2.128.650,20	2.744.385,37	7.587.040,90	5.163.095,59	3.333.234,77
2020-10	2.076.792,77	2.720.121,30	7.473.263,73	5.439.526,24	2.902.261,22
2020-11	2.308.685,20	3.009.867,51	8.256.967,81	5.992.708,18	3.040.060,05
2020-12	2.374.881,11	3.551.462,41	8.087.102,89	6.227.007,79	3.082.890,34
2021-01	2.426.514,90	3.727.687,74	8.100.564,71	6.001.259,60	3.494.374,72
2021-02	2.560.817,16	3.698.980,45	8.197.739,68	6.261.553,30	3.590.274,99
2021-03	2.667.796,17	3.869.294,44	8.652.198,43	6.363.416,70	3.806.326,86
2021-04	2.778.440,03	4.042.374,66	8.694.690,92	6.607.774,92	3.866.187,84
2021-05	2.790.777,77	4.080.287,00	8.816.328,69	6.556.791,39	3.871.440,75
2021-06	2.927.333,40	4.229.713,07	9.189.178,97	6.481.404,11	4.324.891,89
2021-07	2.961.322,14	4.109.364,53	9.051.293,45	6.841.838,33	4.342.362,25
2021-08	3.025.379,63	4.322.318,16	9.175.381,84	6.962.866,61	4.504.067,02
2021-09	1.199.722,17	5.919.570,28	8.625.653,11	7.237.648,95	4.430.937,48
2021-10	1.221.397,72	5.980.935,67	9.138.190,37	7.422.691,49	4.675.394,85
2021-11	1.044.303,35	6.211.240,12	9.043.130,56	7.413.744,17	4.671.462,09
2021-12	678.539,89	6.613.248,29	9.297.541,54	7.831.530,16	4.634.935,41
2022-01	680.868,13	6.355.952,71	8.843.591,20	7.135.814,17	4.507.603,97

Source: Own Creation

Appendix 3
Monthly Factor Real Return

	Mkt-RF	SMB	HML	WML	NET GMR	GROSS GMR
2018-09	0,23337	-1,46	2,34	1,59	-0,08809	-0,08999
2018-10	-5,58286	-1,70	1,47	-1,47	1,39195	1,38824
2018-11	-1,16294	-1,18	-0,57	-2,09	0,29146	0,28547
2018-12	-5,61116	-0,68	0,95	3,24	1,34396	1,33999
2019-01	6,58132	0,59	-0,95	-2,23	-1,17148	-1,17799
2019-02	4,07945	-1,47	-1,23	-1,15	-0,22516	-0,23004
2019-03	1,97317	-1,76	-2,33	4,52	0,21517	0,20920
2019-04	3,91540	0,10	-1,04	-4,39	-0,43344	-0,43995
2019-05	-5,03089	1,32	-1,54	8,50	0,77951	0,77500
2019-06	4,26299	-2,64	-1,32	-0,45	0,21409	0,20851
2019-07	0,27627	-1,28	0,09	1,39	0,07448	0,07002
2019-08	-1,43652	-0,59	-1,96	3,28	0,57068	0,56611
2019-09	3,77169	-0,89	3,08	-2,28	-0,33639	-0,33670
2019-10	1,09976	0,93	-0,50	-1,19	0,08711	0,08766
2019-11	2,97331	2,07	-2,24	0,70	-0,23766	-0,23725
2019-12	2,38568	2,79	0,41	1,66	-0,07868	-0,07865
2020-01	-1,27866	0,36	-2,88	3,55	0,76068	0,76208
2020-02	-8,37901	0,29	-0,73	0,77	0,76023	0,76361
2020-03	-15,20906	-4,22	-11,30	7,55	2,36039	2,36565
2020-04	6,78994	5,04	-3,81	1,02	-0,93652	-0,93653
2020-05	3,26981	1,21	-4,14	2,90	-0,17527	-0,17392
2020-06	2,89045	-1,20	1,74	0,75	0,66153	0,66421
2020-07	-1,02237	2,69	-4,75	6,71	1,13018	1,13355
2020-08	3,33208	2,91	-1,74	0,04	0,12441	0,12742
2020-09	-1,26436	0,85	-3,74	4,86	0,51992	0,52447
2020-10	-4,88373	1,21	-0,20	0,67	0,39383	0,39863
2020-11	14,14267	0,30	10,76	-18,39	-1,52332	-1,51927
2020-12	2,88737	4,66	-1,76	2,13	-0,25275	-0,24760
2021-01	-0,54206	1,66	-0,29	2,39	-0,21710	-0,21072
2021-02	2,76206	0,87	5,73	-4,52	-1,35482	-1,35009
2021-03	6,33240	-1,97	3,47	-1,66	-0,44947	-0,44323
2021-04	2,33914	2,14	-3,19	1,66	0,30658	0,31289
2021-05	2,54454	-0,99	2,06	0,78	-0,38931	-0,38368
2021-06	1,42906	-1,49	-2,50	-0,91	0,41294	0,42089
2021-07	2,15575	0,60	-2,98	2,57	0,45885	0,46644
2021-08	2,22624	1,83	-1,18	0,06	0,37557	0,38405
2021-09	-3,16549	-0,60	4,30	-0,59	-1,10747	-1,10089
2021-10	4,55179	-1,62	-0,64	2,73	0,43248	0,44035
2021-11	-2,53984	-0,92	-2,11	-0,43	0,88551	0,89430
2021-12	5,41113	-1,34	1,86	0,03	0,09354	0,10112
2022-01	-3,62805	-3,22	12,09	-5,09	-1,32510	-1,31957

Source: Own Creation

Appendix 4

Monthly Number of Funds of the nine value weigther portfolios

	G/S	G/M	G/B	A/S	A/M	A/B	R/S	R/M	R/B
2018-09	2453	2996	2104	2475	3289	2884	1807	2699	1748
2018-10	2474	3087	2060	2408	3245	2934	1851	2655	1741
2018-11	2532	3049	2093	2355	3320	2942	1847	2623	1694
2018-12	2472	3154	2141	2433	3291	2846	1831	2540	1747
2019-01	2461	3174	2150	2459	3269	2914	1811	2547	1670
2019-02	2485	3186	2137	2424	3332	2943	1827	2476	1645
2019-03	2543	3257	2143	2394	3262	2965	1800	2465	1626
2019-04	2528	3233	2148	2454	3302	2945	1755	2452	1638
2019-05	2511	3294	2168	2470	3208	2974	1751	2486	1593
2019-06	2526	3319	2118	2431	3243	3039	1780	2426	1573
2019-07	2587	3367	2194	2387	3228	2972	1758	2391	1571
2019-08	2572	3346	2195	2458	3258	2991	1707	2382	1546
2019-09	2537	3476	2403	2253	3080	2757	1947	2426	1576
2019-10	2546	3492	2443	2235	3143	2798	1952	2351	1495
2019-11	2631	3488	2463	2198	3206	2787	1906	2291	1485
2019-12	2649	3481	2457	2233	3275	2849	1855	2226	1430
2020-01	2588	3537	2444	2277	3235	2851	1870	2211	1442
2020-02	2601	3477	2482	2300	3257	2831	1833	2250	1424
2020-03	2551	3478	2570	2324	3318	2708	1860	2188	1458
2020-04	2511	3512	2590	2345	3281	2712	1880	2190	1434
2020-05	2544	3430	2616	2331	3301	2639	1862	2260	1472
2020-06	2526	3494	2692	2357	3255	2598	1854	2232	1447
2020-07	2464	3543	2724	2376	3137	2632	1897	2301	1381
2020-08	2509	3569	2754	2292	3145	2621	1932	2271	1362
2020-09	2541	3635	2777	2269	3099	2585	1927	2249	1373
2020-10	2511	3600	2775	2269	3116	2632	1957	2266	1329
2020-11	2581	3577	2670	2203	3106	2719	1953	2301	1345
2020-12	2579	3468	2706	2199	3191	2602	1958	2326	1426
2021-01	2643	3488	2705	2150	3215	2591	1944	2278	1441
2021-02	2630	3469	2720	2171	3237	2572	1934	2277	1445
2021-03	2634	3447	2739	2158	3211	2571	1945	2327	1423
2021-04	2631	3499	2754	2179	3152	2517	1925	2336	1462
2021-05	2655	3452	2703	2208	3174	2558	1873	2360	1472
2021-06	2644	3485	2692	2226	3160	2549	1867	2337	1495
2021-07	2666	3481	2774	2188	3120	2546	1883	2381	1416
2021-08	2677	3476	2832	2150	3187	2473	1910	2318	1432
2021-09	2653	3662	2880	2184	3135	2410	1900	2187	1444
2021-10	2751	3662	2904	2127	3174	2404	1858	2148	1427
2021-11	2754	3698	2897	2125	3138	2441	1858	2146	1398
2021-12	2781	3758	2917	2147	3156	2432	1809	2073	1382
2022-01	2774	3770	2881	2176	3151	2432	1786	2066	1419

Source: Own Creation

Appendix 5

Monthly Capitalization of the nine value weigther portfolios in billions of euros

	G/S	G/M	G/B	A/S	A/M	A/B	R/S	R/M	R/B
2018-09	170,77	1.182,81	5.072,68	181,82	1.317,29	7.214,28	123,71	1.085,84	5.109,12
2018-10	157,47	1.149,87	4.579,87	170,21	1.212,12	7.115,05	119,87	998,33	4.671,57
2018-11	163,82	1.139,30	4.656,87	167,78	1.262,53	7.211,20	120,38	970,27	4.550,96
2018-12	148,32	1.094,43	4.419,50	161,06	1.158,74	6.433,41	111,66	865,40	4.357,10
2019-01	157,07	1.170,63	4.713,83	175,49	1.217,15	7.053,80	115,37	923,82	4.355,48
2019-02	163,37	1.198,28	4.739,98	173,77	1.277,35	7.388,52	120,39	917,27	4.381,46
2019-03	169,52	1.248,97	4.855,28	172,92	1.253,92	7.454,97	119,96	909,45	4.397,31
2019-04	169,51	1.251,38	4.970,69	181,47	1.317,65	7.459,75	121,06	936,46	4.678,60
2019-05	158,50	1.199,48	4.783,68	174,17	1.210,70	6.986,67	111,91	897,90	4.369,84
2019-06	165,11	1.241,81	4.547,16	177,04	1.279,94	7.644,30	119,67	911,61	4.513,83
2019-07	171,33	1.270,74	4.849,32	174,55	1.298,75	7.535,70	119,85	906,33	4.561,21
2019-08	164,79	1.235,95	4.799,01	177,09	1.283,61	7.449,41	115,35	882,24	4.362,21
2019-09	174,15	1.342,89	6.036,64	158,50	1.227,54	6.567,82	133,47	917,84	4.347,09
2019-10	175,92	1.369,74	6.183,88	158,25	1.257,38	6.665,96	135,62	892,00	4.187,45
2019-11	186,00	1.428,64	6.399,52	159,87	1.299,50	6.873,99	135,48	902,33	4.315,68
2019-12	194,67	1.459,29	6.597,86	166,63	1.366,83	7.096,08	133,55	884,75	4.260,26
2020-01	185,82	1.474,34	6.675,51	167,81	1.339,58	7.104,01	134,34	880,61	4.244,21
2020-02	176,54	1.334,48	6.286,33	154,97	1.251,67	6.558,71	119,99	832,33	3.939,87
2020-03	144,29	1.093,95	5.534,00	125,84	1.075,11	5.354,01	97,97	664,91	3.347,68
2020-04	150,93	1.209,91	6.101,79	141,36	1.185,16	5.977,83	108,93	718,73	3.648,76
2020-05	155,56	1.222,19	6.292,99	145,55	1.205,96	6.030,89	106,43	765,65	3.781,31
2020-06	156,78	1.281,34	6.619,01	151,28	1.209,65	6.112,87	108,02	772,10	3.811,13
2020-07	151,80	1.292,25	6.640,71	151,18	1.164,63	6.251,09	110,11	808,22	3.807,93
2020-08	157,92	1.341,16	6.918,34	149,74	1.206,57	6.458,17	113,73	812,59	3.933,87
2020-09	158,01	1.337,32	7.001,00	144,65	1.177,88	6.264,51	113,05	795,28	3.964,71
2020-10	152,84	1.301,21	6.887,74	139,37	1.147,61	6.186,28	113,34	792,34	3.891,24
2020-11	174,51	1.445,24	7.413,02	148,71	1.251,73	6.856,53	122,60	881,80	4.314,15
2020-12	179,86	1.428,19	7.701,85	151,50	1.358,86	6.576,74	126,04	915,09	4.885,21
2021-01	185,38	1.475,07	7.835,18	147,35	1.344,39	6.608,82	128,45	921,22	5.104,53
2021-02	186,07	1.500,57	8.165,20	154,66	1.423,36	6.619,72	130,06	916,78	5.212,96
2021-03	196,18	1.559,38	8.414,19	156,65	1.483,11	7.012,44	139,70	1.011,63	5.385,76
2021-04	198,32	1.603,38	8.672,27	162,55	1.482,73	7.049,41	136,60	1.038,55	5.645,67
2021-05	204,69	1.614,69	8.608,85	166,05	1.491,26	7.159,02	133,99	1.063,43	5.673,64
2021-06	205,20	1.682,71	8.918,38	173,86	1.517,78	7.497,54	138,20	1.089,87	5.928,98
2021-07	207,30	1.669,55	9.307,35	169,17	1.497,95	7.384,18	138,75	1.127,92	5.804,01
2021-08	210,52	1.676,65	9.579,76	168,56	1.559,09	7.447,74	142,86	1.145,14	6.059,70
2021-09	202,22	1.734,64	9.731,73	168,32	1.510,77	6.946,56	138,18	1.027,70	5.953,41
2021-10	216,84	1.799,88	10.081,37	166,64	1.570,47	7.401,08	133,68	1.023,92	6.044,74
2021-11	212,34	1.774,87	10.098,00	160,31	1.518,24	7.364,59	133,69	1.020,07	6.101,78
2021-12	214,48	1.852,06	10.399,92	164,40	1.561,90	7.571,24	134,03	999,45	6.158,31
2022-01	203,60	1.766,39	9.673,43	161,27	1.495,76	7.186,56	126,74	952,79	5.957,29

Source: Own Creation