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# The Cost of Socially Responsible Investing (SRI)

Risk-Adjusted Evidence from European ESG Funds

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**ABSTRACT**

This thesis examines the question of whether or not environmental, social, and governance (ESG) investing bears a quantifiable financial cost in comparison to standard measures. Although ESG integration has taken a structural dimension in the world of capital markets, academia has been divided on whether sustainable ways of investing increase, decrease, or merely redistribute risk-adjusted returns.

This paper determines the performance of 58 ESG funds using different asset pricing specifications, such as the Capital Asset Pricing Model (CAPM), the Fama-French three-factor model, and the Fama-French five-factor model. The panel fixed effects regressions used to control unobserved fund heterogeneity, and interaction terms during the period of crisis analyze the performance in the COVID-19 market shock. The measure of robustness is done on fund-clustered standard errors.

The findings suggest that ESG funds exhibit negative abnormal performance, which is partially attenuated under the three-factor model, as proposed by the CAPM. Nevertheless, negative alpha does survive under the five-factor specification and implies that we cannot entirely blame underperformance on conventional factor exposures. ESG funds have high positive returns on profitability and size variables, which represent structural portfolio biases. Where systematic risk exposures are adjusted, there is no statistically significant crisis-period alpha.

Generally, the results indicate that differences in the performance of ESG funds are primarily structural and exposure-related, rather than being attributed to long-term managerial inefficiency. ESG investing seems to have a small financial price, which is model-dependent and is mainly described by systematic factor properties and not in the smooth generation of abnormal returns.

**KEYWORDS:** ESG Funds, Financial Cost of ESG, CAPM, Fama- French Model, Risk-Adjusted Return, Factor Loadings, Crisis-Period Analysis

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# 1. INTRODUCTION

Sustainability has been shifted from the outskirts of the corporate strategy to the heart of financial decision-making over the last twenty years. The concept that was formerly structured as Corporate Social Responsibility (CSR) on the firm level has been transformed into the integration of Environmental, Social and Governance (ESG) into capital markets. This change is an extension of the redefinition of the role of corporations and investors in society.

Historically, the paradigm of finance was dominated by the primacy of shareholders and the maximization of profits. Friedman (1970) argues that the major role of firms is to ensure that they maximize shareholder value within market regulations. Within the traditional structure, non-financial goals were usually perceived as limiting efficiency or cutting returns.

However, globalization, global warming, social inequality and financial crises have changed the corporate behavior and investors' expectations too. Stakeholders are increasingly expecting transparency, environmental responsibility, ethical governance, and long-term resilience. ESG criteria are no longer regarded by investors, pension funds, and asset managers as an ethical overlay but as part of risk management and strategic asset allocation (Amel-Zadeh & Serafeim, 2018). This has seen sustainable investing increase at a very high pace, which forms a large portion of professionally managed funds across the globe.

This is a structural change with far-reaching capital market implications. When investors have systematic preferences for investing in more ESG-oriented firms, asset prices will change as well. This kind of preference-based demand will potentially reduce the cost of capital of sustainable firms, which can result in what Pastor, Stambaugh, and Taylor (2021) refer to as a greenium. At equilibrium, the expected returns decrease with an increase in the prices. The essential question, therefore, posed by ESG investing is this: can one balance sustainability preferences with financial results in the portfolio?

The scholarly data is still inconclusive. According to meta-analyses, ESG integration is not detrimental to financial performance and, on the contrary, be positively linked to long-term results (Friede et al., 2015; Whelan et al., 2021). At the firm level, the existence of a downside risk and resilience in the period of crisis has been documented (Albuquerque et al., 2020; Broadstock et al., 2021). Other studies, however, point to the fact that there can be certain performance cost relating to exclusionary screening, sector tilt, and limited diversification (Renneboog et al., 2008; Pedersen et al., 2021.

Making this argument further debatable is the heterogeneity of measurements. The ratings of ESG have pronounced variations among providers, and this is because of the difference in scope, emphasis and following different approaches (Berg et al., 2022; Christensen, Serafeim, and Sikochi, 2021). This divergence raises issues of comparability, greenwashing, and the consistency of empirical performance evaluation.

Consequently, this leads to the central question of whether ESG investing is an ethically desirable activity or whether it involves a quantifiable financial cost. Do ESG-focused funds underperform systematically compared to conventional benchmarks with systematic risk factors held constant? Are the differentials in return noted to be structural or equilibrium-based, and are they signs of managerial inefficiency? And does the ESG integration confer crisis-period standing at the diversified portfolio-level, or do such impacts remain firm-level only analyses?

These are not just hypothetical questions. They directly affect the topics of fiduciary responsibility, portfolio construction, regulatory design and the allocation of capital in general in the shift towards sustainable economies. It is on this background that the current thesis empirically studies the financial cost of ESG investing through ESG-labelled equity funds in comparison to conventional benchmarks according to various asset pricing specifications, structural exposures, and crisis conditions.

## 1.1 Motivation and Historical Background

The integration of ESG has, over the last decade, shifted away from a value-based screening exercise to an institutionally entrenched aspect of asset management. This has been experienced especially in Europe, where regulatory endeavors, including the Sustainable Finance Disclosure Regulation and increased sustainability reporting standards, have formalized ESG factors into the decision-making process of portfolio construction and capital allocation (European Commission, 2023). Consequently, sustainable funds have received a lot of inflows in capital, particularly in the years after 2015, after the Paris Agreement.

This has been fueled by the rapid growth in ESG-labelled investment products, and their financial implications remain controversial. Although at the beginning of its development, early socially responsible investment (SRI) strategies were subject to criticism of imposing constraint in terms of diversification (Renneboog et al., 2008), the more recent literature has noted that ESG integration can be interpreted as systematic exposure to established risk factors rather than outright ethical exclusionary (Pedersen et al., 2021). As a result, structural portfolio tilts can lead to the occurrence of observed performance differentials and not managerial inefficiency.

In the theoretical perspective, this discussion will overlap with two opposite schools of thought in asset prices. The classical shareholder- primacy model presupposes that any non-financial constraint can bring the expected returns down (Friedman, 1970). Equilibrium models that include investor preferences, in contrast, imply that sustainability attributes could attract a demand premium and increase asset values as well as reduce anticipated returns, but they do not imply inefficiency (Pastor, Stambaugh, and Taylor, 2021). In this so-called greenium, reduced later returns on ESG assets are reasonable pricing changes, as opposed to failure to perform.

There is conflicting empirical evidence. Most of the meta-analytical studies report mainly non-negative relations between ESG traits and firm-level financial performance (Friede et al., 2015; Whelan et al., 2021). Another set of studies analyzing the crisis periods shows that high-ESG companies can have a lower downside risk in times of market stress (Albuquerque et al., 2020; Broadstock et al., 2021). But fund-level evidence is not as conclusive. With the systematic risk exposures eliminated using multi-factor asset pricing models, the abnormal performance tends to fade away or vanish (Auer and Schuhmacher, 2016; Pedersen et al., 2021). This difference between the resilience of firms and the performance of diversified funds highlights the significance of differentiating between the effects of stocks and exposures of portfolios.

This thesis is motivated by three factors that are related to each other. Primarily, although there is no authenticated evidence on a large-scale corporate-level, there is less agreement on whether diversified ESG funds create abnormal risk-adjusted returns when compared to conventional performance in the established asset pricing models. Second, the regulatory environment after 2018 gives a different institutional background where ESG adoption has come out of the initial test periods. Third, the interplay of structural factor tilts, equilibrium pricing models, and the crisis period sensitivity is not well incorporated into a single empirical model.

This paper will attempt to elucidate the financial cost of ESG investment by placing the performance of ESG funds in the context of traditional multi-factor models (Fama and French, 1993, 2015) and equilibrium sustainability pricing theory (Pastor et al., 2021). This difference is not just a core of academic discussion, but also of investors who conduct their investment actions under fiduciary and regulatory responsibilities in capital market environments that are growing in sustainability concerns.

## 1.2 Purpose of the Thesis

Based on this theoretical and empirical background, this thesis aims to test the hypothesis of whether ESG-labelled equity funds bear systematic performance premises as compared to conventional benchmarks when risk and structural exposures are appropriately maneuvered.

In particular, the paper examines three related aspects of what the sustainable cost of investing may be, which are:

The first is that it compares risk-adjusted performance based on the Capital Asset Pricing Model and multi-factor asset pricing models. This enables the determination of whether abnormal returns are persistent or not when systematic risk exposures are accounted.

Second, it focuses on the explanatory power of tilts at the structural level, which include size, value, profitability and investment exposures in explaining observed returns differentials. This difference plays an important role in identifying whether the differences in ESG performance are those of management ability or due to portfolio composition.

Third, it analyses dynamic of the period of crisis to determine how ESG funds deliver abnormal resilience in periods of market stress or performance dispersion is abnormally explained by exposure. Using these insights as a unifying structural panel, the thesis aims at drawing a line between three rival conceptualizations of ESG performance:

- A performance-cost interpretation grounded in portfolio constraints.
- A structural exposure interpretation driven by systematic factor tilts.
- An equilibrium interpretation consistent with preference-driven pricing mechanisms.

By so doing, the research helps to further debate the existing discussion about the economic consequences of sustainable investing and offers data that can be used by the investors, policymakers, and regulators that are subject to growing regulatory challenges. To empirically structure this investigation, the following hypotheses are developed.

## 1.3 Development of Hypotheses

In order to empirically organize this study, the hypothesis is formulated as follows. First, there is the screening-based constraint hypothesis that claims that the feasible investment universe is limited by the exclusionary practices in investment, which may hamper the diversification process and lead to lower efficiency in the mean variation. Based on this perspective, the cost of ethical restrictions is economic in any observed underperformance. Second, the systematic factor exposure hypothesis also assumes that ESG portfolios are not neutral in relation to the established risk factors; instead, they have consistent tilts towards size, growth, profitability, or conservative investment characteristics. Observed abnormal performance can thus be a compensation of the exposures to systematic risks and not managerial inefficiency. Third, the equilibrium pricing view highlights the desire of investors in sustainability features, implying that the high demand for assets with high-ESG can push their prices up and squeeze the expected returns. In this model, reduced future returns cannot be a sign of inefficiency, but a logical consequence of preference-based price-setting of assets. These mechanisms are empirically de-mechanized through the following hypotheses.

Hypothesis 1: ESG funds have lower raw and CAPM-adjusted returns as compared to their conventional benchmarks.

Wholesale screening and underweighting of the sector can lower exposure to benchmarking driving industries, which could result in adverse single-factor abnormal performance (Statman and Glushkov, 2009).

Hypothesis 2: The degree of negative abnormal performance can be mitigated by multi-factor asset pricing models, although this is not anticipated to completely vanish.

In case ESG returns differentials are partially motivated by systematic exposures to size, value, profitability, or investment factors, multi-factor controls must also own down CAPM alpha (Fama and French, 1993, 2015, Pedersen et al., 2021). Nevertheless, a negative alpha would persist, which would be in line with the equilibrium pricing effect or structural factors outside of the conventional risk premia (Pastor, Stambaugh, and Taylor, 2021).

Hypothesis 3: ESG funds have a high systematic exposure to profitability and size factors.

There is previous evidence indicating that ESG portfolios are skewed towards companies with higher operating profitability and some capitalization properties (Pedersen et al., 2021). Part of the performance differences may thus be due to structure factor tilt.

Hypothesis 4: Crisis abnormal returns of ESG funds are statistically insignificant after controlling for systematic exposures.

Despite the fact that firm-level research shows persistence in market stress (Albuquerque et al., 2020), the post-adjustment of abnormal performance of diversified funds at the fund level may not be sustained.

Collectively, these hypotheses enable the thesis to examine whether the underperformance of ESG measures an inefficient control of managers, the composition of portfolio structure, or a rational equilibrium price.

## 1.4 Contribution of the Study

This thesis contributes to the sustainable finance literature in three major ways. First, it provides performance of ESG funds against various asset pricing specifications as opposed to the sole use of CAPM. This is to enable systematic comparison of abnormal performance with risk controls, which progressively become more comprehensive.

Second, the paper uses panel fixed effects regressions to capture unobserved, time-invariant fund features that can be related to factor exposures. This reinforces the inference as compared to purely cross-sectional designs. Third, interaction modelling of the crisis period is integrated into a multi-factor framework that is a more rigorous test of ESG resilience in comparison to event-window analysis only.

The empirical evidence suggests that ESG funds perform abnormally negatively when using CAPM and partial attenuation when using the three-factor model and negative persistent alpha in the five-factor specification. The exposure of ESG funds to profitability and size factors is substantial, whereas crisis-period abnormal returns are also not significant. Such findings indicate that the difference in ESG performance can be mainly attributed to structural and exposure-related factors as opposed to long-term stock-selection ability.

## 1.5 Structure of the Thesis

To offer some clarity and coherence, this thesis is divided into seven chapters. The chapters cover a particular element of the research process and progress logically in finding answers to the main research questions concerning the financial cost of Socially Responsible Investing (SRI) and its impact on fund performance relative to their respective benchmarks. The way the chapter is organized helps to lead the reader through theoretical background, methodological development, empirical findings and practical inferences of the research. The thesis is described in detail as follows.

# 2. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

The economic consequences of the Environmental, Social, and Governance (ESG) integration are still theoretically disputed in contemporary asset pricing. The classical theory of finance, which is based on the mean-variance optimization and maximization of stockholder value, sees investment decisions as being made on a risk-return trade-off basis (Markowitz, 1952; Sharpe, 1964). In this context, sustainability tilts or ESG screening can limit the set of investment opportunities and even move portfolios off the efficient frontier, which would mean that there is a potential cost on performance. Later thought, however, criticizes this interpretation in terms of constraints. Behavioral finance acknowledges the potential utility of sustainability preferences of investors (Riedl and Smeets, 2017), and the equilibrium models show that the demand for ESG-based preferences can reduce the expected returns without suggesting inefficiency (Pastor, Stambaugh, and Taylor, 2021). ESG investing thus, is held in a grey place within financial theory, one that can be interpreted as an exposure to portfolio constraint, or as an exposure to a structural factor, and/or an equilibrium pricing. It is this theoretical tension that gives the discussion below its analytical basis.

## 2.1 Evolution of ESG and Sustainable Investing

However, over the last twenty years, socially responsible investing has developed to become more than merely exclusionary, values-based screening and has evolved to incorporate the overall investment processes systematically, in an environmental, social, and governance manner. Previously, an esoteric ethical strategy has become a primary factor in international capital investment. The Global Sustainable Investment Alliance has reported that the assets of sustainable investment have been increasing to constitute a significant portion of the professionally managed capital all over the globe, with Europe still bearing the biggest portion of the market. The shift in investor preferences is not the only area where this growth has been notable, but also the growing standardization of the regulatory framework and institutional uptake.

Formalization of ESG Investing has gained pace since the introduction of the United Nations Principles of Responsible Investment in 2006, making ESG integration to be seen as consistent with the fiduciary duty but not an act of mere ethical compromise. ESG factors become more financially important to institutional investors, especially when it comes to long-term risk management, climate transition exposure, and quality of governance (Amel-Zadeh and Serafeim, 2018). In Europe, regulatory changes such as the Sustainable Finance Disclosure Regulation and the Corporate Sustainability Reporting Directive have further institutionalized the integration of ESG by requiring greater sustainability disclosure. Sustainable Finance Disclosure Regulation and the Corporate Sustainability Reporting Directive are such regulatory developments that further institutionalize ESG integration by mandating enhanced sustainability disclosures and transparency requirements in Europe (European Commission, 2023).

This tension leads to the main question that is to be analyzed in this thesis: does the ESG integration mean an assessable financial cost after the systematic risk factors have been adequately regulated? To find the answer to this question, it is necessary to base the analysis on the existing asset pricing theory and explore the interaction between ESG preferences and portfolio construction and the formation of expected returns.

## 2.2 Theoretical Foundations of ESG Performance

The economic consequences of ESG investment can be analyzed using three complementary theories on the same, i.e. portfolio theory, equilibrium asset pricing, and multi-factor return models. Collectively, these frameworks explain the presence or absence of differences in observed ESG performance as either inefficiency, structural tilt or equilibrium pricing impacts.

### 2.2.1 Modern Portfolio Theory and Diversification Constraints

Modern Portfolio Theory (Markowitz, 1952) is the background upon which diversification and risk-return efficiency is assessed. When under MPT, the investors choose portfolios that provide a maximum expected return at a particular risk level. The efficient frontier is the collection of optimal portfolios that are built using the entire investment universe without any non-financial restrictions.

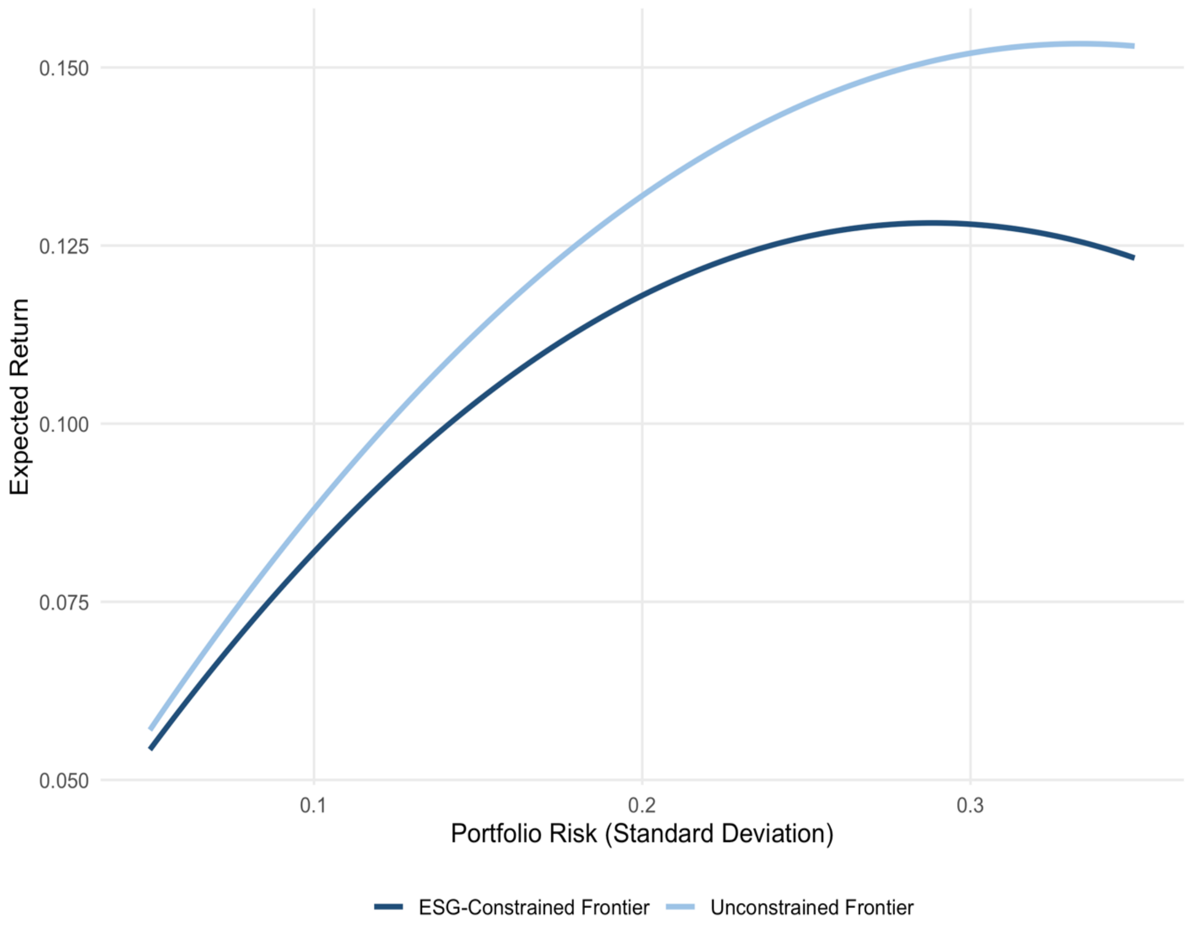


**Figure 1: Mean–variance efficient frontier under unconstrained and ESG-constrained portfolio sets (conceptual illustration based on Markowitz, 1952).**

When ESG-related screening, such as removing fossil fuel producers or unethical sectors, is taken into consideration, the investment universe becomes smaller. Considering an efficient frontier drawn purely on the mean-variance, this constraint can cause a shift of the efficient frontier inward, meaning that the expected returns that can be achieved given a given risk level are lower. This theoretical mechanism is depicted in the ESG-constrained frontier in Figure 1: the opportunity set is contracted, and the diversification efficiency may decrease.

This internalized twist is the classical argument of the cost of constraints that was developed in the early socially responsible investment literature. According to Renneboog et al. (2008) and Statman and Glushkov (2009), exclusionary screening may decrease the diversification benefits and augment tracking error compared with generic market indices. In this understanding, ESG investing can involve an objective amount of opportunity cost.

Nevertheless, the diversification-cost argument is not so clear-cut. In case the excluded sectors have a transition risk, regulatory exposure, or stranded asset risk, their elimination can be explained by financial reasons, not as a limitation (Pastor et al., 2021). The observed inward move in such scenarios can be indicative of a re-definition of the efficient set after considering the climate risk or governance risk appropriately. The question of whether the ESG integration is indeed an efficiency loss or a logical adaptation to a changing risk structure is thus an empirical issue rather than a theoretical fact.

### 2.2.2 CAPM and the Greenium Mechanism

Capital Asset Pricing Model (Sharpe, 1964) is a continuation of the Modern Portfolio Theory in which the expected returns are associated with systematic market risk. CAPM assumes that the expected returns of an asset are determined by its own beta with the market portfolio. Positive alpha is seen in assets whose returns exceed the expected returns due to systematic risk, and negative alpha is seen in assets whose returns are lower than expected due to systematic risk.

The typical Security Market Line diagram is presented in Figure 2. The line that slopes up portrays equilibrium expected returns in relation to beta. Anything above and below this line provides an abnormal performance (alpha). In this context, a negative alpha would be persistently viewed as a manifestation of managerial inefficiency or mispricing.

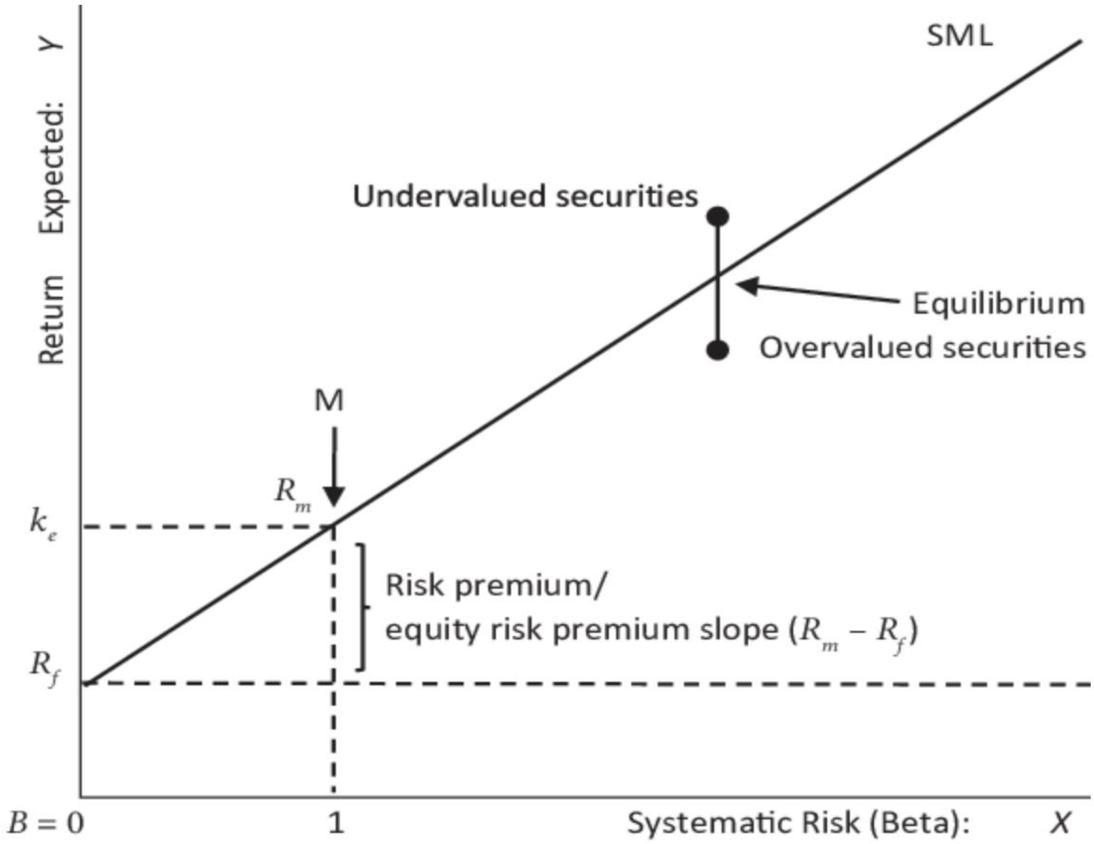


**Figure 2: Security Market Line -SML is the graphical representation of CAPM Source: (Sharpe, 1964)**

However, in this case, with ESG investing, it is a bit trickier to interpret the alpha. In the study by Pastor, Stambaugh, and Taylor (2021), the equilibrium asset pricing model hypothesizes that the asset preference of investors on sustainable assets influences the price directly. In case investors have non-financial utility when owning ESG-compliant companies, the demand for this type of asset would be high, and the price would go up and would push the expected returns down, which is a mechanical process. This is a demand-based premium commonly known as the greenium that suggests that ESG assets can fall below the traditional Security Market Line without showing inefficiency.

Under this equilibrium reading, a negative CAPM alpha is not always a sign of poor portfolio management. Rather, it can be an indicator of preference-based changes in price in line with market equilibrium. In this thesis, the key issue with explaining the ESG fund performance is drawing the line between actual underperformance and equilibrium demand effects.

### 2.2.3 Multi-Factor Models and Structural Tilts

Although CAPM is a one-factor benchmark, empirical studies of asset pricing evidence that the expected returns are impacted by various systematic risk factors. The size and value factors are included in the Fama-French three-factor model (Fama and French, 1993), and the additional factors of the five-factor model (Fama and French, 2015) are profitability and investment factors.

The systematic tilt of ESG portfolios in some of their characteristics is a common phenomenon. It has been empirically found that ESG funds tend to overvalue large-cap, growth-oriented, and profitable companies (Auer and Schuhmacher, 2016; Pedersen et al., 2021). As a result, the apparent differences in performance could be caused by traditional risk premia exposure, as opposed to ESG features.

Multi-factor models are thus important in ensuring that the abnormal returns produced by ESG funds are actually abnormal or whether the difference in performance can be attributed to systematic exposures to factors. When alpha decays following size, value, profitability and investment, it means that ESG performance is structural but not skill-based.

### 2.2.4 Stakeholder Theory and Shareholder Primacy

On the firm level, the ESG integration is also connected to rival theories of corporate purpose. The theory of shareholder primacy (Friedman, 1970) states that the maximization of shareholder value is the central idea of the firm, and therefore, the ESG activities have to be justified by the increase in the profitability of the corporation in the long run. Conversely, the stakeholder theory (Freeman, 1984) is of the opinion that organizations generate value by benefiting more stakeholders, such as employees, communities, and the environment.

In terms of finance, block-based governance can help to decrease litigation risk, increase reputation and achieve resilience (Clark et al., 2015). Nevertheless, critics say that ESG initiatives can weaken managerial concentration or bring about agency problems (Bebchuk &

Tallarita, 2020). Such conflicting opinions also confirm the necessity of supporting the risk-adjusted performance with empirical analysis rather than normative assumptions.

## 2.3 ESG and Corporate Financial Performance

There has been a significant growth in empirical studies on ESG and financial performance in the last thirty years. Nevertheless, the results have been heterogeneous and tend to be contingent on methodology, time, geographic point, and whether the analysis is done at the firm or fund level. Here is a review of corporate-level evidence, and then it moves on to portfolio-level implications.

### 2.3.1 Meta-Analytical Evidence

Friede, Busch, and Bassen (2015) provide one of the broadest syntheses of the ESG performance relationship by reviewing more than 2,000 empirical studies. Their meta-analysis concludes that most of the studies indicate that there is a non-negative correlation between ESG and corporate financial performance, and a large proportion of them indicate a positive correlation. These findings contradict the common belief that being a socially responsible investor requires a financial trade-off. Figure 3 indicates that, as shown, about 60 per cent of studies provide a positive correlation, about 30 per cent show a neutral result, and only a tiny percentage of studies demonstrate negative correlations

These findings provide a counter to the traditional belief concerning the impossibility of socially responsible investing without a financial sacrifice. Likewise, Whelan, Atz, and Clark (2021) review academic and practitioner literature and find that ESG integration does not have a systemic negative impact on financial performance and can provide downside protection during times of market stress. They, however, point out that ESG outperformance is not consistent and usually relies on contextual elements like industry exposure and macroeconomic environment.

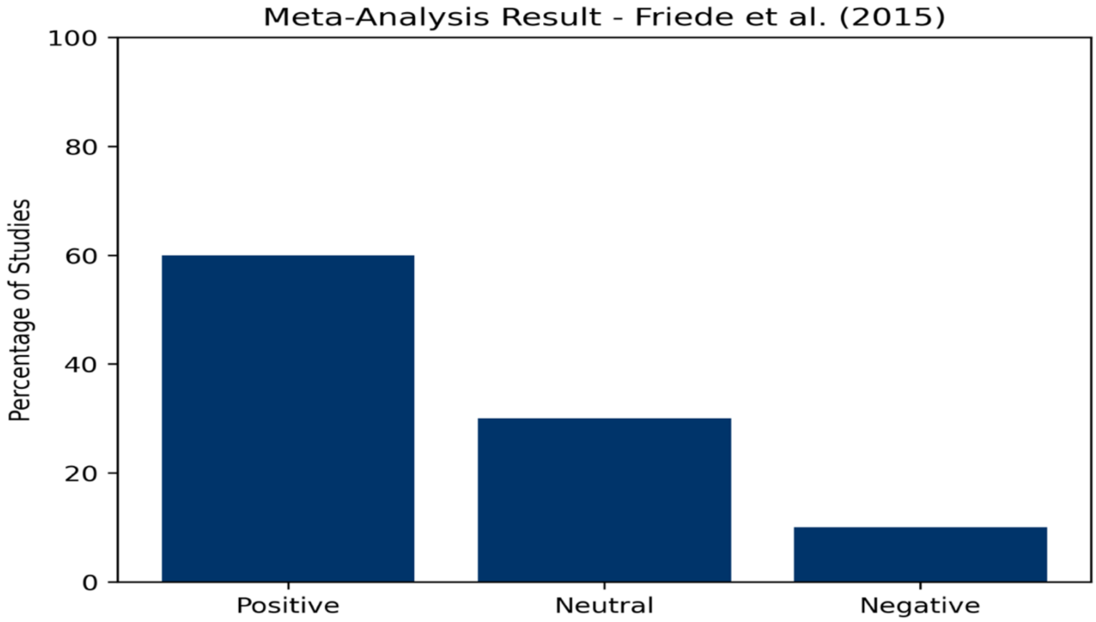


**Figure 3: Meta- Analysis Results, Recreated based on the vote-count distribution reported in Friede et al. (2015).**

Although meta-analyses offer some general confidence that ESG is not unanimously detrimental, they do not answer the question of whether the results are manifesting causal processes, exposure to factors or measurement biases. In this regard, ESG performance needs a more granular analysis to obtain an interpretation of asset pricing frameworks.

### 2.3.2 Materiality and Governance Effects

One of the most crucial developments in the ESG literature is the concept of materiality. Khan, Serafeim, and Yoon (2016) show that the performance of firms that are doing well on industry-specific material ESG issues is far better than that of firms that are doing poorly on the same dimensions. Notably, ESG capabilities in intangible spheres do not have the same financial implications. This implies that the financial implications of ESGs are based on economic relevance and not aggregate scoring.

Risk-wise, Giese et al. (2019) discovered that in high ESG-rated companies, higher idiosyncratic volatility and demands are observed. The findings confirm the thesis that the integration of

ESG can enhance the process of risk management, governance quality, and stability to negative incidents.

Evidence is not, however, entirely favorable. Krueger (2015) demonstrates that the market reacts negatively to some ESG-based announcements when they are seen as expensive or symbolic, but not economically significant. This underlines the ESG diversification issues and the need to separate reputational signaling and substantive governance enhancement.

Overall, the evidence at the firm level indicates that ESG can possibly impact financial performance in terms of quality of governance, relationship with stakeholders, and risk reduction. It is, however, an open question as to whether these firm-level effects are converted into diversified fund-level alpha.

### 2.3.3 Cost of Capital and Equilibrium Pricing

The other channel of significance between ESG and financial performance is the cost of capital. Companies that have good ESG practices can experience reduced equity financing costs because investor demand is increased, and their risk to the investor is also seen to be reduced (Giese et al., 2019).

Formally, Pastor, Stambaugh, and Taylor (2021) explain this mechanism as part of an asset pricing equilibrium. According to their model, the higher the utility associated with holding green assets, the higher the demand and consequently the price and reduction of expected returns. This greenium means that sustainable companies can receive lower costs of capital, and investors can receive smaller expected returns in comparison to similar brown companies.

This balance understanding brings up a very important difference, which is that reduced returns expected on ESG investments are not always inefficient or underperforming, but instead, preference-based pricing mechanisms. The empirical testing should thereby be able to tell the difference between abnormal alpha and structural equilibrium effects.

## 2.4 ESG Fund-Level Performance and Crisis Evidence

Although corporate-level analysis focuses on the firm basics and returns on stocks, the majority of capital decisions by investors are made by diversified funds and exchange-traded products. Evidence of fund level performance is thus directly applicable to measuring the cost of SRI.

### 2.4.1 Early SRI Fund Studies

Initial studies of socially responsible mutual funds produced inconclusive findings. Renneboog, Ter Horst and Zhang (2008) perform an analysis of international SRI funds and discover that on average, they do not perform better than conventional funds after risk and fees adjustments. The authors explain the differences in performance through the limitations of screening and institutional factors.

Statman and Glushkov (2009) break down the performance impacts of sin-stock exclusion and ESG tilting. They also determine that exclusion of controversial industries can lead to a reduction in returns, but tilt in favor of those firms with good characteristics partially counteracts the effect. Its overall effect is not very strong statistically.

These initial investigations propose that the performance of ESG funds depends on structural portfolio decisions as opposed to systematic managerial alpha.

### 2.4.2 Factor Exposures and Alpha Attenuation

Subsequent studies place more importance on the factor exposures. Auer and Schuhmacher (2016) demonstrate that the overall performance differences between ESG and conventional funds are almost removed once the style and factor controls are implemented. In the same vein, Pedersen, Fitzgibbons, and Pomorski (2021) claim that ESG investing is associated with conventional risk variables, especially quality and profitability levels.

This interpretation, which is based on factors, is in line with the multi-factor asset pricing theory (Fama and French, 2015). When ESG funds have systematic size, growth or profitability tilt, then any observed differences in returns may be due to exposure to rewarded risk premia rather than to ESG attributes.

This means that the alpha obtained after CAPM is likely to become weakened in multi-factor models. Testing the ESG performance, thus, must undertake more and more comprehensive specifications of asset prices.

### 2.4.3 Crisis-Period Resilience

The COVID-19 pandemic created a new interest in ESG resilience. Albuquerque et al. (2020) establish that companies that had good scores in the environmental and social rating received greater returns and reduced volatility at the beginning of the market collapse. Similar results are recorded by Broadstock et al. (2021) in the Chinese market, indicating that ESG qualities lowered the downside risk.

Nofsinger and Varma (2014) state that in times of crisis, socially responsible funds tend to outperform and underperform in times of normal economic conditions, which is a result of a downside-protection hypothesis.

Nonetheless, there is one critical difference that should be highlighted. The majority of studies related to crisis periods deal with individual firm returns or short time frames. Mutual funds that are diversified combine exposures to a variety of sectors and securities and therefore may attenuate the effect of firm-specific resilience. As a result, outperformance during periods of crisis at the stock level might not be directly transferred to statistically significant alpha in fund level after controls of systematic risk exposures.

This difference induces explicit crisis interaction testing in panel asset pricing models.

### 2.4.4 Tracking Error and Structural Bias

There are systematic industry and regional biases as a consequence of ESG integration. Omission of the fossil fuel producers and contentious industries may result in the underweighting of the energy and basic materials industries and the overweighting of technology and industrial companies.

Leite and Cortez (2016) demonstrate that European socially responsible ETFs have a greater tracking error as compared to traditional benchmarks. Ferriani and Natoli (2023) also show that the disagreement in ESG rating can increase the tracking error by changing the portfolio construction decisions.

Inferior performance does not necessarily imply higher tracking error, but it reflects structural deviation from benchmark indices. These deviations may generate cyclical performance differences depending on prevailing sector rotations and macroeconomic conditions.

## 2.5 ESG Rating Divergence and Measurement Challenges

The measurement of sustainability is considered one of the most serious methodological problems of ESG research. With the exception of traditional financial variables, ESG scores lack standardization among the rating agencies. The variation in methodology, priority of weighting, scope and data might produce significant disparity in firm-level ESG rating.

According to Berg, Kölbel, and Rigobon (2022), there is a strong disagreement between the major ESG rating providers, which proves that the correlations between agency ratings are much lower than those that are usually provided with credit ratings. The authors break down this divergence into three major sources, namely, measurement differences, scope differences, and weighting differences. The differences of measurement occur when different agencies measure the same concept using different indicators. The differences in scopes arise when agencies evaluate the dimensions of sustainability differently. When there are differences on weighting, it indicates that there is different importance placed on the elements of the environmental, social and governance.

This variation brings measurement error to this field of empirical studies. In case ESG ratings are noisy or unstable, the estimated relationships between ESG and financial performance also can be weak or volatile. Christensen, Serafeim, and Sikochi (2021) also demonstrate that more disclosure can actually lead to more rating disagreement, especially when agencies have a different interpretation of information disclosed. This disagreement has the potential to enhance the volatility of returns and make it difficult to interpret ESG-related alpha.

The implication of these findings is that empirical analysis of ESG performance should be viewed with a degree of caution. The effects of performance that are observed may be linked to the rating provider taken, how the composite scores are constructed and the time frame in which they are taken. In turn, the ESG alpha conclusions cannot be considered as generalizable.

Rating divergence may also be a factor in portfolio construction at the fund level. When ESG screens are founded on a differing rating methodology, an ESG-labeled fund can have heterogeneous exposures and factor tilts. Such heterogeneity may affect tracking error as well as risk-adjusted performance results.

In this thesis, rating uncertainty will be a strong point that supports the need to use systematic asset pricing models as opposed to just using raw ESG scores. The performance analysis using CAPM and multi-factor models is aimed at evaluating performance based on the observable performance of returns and not the subjective classification of sustainability.

For this thesis, the presence of rating divergence reinforces the importance of relying on systematic asset pricing frameworks rather than raw ESG scores alone. By evaluating performance through CAPM and multi-factor models, the analysis focuses on observable return behavior rather than subjective sustainability classification.

## 2.6 Integrated Conceptual Framework and Research Positioning

The above literature review shows that the financial implications of ESG investing cannot be linked to any single mechanism. Instead, sustainable investment plans have effects on performance in a variety of interacting channels that will be operated concurrently at the portfolio, pricing and risk levels. The combination of these strands of theory and empirical evidence gives rise to three main mechanisms: a structural portfolio channel, an equilibrium pricing channel, and a risk and resilience channel.

- **Structural Portfolio Channel**

ESG integration often creates sectoral exclusions and systematic tilts, which redefine the portfolio composition. ESG funds can also change their exposure to traditional risk factors by filtering certain industries, e.g. fossil fuels, or overweighting firms with good governance or profitability attributes. In a Modern Portfolio Theory viewpoint, these constraints have the ability to decrease the efficiency of diversification when the omitted assets are the ones that are mean-variance efficient (Markowitz, 1952). According to Renneboog et al. (2008) and Statman and Glushkov (2009), such structural adjustment can raise the tracking error rate, in comparison to broad benchmarks, and consequently reduce the achievable risk-adjusted returns. These tilts can, however be risk reallocation instead of inefficiency in case the excluded sectors have increased transition, regulatory or stranded asset risk. This channel is empirically tested in this thesis by following error analysis, loading of factors in multi-factor regressions, and panel fixed-effects models of systematic patterns of exposures.

- **Equilibrium Pricing Channel (Greenium Mechanism)**

Along with structural tilts, ESG integration could affect returns via equilibrium pricing dynamics. Pastor, Stambaugh, and Taylor (2021) illustrated that when investors have non-financial utility of holding sustainable assets, the demand of such assets goes up, and it will raise the prices and decrease the expected returns. With this mechanism, ESG funds may exhibit negative CAPM alpha even though this is not a sign of managers performing poorly. The demand due to preference is lower than inefficiency, leading to lower expected returns, and the issuers gain in terms of low cost of capital. This meaning makes simple stories of ESG underperformance more difficult and shows the significance of separating between abnormal returns as inefficiency and negative alpha as the process of equilibrium pricing

- **Risk and Resilience Channel**

  Another set of literature indicates that ESG features can increase firm-level stability under conditions of market stress. The studies during the crisis period record reduced volatility and enhanced downside protection of high-ESG companies (Albuquerque et al., 2020; Broadstock et al., 2021; Nofsinger and Varma, 2014). Nevertheless, there are conflicting results at the fund-level. Crisis-period alpha tends to be dampened once the systematic exposures are adjusted, which suggests the observed resilience can be due to a sensitivity to structural factors, as opposed to a better stock selection. This channel, thus, closely overlaps the structural portfolio mechanism, and this argument justifies multi-factor empirical testing.

Combined, these processes suggest that the financial cost of socially responsible investment is multidimensional as opposed to being singular. It can either be in form of variations in risk-adjusted performance or structural variations between benchmark exposures or equilibrium pricing influences due to investor preferences.

These channels are integrated into a single conceptual framework, as in Figure 4. As shown in the figure, ESG integration is subject to the portfolio constraints, investor preferences, and regulatory pressures, which subsequently affect factor exposure, tracking error, expected returns, and expense ratios.

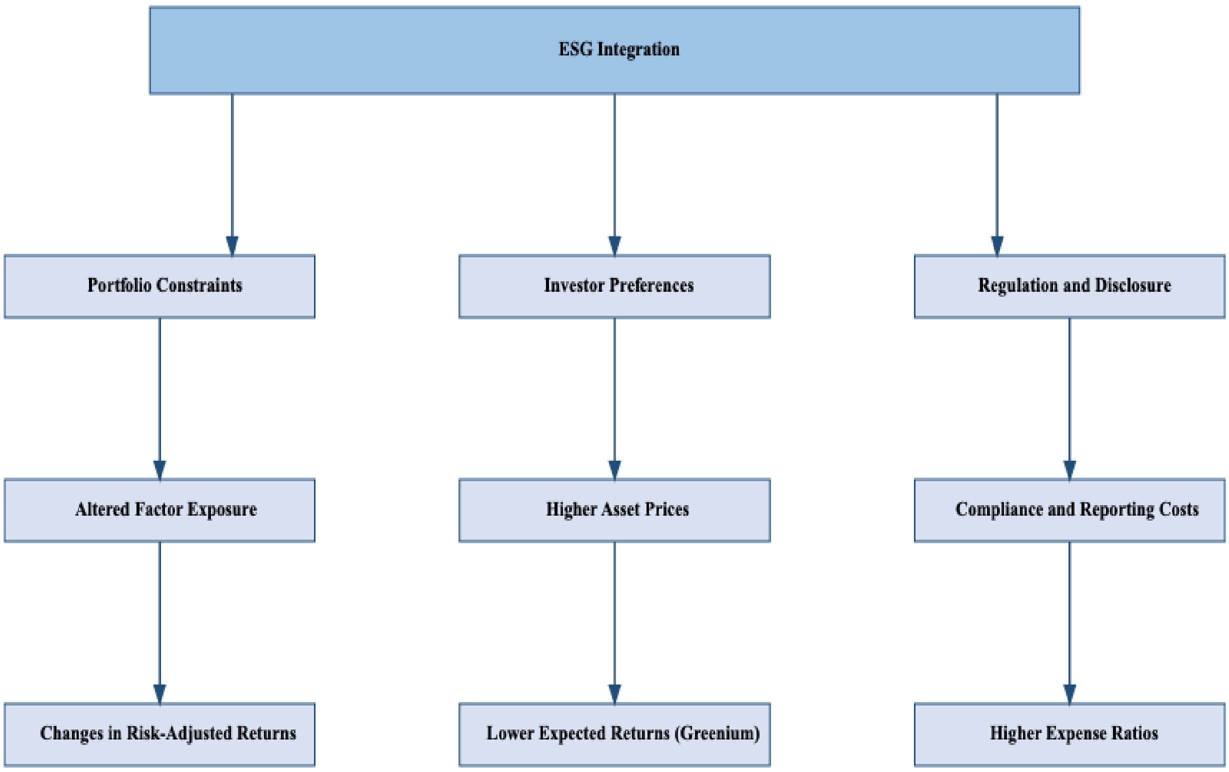


**Figure 4: Conceptual Framework of the Financial Cost of ESG Investing**

By visually linking theoretical processes with performance outcomes that are seen and analytically linking them to empirical models of ESG performance construction developed in the following chapter, this thesis does not take either of the two inherently beneficial and inherently expensive approaches to ESG performance. Rather, it examines how the observed differentials in returns are due to structural portfolios, equilibrium pricing or risk-related behavior in times of market stress.

## 2.8 Research Gap and Positioning of This Thesis

Although there is a vast amount of literature available on ESG and financial results, there are myriad gaps that are directly applicable to the present research. One, a significant portion of the empirical data is based on firm-level returns or short-term windows of crisis events as opposed to diversified mutual fund returns measured over long periods of years. Although firm-level studies are informative on cross-sectional pricing impacts, they may not be informative on portfolio-level results where diversification and factor exposures have key significance.

Second, the performance analysis adjusted to factors is not always used in ESG fund studies. Other studies are based on the comparison of raw returns or single-factor performance, and this prevents the possibility of distinguishing between an abnormal performance and systematic risk exposure. Third, the number of frameworks that are panel-based and manage unobserved fund-specific heterogeneity is comparatively small, and in this respect, it is in the European environment that regulatory integration and ESG adoption are most developed. Lastly, crisis-period sensitivity is often studied in the absence of explicitly modelling interaction in multi-factor specifications, and it is unclear as to whether resilience is an exposure shift or an abnormal return.

This thesis addresses these gaps by providing first-hand comparisons between ESG-labelled equity funds and matched benchmarks as part of established asset pricing models. Performance is measured in terms of CAPM, Fama-French three-factor and five-factor models to determine whether the abnormal returns survive at the end of systematic risk exposures. They use a panel fixed-effects model to incorporate unobserved heterogeneity among funds, and also include terms of interaction at periods of crisis to test the stress sensitivity in a multi-factor environment. Robustness is also tested by the fund-clustered standard errors to test the statistical reliability. The research aims to identify the difference between the effects of structural exposure and the actual performance of abnormality in an effort to differentiate the effects of ESG fund performance in traditional asset pricing theory and an equilibrium preference-based pricing research, thus adding a more comprehensive and methodologically sound view to the financial cost of sustainable investing debate.

# 3. METHODOLOGY

The literature confirms that the ESG performance should be measured through a strict asset pricing model that differentiates the cases of abnormal returns, structural exposures, and the equilibrium pricing effects. With the sensitivity of ESG results reported to factors specifications and measurement design, a multi-model empirical approach is needed.

To this end, this section will provide the data construction, the specification of the variables, asset pricing models, the specifications of the panel, and the robustness processes to tests the hypothesis of whether or not ESG funds have persistent risk-adjusted underperformance after adjusting the systematic exposures.

## 3.1 Research Design

In this research, a quantitative asset pricing model is used to test the hypothesis that ESG-labelled equity funds produce abnormal risk-adjusted returns over benchmarks (conventional and systematic risk). Instead of basing the empirical strategy on the mere descriptive performance comparison, it is based on the equilibrium asset pricing theory. This means that performance differentials can be broken down to systematic factor exposures and abnormal returns (alpha).

Methodological approach, It is a time-series regression of individual funds combined with panel data estimation. The time-series structure allows the cross-sectional assessment of abnormal performance of funds, and the panel specification manages the unobserved heterogeneity and is based on the longitudinal nature of data. This binary setup reinforces inference and enables structural elaboration of the interactions of the ESG performance.

The empirical frameworks are based on the Capital Asset Pricing Model (Sharpe, 1964) and the Fama-French three- and five-factor models (Fama French, 1993, 2015). The estimation processes of panels are performed through the usual econometric principles described in Wooldridge (2010), and the analysis of ESG-related returns dynamics is informed by the framework of the equilibrium as developed by Pastor, Stambaugh, and Taylor (2021). The sample interval is January 2018 to December 2024, including expansionary markets, the shock of the COVID-19 crisis, and the recovery of the crisis.

## 3.2 Data and Sample Selection

The final sample comprises of 58 EUR-denominated ESG-labelled equity funds, which have a continuous monthly net asset value (NAV) data, covering the period of January 2018 to December 2024. Funds were chosen according to clear ESG or sustainability requirements and had continuous observations of returns over the entire sample duration. Every single return taken is in euros to maintain consistency in currency.

NVA information and fund characteristics are provided by Morningstar and JustETF on a monthly basis. Cross-validation of the data was made by Investing.com and Bloomberg to make sure the data is accurate and consistent, and benchmark index data were retrieved from MSCI and STOXX databases. The three-month EURIBOR of the European Central Bank's statistical database is used as the risk-free rate.

The market risk premium (Mkt_RF), size (SMB), value (HML), profitability (RMW) and investment (CMA) factor returns series were obtained at the Kenneth French Data Library. These have been extensively applied in empirical studies of asset prices and give homogeneous measures of systematic risk exposures.

The resulting balanced panel contains 4787 fund-month observations. The structure of the multi-year enables analysis of the ESG fund performance over various market regimes, such as the COVID-19 shock period.

## 3.3 Variables and Measurement

This section outlines the important variables that are applied in the empirical analysis and how they are applicable in the asset pricing framework. To be able to separate the difference between the raw returns and the systematic risk exposures, the performance evaluation needs both descriptive measures of performance as well as factor-adjusted measures. Fund excess return is the main dependent variable, with the explanatory variables being the conventional Fama-French risk factors and an indicator of the crisis period. Besides regression-based measures, descriptive indicators, including volatility, Sharpe ratio, and tracking error, are also calculated to give an intuitive comparison of ESG funds and their benchmarks. These measures combined will enable the performance to be viewed both structurally and risk adjusted. Table 1 summarizes the definitions and measures of all variables.

**Table 1: A summary of the key variables**

| Variable | Definition | Measurement |
|---|---|---|
| **Ri** | Fund excess return | Fund return minus Risk-free rate |
| **Mkt_RF** | Market excess return | Market return minus Risk-free rate |
| **SMB** | Size factor (Small minus Big) | Fama-French size factor |
| **HML** | Value factor (High minus Low) | Fama-French value factor |
| **RMW** | Profitability factor (Robust minus Weak) | Fama-French profitability factor |
| **CMA** | Investment factor (Conservative minus Aggressive) | Fama-French investment factor |
| **Crisis** | COVID-19 crisis dummy | 1 = March–December 2020, 0 otherwise |
| **Mkt_RF_Crisis** | Interaction: Market × Crisis | Mkt_RF multiplied by Crisis dummy |

### 3.3.1 Fund Returns and Excess Returns

Calculation of monthly fund returns is based on the terms of percentage change in NAV:

$$R_{i,t} = \frac{P_{i,t}}{P_{i,t-1}} - 1$$

where $P_{i,t}$ denotes the NAV of fund i in month t.

Excess returns are computed as:

$$R_{i,t}^{excess} = R_{i,t} - R_{f,t}$$

where $R_{f,t}$ represents the risk-free rate (3-month EURIBOR). Excess returns form the dependent variable in all asset pricing regressions.

### 3.3.2 Volatility

The standard deviation of returns is used to measure the volatility monthly. Volatility per annum is calculated as:

σ annual = σ monthly x 12

Volatility gives a measure of the dispersion of total returns and is applied in descriptive comparisons of ESG funds and benchmarks.

### 3.3.3 Sharpe Ratio

Risk-adjusted performance is evaluated using the Sharpe ratio:

$$S = \frac{\overline{R_p} - R_f}{\sigma_p}$$

Sharpe ratios, which are annualized, are calculated by multiplying the Sharpe ratio per month by 12. The Sharpe ratio makes it possible to directly compare the performance of ESG funds with their benchmarks in terms of pay-off per unit of overall risk.

### 3.3.4 Tracking Error

Tracking error measures deviation from benchmark returns:

$$TE = \sqrt{\frac{1}{n-1}\sum_{t=1}^{n}\left(R_{fund,t} - R_{benchmark,t}\right)^2}$$

Where:

$R_{fund,t}$ = return of ESG funds at time t,

$R_{benchmark,t}$ = return of benchmark at time t

And n being the number of observations.

Tracking error captures structural deviations resulting from ESG screening and portfolio tilts in comparison to the benchmark.

## 3.4 Asset Pricing Model Specifications

The empirical evaluation proceeds through a hierarchical asset pricing framework designed to distinguish between abnormal performance and systematic risk exposure. While descriptive measures provide initial insight into return and risk characteristics, formal inference requires estimation of established equilibrium asset pricing models. The analysis begins with the Capital Asset Pricing Model (CAPM), which captures exposure to market risk. It then extends to the Fama–French three-factor and five-factor specifications to control for additional systematic return drivers related to size, value, profitability, and investment characteristics. This stepwise expansion allows assessment of whether observed ESG performance differentials persist after accounting for increasingly comprehensive factor structures. Consistent with Fama and French (1993, 2015) and Pastor, Stambaugh, and Taylor (2021), the objective is to determine whether ESG funds generate true abnormal returns or whether performance is explained by structural factor tilts.

### 3.4.1 Capital Asset Pricing Model (CAPM)

The Capital Asset Pricing Model (CAPM) is a mathematical framework that attempts to characterize and clarify the association between risk and appropriate returns on investments and securities. The baseline specification follows Sharpe (1964):

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_i\left(R_{m,t} - R_{f,t}\right) + \varepsilon_{i,t} \qquad \text{(Equation 1)}$$

Where:

$R_{i,t}$ = return of fund ii at time t

$R_{f,t}$ = risk-free rate

$R_{m,t}$ = market return

$\alpha_i$ = abnormal return (alpha)

$\beta_i$ = sensitivity to market risk

$\varepsilon_{i,t}$ = idiosyncratic error term

According to the CAPM, an insignificant αi implies that there is no abnormal performance due to market risk being adjusted.

### 3.4.2 Fama–French Three-Factor Model (FF3)

To control for additional systematic risk premia, the three-factor model of Fama and French (1993) is estimated:

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_{i,M}\left(R_{m,t} - R_{f,t}\right) + \beta_{i,SMB}SMB_t + \beta_{i,HML}HML_t + \varepsilon_{i,t} \qquad \text{(Equation 2)}$$

Where:

$MKT_t$ = market risk premium

$SMB_t$ = size factor (small minus big)

$HML_t$ = value factor (high minus low)

$\beta_{i,SMB}$ = sensitivity to size factor

$\beta_{i,HML}$ = sensitivity to value factor

$\beta_{i,M}$ = sensitivity to the market factor

This specification determines whether the existing structural tilts towards small-cap stocks or growth stocks can explain the existence of ESG performance differentials, which is frequently observed in ESG portfolios (Pedersen et al., 2021).

### 3.4.3 Fama–French Five-Factor Model (FF5)

To incorporate profitability and investment effects, the five-factor model of Fama and French (2015) is estimated:

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_{i,M} MKT_t + \beta_{i,SMB} SMB_t + \beta_{i,HML} HML_t + \beta_{i,RMW} RMW_t + \beta_{i,CMA} CMA_t + \varepsilon_{i,t} \quad \text{(Equation 3)}$$

Where:

$RMW_t$ = profitability factor (robust minus weak)

$CMA_t$ = investment factor (conservative minus aggressive)

$\beta_{i,RMW}$ = sensitivity to profitability

$\beta_{i,CMA}$ = sensitivity to investment

The five-factor model of Fama and French (2015) is estimated to account for profitability and investment effects: This specification enables the measurement of whether the ESG underperformance remains despite the profitability and investment patterns that are structure-wise related to the ESG firm characteristics (Pedersen et al., 2021).

## 3.5 Cross-Sectional Alpha Evaluation

Time-series regressions are estimated of all 58 funds of CAPM, FF3, and FF5. Alphas are calculated on an annual basis and the significance is checked at 5 percent. Cross-sectional summaries also contain the mean alpha, median alpha, and the share of significantly negative alpha.

The negative alpha persistence in progressively factored out models represents performance differentials in addition to the classical systematics risks exposures.

## 3.6 Panel Fixed Effects Estimation

To control for unobserved time-invariant heterogeneity across funds, a fixed effects panel estimator is employed:

$$R_{i,t}^{excess} = \alpha_i + \beta' X_t + u_{i,t} \qquad \text{(Equation 4)}$$

Where:

$\alpha_i$ = fund-specific intercept

$X_t$ = vector of factor returns

$u_{i,t}$= error term

The within transformation removes fund-specific time-invariant features like management style, ESG screening intensity and structural cost differences. According to Wooldridge (2010), the fixed effects estimation will give consistent parameter estimates where parameters are correlated with individual effects and explanatory variables.

## 3.7 Hausman Specification Test

This thesis conducted the Hausman Test to determine whether fixed or random effects are appropriate. The equation is mentioned below.

$$H = \left(\widehat{\beta_{FE}} - \widehat{\beta_{RE}}\right)' \left[Var\left(\widehat{\beta_{FE}}\right) - Var\left(\widehat{\beta_{RE}}\right)\right]^{-1} \left(\widehat{\beta_{FE}} - \widehat{\beta_{RE}}\right) \qquad \text{(Equation 5)}$$

Where:

$\widehat{\beta_{FE}}$ = fixed effects estimator

$\widehat{\beta_{RE}}$ = random effects estimator

The null hypothesis is known to be consistent with the random effects estimator. Even though, the statistical findings do not turn the null down, the fixed effects are still used because the economic expectation is quite strong, that the fund-specific traits are related to factor exposures.

## 3.8 Crisis Interaction Specification

To examine whether ESG performance structurally changed during the COVID-19 crisis, a crisis dummy variable is defined:

Crisis $_t$ ={1 March 2020 – December 2020, 0 otherwise

The interaction model is specified as:

$R_{i,t}^{excess} = \alpha_i + \beta_{i,M} MKT_t + \beta_{i,C} Crisis_t + \beta_{i,MC}(MKT_t \times Crisis_t) + \gamma' Z_t + u_{i,t}$ (Equation 6)

Where:

$Crisis_t$ = crisis indicator

$MKT_t \times Crisis_t$ = interaction capturing crisis-period beta shifts

$Z_t$ = Vector of additional factors

The market factor is the only one that combines with the crisis dummy to maintain parsimony and to prevent the presence of multicollinearity. Pastor et al. (2021) believe that the effects of ESG-related performance can be the result of changes in systematic exposure instead of the abnormal stock selection; this specification directly tests this hypothesis.

## 3.9 Robustness and Inference Strategy

Panel regressions can exhibit correlation to within-fund serially and heteroskedasticity, resulting in underestimation of standard errors and overstatement of statistical significance.

Standard errors are aggregated at the fund level in a bid to ensure a consistent inference. Arellano (1987) shows that a cluster-robust covariance estimation gives an estimable covariance when there is unspecified within-group dependence in panel data. Wooldridge (2010) also highlights the fact that there is a need for clustering in cases where the residuals can have some level of correlation across cross-sectional units over time. Using fund-level clustered standard errors, the analysis takes into consideration the possibility of persistence in the returns dynamics and stochastic dominance of funds in volatility. The modification will give strong statistical inference of factor loadings, alpha estimates, and interaction effects of the crisis.

In addition to statistical correction, performance assessment has a hierarchical interpretative process. When the abnormal returns (alpha) are observed to reduce with the increase of risk factors, then underperformance is considered to be exposure-based and not skill-based. When explanatory power ($R^2$) also rises with an increase in model complexity, then it is concluded to be explained by systematic factors. When both crisis period alpha and factor sensitivities are statistically insignificant, but performance dynamics at stress periods can be explained by structural exposure changes as opposed to abnormal stock selection.

This system of interpretation is consistent with the equilibrium ESG pricing theory developed by Pastor, Stambaugh and Taylor (2021), where preference-motivated demand may affect the expected returns without suggesting inefficiency. It is also aligned with the factor-based account of ESG returns dynamics developed by Pedersen et al. (2021), who point out that the performance difference observed tends to be a systematic tilt and not a skill of the manager. The combination of the robustness procedures and interpretative structure gives a rigorous foundation of assessing whether ESG fund performance is based on structural exposure influences or actual abnormal returns.

# 4. RESULTS

This chapter shows empirical research findings of the study. The analysis takes place in a well-structured chronological sequence. First, descriptive statistics and raw performance comparison between ESG funds and benchmarks are presented. Second, time-series regressions based on the CAPM and Fama-French specifications assess the abnormal risk-adjusted performance of individual funds. Third, panel fixed effects estimate tests are used to determine structural factor exposures, and they rectify unobserved heterogeneity. Lastly, the models of crisis-period interaction and clustered standard errors evaluate the robustness and structural sensitivity in the stressful times of the market.

## 4.1 Descriptive Statistics

Table 2 presents the summary descriptive statistics of the final sample of 58 EUR-denominated ESG funds after dropping two funds with zero variance of returns. The fund level statistics are presented individually in Appendix 1.

**Table 2: Descriptive Statistics summary**

| Statistic | Value |
|---|---|
| Number of Funds | 58 |
| Mean Monthly Return | 0.004 |
| Mean Annual Return | 0.053 |
| Median Monthly Return | 0.004 |
| Average Monthly Volatility | 0.037 |
| Average Minimum Monthly Return | -0.145 |
| Average Maximum Monthly Return | 0.107 |

The mean monthly fund-to-fund returns are 0.44%, which represents an annualized fund-to-fund return of about 5.3%. The median monthly return of 0.47% shows that the distribution of fund-level mean returns is fairly symmetric and is not pushed by the extreme outliers. The mean monthly volatility is 3.73%, which is medium volatility, as it is in line with diversified equity-based strategies.

The average negative minimum monthly return (14.53%) is larger than the size of the average positive monthly return (10.71%), which implies the existence of asymmetric negative risks during stressful times. This volatility is aligned with that of crisis periods, where volatility of equity markets worldwide is being recorded during the COVID-19 pandemic (Khalid et al., 2021).

Comprehensively, the descriptive statistics show that ESG funds in the sample have an average moderate level of returns, significant volatility, and large extreme monthly returns dispersion.

## 4.2 Raw Fund–Benchmark Performance Comparison

Table 3 contains raw performance comparisons between ESG funds and matched benchmarks, even prior to the exposures to systematic risks being adjusted.

**Table 3: Fund Vs Benchmark Performance**

| Metric | Fund Average | Benchmark Average | Difference |
|---|---|---|---|
| Annualized Return | 0.05 | 0.136 | -0.086 |
| Annualized Volatility | 0.145 | 0.177 | -0.033 |
| Sharpe Ratio | 0.055 | 0.185 | -0.129 |
| Tracking Error | 0.147 | | |
| Tracking Difference | -0.086 | | |
| Excess Sharpe | -0.129 | | |

The average annualized returns of the ESG funds are 5.0% versus 13.6 % of benchmarks, resulting in a gap in returns of -8.6 percentage points. Though ESG funds have low annualized volatility (14.5%) in comparison with benchmarks (17.7%), the risk reduction does not offset the high loss of returns. The mean Sharpe ratio of ESG funds (0.055) is therefore significantly lower than that of benchmarks (0.185). The tracking difference and the annualized tracking error of 14.7% show that there are economically significant variations in benchmark exposures and that the tracking error proves the systematic underperformance.

Figure 5 visually illustrates the cumulative value of a €1 investment in ESG funds for the period of January 2018 to December 2024 compared to its benchmark index.

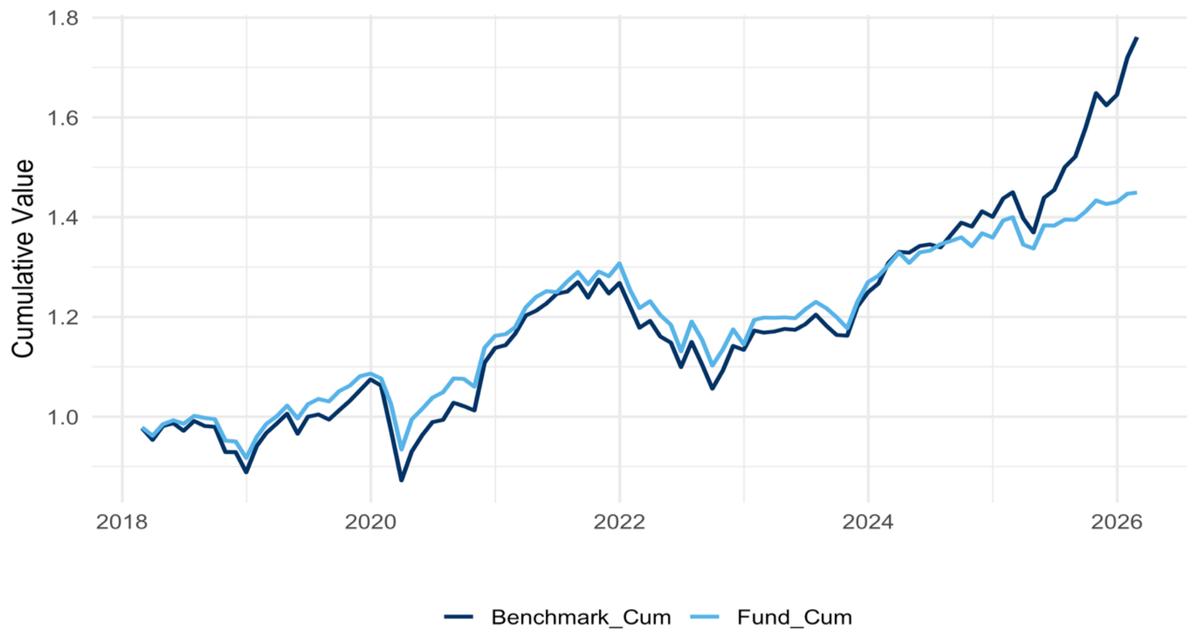


**Figure 5: Cumulative Fund vs benchmark Performance Plot**

The cumulative substantial return difference between funds and benchmarks is well illustrated by the comparison of both series plotted graphically, in which the values are normalized to one at the starting point of the sample. The difference in cumulative wealth in the long run underscores the economic scale of the recorded difference in returns. Although ESG funds have a little bit low volatility, the cumulative performance difference is persistent, which indicates the continuous underperformance of returns compared to the raw performance. This is graphical evidence to go hand in hand with the regression results to show the long-run economic implications of structural differences in portfolios.

Since the raw underperformance is recorded, the following section is an assessment of whether the differences are maintained after, including the systematic market risk, with the CAPM framework. Although the above analysis reports huge raw underperformance of ESG funds against their benchmarks, raw returns comparisons fail to report systematic risk exposure differences. Specifically, ESG funds might be more or less sensitive to the market movements, which can be one of the reasons behind the noticed alteration in returns.

In order to determine whether ESG funds yield abnormal returns after the market risk has been taken into account, the second section approximates the Capital Asset Pricing Model (CAPM) of each fund. The risk-adjusted alpha can be evaluated with the help of this framework and it gives an insight into whether the underperformance recorded can be continued after taking into consideration the systematic market exposure.

## 4.3 CAPM Results

Table 4 reports the cross-sectional summary of CAPM regressions estimated separately for each of the 58 funds. Individual fund-level estimates are provided in Appendix 2.

**Table 4: CAPM Regression Analysis Summary**

| Statistic | CAPM |
|---|---|
| Number of Funds | 58 |
| Mean Alpha (Annual, %) | -2.72 |
| Median Alpha (Annual, %) | -3.91 |
| Significant Negative Alphas (5%) | 21 |
| Significant Positive Alphas (5%) | 2 |
| Percentage Significant Negative (%) | 36.2 |

The average alpha per year is -2.72%, and the median alpha is -3.91%. There are 21 (36.2%) out of the 58 funds with statistically significant negative alpha at the 5% level, and only 2 funds with significantly positive abnormal performance.

These findings suggest that a significant proportion of ESG funds perform poorly below market-adjusted expectations when applying the CAPM. Even though the estimated market betas are below unity, indicating that there is a slight degree of defensive exposure, this lower systematic risk does not reflect in the positive abnormal returns.

The evidence is contrary to the firm-level crisis-event literature, e.g., Albuquerque et al. (2020) and Broadstock et al. (2021), which record stock-level resiliency in high-ESG firms through the COVID-19 crash. Nonetheless, those literature review analyses are on cross-sectional firm returns within short event windows as compared to the current analysis of diversified fund portfolios in a multi-year period. The difference between a firm-level resilience and a portfolio-level alpha is economic.

## 4.4 Fama–French Three-Factor Model

Table 4 summarizes the cross-sectional estimates of alpha according to the Fama-French three-factor model of the final sample size of 58 ESG funds. The regression outcomes on the individual fund level are provided in Appendix 3.

**Table 5: Fama and French 3-Factor Regression Analysis summar**y

| Statistic | FF3 |
| --- | --- |
| Number of Funds | 58 |
| Mean Alpha (Annual, %) | -2.38 |
| Median Alpha (Annual, %) | -3.88 |
| Number of Significantly Negative Alphas (5% level) | 19 |
| Number of Significantly Positive Alphas (5% level) | 2 |
| Percentage of Significantly Negative Alphas (%) | 32.8 |

Mean of the annualized alpha becomes smaller in value of -2.38%, whereas the median alpha is -3.88%. The ratio of significantly negative alphas decreases slightly under CAPM from being at 36.2% to FF3 at 32.8%.

Attenuation of the alpha implies that some of the underperformance realized under CAPM could be explained by systematic exposure to size (SMB) and value (HML) risk factors. This is in line with the academic evidence of structural tilts in ESG portfolios regarding particular factor characteristics (Pedersen et al., 2021).

Nevertheless, even abnormal performance is, in economical and statistical sense, significant, which means that the difference in returns cannot be entirely explained by the traditional size and value exposures.

## 4.5 Fama–French Five-Factor Model

Table 6 presents result from the Fama–French five-factor model, incorporating profitability (RMW) and investment (CMA) factors for the final sample of 58 ESG funds. Individual fund-level regression results are reported in Appendix 4

**Table 6: Fama and French 5-Factor Regression Analysis summary**

| Statistic | FF5 |
|---|---|
| Number of Funds | 58 |
| Mean Alpha (Annual, %) | -2.9 |
| Median Alpha (Annual, %) | -4.07 |
| Number of Significantly Negative Alphas (5% level) | 22 |
| Number of Significantly Positive Alphas (5% level) | 0 |
| Percentage of Significantly Negative Alphas (%) | 37.9 |

The mean of alpha per annum under FF5 is -2.90%, and the median alpha is -4.07%. The ratio of significantly negative alphas goes up to 37.9%, and there is no fund that has significantly positive abnormal performance.

This is supported by the fact that negative alpha persists and slightly increases during FF5, indicating that the profitability and exposure to investments do not explain the underperformance observed. The attenuation seen with FF3 is not maintained with the five-factor specification.

The trend is consistent with the larger empirical evidence, which indicates that the effect of ESG-related performances is model-dependent and might not indicate persistent stock-selection ability when comprehensive factor controls are considered (Khan et al., 2016; Fama and French, 2015).

Table 7 summarizes the cross-sectional alpha estimates in CAPM, FF3 and FF5 models to make comparisons across specifications.

**Table 7 cross-model comparison summary**

| Statistic | CAPM | FF3 | FF5 |
|---|---|---|---|
| Number of Funds | 58 | 58 | 58 |
| Mean Alpha (Annual, %) | -2.72 | -2.38 | -2.9 |
| Median Alpha (Annual, %) | -3.91 | -3.88 | -4.07 |
| Percentage of Significantly Negative Alphas (%) | 36.2 | 32.8 | 37.9 |

The negative abnormal performance is still in existence in all the asset pricing specifications as revealed in Table 7. The FF3 model slightly decreases the size of underperformance in comparison to the CAPM, but the FF5 model does not eradicate differentials of abnormal returns.

Figure 6 gives a graphical comparison of what mean alpha is and the percentage of significantly negative alpha among specifications. In every model, the negative abnormal performance is economically significant. The addition of further factor structure changes the entire conclusion of underperformance without significant changes.

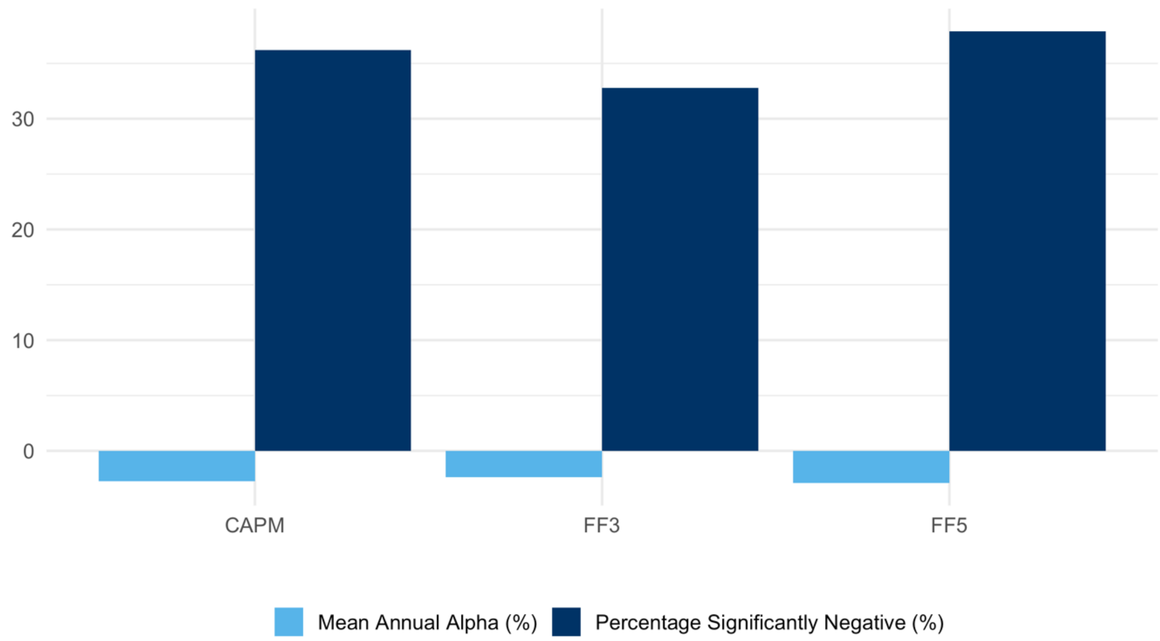


**Figure 6: All models comparison**

The above analysis emphasizes the abnormal performance (alpha). To gain insight into the structural composition of ESG funds, one needs to analyze systematic factor loadings. The table below contains cross-sectional means factor exposures estimated using individual fund-specific regressions by asset pricing specifications.

**Table 8: Factor Loading Summary**

| Model | Mean_Beta_ Mkt | Mean_Beta_ SMB | Mean_Beta_ HML | Mean_Beta_ RMW | Mean_Beta_ CMA |
|---|---|---|---|---|---|
| **CAPM** | 0.489 | - | - | - | - |
| **FF3** | 0.480 | 0.037 | 0.052 | - | - |
| **FF5** | 0.464 | 0.091 | 0.032 | 0.129 | -0.013 |

Table 8 shows that the ESG funds show defensive market exposure, and the average market betas across specifications are less than unity. A positive loading in the size factor (SMB) can be seen especially when the five-factor model is used, indicating a systematic bias towards the small-cap firms. Most interestingly, the profitability factor (RMW) is revealed to be strongly positively exposed, which means that ESG portfolios have a structural alignment with firms that are characterized by an increased operating profitability. Conversely, there is a negligible exposure to the investment factor (CMA). These results support the inference that the differences in performance in previous sections can be explained in large part by structural portfolio make-up, but not long-term, unchanging abnormal stock-selection skills.

## 4.6 Panel Fixed Effects Results

Fixed effects regressions are estimated using excess fund returns as the dependent variable to estimate the unobserved time-invariant between-fund heterogeneity and to take advantage of the panel structure of the data. The panel contains 4,787 fund-months.

**Table 9: Panel Fixed Effects for CAPM, FF3 and FF5**

| Variable | Coefficient |
|---|---|
| **Panel: A - Fixed Effects CAPM** | |
| Mkt_RF | 0.491*** (52.137) |
| R-squared | 0.365 |
| Adj. R-squared | 0.357 |
| Observations | 4787 |
| Funds | 58 |
| | |
| **Panel: B - Fixed Effects FF3** | |
| Mkt_RF | 0.48*** (47.836) |
| SMB | 0.039* (2.284) |
| HML | 0.052*** (4.261) |
| R-squared | 0.37 |
| Adj. R-squared | 0.362 |
| Observations | 4787 |
| Funds | 58 |
| | |
| **Panel: C - Fixed Effects FF5** | |
| Mkt_RF | 0.465*** (43.72) |
| SMB | 0.092*** (4.36) |
| HML | 0.033. (1.80) |
| RMW | 0.127*** (5.06) |
| CMA | -0.012 (-0.47) |
| R-squared | 0.373 |
| Adj. R-squared | 0.365 |
| Observations | 4787 |
| Funds | 58 |

Notes: t-values are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

The fixed effects CAPM outcomes are reported in panel A. Its market factor (Mkt_RF) is positive and significant (0.491, $p < 0.001$), which means that excess fund returns are also strongly associated with market excess returns. The within R-squared of 0.365 indicates that only market factor accounts for about 36.5% of the variation of excess returns with fund-specific factors controlled.

The size (SMB) and value (HML) factors are added to the specification in Panel B. The market coefficient has a statistically significant positive value (0.480, $p < 0.001$). The SMB factor is significant and positive at 5% level (0.039), and the HML factor is positive and significant at

5% level (0.052). The incorporation of these added risk factors adds a little bit more power to the explanations, yielding an R-squared of 0.370.

Panel C gives the specification of the five factors. The market factor is positive and significant (0.465, $p < 0.001$). The factors of SMB (0.092) and RMW (0.127) are positive and significant at the 1% level. HML factor is also positive but has only significant values near the borderline 10% level (0.033). The CMA factor is statistically insignificant. The five-factor model produces an R-squared of 0.373, which shows a small increment of explanatory power over the three-factor specification.

The fact that the incremental increase in explanatory power between FF3 and FF5 is low indicates that the profitability and investment exposures, although statistically significant, do not cause a drastic change in overall return variation. Although adding more factors results in relatively small gains in explanatory power, the general increase in $R^2$ is not large, which suggests that common systematic factors explain a significant but not all of the variation in returns. These results suggest the fact that the performance of ESG funds is more exposure-based than alpha-based.

## 4.7 Hausman Specification Test

In order to identify which specification is more suitable, either a fixed effects (FE) or random effects (RE) specification, a Hausman specification test was carried out. The test determines the correlated-ness of individual-specific effects with the explanatory variables, which would render the random effects estimator inconsistent.

**Table 10: Hausman Test**

| Test | Chi_Square | Degrees_of_Freedom | p_value | Decision |
|---|---|---|---|---|
| **Hausman Specification Test (FE vs RE)** | 2.708 | 1 | 0.099 | Fail to Reject RE (RE Acceptable) |

Table 10 presents the results of the Hausman test. The Hausman test ($\chi^2 = 2.708$, $p = 0.0998$) is not significant to reject the null hypothesis of random effects consistency.

Though random effects are statistically acceptable, fixed effects are maintained based on the economic practicality that unobserved fund characteristics, including ESG screening intensity and management philosophy, are associated with factor exposures.

## 4.8 Crisis Interaction Analysis

The fixed effects model is enhanced by the COVID-19 crisis dummy and a market interaction term in order to examine the impact of the dynamics of crisis periods.

**Table 11: Panel Fixed Effect Crisis Period model**

| Variable | Coefficient | Std_Error | t_value | p_value | |
|---|---|---|---|---|---|
| **Market (Mkt_RF)** | 0.452 | 0.012 | 37.887 | 0 | *** |
| **Size (SMB)** | 0.083 | 0.022 | 3.789 | 0.00 | *** |
| **Value (HML)** | 0.031 | 0.019 | 1.593 | 0.11 | |
| **Profitability (RMW)** | 0.117 | 0.025 | 4.612 | 0.00 | *** |
| **Investment (CMA)** | -0.013 | 0.027 | -0.496 | 0.62 | |
| **Crisis** | -0.001 | 0.002 | -0.480 | 0.63 | |
| **Market × Crisis** | 0.054 | 0.022 | 2.459 | 0.01 | * |
| **R-squared** | 0.374 | | | | |
| **Adjusted R-squared** | 0.365 | | | | |

Notes: t-values are reported in the table. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

In Table 11, the crisis dummy is accounted for and is statistically not significant ( 0.001, p = 0.63), which implies no abnormal period of crisis alpha after consideration of the systematic factors. This is in contrast to firm-level evidence of volatility-buffering or downside-risk reduction effects of high-ESG stocks (Zhou and Zhou, 2022; Albuquerque et al., 2020), indicating that the effects of resilience can also be reduced in diversified fund portfolios when systematic risk exposures are fixed.

Nevertheless, there is a significant positive interaction between Market x Crisis ( 0.054, 0.01), meaning that market beta raises its values in normal periods to 0.506 in the crisis. This implies increased systematic exposure and not enhanced stock picking.

The results indicate thus that the dynamics of performance during crises are explained by changes in beta structure but not by alpha creation, as per the equilibrium explanations of ESG pricing (Pastor et al., 2021).

## 4.9 Robustness Test: Clustered Standard Errors

To account for within-fund serial correlation and heteroskedasticity, fund-level clustering is performed for standard errors.

**Table 12: Fixed Effects Model with Fund-Clustered Standard Errors**

| Variable | Coefficient | Std_Error_Clustered | t_value | p_value | |
|---|---|---|---|---|---|
| **Mkt_RF** | 0.465 | 0.039 | 11.892 | 0 | *** |
| **SMB** | 0.092 | 0.018 | 5.079 | 0 | *** |
| **HML** | 0.033 | 0.024 | 1.368 | 0.172 | |
| **RMW** | 0.127 | 0.020 | 6.427 | 0 | *** |
| **CMA** | -0.013 | 0.025 | -0.507 | 0.612 | |

Notes: t-values are reported in the table. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively

Market, SMB, and RMW coefficients are extremely significant when it comes to clustering, whereas the HML and CMA are not significant. The economic explanation remains the same. Table 2gives the results of the clustered specification. The market factor is also positive and statistically significant ( 0.465, p = 0.001), which proves that the investment in ESG funds has a defensive, though systematic, exposure to general market movements. The clustered standard error is higher than that of the baseline model; however, the coefficient is highly significant, which shows that the market exposure outcome is very strong.

In the same fashion, the size factor (SMB) is statistically significant ( = 0.092, p < 0.001), indicating that the small-cap tilt of ESG funds is not a sensitivity to other variance assumptions. Another factor that has a high significance (RMW) (0.127, p < 0.001) also supports the conclusion that ESG funds have a tendency to select more profitable companies.

The value factor (HML) still has no significant value under clustering ($p = 0.172$), whereas the investment factor (CMA) still demonstrates no significant explanatory value ($p = 0.612$). These findings are in line with the baseline specification. This robustness test ensures that inference is not made by underestimated standard errors, which is in line with panel econometric advice to estimate clustered covariance.

In raw comparisons, time-series regressions, panel estimates, crisis interaction models and clustered robustness tests, none of the statistically significant results of positive abnormal returns are observed after conditioning on systematic risk factors. Although the previous literature reports on crisis-period resilience at the firm level, the current findings indicate that systematic exposures and not the consistent alpha are the main determinants of diversified ESG funds' performance. The data is also more conducive to a structural, exposure-driven explanation of ESG performance when compared to a long-standing stock-selection or competency-driven account.

# 5. DISCUSSION

This chapter deciphers the empirical results presented in Chapter 4 and assesses their implication to the financial cost of ESG investing. The four core themes that are used to structure the discussion are risk-adjusted performance as it is modelled by CAPM and multi-factor products, structural factor exposures and portfolio tilts, crisis-period sensitivity during the COVID-19 shock, and the greater implications to investors and sustainable finance theory. This chapter combines descriptive evidence alongside asset pricing findings to evaluate the hypothesis on whether the observed ESG performance differentials are due to abnormal returns, structural exposure effect, or equilibrium operations. Risk-Adjusted Performance may be interpreted in two ways: (a) using value-added performance, or (b) using the observed performance, adjusted by risk, as adopted by the SEC in the 2001 annual report.

## 5.1 Interpretation of Risk-Adjusted Performance

The empirical results of the sample period 2018-2024 show that the ESG funds exhibit lower returns relative to their benchmarks, both on a raw and CAPM-adjusted basis, which is in line with Hypothesis 1. The mean annualized alpha of CAPM is negative and significant for a reasonable share of funds. There is, however, theoretical caution to this interpretation of this result. As suggested by Pastor, Stambaugh, and Taylor (2021) in the equilibrium model, negative CAPM alpha might indicate preference-based pricing, as opposed to managerial inefficiency. Negative abnormal performance can be a manifestation of equilibrium adjustment instead of skill shortage in case investor demand of sustainable assets increases prices and reduces the expected returns.

As incremental systematic risk factors are added in the form of the Fama-French three and five factor models, the size of negative alpha decreases, although not to zero. This provides partial support for Hypothesis 2. The attenuation in the three-factor model implies that not all the perceived underperformance indicates exposure to size and value attributes. Nonetheless, the negative alpha that exists when specifying to the five factors shows that the differentials in abnormal returns are not eradicated by controlling for profitability and investment. The data, however, indicate that the ESG underperformance is not a mere miscalculation of factors exposure only, nor does it suggest long-term managerial ineffectiveness. This interpretation is further explained by the equilibrium framework of Pedersen, Fitzgibbons and Pomorski (2021). Their model shows that ESG traits can be predictors of positive returns in the informationally underpriced, informationally neutral, and informationally negative cases and returns are expected to be compressed by strong investor demands. The negative CAPM and multi-factor alpha persistence recorded in the current study is most in line with the latter equilibrium result. In a well-developed European ESG context, with sustainability information being extensively distributed and the capital flowing towards sustainable assets are large, then the ESG properties are most likely already factored in prices. According to this understanding, the underperformance is due to shifts in the pricing and preference-based valuation effects other than informational inefficiency and managerial frailty**.**

The sample period corresponds to the institutionalization phase of ESG investing after the Paris Agreement and encompasses rapid capital inflows and a state of crisis. Accordingly, the results reflect ESG performance in an environment of mature regulatory integration, rather than in the dynamics of early adopters. Notably, the findings indicate high positive exposures to profitability and size factors, consistent with Hypothesis 3. ESG funds seem to have a structural bias towards firms that are more operationally profitable, as well as some size specifications. This aligns with previous studies showing that ESG portfolios are correlated with quality and profitability dimensions (Pedersen et al., 2021). This interpretation of structural exposure is also supported by the small increase in explanatory power when CAPM is replaced by multi-factor models. The performance disparity is thus more exposure-based than idiosyncratic.

## 5.2 Crisis-Period Performance and Structural Sensitivity

The interaction crisis analysis also gives more insight into ESG dynamics during market stress. As compared to a few firm-level studies that report crisis resilience (Albuquerque et al., 2020), statistically significant crisis-period alpha is not observed when systematic exposures are conditioned. This result confirms Hypothesis 4 and indicates that ESG funds failed to generate abnormal defensive performance during the COVID-19 period.

Rather, results of the interaction point to a rise in market beta in the midst of the crisis. It means that variation in performance in stress times was provoked by shifting systematic exposure and not excellent stock choice or downside insurance. The fact that firm-level optimism and diversified fund-level neutrality are divergent highlights the significance of studying ESG performance through a multi-factor panel model.

## 5.3 Structural Versus Equilibrium Interpretation

Overall, the results indicate that the performance of ESG funds can be best regarded as a structural and equilibrium viewpoint instead of an unadulterated alpha story. Consistent negative abnormal returns in CAPM align with the greenium hypothesis of Pastor et al. (2021), whilst partial attenuation in multi-factor models suggests that structural tilts are important contributors to the performance differentials. The lack of the crisis alpha also undermines the statement according to which ESG funds are systematic in delivering downside protection at the diversified portfolio level.

Accordingly, the financial cost of ESG investing seems small and is mostly structural. Factor exposures and the portfolio construction decisions are some of the reasons why ESG funds move off the benchmarks, and not because of the continued underperformance of managers. This interpretation brings the empirical findings to consistency with the rest of the asset pricing theory and is part of the current debate on the economic implications of sustainable investing.

## 5.4 Implications for Investors and Policymakers

To the investor, this would mean that the ESG allocations cannot be expected to provide consistent positive abnormal returns when compared to multi-factor benchmarks. Nevertheless, the associated financial burden of SRI seems to be small and mostly structural as opposed to managerial inefficiency.

Non-financial preferences that are reported by Riedl and Smeets (2017) and Renneboog, Ter Horst, and Zhang (2008) can lead to investors being willing to tolerate small delays of benchmark performance without systematic alpha.

The findings are relevant to policymakers because they propose that ESG investing does not involve imposing huge penalties due to the abnormal returns after taking into consideration the systematic risk exposures. The performance differentials are found to be more due to the effects of portfolio construction and sector tilts as opposed to inefficiency.

In general, the difference in the performance of ESG is situation-specific and structurally based. The data failed to substantiate the assertion that ESG funds academically beat traditional benchmarks, and it does not imply huge and chronic penalties after factor exposures are considered.

# 6. LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

While this study provides a structured asset pricing evaluation of ESG fund performance across multiple model specifications and market regimes, certain limitations must be acknowledged. No empirical design can fully capture the multidimensional nature of sustainable investing, and the interpretation of results remains conditional on the chosen sample, time frame, and modelling framework. Recognizing these constraints is essential for contextualizing the findings and identifying avenues for future research that may extend or refine the present analysis.

## 6.1 Limitations

One should admit several limitations to the interpretation of the findings of this study.

To begin with, the analysis is done on EUR-denominated ESG mutual funds and ETFs from 2018-2024. This sample represents the institutionalization stage of ESG investing that followed the Paris Agreement, such as a fast influx of capital, regulatory convergence, and the COVID-19 shock. Yet, it does not cover several long-term business cycles and cannot be compared to the pre-ESG mainstream adoption periods. This means that the findings represent performance on ESG, considering the mature regulator integration and not the long historical periods. Future studies can test whether equilibrium price processes vary between regimes of adoption.

Second, the research measures the fund performance as opposed to the stock performance on a firm level. ESG resilience studies recorded elsewhere in the crisis period (Albuquerque et al., 2020; Broadstock et al., 2021; Zhou and Zhou, 2021) investigated individual stocks on a short-event basis. Conversely, the portfolio of diversified funds pools the exposure of firms, which, perhaps, can blur the effects of stock-specific resilience. Consequently, the variance in the findings in the firm levels and fund levels should not be viewed as contradicting, but rather as being an outcome of different aggregation levels.

Third, ESG measurement is prone to rating dispersion. According to Berg et al. (2022), there is widespread dispersion among ESG rating providers, and disclosure can expand rating dispersion (Christensen et al., 2021). The fact that ESG funds depend on external scorecard frameworks means that changes in the rating construction might affect portfolio construction and performance attribution. The current research lacks a cross-rating robustness analysis and thus is unable to test the measurement sensitivity directly.

Fourth, as CAPM, FF3 and FF5 are valuable in offering established asset pricing rates (Fama and French, 2015), there is no explicit consideration of an ESG factor in the analysis. Theoretically, Pastor et al. (2021) show that the dynamics of equilibrium pricing on assets related to ESG can be different. The current research considers abnormal returns against conventional risk factors alone without having an ESG-specific factor.

Lastly, the model uses fixed effects estimation to adjust for the heterogeneity of funds across time but fails to adjust for the possibility of time-varying screening intensity of ESGs, the development of mandates, and rebalancing dynamics. These dynamics can affect the performance, though they are not directly specified in the current specification.

## 6.2 Future Study Recommendations

Further investigations can be performed on the analysis of the thesis due to the presented limitations. To start with, an explicit ESG factor should be included that is in line with the equilibrium model by Pastor et al. (2021) to explicitly test whether ESG-related exposures counteract negative CAPM alpha in some regimes.

Second, it may be more accurate to identify effects of performance with the help of integrating materiality-based ESG measures as suggested by Khan et al. (2016). The separation of material and immaterial dimensions of ESG may help understand whether material performance differential is correlated with economic material sustainability concerns.

Third, the sensitivity of abnormal returns estimation to the choice of ESG score providers could be tested using cross-rating robustness analysis, which would help to overcome the concern expressed by Berg et al. (2022).

Fourth, extending the geographic coverage to incorporate the emerging markets can indicate the institutional variation in the ESG pricing. The Chinese experience (Broadstock et al., 2021) and the emerging market situation point to the possibility that regulatory frameworks and investor structure might shape the dynamics of ESG performance.

Lastly, regime-dependent or state-dependent models can be used to test the issue of ESG exposures being worse in times of inflation, commodity-based or climate-policy shocks.

# 7. CONCLUSION

This thesis considered the question of ESG investing involving any quantifiable financial cost compared to traditional standards. On the sample of 58 ESG funds between 2018 and 2024, the performance was analyzed with the CAPM, Fama-French 3-factor, and five-factor models, supplemented with the estimation of the five-factor model with the help of the panel fixed effects, the analysis of crisis interactions, and fund-clustered robustness.

The empirical findings show that ESG funds perform poorly against benchmarks on a risk-adjusted basis on the CAPM. The size of negative alpha decreases under three factor specification but it is negative in five factor model. These results indicate that, although structural exposures to conventional risk factors do account to some extent the performance difference, multi-factor adjustment does not remove underperformance.

ESG funds are highly positive to profitability and size factors, which means they are systematic structural tilts. These exposures explain a significant portion of the variance of returns, which supports the conclusion that the difference in ESG performance is mostly due to the fact that portfolio composition, rather than long-term stock-selection ability.

The analysis of the crisis interaction indicates that there are no statistically significant abnormal returns in the COVID-19 period when the systematic risk factors have been controlled. Rather, shifts in market beta indicate that performance behavior in times of stress is indicative of variations in systematic exposure as opposed to defensive alpha generation.

A combination of the findings supports the structural and equilibrium explanation of ESG performance. The presence of negative abnormal returns in the framework of single-factor models can also be associated with the effects of the preference-driven pricing, which is proposed by Pastor, Stambaugh, and Taylor (2021). Simultaneously, multi-factor analysis indicates that ESG funds are systematically tilted portfolios and are not differentiated as return-generating strategies.

The cost of ESG investing thus seems to be small and model-specific. The structural exposures and the dynamics of equilibrium pricing are a primary cause of performance variations and not an underlying managerial inefficiency. To an investor, it is possible that ESG allocations come at a price of not conforming to standard benchmarks, but does not reflect strong unexplained underperformance. To policymakers, the implications of the findings are that the sustainable finance regulation would not seem to create substantial penalties for abnormal returns after the systematic risk exposures are corrected.

Future studies can look at longer horizons and the variance of ESG classification systems, as well as cross-regional comparisons to deepen the understanding of the dynamics of the equilibrium of sustainable investing.

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## Appendix 1: Descriptive Statistics of All Funds

| Fund Names | Mean_Monthly_ Return | SD_Monthly_ Return | Min_Monthly_ Return | Max_Monthly_ Return | Mean_Annual _ Return |
|---|---|---|---|---|---|
| **AAF GLOBAL ESG EQS E EUR CAP** | 0.008 | 0.041 | -0.106 | 0.108 | 0.096 |
| **ACOMEA PMITALIA ESG A2** | 0.005 | 0.056 | -0.238 | 0.238 | 0.062 |
| **AIM LUX C-QUADRAT EUROPE MULTICAP ESG B** | 0.005 | 0.050 | -0.182 | 0.155 | 0.058 |
| **ALLIANZ EURO CREDIT SRI I (EUR)** | 0.000 | 0.021 | -0.100 | 0.053 | -0.003 |
| **ALLIANZ EURO CREDIT SRI IT (EUR)** | 0.001 | 0.020 | -0.100 | 0.053 | 0.013 |
| **ALLIANZ EUROPE EQUITY SRI AT-EUR** | 0.005 | 0.043 | -0.154 | 0.136 | 0.059 |
| **ALLIANZ INVEST ESG RENTEN EURO (A)** | 0.000 | 0.009 | -0.041 | 0.022 | -0.002 |
| **AMU Stox 600 Industrial UCITS Etf acc** | 0.010 | 0.063 | -0.258 | 0.207 | 0.118 |
| **AMUNDI IDX MSCI PAC EX JPN SRI-A3E (A)** | 0.002 | 0.035 | -0.201 | 0.121 | 0.027 |
| **AMUNDI INDEX EURO CORPORATE SRI - OE (C)** | 0.000 | 0.015 | -0.072 | 0.050 | -0.005 |
| **AMUNDI MSCI JPN ESG BRD TRANSITION IE A** | 0.006 | 0.036 | -0.084 | 0.096 | 0.072 |
| **AMUNDI MSCI PAC EX JPN SRI CL PAR ALG IE A** | 0.004 | 0.047 | -0.201 | 0.121 | 0.045 |
| **APOLLO AKTIEN GLOBAL ESG T** | 0.007 | 0.043 | -0.179 | 0.117 | 0.078 |
| **APOLLO HIGH YIELD BOND ESG (EUR) (T)** | 0.001 | 0.021 | -0.122 | 0.053 | 0.015 |
| **ASR FONDS SRI MEERWAARDE AANDELENFOND** | 0.003 | 0.023 | -0.093 | 0.082 | 0.038 |
| **Aallianz Glbl S** | 0.009 | 0.041 | -0.139 | 0.132 | 0.106 |
| **Amundi ETF** | 0.007 | 0.038 | -0.145 | 0.086 | 0.082 |
| **BEST BUSINESS MODELS SRI RC** | 0.005 | 0.046 | -0.138 | 0.154 | 0.063 |
| **BNPP EASY MSCI WORLD SRI PAB TP HEUR C** | 0.007 | 0.044 | -0.102 | 0.109 | 0.090 |
| **CANDRIAM SRI EQUITY WORLD - V EUR CAP** | -0.006 | 0.106 | -0.972 | 0.107 | -0.074 |
| **CIF-ESG EMERGING MARKETS FUND A EUR** | 0.006 | 0.046 | -0.190 | 0.095 | 0.071 |
| **CPR EUROPE ESG - I (C)** | 0.007 | 0.041 | -0.152 | 0.141 | 0.079 |
| **DEKA-ESG AKTIEN CF(A)** | 0.007 | 0.040 | -0.101 | 0.117 | 0.089 |
| **DNCA INVEST - SRI NORDEN EUROPE A EUR** | 0.007 | 0.049 | -0.146 | 0.142 | 0.080 |
| **DNCA INVEST SRI EUROPE GROWTH I** | 0.005 | 0.045 | -0.144 | 0.130 | 0.062 |

| | | | | | |
|---|---|---|---|---|---|
| **DPAM L EQUITIES EMU SRI MSCI INDEX B EUR CAP** | 0.007 | 0.049 | -0.138 | 0.174 | 0.088 |
| **DWS ESG CONVERTIBLES FC** | 0.003 | 0.022 | -0.073 | 0.053 | 0.032 |
| **DWS ESG ZINSEINKOMMEN LD** | -0.001 | 0.011 | -0.054 | 0.024 | -0.007 |
| **DWS INVEST ESG EMERGING MARKETS TOP DIV TFD** | 0.003 | 0.041 | -0.177 | 0.092 | 0.041 |
| **ECHIQUIER SMID BLEND EURO SRI I** | 0.004 | 0.050 | -0.200 | 0.173 | 0.049 |
| **ECUREUIL SRI OBLI EURO C** | -0.001 | 0.015 | -0.049 | 0.041 | -0.008 |
| **FORTIS SRI FUTUREVISION SUSP - UNSUPPORTED** | 0.003 | 0.026 | -0.099 | 0.095 | 0.034 |
| **GENERALI IS - SRI AGEING POPULATION AX** | 0.004 | 0.038 | -0.129 | 0.114 | 0.053 |
| **GREAT EUROPEAN MODELS SRI IPC** | 0.004 | 0.047 | -0.147 | 0.140 | 0.044 |
| **GUTMANN ESG EQUITIES (T1)** | 0.007 | 0.039 | -0.140 | 0.125 | 0.082 |
| **HSBC RESP INVSTMT FUNDS SRI EUR BD AD** | -0.001 | 0.016 | -0.048 | 0.043 | -0.015 |
| **HSBC RIF SRI EUROLAND EQUITY I** | 0.006 | 0.045 | -0.161 | 0.179 | 0.074 |
| **IQAM SRI SPAR TRUST M (AA)** | -0.001 | 0.010 | -0.028 | 0.039 | -0.014 |
| **Ishares** | 0.008 | 0.053 | -0.305 | 0.180 | 0.094 |
| **KATHREIN ESG GLOBAL EQUITY R T** | 0.008 | 0.040 | -0.110 | 0.097 | 0.093 |
| **KBC EQ.SRI MIN VNCE. CLC.SHRS WTH.CAP** | 0.003 | 0.025 | -0.109 | 0.074 | 0.041 |
| **KCD-UNION ESG AKTIEN I** | 0.005 | 0.036 | -0.093 | 0.094 | 0.056 |
| **LAZARD EQUITY SRI PD EUR** | 0.006 | 0.047 | -0.180 | 0.191 | 0.071 |
| **LUX IM ESG SYCOMORE EUROPEAN EQ C CAP EUR** | -0.002 | 0.036 | -0.153 | 0.145 | -0.021 |
| **MIRAE ASSET ESG ASIA SECTOR LDR EQ A EUR** | 0.004 | 0.045 | -0.165 | 0.105 | 0.046 |
| **MM WORLD EQUITY INDEX SRI FUND A EUR ACC** | 0.010 | 0.042 | -0.105 | 0.115 | 0.117 |
| **NATIXIS ESG PEA** | 0.004 | 0.034 | -0.116 | 0.101 | 0.047 |
| **OFI INV ESG PRUDENT EUR OFI INV ESG PRUDENT** | 0.001 | 0.017 | -0.067 | 0.045 | 0.010 |
| **PAX ESG GLOBAL FONDS R** | 0.000 | 0.018 | -0.047 | 0.046 | 0.000 |
| **Pictet Global** | 0.010 | 0.047 | -0.133 | 0.114 | 0.120 |
| **Pictet Q** | 0.011 | 0.040 | -0.129 | 0.119 | 0.137 |

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|---|---|---|---|---|---|
| **QUADRATOR SRI ID DEAD - Merged:2918AG** | 0.001 | 0.048 | -0.166 | 0.135 | 0.012 |
| **ROBECO SUSTAINABLE WATER D EUR** | 0.009 | 0.049 | -0.143 | 0.118 | 0.104 |
| **SCOR FUNDS-ESG EURO STDUR HGH YLD IC EUR** | 0.002 | 0.012 | -0.066 | 0.043 | 0.029 |
| **STATE ST SRI EUR CORP BD IDX A2 EUR DIS** | 0.000 | 0.017 | -0.089 | 0.049 | -0.001 |
| **UBS EQ** | 0.012 | 0.046 | -0.196 | 0.119 | 0.138 |
| **UNI ESG AKTIEN GLOBAL** | 0.007 | 0.039 | -0.117 | 0.096 | 0.088 |
| **VANGD.SRI FTSE DVLPWLD II INST B EUR** | 0.010 | 0.041 | -0.133 | 0.110 | 0.121 |

**Appendix 2: CAPM Baseline Regression of All Funds**

| Fund | Alpha_Annual | Alpha_p | | Beta | Beta_p | R2 |
|---|---|---|---|---|---|---|
| SCOR FUNDS-ESG EURO SHRT TERM DUR HGH YLD IC EUR | -1.626 | 0.156 | | 0.174 | 0 | 0.53 |
| APOLLO HIGH YIELD BOND ESG (EUR) (T) | -4.859 | 0.016 | * | 0.337 | 0 | 0.582 |
| CIF-ESG EMERGING MARKETS FUND A EUR | -5.642 | 0.161 | | 0.664 | 0 | 0.571 |
| OFI INV ESG PRUDENT EUR OFI INV ESG PRUDENT | -5.002 | 0.001 | *** | 0.276 | 0 | 0.647 |
| AAF GLOBAL ESG EQS E EUR CAP | 0.705 | 0.762 | | 0.748 | 0 | 0.833 |
| ACOMEA PMITALIA ESG A2 | -8.292 | 0.151 | | 0.809 | 0 | 0.49 |
| ALLIANZ INVEST ESG RENTEN EURO (A) | -3.919 | 0.001 | *** | 0.084 | 0 | 0.214 |
| DEKA-ESG AKTIEN CF(A) | -0.554 | 0.827 | | 0.715 | 0 | 0.795 |
| DWS ESG CONVERTIBLES FC | -4.5 | 0.006 | ** | 0.379 | 0 | 0.736 |
| DWS ESG ZINSEINKOMMEN LD | -4.704 | 0.000 | *** | 0.128 | 0 | 0.338 |
| DWS INVEST ESG EMERGING MARKETS TOP DIV TFD | -7.604 | 0.048 | * | 0.552 | 0 | 0.505 |
| GUTMANN ESG EQUITIES (T1) | 0.307 | 0.908 | | 0.685 | 0 | 0.764 |
| KATHREIN ESG GLOBAL EQUITY R T | -0.329 | 0.883 | | 0.739 | 0 | 0.84 |
| KCD-UNION ESG AKTIEN I | -3.905 | 0.052 | . | 0.644 | 0 | 0.836 |
| ALLIANZ EURO CREDIT SRI I (EUR) | -6.015 | 0.005 | ** | 0.298 | 0 | 0.493 |
| DNCA INVEST SRI EUROPE GROWTH I | -3.71 | 0.283 | | 0.757 | 0 | 0.701 |
| ECUREUIL SRI OBLI EURO C | -5.19 | 0.007 | ** | 0.169 | 0 | 0.283 |
| FORTIS SRI FUTUREVISION SUSP - UNSUPPORTED | -2.367 | 0.414 | | 0.364 | 0 | 0.434 |
| GENERALI IS - SRI AGEING POPULATION AX | -3.907 | 0.162 | | 0.691 | 0 | 0.749 |
| HSBC RIF SRI EUROLAND EQUITY I | -5.125 | 0.175 | | 0.745 | 0 | 0.656 |
| IQAM SRI SPAR TRUST M (AA) | -4.638 | 0.000 | *** | 0.074 | 0.0003 | 0.147 |
| KBC EQ.SRI MIN VNCE. CLC.SHRS WTH.CAP | -1.374 | 0.626 | | 0.347 | 0 | 0.424 |
| LAZARD EQUITY SRI PD EUR | -5.394 | 0.180 | | 0.777 | 0 | 0.646 |
| QUADRATOR SRI ID DEAD - Merged:2918AG | -11.173 | 0.002 | ** | 0.846 | 0 | 0.743 |
| STATE ST SRI EUR CORP BD IDX A2 EUR DIS | -5.196 | 0.005 | ** | 0.23 | 0 | 0.437 |

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|---|---|---|---|---|---|---|
| **VANGD.SRI FTSE DVLPWLD II INST B EUR** | 1.788 | 0.374 | | 0.773 | 0 | 0.878 |
| **ALLIANZ EURO CREDIT SRI IT (EUR)** | -4.403 | 0.039 | * | 0.291 | 0 | 0.48 |
| **AMUNDI INDEX EURO CORPORATE SRI - OE (C)** | -5.055 | 0.004 | ** | 0.193 | 0 | 0.387 |
| **GREAT EUROPEAN MODELS SRI IPC** | -6.673 | 0.032 | * | 0.844 | 0 | 0.786 |
| **HSBC RESP INVSTMT FUNDS SRI EUR BD AD** | -6.013 | 0.003 | ** | 0.178 | 0 | 0.29 |
| **MM WORLD EQUITY INDEX SRI FUND A EUR ACC** | 2.348 | 0.308 | | 0.772 | 0 | 0.845 |
| **AMUNDI IDX MSCI PAC EX JPN SRI-A3E (A)** | -4.061 | 0.319 | | 0.44 | 0 | 0.362 |
| **AMUNDI MSCI PAC EX JPN SRI CL PAR ALG IE A** | -6.007 | 0.156 | | 0.727 | 0 | 0.592 |
| **ASR FONDS SRI MEERWAARDE AANDELENFOND** | -1.517 | 0.558 | | 0.312 | 0 | 0.414 |
| **CANDRIAM SRI EQUITY WORLD - V EUR CAP** | -14.753 | 0.322 | | 0.274 | 0.251 | 0.016 |
| **DNCA INVEST - SRI NORDEN EUROPE A EUR** | -2.094 | 0.550 | | 0.838 | 0 | 0.735 |
| **ALLIANZ EUROPE EQUITY SRI AT-EUR** | -5.696 | 0.062 | . | 0.728 | 0 | 0.738 |
| **BEST BUSINESS MODELS SRI RC** | -6.347 | 0.057 | . | 0.797 | 0 | 0.739 |
| **BNPP EASY MSCI WORLD SRI PAB TP HEUR C** | -3.038 | 0.047 | * | 0.875 | 0 | 0.942 |
| **DPAM L EQUITIES EMU SRI MSCI INDEX B EUR CAP** | -3.456 | 0.352 | | 0.829 | 0 | 0.708 |
| **ECHIQUIER SMID BLEND EURO SRI I** | -7.962 | 0.058 | . | 0.815 | 0 | 0.651 |
| **CPR EUROPE ESG - I (C)** | -2.967 | 0.342 | | 0.687 | 0 | 0.702 |
| **LUX IM ESG SYCOMORE EUROPEAN EQ C CAP EUR** | -11.522 | 0.001 | *** | 0.593 | 0 | 0.614 |
| **NATIXIS ESG PEA** | -6.038 | 0.013 | * | 0.611 | 0 | 0.76 |
| **UNI ESG AKTIEN GLOBAL** | 0.235 | 0.906 | | 0.722 | 0 | 0.864 |
| **ROBECO SUSTAINABLE WATER D EUR** | -1.343 | 0.671 | | 0.839 | 0 | 0.773 |
| **MIRAE ASSET ESG ASIA SECTOR LDR EQ A EUR** | -3.688 | 0.448 | | 0.529 | 0 | 0.365 |
| **PAX ESG GLOBAL FONDS R** | -5.367 | 0.001 | *** | 0.275 | 0 | 0.6 |
| **AIM LUX C-QUADRAT EUROPE MULTICAP ESG B** | -8.733 | 0.012 | * | 0.888 | 0 | 0.765 |
| **AMUNDI MSCI JPN ESG BRD TRANSITION IE A** | -1.793 | 0.619 | | 0.513 | 0 | 0.495 |
| **APOLLO AKTIEN GLOBAL ESG T** | -3.582 | 0.192 | | 0.776 | 0 | 0.797 |
| **Pictet Q** | 12.059 | 0.035 | * | -0.032 | 0.716 | 0.002 |
| **Pictet Global** | 10.233 | 0.126 | | -0.025 | 0.812 | 0.001 |
| **UBS EQ** | 12.879 | 0.047 | * | -0.1 | 0.322 | 0.013 |

| | | | | | |
|---|---|---|---|---|---|
| **Aallianz Glbl S** | 6.853 | 0.223 | 0.136 | 0.130 | 0.029 |
| **Ishares** | 7.019 | 0.334 | 0.015 | 0.899 | 0 |
| **Amundi ETF** | 5.806 | 0.266 | 0.02 | 0.805 | 0.001 |
| **AMU Stox 600 Industrial UCITS Etf acc** | 9.239 | 0.280 | 0.024 | 0.862 | 0 |

**Appendix 3: Fama and French 3 Factor regression of All Funds**

| Fund | Alpha_Annual | t_Alpha | Alpha_p | | R2 |
|---|---|---|---|---|---|
| **SCOR FUNDS-ESG EURO SHRT TERM DUR HGH YLD IC EUR** | -1.436 | -1.302 | 0.197 | | 0.574 |
| **APOLLO HIGH YIELD BOND ESG (EUR) (T)** | -4.454 | -2.277 | 0.025 | * | 0.608 |
| **CIF-ESG EMERGING MARKETS FUND A EUR** | -4.658 | -1.185 | 0.239 | | 0.601 |
| **OFI INV ESG PRUDENT EUR OFI INV ESG PRUDENT** | -4.831 | -3.448 | 0.001 | *** | 0.667 |
| **AAF GLOBAL ESG EQS E EUR CAP** | 0.836 | 0.355 | 0.723 | | 0.835 |
| **ACOMEA PMITALIA ESG A2** | -6.426 | -1.247 | 0.216 | | 0.603 |
| **ALLIANZ INVEST ESG RENTEN EURO (A)** | -3.833 | -3.387 | 0.001 | ** | 0.218 |
| **DEKA-ESG AKTIEN CF(A)** | -0.601 | -0.235 | 0.815 | | 0.797 |
| **DWS ESG CONVERTIBLES FC** | -4.132 | -2.684 | 0.009 | ** | 0.759 |
| **DWS ESG ZINSEINKOMMEN LD** | -4.544 | -3.629 | 0.001 | *** | 0.361 |
| **DWS INVEST ESG EMERGING MARKETS TOP DIV TFD** | -6.332 | -1.745 | 0.085 | . | 0.565 |
| **GUTMANN ESG EQUITIES (T1)** | 0.219 | 0.083 | 0.934 | | 0.776 |
| **KATHREIN ESG GLOBAL EQUITY R T** | -0.373 | -0.166 | 0.869 | | 0.845 |
| **KCD-UNION ESG AKTIEN I** | -3.853 | -1.911 | 0.060 | . | 0.837 |
| **ALLIANZ EURO CREDIT SRI I (EUR)** | -6.039 | -2.84 | 0.006 | ** | 0.498 |
| **DNCA INVEST SRI EUROPE GROWTH I** | -3.968 | -1.165 | 0.248 | | 0.717 |
| **ECUREUIL SRI OBLI EURO C** | -5.205 | -2.744 | 0.008 | ** | 0.287 |
| **FORTIS SRI FUTUREVISION SUSP - UNSUPPORTED** | -1.781 | -0.62 | 0.537 | | 0.459 |
| **GENERALI IS - SRI AGEING POPULATION AX** | -3.917 | -1.409 | 0.163 | | 0.758 |
| **HSBC RIF SRI EUROLAND EQUITY I** | -4.199 | -1.231 | 0.222 | | 0.726 |
| **IQAM SRI SPAR TRUST M (AA)** | -4.565 | -3.608 | 0.001 | *** | 0.15 |
| **KBC EQ.SRI MIN VNCE. CLC.SHRS WTH.CAP** | -1.207 | -0.43 | 0.668 | | 0.447 |
| **LAZARD EQUITY SRI PD EUR** | -4.634 | -1.276 | 0.206 | | 0.718 |
| **QUADRATOR SRI ID DEAD - Merged:2918AG** | -10.135 | -2.985 | 0.004 | ** | 0.761 |
| **STATE ST SRI EUR CORP BD IDX A2 EUR DIS** | -5.114 | -2.768 | 0.007 | ** | 0.438 |

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|---|---|---|---|---|---|
| **VANGD.SRI FTSE DVLPWLD II INST B EUR** | 1.908 | 0.943 | 0.349 | | 0.88 |
| **ALLIANZ EURO CREDIT SRI IT (EUR)** | -4.331 | -2.035 | 0.045 | * | 0.487 |
| **AMUNDI INDEX EURO CORPORATE SRI - OE (C)** | -5.237 | -3.055 | 0.003 | ** | 0.394 |
| **GREAT EUROPEAN MODELS SRI IPC** | -7.057 | -2.302 | 0.024 | * | 0.793 |
| **HSBC RESP INVSTMT FUNDS SRI EUR BD AD** | -6.102 | -3.115 | 0.003 | ** | 0.3 |
| **MM WORLD EQUITY INDEX SRI FUND A EUR ACC** | 2.378 | 1.02 | 0.311 | | 0.846 |
| **AMUNDI IDX MSCI PAC EX JPN SRI-A3E (A)** | -2.896 | -0.743 | 0.460 | | 0.433 |
| **AMUNDI MSCI PAC EX JPN SRI CL PAR ALG IE A** | -4.487 | -1.12 | 0.266 | | 0.642 |
| **ASR FONDS SRI MEERWAARDE AANDELENFOND** | -0.889 | -0.347 | 0.730 | | 0.443 |
| **CANDRIAM SRI EQUITY WORLD - V EUR CAP** | -14.461 | -0.971 | 0.334 | | 0.046 |
| **DNCA INVEST - SRI NORDEN EUROPE A EUR** | -2.756 | -0.806 | 0.423 | | 0.756 |
| **ALLIANZ EUROPE EQUITY SRI AT-EUR** | -5.45 | -1.899 | 0.061 | . | 0.771 |
| **BEST BUSINESS MODELS SRI RC** | -6.154 | -1.864 | 0.066 | . | 0.747 |
| **BNPP EASY MSCI WORLD SRI PAB TP HEUR C** | -3.049 | -1.988 | 0.050 | . | 0.942 |
| **DPAM L EQUITIES EMU SRI MSCI INDEX B EUR CAP** | -3.599 | -0.966 | 0.337 | | 0.714 |
| **ECHIQUIER SMID BLEND EURO SRI I** | -6.584 | -1.69 | 0.095 | . | 0.703 |
| **CPR EUROPE ESG - I (C)** | -2.455 | -0.861 | 0.392 | | 0.759 |
| **LUX IM ESG SYCOMORE EUROPEAN EQ C CAP EUR** | -11.261 | -3.41 | 0.001 | ** | 0.621 |
| **NATIXIS ESG PEA** | -5.772 | -2.46 | 0.016 | * | 0.776 |
| **UNI ESG AKTIEN GLOBAL** | 0.032 | 0.016 | 0.988 | | 0.865 |
| **ROBECO SUSTAINABLE WATER D EUR** | -0.268 | -0.087 | 0.931 | | 0.793 |
| **MIRAE ASSET ESG ASIA SECTOR LDR EQ A EUR** | -2.534 | -0.524 | 0.602 | | 0.393 |
| **PAX ESG GLOBAL FONDS R** | -5.573 | -3.548 | 0.001 | *** | 0.609 |
| **AIM LUX C-QUADRAT EUROPE MULTICAP ESG B** | -7.94 | -2.327 | 0.023 | * | 0.775 |
| **AMUNDI MSCI JPN ESG BRD TRANSITION IE A** | -0.927 | -0.258 | 0.797 | | 0.517 |
| **APOLLO AKTIEN GLOBAL ESG T** | -2.623 | -1.021 | 0.310 | | 0.826 |
| **Pictet Q** | 12.526 | 2.224 | 0.029 | * | 0.049 |
| **Pictet Global** | 10.502 | 1.582 | 0.118 | | 0.041 |
| **UBS EQ** | 13.363 | 2.071 | 0.042 | * | 0.042 |
| **Aallianz Glbl S** | 6.109 | 1.082 | 0.283 | | 0.044 |

| | | | | |
|---|---|---|---|---|
| **Ishares** | 6.699 | 0.916 | 0.363 | 0.012 |
| **Amundi ETF** | 6.006 | 1.139 | 0.258 | 0.007 |
| **AMU Stox 600  Industrial UCITS Etf acc** | 10.016 | 1.167 | 0.247 | 0.015 |

**Appendix 4: Fama and French Factor regression of All Funds**

| Fund | Alpha_Annual | t_Alpha | Alpha_p | | R2 |
|---|---|---|---|---|---|
| SCOR FUNDS-ESG EURO SHRT TERM DUR HGH YLD IC EUR | -1.542 | -1.363 | 0.177 | | 0.581 |
| APOLLO HIGH YIELD BOND ESG (EUR) (T) | -4.274 | -2.126 | 0.037 | * | 0.613 |
| CIF-ESG EMERGING MARKETS FUND A EUR | -3.745 | -0.931 | 0.355 | | 0.609 |
| OFI INV ESG PRUDENT EUR OFI INV ESG PRUDENT | -5.159 | -3.668 | 0.000 | *** | 0.686 |
| AAF GLOBAL ESG EQS E EUR CAP | 0.433 | 0.181 | 0.857 | | 0.842 |
| ACOMEA PMITALIA ESG A2 | -7.965 | -1.515 | 0.134 | | 0.614 |
| ALLIANZ INVEST ESG RENTEN EURO (A) | -3.974 | -3.521 | 0.001 | *** | 0.274 |
| DEKA-ESG AKTIEN CF(A) | -0.399 | -0.151 | 0.880 | | 0.798 |
| DWS ESG CONVERTIBLES FC | -3.781 | -2.431 | 0.017 | * | 0.77 |
| DWS ESG ZINSEINKOMMEN LD | -4.335 | -3.392 | 0.001 | ** | 0.378 |
| DWS INVEST ESG EMERGING MARKETS TOP DIV TFD | -5.506 | -1.479 | 0.143 | | 0.572 |
| GUTMANN ESG EQUITIES (T1) | -0.077 | -0.028 | 0.977 | | 0.777 |
| KATHREIN ESG GLOBAL EQUITY R T | -0.83 | -0.36 | 0.720 | | 0.848 |
| KCD-UNION ESG AKTIEN I | -4.093 | -1.983 | 0.051 | . | 0.84 |
| ALLIANZ EURO CREDIT SRI I (EUR) | -5.91 | -2.743 | 0.008 | ** | 0.519 |
| DNCA INVEST SRI EUROPE GROWTH I | -5.547 | -1.638 | 0.106 | | 0.739 |
| ECUREUIL SRI OBLI EURO C | -5.413 | -2.82 | 0.006 | ** | 0.318 |
| FORTIS SRI FUTUREVISION SUSP - UNSUPPORTED | -2.222 | -0.751 | 0.455 | | 0.465 |
| GENERALI IS - SRI AGEING POPULATION AX | -5.129 | -1.836 | 0.070 | . | 0.772 |
| HSBC RIF SRI EUROLAND EQUITY I | -5.277 | -1.518 | 0.133 | | 0.734 |
| IQAM SRI SPAR TRUST M (AA) | -4.698 | -3.596 | 0.001 | *** | 0.153 |
| KBC EQ.SRI MIN VNCE. CLC.SHRS WTH.CAP | -2.577 | -0.925 | 0.358 | | 0.491 |
| LAZARD EQUITY SRI PD EUR | -5.725 | -1.549 | 0.126 | | 0.728 |
| QUADRATOR SRI ID DEAD - Merged:2918AG | -11.365 | -3.314 | 0.001 | ** | 0.772 |
| STATE ST SRI EUR CORP BD IDX A2 EUR DIS | -5.185 | -2.806 | 0.006 | ** | 0.475 |

| | | | | | |
|---|---|---|---|---|---|
| **VANGD.SRI FTSE DVLPWLD II INST B EUR** | 1.982 | 0.967 | 0.337 | | 0.885 |
| **ALLIANZ EURO CREDIT SRI IT (EUR)** | -4.257 | -1.963 | 0.053 | . | 0.502 |
| **AMUNDI INDEX EURO CORPORATE SRI - OE (C)** | -5.627 | -3.303 | 0.001 | ** | 0.441 |
| **GREAT EUROPEAN MODELS SRI IPC** | -8.079 | -2.619 | 0.011 | * | 0.804 |
| **HSBC RESP INVSTMT FUNDS SRI EUR BD AD** | -6.154 | -3.073 | 0.003 | ** | 0.317 |
| **MM WORLD EQUITY INDEX SRI FUND A EUR ACC** | 2.209 | 0.925 | 0.358 | | 0.849 |
| **AMUNDI IDX MSCI PAC EX JPN SRI-A3E (A)** | -3.674 | -0.921 | 0.360 | | 0.445 |
| **AMUNDI MSCI PAC EX JPN SRI CL PAR ALG IE A** | -5.378 | -1.315 | 0.192 | | 0.652 |
| **ASR FONDS SRI MEERWAARDE AANDELENFOND** | -1.23 | -0.464 | 0.644 | | 0.445 |
| **CANDRIAM SRI EQUITY WORLD - V EUR CAP** | -13.602 | -0.898 | 0.372 | | 0.079 |
| **DNCA INVEST - SRI NORDEN EUROPE A EUR** | -3.947 | -1.143 | 0.257 | | 0.768 |
| **ALLIANZ EUROPE EQUITY SRI AT-EUR** | -6.019 | -2.039 | 0.045 | * | 0.774 |
| **BEST BUSINESS MODELS SRI RC** | -7.521 | -2.271 | 0.026 | * | 0.763 |
| **BNPP EASY MSCI WORLD SRI PAB TP HEUR C** | -4.04 | -2.757 | 0.007 | ** | 0.951 |
| **DPAM L EQUITIES EMU SRI MSCI INDEX B EUR CAP** | -4.754 | -1.252 | 0.214 | | 0.723 |
| **ECHIQUIER SMID BLEND EURO SRI I** | -7.694 | -1.934 | 0.057 | . | 0.711 |
| **CPR EUROPE ESG - I (C)** | -3.734 | -1.307 | 0.195 | | 0.774 |
| **LUX IM ESG SYCOMORE EUROPEAN EQ C CAP EUR** | -12.019 | -3.548 | 0.001 | *** | 0.627 |
| **NATIXIS ESG PEA** | -6.814 | -2.894 | 0.005 | ** | 0.79 |
| **UNI ESG AKTIEN GLOBAL** | -0.034 | -0.017 | 0.987 | | 0.874 |
| **ROBECO SUSTAINABLE WATER D EUR** | -1.72 | -0.578 | 0.565 | | 0.819 |
| **MIRAE ASSET ESG ASIA SECTOR LDR EQ A EUR** | -1.391 | -0.281 | 0.780 | | 0.403 |
| **PAX ESG GLOBAL FONDS R** | -5.606 | -3.451 | 0.001 | *** | 0.61 |
| **AIM LUX C-QUADRAT EUROPE MULTICAP ESG B** | -8.901 | -2.56 | 0.012 | * | 0.781 |
| **AMUNDI MSCI JPN ESG BRD TRANSITION IE A** | -0.584 | -0.158 | 0.875 | | 0.52 |
| **APOLLO AKTIEN GLOBAL ESG T** | -2.37 | -0.896 | 0.373 | | 0.828 |
| **Pictet Q** | 10.893 | 1.905 | 0.061 | . | 0.088 |
| **Pictet Global** | 8.931 | 1.326 | 0.189 | | 0.082 |
| **UBS EQ** | 11.907 | 1.794 | 0.077 | . | 0.057 |
| **Aallianz Glbl S** | 6.443 | 1.119 | 0.267 | | 0.08 |

| | | | | |
|---|---|---|---|---|
| **Ishares** | 4.523 | 0.611 | 0.543 | 0.055 |
| **Amundi ETF** | 5.931 | 1.084 | 0.282 | 0.009 |
| **AMU Stox 600  Industrial UCITS Etf acc** | 8.358 | 0.947 | 0.347 | 0.027 |