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QUANTIFICATION OF SUSTAINABILITY IN ASSET MANAGEMENT: A COMPREHENSIVE STUDY ON ESG PORTFOLIO ALLOCATION

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ABSTRACT

This thesis explores the impact of ESG criteria on investment portfolios through the lens of the Modern Portfolio Theory. Utilizing MSCI indexes, it analyzes various portfolio construction methods, including the Sample Statistics and Exponentially Weighted Moving Average. The findings reveal that ESG portfolios in Global Minimum Variance strategies, present better risk-adjusted returns, consistently delivering a higher Sharpe Ratio with respect to the traditional counterparts. However, traditional portfolios perform better in terms of Sharpe Ratio when the Maximum Sharpe strategy is employed.

Keywords: ESG Integration, Portfolio Allocation, Sustainable Finance, Portfolio Management, ESG Investing, Risk-Adjusted Performance.

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1. INTRODUCTION

"Most stakeholders – from shareholders, to employees, to customers, to communities, and regulators – now expect companies to play a role in decarbonizing the global economy. Few things will impact capital allocation decisions – and thereby the long-term value of your company – more than how effectively you navigate the global energy transition in the years ahead." - Larry Fink, 2022 annual letter to CEOs.

Larry Fink's impactful statement captures a significant transformation in the values of contemporary business, underscoring the necessity for companies to actively play a role in advancing global sustainability objectives. This evolution in corporate expectations extends beyond shareholder value, touching every facet of stakeholder engagement. As businesses navigate a landscape increasingly shaped by environmental, social, and governance (ESG) considerations, the lens through which capital is allocated takes on new significance. The profound impact of these decisions not only impacts within individual companies but also echoes across the broader economic landscape. In the wake of this transformative narrative, this thesis embarks on a comprehensive exploration of portfolio allocation strategies, with a particular focus on integrating ESG criteria. The subsequent chapters explore the complexities of gathering data, analyzing both traditional and ESG indexes, and implementing the Markowitz Portfolio Theory (MPT).

In a world where stakeholders increasingly demand accountability and responsible business practices, the thesis seeks to explore the intersections of financial strategy and sustainable investing. The MPT and an array of performance measures serve as the compass guiding this exploration. As investors seek to align their portfolios with the imperatives of a rapidly evolving global economy, this thesis aims to provide valuable insights and practical guidance for optimizing portfolios that not only deliver financial returns but also resonate with the values and expectations of today's conscientious stakeholders.

2. LITERATURE REVIEW

At the start of 2020, global sustainable investment reached USD 35.3 trillion in five major markets, a 15% increase in the past two years. Sustainable investment assets under management make up a total of 35.9% of total assets under management (Global Sustainable Investment Alliance, 2020). The concept of sustainable finance represents a paradigm shift: it involves the fusion of financial and ESG data in investment and credit decisions, aiming to minimize risk, maximize risk-adjusted returns, or generate positive social and environmental impacts (Fatemi and Fooladi, 2013). This paradigm acknowledges that sustainable finance goes beyond risk management, becoming a strategic approach for creating long-term value. The evolution of corporate engagement with ESG factors has passed through distinct phases, reflecting changing perspectives on the integration of sustainability into business practices.

In the 2020s, the concept of Full ESG emerged, portraying companies as engines of social and environmental impact. Beyond mere reduction of negative externalities, corporations began actively regenerating, restoring, and repairing. Sustainability became a source of innovation, opening new market opportunities and driving the creation of products and processes aligned with sustainability goals. Notably, the era marked the end of dedicated sustainability departments, reflecting the mainstream integration of ESG considerations into core business functions.

Responsible investment, defined by the integration of ESG factors into investment practices, aimed to enhance risk-adjusted returns without necessarily aligning with normative or ethical perspectives. Sustainable investment, on the other hand, represents the intentional pursuit of sustainability objectives alongside financial goals. Investors selecting assets based on the economic activities and business conduct of investee companies demonstrated a commitment to positive societal and environmental impacts.

Recent studies, including Whelan et al. (2021), underlined a positive relationship between ESG factors and financial performance. Analyzing evidence from over 1,000 studies between 2015-2020, they report a majority of corporate studies (58%) finding a positive correlation between ESG and operational metrics. Investment studies (59%) demonstrate similar or better performance relative to conventional approaches.

Investor's interest in ESG investing, as explained by Broadstock et al. (2021), is driven by both ethical considerations and the potential to enhance portfolio performance, increase returns, and reduce risk. The literature reflects divergent views on the relationship between ESG measures and stock returns. Some studies suggest a negative correlation between ESG considerations and stock returns. For instance, Hong and Kacperczyk (2009) found that excluding companies involved in tobacco, alcohol, or gaming industries, known as "sin stocks," led to lower financial returns. Renneboog, ter Horst, and Zhang (2008) demonstrated that pursuing social or ethical objectives in investment decisions might result in lower financial performance. Galema, Plantinga, and Scholtens (2008) and Halbritter and Dorfleitner (2015) found no evidence for abnormal risk-adjusted returns based on ESG factors in the US market. Studies such as those by Statman and Glushkov (2009) and Eccles, Ioannou, and Serafeim (2014) provide evidence supporting the positive relationship between high ESG scores and abnormal excess returns. However, the direction and extent of this relationship remain a subject of ongoing debate. The esearch also delves into specific ESG factors, such as environmental actions and emissions, showcasing varied impacts on stock returns.

ESG integration in the investment management process, discussed by Van Duuren, Plantinga, and Scholtens (2015), explores the potential of ESG information to positively influence financial performance. This integration, driven by a systematic process, aims to identify, assess, monitor, and respond to ESG-related risks, enhancing risk-adjusted returns. As can be seen in the existing literature, the research on sustainable finance is young and there is a lot

of movement in the field. This research tries to fill some existing gaps in the literature and tries to proof existing claims or even contradicting facts, which might steer future discussions into different directions. The literature on sustainable finance is relatively new, and there is considerable dynamism within the field. This study aims to fill gaps in our current understanding, working to support existing ideas or question established facts. In doing so, it hopes to actively contribute to ongoing conversations and shape future discussions in new and insightful directions.

3. RESEARCH QUESTION

The main purpose of this work is to examine the impact of ESG criteria on investment portfolios. Anchored in Markowitz Portfolio Theory, the study explores how the integration of ESG criteria influences risk and return dynamics. The efficient frontier concept is employed to identify portfolios optimizing returns for a given level of risk or minimizing risk for a given level of expected returns. Moreover, through the Fama-French 5 Factor Model, it will be possible to get insights on which type of risks the constructed portfolios are exposed to.

How does the integration of ESG criteria impact the risk-return profile of investment portfolios, as assessed through Markowitz Portfolio Theory, considering both Traditional and ESG indexes?

Furthermore, how do different portfolio construction methods, such as Sample Statistics and Exponentially Weighted Moving Average (EWMA), influence the performance and efficiency of Traditional and ESG portfolios under various investment strategies, including Short Selling and No Short Selling scenarios?

4. DATA AND METHODOLOGY

This section illustrates how data has been collected for the creation of the portfolios analyzed. The indexes object of analysis were retrieved from the MSCI platform where all Traditional and ESG indexes' performance are stored. Traditional indexes comprise the mid and large-cap segments of the market, encompassing 85% of the free-float-adjusted market capitalization within the respective countries under consideration. The Traditional indexes taken into account for this analysis are:

I. MSCI USA Index: it contains only US companies, and it is composed of 626 constituents.

II. MSCI EAFE Index: it is an equity index which captures companies from 21 Developed Market countries around the world with the exception of the USA and Canada. It is composed of 797 constituents.

III. MSCI EMERGING MARKETS Index: it contains companies from across 24 Emerging Markets countries and it has 1427 constituents.

As far as ESG indexes are concerned, they are free float-adjusted market capitalization-weighted indexes to represent the performance of companies that are selected from an underlying index based on ESG criteria. These indexes aim at a 50% coverage of the free float-adjusted market capitalization coverage of each Global Industry Classification Standard (GICS) sector of the regional Parent Index by selecting constituents primarily based on criteria including the ESG rating, the trend in that rating and the company's industry-adjusted ESG score. Ideal for individuals and investors in search of a comprehensive and diversified sustainability benchmark, these indexes offer a low tracking error to the underlying stock market. The companies featured in these indexes are primarily large and mid-cap, showcasing superior ESG performance relative to their peers.

I. MSCI USA ESG LEADERS Index: It represents the performance of companies that are selected from the parent index MSCI USA Index based on ESG criteria. It contains companies only from the US market.

II. MSCI EAFE ESG LEADERS Index: it contains data on the performance of companies across Developed Markets countries based on ESG criteria. As for the USA ESG one, the companies are selected from the parent index, namely MSCI EAFE Index.

III. MSCI EMERGING MARKETS ESG Index: it contains the performance of companies selected from the Emerging Market Index based on ESG criteria. The number of countries taken into account by this index is 24.

In order to better compare both the ESG and Traditional indexes, a set of appropriate benchmarks has been selected:

I. ACWI Index: It captures large and mid-capitalization companies across 23 Developed Markets and 24 Emerging Markets countries. This Index has 2948 constituents and covers approximately 85% of the global investable equity opportunity set.

II. ACWI ESG Index: This Index is derived from the parent ACWI Index, and it consists of mid and large cap companies from 23 Developed Market and 24 Emerging Market countries. The index construction targets 50% free float-adjusted market capitalization coverage.

4.1 Markowitz Portfolio Theory

A key problem for an investor is how to organize the assets available in a market into a portfolio. The base of the solution to this problem was introduced by Harry Markowitz in 1952 and it is known as Modern Portfolio Theory (MPT). MPT revolutionized the field of investment by providing a systematic framework for constructing portfolios that aim to maximize expected returns for a given level of risk or, conversely, minimize risk for a given

level of expected returns. At its core, MPT relies on mathematical formulations to analyze the relationship between individual assets within a portfolio.

The efficient frontier is the set of portfolios that maximizes expected return for a given level of risk or minimizes risk for a given level of expected return, providing investors with optimal trade-offs between risk and return.

The construction of the efficient frontier can take two forms: one involves more than one risky asset without the inclusion of a risk-free asset, and the other includes both N risky assets and a risk-free asset R_f.

4.1.2 Efficient Frontier with N risky assets

The expected return $E(R_p)$ of a portfolio comprising *N* risky assets is computed as the weighted sum of the expected returns of individual assets ($E(Ri)$):

$$E(Rp) = \sum_{i=1}^{N} w_i \cdot E(Ri)$$

Here, w_i represents the weight of the i-th asset, and $E(R_i)$ is the expected return of the i-th asset.

The variance σ_p^2 of the portfolio, representing its risk, takes into account both the individual asset variances and their pairwise covariances $Cov(R_i, R_j)$:

$$\sigma_p^2 = \sum_{i=1}^{N} \sum_{j=1}^{N} w_i * w_j * Cov(R_i, R_j)$$

It reflects not only the volatility of individual assets but also how they move in relation to each other.

4.1.3. Efficient Frontier with N risky assets and a risk-free asset

The addition of a risk-free asset introduces a new dimension to portfolio construction, offering investors an asset with a known and fixed rate of return R_f.

The expected return of a portfolio $E(R_p)$ incorporating a risk-free asset is expressed as a weighted combination of the risk-free rate and the expected return of the risky portfolio $E(R_{risky})$:

$$E(R_p) = w_r * R_f + (1 - w_r) * E(R_{risky})$$

This formula allows investors to incorporate a risk-free asset into their portfolios.

The standard deviation σ_p of the portfolio, accounting for the risk-free asset, is calculated by considering the standard deviation of the risky portfolio σ_{risky} and the covariance between the risky portfolio and the risk-free rate:

$$\sigma_p = \sqrt{w_r^2 * 0 + (1 - w_r)^2 + 2 * w_r * (1 - w_r) * Cov(R_{risky}, R_f)}$$

The Capital Market Line (CML) represents the set of optimal portfolios that include the risk-free asset. The optimal weight of risky assets in the portfolio w^*_{risky} is determined by the investor's risk aversion and is given by:

$$w^*_{risky} = \frac{E(R_{risky}) - R_f}{\sigma_{risky}}$$

This formal integration of risk-free assets enhances portfolio optimization by providing investors with the opportunity to achieve a risk-return profile beyond the traditional efficient frontier.

4.2 Methodology

The techniques employed to calculate Markowitz inputs encompass two main approaches:

I. Sample statistics: It computes the moments on the overall dataset;

II. Exponentially Weighted Average Method: In this approach, the initial 15 prices contribute to the computation of moments, and subsequently, each new period includes an additional observation while automatically discarding the oldest one. Unlike a simple rolling window method, EWMA assigns greater weight to recent observations

compared to older ones. The significance of these weights increases with a higher parameter value, emphasizing the importance of recent data. For this analysis, smoothing factors (λ) of 0.90 and 0.99 have been considered.

Below are presented the performance metrics used to assess the risk-adjusted performance of the portfolios:

I. Sharpe Ratio: this metric measures the risk-adjusted performance of an investment by evaluating the excess return per unit of risk. It provides insights into the relationship between investment returns and associated risks.

$$Sharpe\ Ratio: \frac{(R_p - R_f)}{\sigma_p}$$

II. Sortino Ratio: measures the risk-adjusted return, but it focuses on downside risk only, considering the standard deviation of negative returns.

$$Sortino\ Ratio: \frac{(R_p - R_f)}{\sigma_{downside}}$$

III. Treynor Ratio: evaluates the risk-adjusted performance of an investment by considering systematic risk (beta).

$$Treynor\ Ratio: \frac{(R_p - R_f)}{\beta_p}$$

IV. Value-at-Risk: VaR quantifies the maximum potential loss within a specific confidence level over a defined time horizon. It provides an estimate of the worst expected loss under normal market conditions.

$$VaR = R_p - (Z * \sigma_p)$$

V. Expected Shortfall: represents the expected loss in the tail of the distribution beyond the VaR. It provides information about the average loss in extreme scenarios.

$$Expected\ Shortfall = R_p - \frac{1}{N}\sum_{i=1}^{N} R_i$$

VI. Calmar Ratio: assesses the risk-adjusted performance of an investment by comparing the average annual rate of return to the maximum drawdown.

$$Calmar\ Ratio = \frac{R_{average}}{|Max\ Drawdown|}$$

VII. Sterling Ratio: The Sterling Ratio measures the risk-adjusted return of an investment by considering downside risk. It is similar to the Sharpe Ratio but uses semi-deviation, which only considers downside deviation.

$$Sterling\ Ratio = \frac{(R_p - R_f)}{|Average\ N\ largest\ drawdowns|}$$

5. PERFORMANCE ANALYSIS AND RESULTS

The analysis has been carried out using the eight indexes described in the previous chapter. The prices of each index were retrieved from the MSCI website, and all computations were done using Microsoft Excel. The time frame under consideration ranges from September 30th, 2013, to September 29th, 2023, and returns were computed using the logarithmic method. Presented in Table 1 are the descriptive statistics for all eight indexes. Broadly speaking, ESG indexes exhibit higher returns compared to traditional ones, except for the USA index. In terms of standard deviation, ESG indexes generally show lower volatility than their traditional counterparts, except for the Emerging Markets Index. Traditional indexes, on the other hand, display higher skewness and kurtosis, with the exception of the Emerging Markets' kurtosis.

Table 1: Summary statistics of the Traditional and ESG MSCI Indexes.

This table displays the summary statistics of each Index. The Indexes are divided in Traditional, ESG, and Benchmarks. The statistics chosen for the analysis are: Mean, Volatility, Minimum Return, Maximum Return, Skewness, Kurtosis, and Maximum Drawdown. The period of analysis spans from September 2013 to September 2023.

	Return	St. dev	Min	Max	Skew	Kurt	Max DD
USA	9.30%	15.17%	-13.75%	12.24%	-55.47%	95.09%	-71.52%
EAFE	1.11%	14.99%	-14.87%	14.30%	-29.73%	134.27%	-37.09%
EM	-0.36%	17.05%	-16.97%	13.66%	-19.05%	84.69%	-49.62%
USA ESG	9.14%	14.90%	-13.53%	11.61%	-53.76%	77.44%	-72.61%
EAFE ESG	1.40%	14.87%	-13.51%	14.35%	-23.64%	110.82%	-41.63%
EM ESG	1.02%	17.31%	-16.45%	15.55%	-15.68%	94.76%	-66.34%
ACWI	5.42%	14.60%	-14.77%	11.52%	-55.60%	120.58%	-51.26%
ACWI ESG	5.57%	14.36%	-14.19%	10.77%	-54.78%	101.45%	-56.05%

An interesting observation regarding the dataset is given by the correlation, as showed in table 2. Here, correlation is computed between ESG and traditional indexes and with their benchmarks. What immediately stands out is the very high correlation among the indexes with 0.6745 being the lowest value. There is a very high correlation between EAFE and USA indexes both for the traditional and ESG ones. It is also quite evident that the Emerging Markets index has the lowest correlation values both for the traditional and ESG indexes. The correlation coefficients between the benchmarks and the indexes exceed 0.7857. The USA and EAFE, along with their respective ESG counterparts, exhibit higher values, while the emerging markets index, both in the traditional and ESG categories, displays a comparatively lower correlation.

Table 2: Correlation among Traditional and ESG MSCI Indexes.

The table below represent figures of correlation among the Indexes. For each Index, there is the correlation with indices of the same type and their respective counterparts. Additionally, the correlation with the Benchmarks is also presented.

Correlation	*USA*	*EAFE*	*EM*	*ACWI*	*USA ESG*	*EAFE ESG*	*EM ESG*	*ACWI ESG*
USA	1	0.8763	0.7047	0.9751	0.9927	0.8761	0.6809	0.9720
EAFE	0.8763	1	0.8095	0.9532	0.8718	0.9953	0.7699	0.9493
EM	0.7047	0.8095	1	0.8156	0.6964	0.7964	0.9835	0.8130
ACWI	0.9751	0.9532	0.8156	1	0.9684	0.9490	0.7857	0.9963
USA ESG	0.9927	0.8718	0.6964	0.9684	1	0.8733	0.6745	0.9743
EAFE ESG	0.8761	0.9953	0.7964	0.9490	0.8733	1	0.7600	0.9492
EM ESG	0.6809	0.7699	0.9835	0.7857	0.6745	0.7600	1	0.7900
ACWI ESG	0.9720	0.9493	0.8130	0.9963	0.9743	0.9492	0.7900	1

5.1 Sample Statistics Method

Firstly, I decided to use the Sample Statistics method for the computation of the mean and volatility. The two strategies applied are:

I. Fully Invested (sum of Weights = 1) Short Selling Strategy

II. Fully Invested No Short Selling Strategy

The two portfolios under investigation are

I. Traditional portfolio: USA Index, EAFE Index, and Emerging Markets Index

II. ESG Portfolio: USA ESG Index, EAFE ESG Index, and Emerging Markets ESG Index

As far as Traditional moments are concerned, what stands out is the higher performance of the USA Index that has the best mean-returns and the second-best volatility. Despite having a lower volatility with respect to the USA Index, the EAFE one exhibits a significantly inferior mean return. The Emerging Markets Index has a negative mean return and the highest volatility among the indexes. Moving on to the ESG Indexes, the situation remains fairly the same with the USA ESG Index standing out as the top performer, despite having a slightly lower return and a slight improvement in volatility. The EAFE ESG Index improved the mean-return and volatility with the latter being approximately the same as the one of the USA ESG Index. The Emerging Markets ESG shows the highest improvement as far as mean-returns are concerned but its volatility is higher than the Traditional Emerging Markets Index.

The subsequent section shows the analyzed portfolio strategies. In particular, it focuses on the Efficient Frontiers of both Traditional and ESG portfolio in a situation where the capital is fully invested and there is the possibility of Short Selling. The graphical representation of the efficient frontiers are included in the Appendix. Initially, the Traditional Efficient Frontier dominates the ESG one, then across 9% volatility the situation is reversed. However, as volatility keeps on increasing the gap becomes narrower until the two efficient frontiers are aligned. This suggests that, as volatility rises, the performance of the ESG portfolio becomes more competitive with the Traditional portfolio. Concerning the efficient portfolios, the ESG Global Minimum Variance (GMV) one outperforms the Traditional portfolio since for the same level of volatility, the former has a slightly higher expected return. The two Max Sharpe (MS) portfolios are not directly comparable, given that the Traditional portfolio has a higher return but also exhibits slightly higher volatility. The alignment of the two Efficient Frontiers

at higher volatility levels indicates that, under certain market conditions, the ESG portfolio can be as efficient as the Traditional portfolio. This may reflect the changing dynamics of the market, where ESG considerations become more influential.

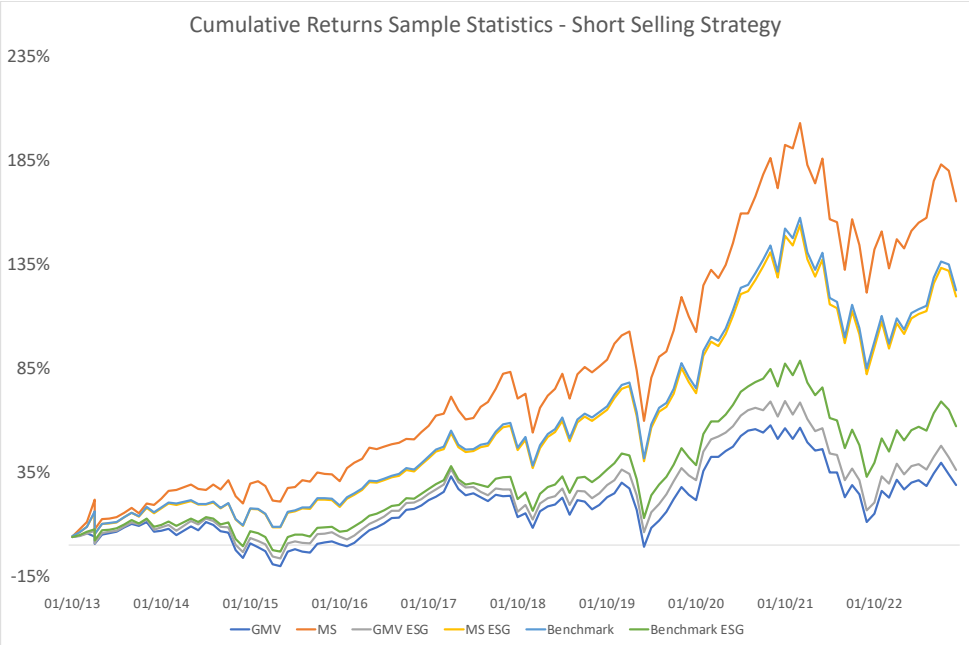
Analyzing now the Efficient Frontiers in a situation where the capital is fully invested, and Short Selling is not allowed, the situation is fairly similar to the previous strategy, namely the ESG GMV sightly dominates over the Traditional GMV portfolio. The two Max Sharpe (MS) portfolios are not directly comparable, as the Traditional portfolio has a superior return compared to the ESG portfolio, but concurrently, the Traditional one exhibits higher volatility. This reinforces the notion that investors need to carefully consider the tradeoff between risk and return, especially in scenarios where Short Selling is not allowed. For risk-averse investors who are restricted from Short Selling, the ESG GMV portfolio could be an attractive option, providing a balance between risk reduction and return generation.

In the upcoming part, the cumulative returns over the entire time horizon are presented, highlighting strategies involving both Short Selling and those without Short Selling. Shifting the focus on the Short Selling strategy, in terms of GMV portfolios, the ESG GMV slightly outperforms the Traditional portfolio, and the difference between the two remains constant as we move forward in time. As for the MS portfolios instead, the Traditional MS portfolio clearly outperforms the ESG MS one across the whole time horizon. This may suggest that sometimes ESG factors can act as constraints, limiting the universe of eligible assets for the portfolio. Moreover, this outperformance may be due to a difference in investment focus. The Traditional MS portfolio include a higher concentration of investments in high-emissions companies which are more likely to be targeted by short-selling strategies (Zhang, 2002). When comparing the performance of each portfolios with respect to the benchmarks it can be seen that both the Traditional and ESG benchmarks outperform the GMV portfolios. As for

the MS portfolios instead, the Traditional MS outperforms all benchmarks while the ESG MS outperforms only the ESG benchmark.

Figure 1 - Cumulative Returns of the Sample Statistics Method with Short Selling Allowed

The graph displays the cumulative returns for the four portfolios and the two benchmarks over the time period September 2013 – September 2023 using the Sample Statistics method and without allowing Short Selling.. The Maximum Sharpe Portfolio (orange line) clearly displays the better performance across the whole time period.



As for the cumulative returns of the No Short Selling strategy, the GMV portfolios performances remain fairly the same with a slight overperformance of the ESG GMV portfolio. A different scenario can be seen when looking at the MS portfolios that now have very similar performances in line with the one of the Traditional benchmark. The convergence of Traditional and ESG MS portfolios, mirroring the performance of the Traditional benchmark, suggests that in this specific scenario, the tradeoff between maximizing the Sharpe ratio and adhering to ESG criteria is less pronounced compared to the Short Selling strategy.

Figure 2 - Cumulative Returns of the Sample Statistics Method with No Short Selling Allowed

The graph displays the cumulative returns for the four portfolios and the two benchmarks over the time period September 2013 – September 2023 using the sample statistics method and without allowing Short Selling. The Traditional and ESG MS Portfolios along with the Traditional Benchmark Index clearly displays the better performance across the whole time horizon.

5.2 Empirical Weighted Moving Average (EMWA)

In this paragraph has been used the EWMA method for the computation of the inputs. The EWMA are:

I. EWMA, with $\lambda = 0.90$

II. EWMA, with $\lambda = 0.99$

Similar to the preceding method, the two implemented strategies applied are a Fully Invested one with No Short Selling and one where Short Selling is Allowed. Initially, returns are calculated for each of the EWMA rolling windows, resulting in 106 returns for each index. Subsequently, the overall mean and variance are computed based on this dataset, encompassing the 106 returns. With an EWMA of 0.90 we have similar situation with respect to the one of the Sample Statistics. As for mean returns, there is small improvement in volatility and a worse performance for the USA Index. Both the EAFE and Emerging Markets Indexes improved both the performance and the volatility of their respective indexes.

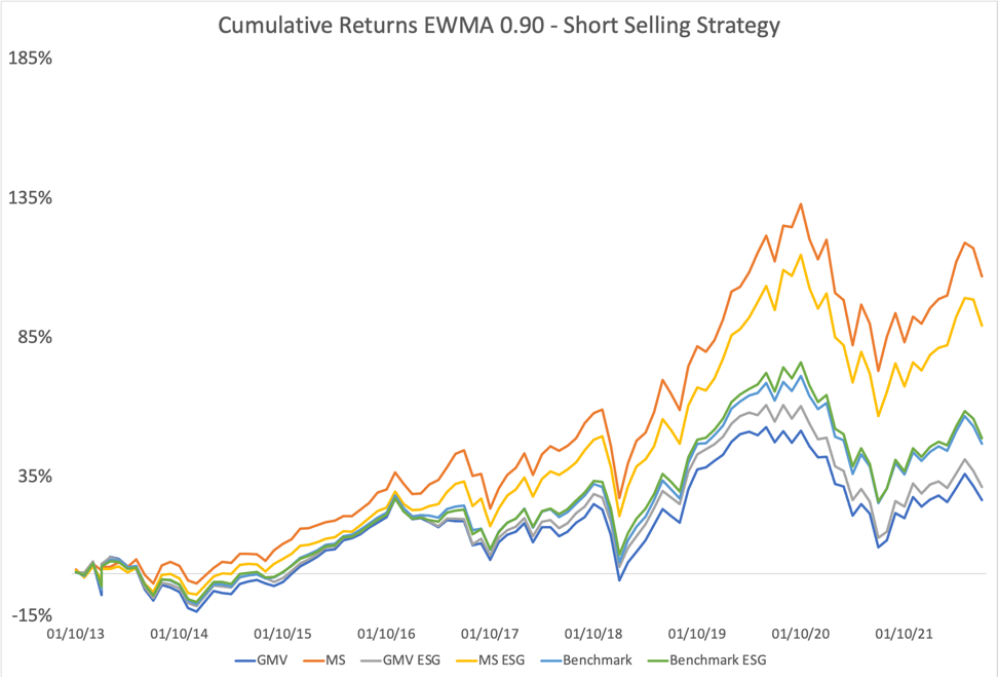
As in the Sample Statistics method, ESG returns are higher than the traditional ones with the USA Index being the only exception. Moreover, when comparing it with the ESG Sample Statistics we can see the same trend as the traditional portfolio, namely a worse return and improved volatility for the USA and a better performance and volatility of the EAFE and Emerging Markets Indexes. The consistency in trends between traditional and ESG portfolios, even under the EWMA method, indicates that ESG criteria influence risk and return dynamics similarly to the overall market trends. The ESG indexes consistently show improvements in volatility, emphasizing the role of ESG criteria in risk mitigation. This aligns with the broader goal of sustainable and responsible investing.

Similar to the earlier approach, this section centers on the interpretation of the Efficient Frontiers, whose graphical representations are included in the Appendix. At first, the Efficient Frontier of a fully invested strategy with an EWMA of 0.90 allowing the option of Short Selling is going to be analyzed. Initially the Traditional portfolio dominates the ESG one and then the latter becomes the one more shifted to the left. In terms of GMV portfolios, the ESG one has both a higher return and a lower volatility, implying that it dominates the Traditional portfolio. However, as far as the MS portfolios are concerned, there is not a superior performance by either the Traditional or the ESG one. As for the Efficient Frontier of a fully invested strategy with an EWMA of 0.90 and No Short Selling allowed, since the weights of the GMV are fairly similar, both GMV portfolios are similar to those of the Short Selling strategy with the ESG GMV that dominates on the Traditional GMV. As for the MS portfolios, the difference between the two is reduced with respect to the previous strategy and the ESG MS has a slightly higher Sharpe Ratio. The reduction in the difference between Traditional and ESG MS portfolios without Short Selling indicates that the constraints on Short Selling influence the performance dynamics, potentially making the two strategies more comparable.

Figure 3 depicts the cumulative returns in case of Short Selling strategy. Here, the Traditional MS portfolio dominates on its ESG counterpart but with a lower difference than the Sample Statistics Short Selling case, while the ESG GMV slightly outperforms the Traditional GMV. A possible reason could be that If there is a trend towards greater investor interest in ESG assets, the EWMA method may give more weight to recent periods where ESG assets performed well. Moreover, the empirical nature of EWMA might implicitly account for the impact of short selling constraints. If the EWMA method adapts to changing market conditions and constraints, it could lead to a more nuanced portfolio construction, potentially benefiting the ESG portfolio. What is interesting to see is the difference between this method and the sample statistics one. In fact, when applying a 0.90 EWMA the ESG benchmark has very similar performance with respect to the Traditional one, with a slight overperformance during 2020.

Figure 3 - Cumulative Returns EWMA 0.90 with Short Selling Allowed

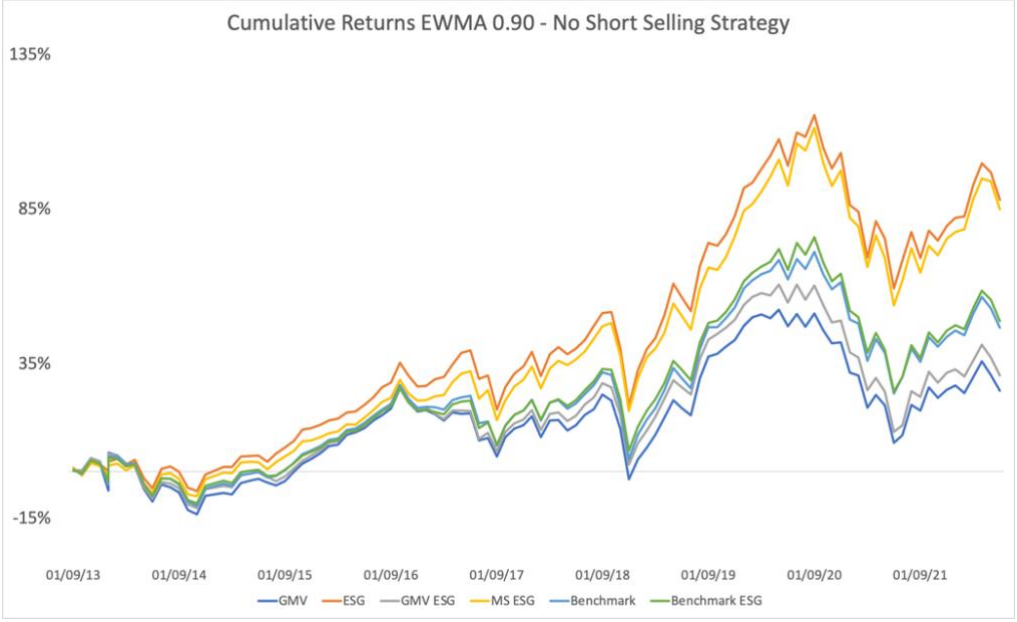
The graph displays the cumulative returns for the four portfolios and the two benchmarks over the time period September 2013 – September 2023 using the EWMA method and allowing Short Selling. Here, the two MS portfolios still present the highest cumulative returns as expected, but their performance is now more similar with respect to the Sample Statistics Method.



In Figure 4, the one where we apply the No Short Selling constraint we have a similar behavior of the MS portfolios with respect to the sample statistics method. In fact, it is no more possible to determine which portfolio clearly outperforms the other, though the MS remains the dominant one in some periods across the time horizon.

Figure 4 - Cumulative Returns EWMA 0.90 with No Short Selling Allowed

The graph displays the cumulative returns for the four portfolios and the two benchmarks over the time period September 2013 – September 2023 using the EWMA 0.90 method and without allowing Short Selling. The two MS portfolios have now almost similar performances, especially during the Covid-19 period.



With an EWMA of 0.99, overall mean returns worsened for all three traditional indexes. Moreover, this trend can also be seen in the volatility values. The same applies to the ESG indexes for both returns and volatilities. The overall worsening of mean returns for both traditional and ESG indexes under the EWMA of 0.99 suggests that the weighting scheme is assigning more significance to recent data, potentially reflecting a trend of lower returns in recent periods. Equivalently, the worsening trend in volatility could be indicative of higher uncertainty in asset prices.

As for the Efficient Frontiers of both portfolios with the EWMA 0.99 in a situation where the capital is fully invested and there is the possibility of Short Selling, the Traditional Efficient Frontier is shifted towards the left and at around 9.30% volatility the ESG Efficient Frontier becomes the dominating one. As in the previous cases, the ESG GMV dominates the Traditional GMV, while this conclusion cannot be made for the MS case since the ESG MS has a lower volatility but a lower return.

With an EWMA of 0.99, the GMV portfolios of the no Short Selling strategy are very similar with respect to the previous one since the wights are fairly the same. However, with the no Short Selling constraint, the ESG MS portfolio has a higher Sharpe Ratio with respect to the Traditional MS one. As far as cumulative returns are concerned, the returns and conclusions obtained with this method are the same as the ones of the EWMA 0.90's approach. All the relevant graphical representations are included in the Appendix.

5.3 Performance measures

In conclusion of this section the computations of the relevant performance measures are presented in Table 3. The Traditional MS portfolio clearly shows a better risk-adjusted performance with respect to the ESG MS portfolio in all methods. The only exceptions concern the Calmar Ratio, where all MS Short Selling strategies measures are slightly lower with respect to the ESG counterparts. This ratio, which considers risk-adjusted performance over maximum drawdown, shows a potential area where ESG portfolios exhibit slightly better risk-adjusted returns during drawdown periods. When examining the GMV portfolios, it is evident that all portfolios achieve very similar results, aligning with the cumulative returns and Efficient Frontiers. Notably, the ESG GMV demonstrates superior risk-adjusted performance across all strategies. Comparing results obtained with EWMA methods to the Sample Statistics, the reduction in Traditional MS portfolios' overperformance indicates a

potential impact of the choice of smoothing parameters on risk and return metrics. According to the GMV portfolios instead, the ESG GMV overperformance for the sample statistics becomes an ESG GMV overperformance for the EWMA 0.90 method and the EWMA 0.99 with no Short Selling allowed, with the Short Selling EWMA 0.99 being the only exception. The exception in the Short Selling EWMA 0.99 scenario, where ESG GMV does not outperform, highlights the sensitivity of results to different constraints and methodologies. It may suggest that, under certain conditions, Traditional GMV portfolios are more effective in minimizing variance.

Table 3: Performance figures for Traditional and ESG portfolios

The table below highlights the performance measures for each portfolios both Traditional and ESG. The overperformance of the ESG Portfolios is evident when the goal is to minimize the variance while in a situation where the investor wants to maximize the Sharpe Ratio, the Traditional Portfolios perform better.

Strategy	Sharpe Ratio	Sortino Ratio	Treynor Ratio	Value-at-Risk	Exp. Shortfall	Calmar Ratio	Sterling Ratio
Benchmark	0.293	0.363	0.157	0.071	0.089	0.043	0.101
Benchmark ESG	0.308	0.366	0.166	0.070	0.084	0.041	0.095
GMV Sample Statistics	0.167	0.212	0.086	0.072	0.088	0.036	0.064
GMV Sample Statistics - No Short Selling	0.167	0.212	0.086	0.072	0.088	0.036	0.063
GMV EWMA 0.90	0.178	0.220	0.085	0.062	0.075	0.096	0.068
GMV EWMA 0.90 - No Short Selling	0.177	0.219	0.085	0.062	0.075	0.097	0.067
GMV EWMA 0.99	0.155	0.197	0.082	0.072	0.086	0.092	0.063
GMV EWMA 0.99 - No Short Selling	0.155	0.198	0.082	0.072	0.086	0.086	0.060
MS Sample Statistics	0.623	0.815	0.335	0.077	0.100	0.038	0.144
MS Sample Statistics - No Short Selling	0.536	0.677	0.278	0.071	0.092	0.040	0.135
MS EWMA 0.90	0.562	0.707	0.277	0.066	0.082	0.069	0.162
MS EWMA 0.90 - No Short Selling	0.498	0.610	0.240	0.060	0.076	0.073	0.148
MS EWMA 0.99	0.506	0.666	0.276	0.076	0.096	0.065	0.157
MS EWMA 0.99 - No Short Selling	0.446	0.567	0.237	0.072	0.089	0.069	0.143
GMV-ESG Sample Statistics	0.206	0.260	0.104	0.070	0.087	0.035	0.068
GMV-ESG Sample Statistics - No Short Selling	0.206	0.261	0.104	0.070	0.087	0.035	0.068
GMV-ESG EWMA 0.90	0.210	0.258	0.098	0.059	0.075	0.084	0.071
GMV-ESG EWMA 0.90 - No Short Selling	0.210	0.258	0.098	0.059	0.075	0.084	0.071
GMV-ESG EWMA 0.99	0.183	0.234	0.095	0.069	0.086	0.079	0.067
GMV-ESG EWMA 0.99 - No Short Selling	0.210	0.258	0.110	0.059	0.075	0.086	0.071
MS-ESG Sample Statistics	0.527	0.669	0.269	0.070	0.089	0.039	0.131
MS-ESG Sample Statistics - No Short Selling	0.522	0.661	0.266	0.070	0.088	0.039	0.130
MS-ESG EWMA 0.90	0.508	0.625	0.241	0.064	0.075	0.072	0.144
MS-ESG EWMA 0.90 - No Short Selling	0.492	0.606	0.232	0.064	0.074	0.072	0.140
MS-ESG EWMA 0.99	0.456	0.583	0.240	0.071	0.088	0.069	0.140
MS-ESG EWMA 0.99 - No Short Selling	0.439	0.559	0.229	0.069	0.086	0.069	0.135

6. FAMA-FRENCH 5 FACTOR MODEL

This section focuses on understanding on which type of risk the set of portfolios are exposed to. In particular, the framework adopted to conduct such analysis is the Fama-French 5 Factor Model (2015):

$$R_t - R_f = \alpha_t + \beta_1(R_{mt} - R_f) + \beta_2(SMB_t) + \beta_3(HML_t) + \beta_4(RMW_t) + \beta_5(CMA_t)$$

Alpha denotes the excess returns of each portfolio that the model fails to explain, whereas the market risk premium assesses how investing in the overall market outperforms the performance of a risk-free asset. The Betas in our regression model reveal how portfolios respond to changes in factor returns. Size (SMB) signifies returns for a portfolio that goes long on small caps and short on large caps, aligning with historical outperformance of small caps. High Minus Low (HML) serves as a value factor, favoring firms with a high book-to-market ratio for sustained performance. Robust Minus Weak captures the profitability premium, while Conservative Minus Aggressive, an investment factor, assesses returns between low and high investment companies.

In order to come up with the results presented in Table 4, I regressed each method's portfolios on the betas using the Excel Data Analysis Regression Tool. As for the Sample Statistics method when Short Selling is allowed, the Market Risk Premium consistently shows a strong positive relationship with portfolio returns across all portfolios. The exposure on the SMB is statistically significant for the Traditional and ESG MS portfolios. Being the coefficient negative, implies a preference for large-cap stocks. Unsurprisingly, an examination of the MSCI Index constituents reveals that the top 10 components consist of some of the largest global companies by market capitalization. As a result, these companies tend to prioritize stable appreciation and offer opportunities for dividend income. The exposure on the HML factor is negative for the Traditional GMV portfolio and positive for all other portfolios, suggesting that the former invests more in growth stocks rather than value. Given the nature of the constituents, it makes sense to have the majority of portfolios favoring value stocks since they place a strong emphasis on dividend payments. However, it should be noted that the exposure of such factor shows no statistical significance (p-value above 5%) but its abovementioned economic significance shall be taken into account. The exposure on the

RMW factor is statistically significant with a positive coefficient for the Traditional and ESG MS portfolios. The preference for robust stocks aligns with the notion that high-quality, financially stable companies with strong fundamentals tend to outperform weaker counterparts. Moreover, larger, and more stable companies may have more resources to implement ESG practices. As for the CMA factor, the beta is negative for the two MS portfolios and positive for the GMV ones but shows statistical insignificance across all portfolios. The negative coefficient may imply that the portfolios is composed of companies with more aggressive investment policies. Similar conclusions can be taken also for the other two methods, namely EWMA 0.90 and 0.99 with the only differences being in the profitability factors. In fact, with a method that gives more importance to recent observations, the CMA coefficients for all portfolios with an EWMA 0.99 method shows a positive value, implying a preference for more conservative investment policies. This can be justified by the recent period of recession caused by the Covid-19 pandemic and geopolitical tensions.

Table 4: Multifactor regression analysis for Traditional and ESG Portfolios

The tables below report the result obtained from the regression using the Fama-French 5 factor model. Each portfolio return was regressed on each factor to understand the exposure. The betas on each factor and the adjusted R-squared are all presented in the table.

Sample Statistics - Fama French 5 Factor Model

Portfolios	*Alpha*	*Mkt-Rf*	*SMB*	*HML*
GMV	-0.0051	0.0090	-0.0011	0.0007
MS	-0.0007	0.0102	-0.0010	-0.0002
ESG GMV	-0.0048	0.0088	-0.0011	0.0003
ESG MS	-0.0019	0.0096	-0.0009	0.0000

Portfolios	*RMW*	*CMA*	*Adj-R^2*
GMV	-0.0003	0.0008	0.858
MS	0.0009	-0.0002	0.979
ESG GMV	0.0001	0.0009	0.853
ESG MS	0.0011	-0.0001	0.979

EWMA 0.90 - Fama French 5 Factor Model

Portfolios	*Alpha*	*Mkt-Rf*	*SMB*	*HML*
GMV	-0.0032	0.0079	-0.0008	0.0006
MS	-0.0001	0.0089	-0.0008	0.0000
ESG GMV	-0.0030	0.0077	-0.0008	0.0003
ESG MS	-0.0007	0.0084	0.0084	0.0000

Portfolios	*RMW*	*CMA*	*Adj-R^2*
GMV	-0.0007	0.0006	0.833
MS	0.0008	-0.0001	0.975
ESG GMV	-0.0003	0.0007	0.825
ESG MS	0.0011	-0.0001	0.963

EWMA 0.99 - Fama French 5 Factor Model

Portfolios	*Alpha*	*Mkt-Rf*	*SMB*	*HML*
GMV	-0.0042	0.0088	-0.0009	0.0007
MS	-0.0010	0.0100	-0.0010	-0.0001
ESG GMV	-0.0040	0.0087	-0.0010	0.0003
ESG MS	-0.0017	0.0095	-0.0009	0.0000

Portfolios	*RMW*	*CMA*	*Adj-R^2*
GMV	-0.0005	0.0008	0.857
MS	0.0008	0.0000	0.984
ESG GMV	-0.0001	0.0009	0.850
ESG MS	0.0012	0.0000	0.976

Trends and patterns for the situation where Short Selling is not allowed are similar and the regression results are included in the Appendix. The only notable difference can be seen in the CMA factor, in which there is even more regard for the conservative investment policies. This may be due to the fact that the no Short Selling approach is a more stringent strategy.

7. LIMITATIONS AND FURTHER RESEARCH

The scope of this study was confined to a select set of MSCI Indexes along with their respective ESG counterparts. While these indexes provide valuable insights, it's essential to acknowledge their limitations in fully representing the vast investment universe. The exclusion of small-cap or niche indexes may have implications on the applicability of the findings, particularly in an investment landscape where these segments are gaining prominence. To enhance the comprehensiveness of the analysis, future research should consider expanding the range of indexes and asset classes. Including small-cap, sector-specific, or regional indexes can provide a more nuanced understanding of portfolio dynamics. This broader approach would capture a diverse array of investment opportunities, allowing for a more holistic evaluation. Simulating real-world scenarios involves integrating transaction costs into the analysis. By considering transaction costs, future research can provide a more practical understanding of portfolio management strategies, acknowledging the impact of trading expenses on overall performance. An additional research focus would be to expand the Fama-French 5 Factor Model and incorporate a Momentum factor to capture the trend of successful stocks continuing to outperform in the short-term.

7. CONCLUSION

There is a clear trend among investors to include sustainable assets in their portfolios, and this inclination is expected to persist in the short-term. The European and US markets are at the

forefront, driving this significant shift. Recent times have seen the introduction of financial regulations aimed at classifying sustainable assets, and the future holds the prospect of more rigorous disclosure demands for companies and financial entities. Despite extensive work on the matter, the existing literature fails to provide a definitive answer to the question of whether ESG investing will positively or negatively impact performance in the domain of passive investments. This thesis navigates the intricate intersection of financial strategy and sustainable investing within the evolving landscape of global markets.

The set of MSCI Indexes' returns that compose the portfolios have been analyzed under the lens of different methods and despite the slight similarities among them, some interesting conclusions can be taken. In fact, it is evident the overperformance in terms of Sharpe Ratio of ESG GMV portfolios with respect to their Traditional counterparts when the aim of the investor is to minimize the volatility. On the other hand, when looking for a strategy that maximizes the returns, the Traditional portfolios have clearly outperformed the ESG ones and both the Fama-French and the performance measures support this conclusion. These trends are relevant across all strategies.

In general, there is a strong preference for value stocks, with the Traditional MS being the only exception. Moreover, we can conclude that the portfolios constructed with the EWMA method have more exposure to conservative investment policies. In conclusion, this research serves as a meaningful contribution to sustainable finance by corroborating previous studies and offering a supplementary quantitative perspective in ESG research. The utilization of the latest data sets adds contemporary relevance to the findings. This study, therefore, seeks to establish ESG as a viable investment strategy, showcasing that it not only safeguards portfolio returns but, depending on investor objectives, may even enhance them. The hope is that this research fosters the recognition of ESG as an integral component in contemporary investment considerations.

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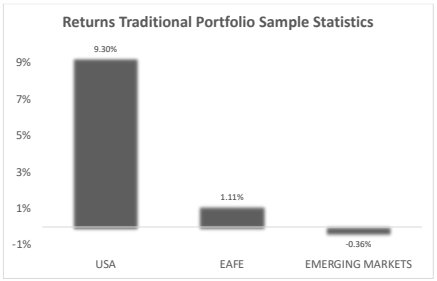
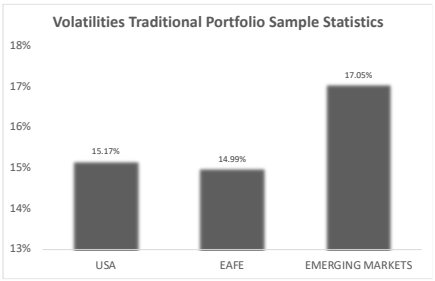
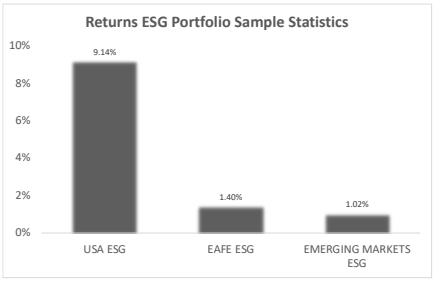
APPENDIX

Exhibit 1: Return and Volatility for the Sample Statistics method







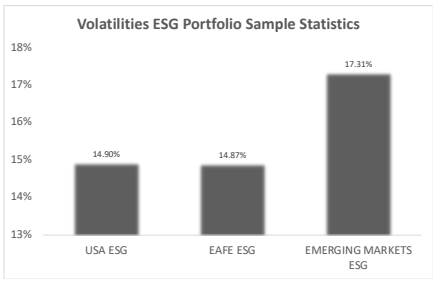
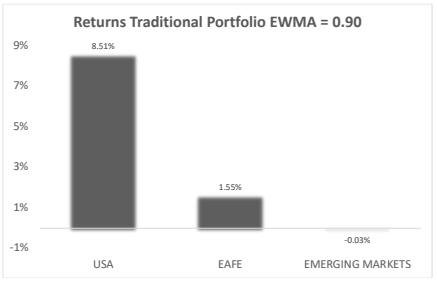
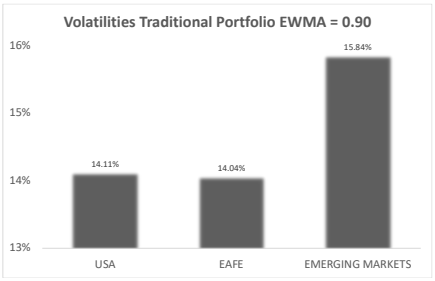
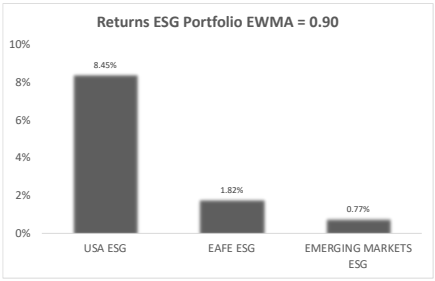


Exhibit 2: Return and Volatility for the EWMA = 0.90 method







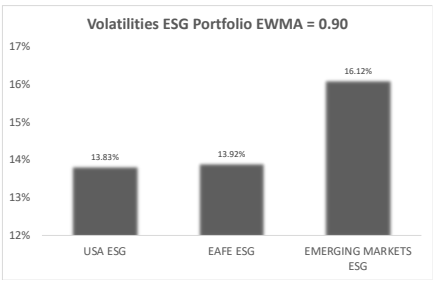


Exhibit 3: Return and Volatility for the EWMA = 0.99 method

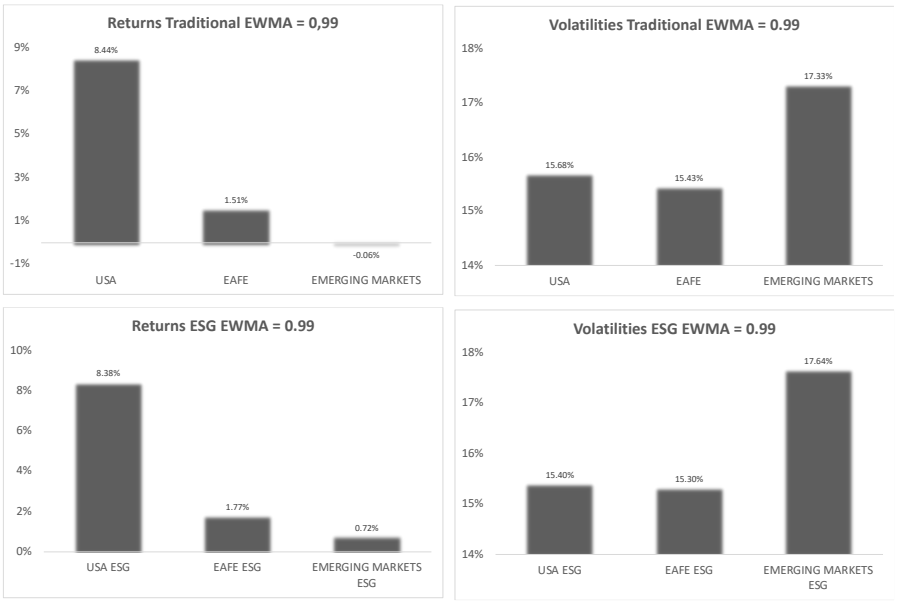
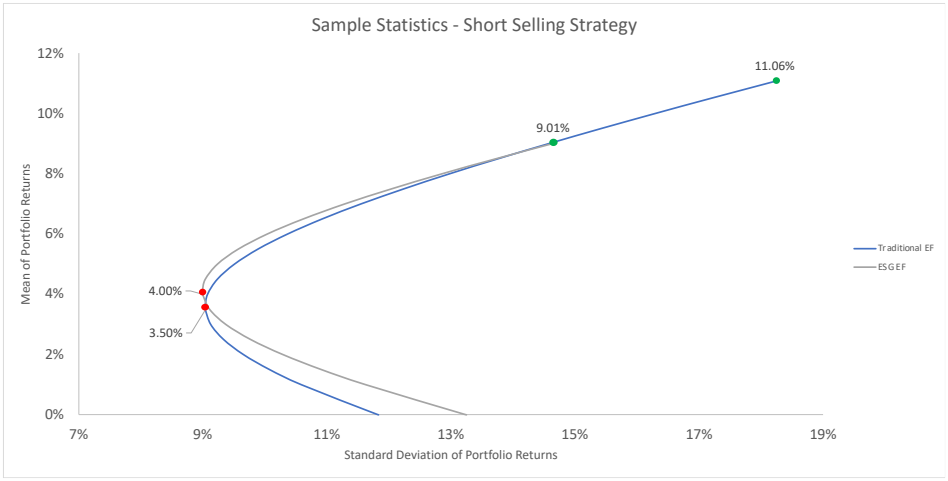
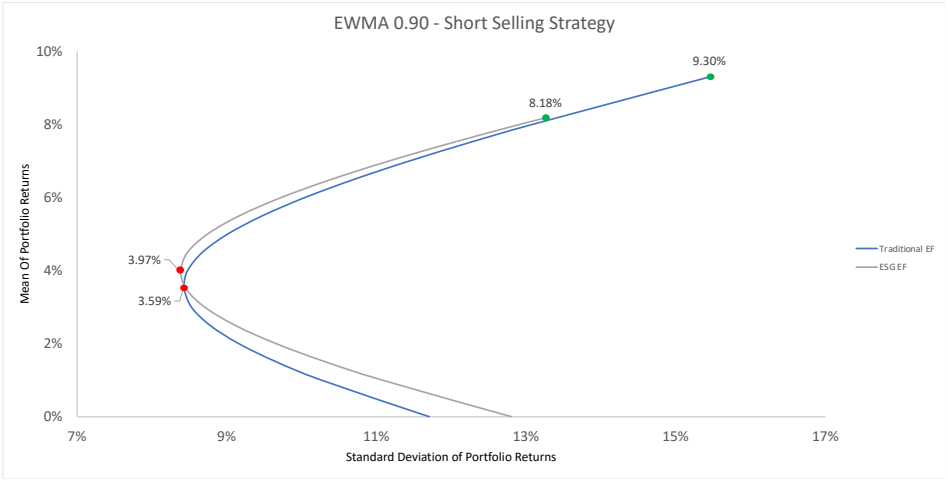


Exhibit 4: Efficient Frontiers with Short Selling Allowed





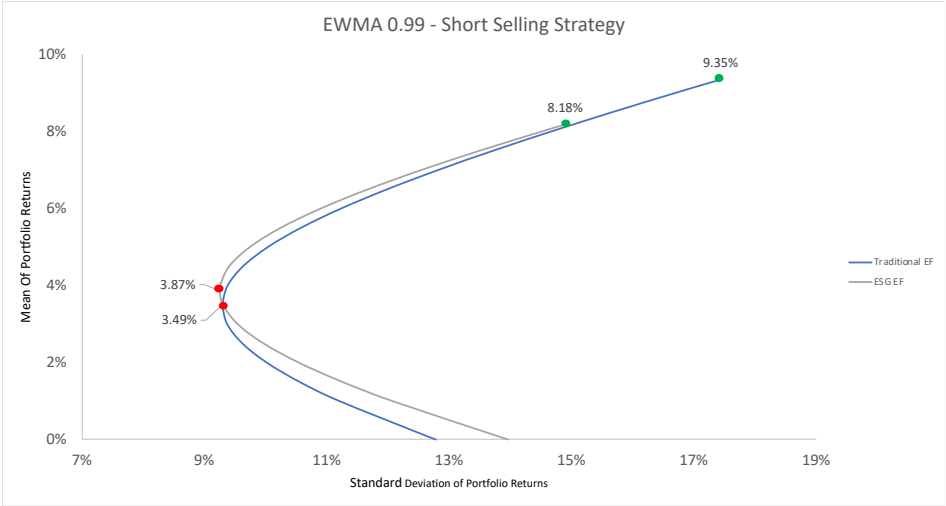
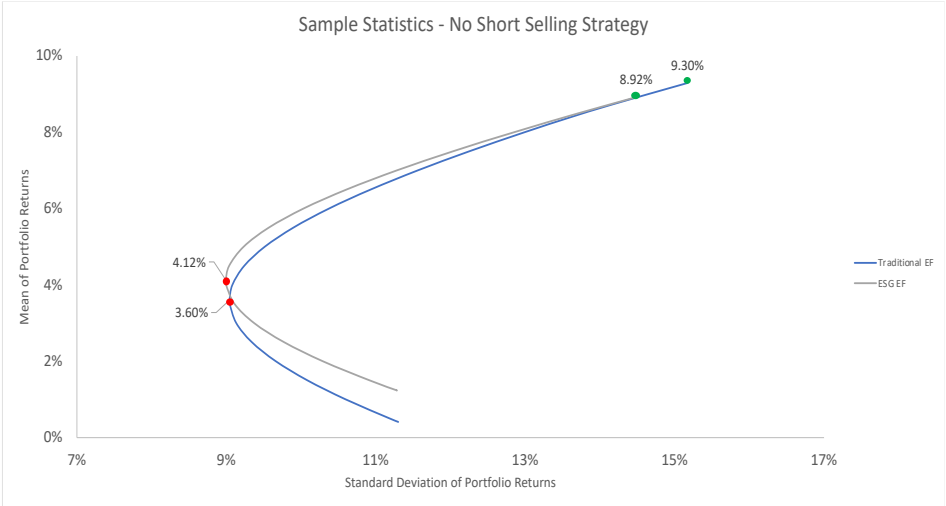
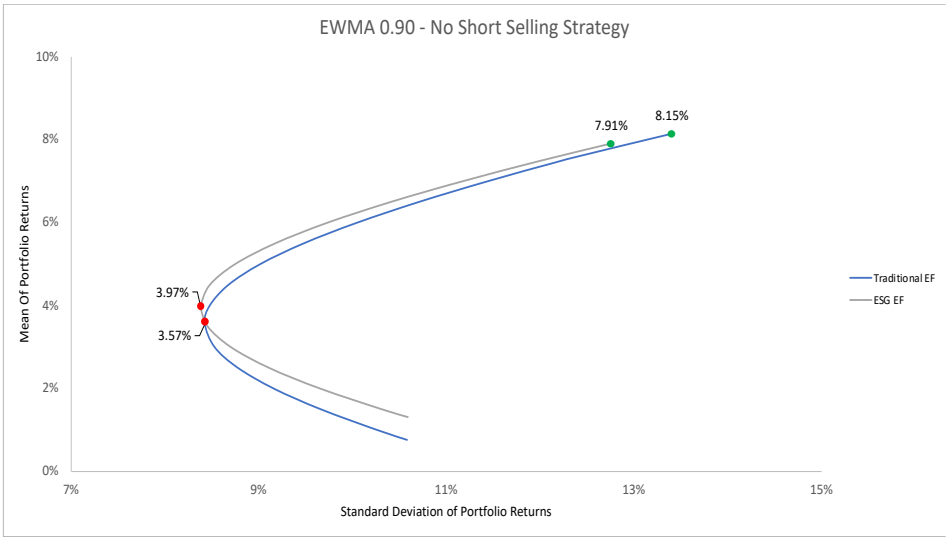


Exhibit 5: Efficient Frontiers No Short Selling





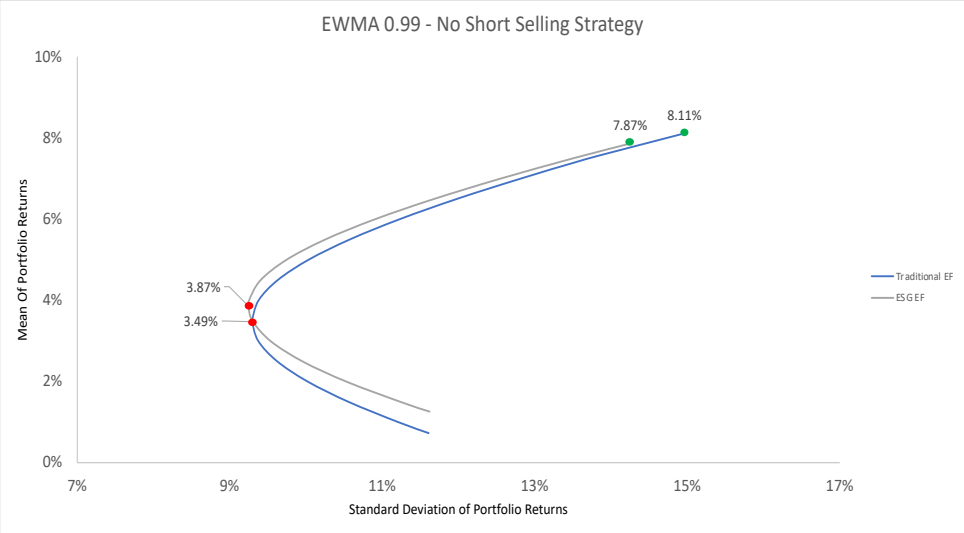


Exhibit 6: Cumulative Returns EWMA 0.99

Exhibit 7: Factor regression of the portfolios with no Short Selling allowed.

Sample Statistics - Fama French 5 Factor Model NO SHORT

Portfolios	*Alpha*	*Mkt-Rf*	*SMB*	*HML*
GMV	-0.0046	0.0090	-0.0010	0.0007
MS	-0.0017	0.0099	-0.0011	0.0001
ESG GMV	-0.0044	0.0088	-0.0011	0.0002
ESG MS	-0.0019	0.0096	-0.0010	0.0000

Portfolios	*RMW*	*CMA*	*Adj-R^2*
GMV	0.0008	0.0008	0.859
MS	0.0000	0.0000	0.996
ESG GMV	0.0009	0.0009	0.854
ESG MS	-0.0001	-0.0001	0.979

EWMA 0.90 - Fama French 5 Factor Model NO SHORT

Portfolios	*Alpha*	*Mkt-Rf*	*SMB*	*HML*
GMV	-0.0032	0.0079	-0.0008	0.0006
MS	-0.0007	0.0087	-0.0008	0.0001
ESG GMV	-0.0030	0.0077	-0.0008	0.0003
ESG MS	-0.0009	0.0084	-0.0007	0.0000

Portfolios	*RMW*	*CMA*	*Adj-R^2*
GMV	-0.0007	0.0006	0.832
MS	0.0004	0.0000	0.979
ESG GMV	-0.0003	0.0007	0.825
ESG MS	0.0010	-0.0001	0.962

EWMA 0.99 - Fama French 5 Factor Model NO SHORT

Portfolios	*Alpha*	*Mkt-Rf*	*SMB*	*HML*
GMV	-0.0042	0.0088	-0.0009	0.0007
MS	-0.0016	0.0097	-0.0010	0.0001
ESG GMV	-0.0030	0.0077	-0.0008	0.0003
ESG MS	-0.0018	0.0094	-0.0009	0.0000

Portfolios	*RMW*	*CMA*	*Adj-R^2*
GMV	-0.0005	0.0008	0.857
MS	0.0004	0.0001	0.993
ESG GMV	-0.0003	0.0007	0.825
ESG MS	0.0010	0.0000	0.976