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Financial Equivalence of ESG and Non-ESG Portfolios: Evidence from US ETFs Using CAPM and Risk-Adjusted Metrics

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Abstract

This study examines the financial performance of ESG and non-ESG portfolios between 2020 and 2024 using monthly data from ten major U.S. exchange-traded funds (ETFs). Leveraging the Capital Asset Pricing Model (CAPM) and Modern Portfolio Theory (MPT), we assess annualized returns, volatility, Sharpe ratios, and maximum drawdowns. The results show that ESG portfolios perform comparably to traditional portfolios in terms of both returns and risk-adjusted efficiency. While the non-ESG portfolio posted slightly higher returns, the difference was statistically insignificant. CAPM estimates revealed betas near unity and no evidence of abnormal returns (alpha), supporting the neutrality hypothesis.

These findings suggest that investors can pursue ESG strategies without compromising financial outcomes. From a policy perspective, the results underscore the need for robust ESG disclosure frameworks to support market transparency and efficiency.

Keywords: ESG investing; portfolio performance; CAPM analysis; risk-adjusted returns; sustainable finance.

JEL Classification: G11; G12; Q56; M14.

Introduction

In recent years, the integration of Environmental, Social, and Governance (ESG) principles into investment decision-making has moved from a niche concept to a mainstream component of global financial markets. The accelerating climate transition, social awareness, and increasing regulatory requirements have led both institutional and retail investors to recognize sustainability as a strategic determinant of long-term financial performance. According to the United Nations Principles for Responsible Investment (UNPRI, 2019), more than 4,000 signatories worldwide now manage over USD 120 trillion in assets under ESG mandates, reflecting a profound transformation in capital allocation priorities. Despite this rapid expansion, the relationship between ESG performance and financial returns remains contested within both academia and practice. On the one hand, proponents argue that companies with strong ESG credentials demonstrate superior risk management, operational efficiency, and reputational resilience, which may translate into enhanced risk-adjusted returns (Friede et. al., 2015; Eccles et al., 2014). Conversely, critics argue that ESG integration imposes investment constraints, excluding certain sectors or firms, and thus limits diversification and expected returns (Krüger, 2015). A third perspective, often referred to as the neutrality hypothesis, posits that ESG and non-ESG investments deliver statistically similar returns once market risk and other factors are controlled (Pedersen et. al., 2021).

The COVID-19 pandemic, subsequent economic recovery, and recent macroeconomic turbulence have provided a unique context for assessing these competing perspectives. Periods of elevated uncertainty tend to amplify the differences in asset resilience, allowing for the observation of whether ESG portfolios behave differently under stress. Moreover, the unprecedented inflow of capital into ESG-themed funds has raised concerns about valuation effects and herd behaviour, potentially distorting the risk–return relationship that underpins traditional portfolio theory.

This study contributes to the ongoing debate by conducting a comparative performance analysis of ESG and non-ESG portfolios over the period 2020–2024 using monthly data from major exchange-traded funds (ETFs). By applying methods grounded in the Capital Asset Pricing Model (CAPM) and Modern Portfolio Theory (MPT), the analysis evaluates differences in returns, volatility, Sharpe ratios, and systematic risk exposures. The research also examines whether ESG portfolios generate significant abnormal returns (alphas) after accounting for market factors. By combining theoretical insights with empirical evidence, this study seeks to clarify whether ESG integration leads to measurable deviations in financial performance or whether sustainable portfolios have effectively converged with traditional market benchmarks. The findings aim to inform both investors and policymakers about the economic rationality of ESG strategies, contributing to a broader understanding of how sustainability considerations influence asset pricing and portfolio efficiency in modern capital markets.

1. Theoretical Background

The relationship between financial performance and sustainability considerations has become a central topic in modern investment theory. The increasing prominence of ESG investing has challenged traditional assumptions about market efficiency, portfolio optimization, and the determinants of asset returns. This paper outlines the theoretical foundations underlying the study, encompassing modern portfolio theory, risk–return optimization, the conceptual framework of ESG integration in finance, and the empirical evidence on the ESG–financial performance linkage. The theoretical foundations of portfolio management and decision modelling, as highlighted in earlier works on decision assistance systems and portfolio analysis (Ștefănescu & Ștefănescu, 2007; Ștefănescu, 2006), continue to provide a structural basis for understanding how optimization frameworks are applied in managing investment risk and asset allocation. These decision models emphasize the integration of quantitative and qualitative factors, ensuring that decision support systems can adequately handle uncertainty and complexity in financial management.

The roots of contemporary investment analysis lie in the modern portfolio theory (MPT) developed by Harry Markowitz (1952). MPT posits that rational investors seek to maximize expected returns for a given level of risk or, equivalently, minimize risk for a given expected return. The theory introduced the concept of diversification, showing that combining assets with imperfectly correlated returns can reduce portfolio variance without proportionally reducing expected returns (Markowitz, 1952). The trade-off between risk and return forms the cornerstone of investment decision-making. Investors evaluate the expected return $E(R_p)$ against the portfolio's standard deviation σ_p, which represents total risk. In equilibrium, only systematic risk, which cannot be diversified away, should be compensated with higher expected returns (Sharpe, 1964; Mossin, 1966). In this context, MPT established the efficient frontier, the locus of portfolios offering the highest expected return for each level of risk. The CAPM extends MPT by introducing a linear relationship between the expected return and market risk, formalized as:

$$E(R_i) = R_f + \beta_i[E(R_M) - R_f]$$

where: $E(R_i)$ is the expected return on asset i, R_f is the risk-free rate, (R_M) is the expected market return, and β_i measures the asset's sensitivity to market movements (systematic risk) (Lintner, 1965; Sharpe, 1964). In this model, alpha (α) represents the deviation of realized returns from those predicted by market exposure.

A positive alpha indicates outperformance, whereas a negative alpha reflects underperformance. Under the Efficient Market Hypothesis (EMH) proposed by Fama (1970), the alpha should, on average, equal zero, implying that markets fully reflect all available information and that persistent abnormal returns are unattainable. Subsequent extensions of CAPM, including multifactor models (Fama & French, 1993), signal that additional factors such as size, value, or momentum may influence returns, yet the core intuition remains: risk compensation is driven by systematic exposure.

The EMH and ESG investments serve as the theoretical backbone for most asset-pricing models. Three forms of efficiency are postulated: weak, semistrong, and strong, depending on the extent of information reflected in prices (Fama, 1970). If markets are semistrongly efficient, as empirical evidence often suggests, then any publicly available information, including ESG disclosures, should already be incorporated into asset prices. Consequently, ESG investing should neither systematically outperform nor underperform non-ESG approaches, except temporarily during market adjustment phases.

However, the emergence of ESG investment has challenged EMH in nuanced ways. ESG factors introduce nonfinancial information, such as carbon intensity, labour practices, or board governance, that may not be fully priced by traditional financial models. This creates potential opportunities for investors who can interpret such data earlier or more effectively than the market can. Proponents of ESG integration argue that market inefficiencies related to sustainability information can be exploited, leading to superior long-term performance (Pedersen et al., 2021). Recent panel evidence further suggests that ESG dimensions can meaningfully influence stock performance in emerging markets, emphasizing the importance of both firm-level ESG quality and country-specific conditions (Singh & Singh, 2024).

The origin of ESG investing can be traced back to Socially Responsible Investing (SRI), which emerged in the 1960s as a value-driven approach that excluded certain sectors (e.g., tobacco, defence, fossil fuels) from investment portfolios. Over time, this negative screening approach evolved into the modern ESG framework, which integrates environmental, social and governance criteria into traditional financial analysis. Unlike SRI, ESG integration seeks not only to exclude risky sectors but also to enhance risk-adjusted returns by identifying financially material sustainability factors (PRI, 2017). The environmental dimension focuses on how companies manage resources, energy efficiency and climate-related risks. The social dimension examines labour practices, community impact and human rights, whereas the governance dimension considers board independence, transparency and ethical conduct.

Collectively, the ESG criteria aim to provide a holistic assessment of long-term corporate resilience (UNPRI, 2019). This trend is also visible at the macro level, where CSR practices have been shown to correlate with broader economic development dynamics across EU member states (Przybysz, 2020). The theoretical rationale for ESG integration rests on an opportunity risk mitigation framework: firms with strong ESG profiles are expected to face lower regulatory, reputational and operational risks. At the same time, they may benefit from access to capital at lower cost, greater investor trust, and strategic positioning in sustainability transitions (Eccles et al., 2014).

Despite its growing popularity, ESG investing has provoked debate across both academia and practice. The discussion largely centers on whether ESG criteria enhance or constrain portfolio efficiency and returns. The Value-Enhancement Hypothesis: This view argues that integrating ESG factors improves financial performance by identifying firms that are better managed, more transparent, and less exposed to long-term risks (Statman & Glushkov, 2016). ESG metrics thus serve as proxies for managerial quality and strategic foresight, leading to superior stability and a lower cost of capital (Friede et al., 2015). The Constraint Hypothesis: Conversely, critics argue that ESG integration imposes investment constraints by excluding profitable yet controversial sectors, thereby reducing diversification and increasing tracking error relative to market benchmarks. According to classical portfolio theory, any such constraint shifts the efficient frontier inwards, leading to suboptimal risk–return combinations (Krüger, 2015). The Neutrality Hypothesis: A third perspective, the neutrality hypothesis, suggests that ESG investing neither systematically outperforms nor underperforms traditional strategies once risk is properly accounted for. This aligns with EMH and is supported by meta-analyses (Friede et al., 2015; NYU Stern, 2021), which show that the majority of empirical studies find no significant difference in financial performance between ESG portfolios and non-ESG portfolios (NYU Stern, 2021).

In quantitative finance, ESG integration can be analysed through risk–return models such as the CAPM or multifactor extensions. ESG factors may influence both systematic and idiosyncratic risk components. For example, firms with high ESG scores might experience reduced exposure to litigation or regulatory shocks, thereby lowering their idiosyncratic risk component (Gasser et al., 2017). Empirical evidence indicates that stronger ESG or CSR practices are sometimes associated with lower credit and default risk, suggesting that sustainability characteristics may function as stabilizing factors in firm-level financial structures (Yadav, 2024). Conversely, sectoral biases, such as overweighting renewable energy or technology, can increase systematic risk relative to the market, resulting in higher betas.

Therefore, the theoretical expectation is that ESG portfolios may demonstrate similar or slightly higher betas but comparable Sharpe ratios relative to traditional portfolios. Over time, as ESG investing becomes more widespread and standardized, its performance is likely to converge with the broader market, reflecting a state of equilibrium integration in sustainable finance (PRI, 2017). The theoretical frameworks discussed above provide the rationale for the empirical design of this study. By constructing equal-weighted ESG and non-ESG portfolios and applying CAPM-based analysis, this research tests whether ESG integration affects key performance dimensions, returns, volatility, and risk-adjusted efficiency. The use of CAPM and rolling metrics aligns with the efficient market paradigm, examining whether ESG portfolios generate significant alphas (abnormal returns) or display distinct betas (systematic risk sensitivity). Under the EMH, a significant alpha would signal temporary inefficiencies in the pricing of sustainability-related information; the absence of an alpha would confirm market neutrality. In essence, the theoretical framework predicts that in an efficient and globally integrated market such as the United States, ESG portfolios should perform comparably to traditional portfolios once risk factors are controlled. The following empirical sections evaluate this hypothesis by analysing the relative performance of ESG and non-ESG portfolios over a dynamic five-year period encompassing multiple market regimes.

2. Data and Methodology

Data Selection

The empirical analysis is based on monthly price data for a selection of ten exchange-traded funds (ETFs), representing both ESG-oriented and conventional investment strategies. The sample covers the period from January 2020 to December 2024, a time frame that encapsulates several distinct market phases, including the COVID-19 crisis, the post pandemic recovery, and the inflationary period associated with monetary tightening. This period was deliberately chosen to evaluate the resilience and relative performance of ESG investments during varying market conditions.

The ESG portfolio consists of five funds, ESGV, DSI, SUSA, ICLN, and SPUS, which explicitly integrate environmental, social, and governance criteria into their investment strategies. These funds track a variety of ESG indices, such as the MSCI USA ESG Select or S&P 500 ESG, which represent both broad-market and sector-specific exposures (e.g., clean energy). The non-ESG portfolio comprises five traditional ETFs, namely, SPY, VOO, IWM, QQQ, and DIA, which track major US market indices, including the S&P 500, Russell 2000, NASDAQ-100, and Dow Jones Industrial Average. All the data were retrieved from Yahoo Finance, ensuring consistency and replicability. To minimize concentration bias, both portfolios were constructed as equally weighted, with each ETF having the same influence on portfolio returns. This approach was chosen to reflect a diversified investor's perspective and to prevent dominance by large-cap index funds.

Return Calculation

Monthly logarithmic returns were calculated from adjusted closing prices to account for dividend reinvestments and stock splits. Log returns were chosen instead of simple returns because they are time-additive and more appropriate for statistical analysis over multiple periods. Each portfolio's monthly return was computed as the equal-weighted mean of the individual ETF returns:

$$R_{p,t} = \frac{1}{N}\sum_{i=1}^{N} R_{i,t}$$

where $R_{p,t}$ denotes the portfolio return at time t, $R_{p,t}$ represents the return of the i^{th} ETF, and N is the number of assets in the portfolio (five in both cases). The risk-free rate R_f was assumed to be constant at 2% per annum, approximating the average yield of 3-month US Treasury bills over the analysed period. Monthly risk-free returns were used for calculating excess returns and the Sharpe ratio, providing a standardized basis for risk-adjusted performance evaluation.

Performance Metrics

The performance evaluation of ESG and non-ESG portfolios is based on both absolute and risk-adjusted measures:

- Annualized Return – measures the compounded average growth rate of the portfolio.
- Annualized Volatility – computed as the standard deviation of monthly returns scaled to yearly terms, representing total risk.
- The Sharpe ratio is defined as the ratio of excess return over the risk-free rate to total volatility and serves as an indicator of efficiency per unit of risk.
- Maximum Drawdown quantifies the largest peak-to-trough decline in cumulative returns, capturing downside risk.
- Welch two-sample t test – used to statistically test the null hypothesis that mean returns between ESG and non-ESG portfolios do not differ significantly.

These indicators jointly allow the assessment of both the profitability and stability of ESG strategies relative to traditional benchmarks.

CAPM Model

To further evaluate portfolio performance in relation to market risk, the capital asset pricing model (CAPM) was estimated for both portfolios. CAPM provides a theoretical framework linking an asset's expected return to its systematic risk exposure relative to the overall market. The model is specified as follows:

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_i(R_{M,t} - R_{f,t}) + \varepsilon_i$$

where: $R_{i,t}$ = return of portfolio *i* at time *t*; $R_{M,t}$ = market return proxied by the S&P 500 (SPY); $R_{f,t}$ = risk-free rate; α_i = intercept (Jensen's alpha), representing abnormal performance unexplained by market movements; β_i = slope coefficient, capturing systematic market sensitivity; ε_i = residual term.

Ordinary Least Squares (OLS) regression was applied to estimate the coefficients. The beta (β) indicates how strongly portfolio returns respond to market movements, whereas the alpha (α) measures whether the portfolio generates excess returns beyond market risk exposure. Additionally, rolling 24-month CAPM regressions were used to analyse the time-varying behaviour of the beta, providing insight into how the sensitivity of ESG portfolios to market conditions evolved.

3. Research Results

3.1 Descriptive Performance

Table 1 summarizes the basic performance metrics for the ESG and non-ESG portfolios during the 2020–2024 period. Compared with the ESG portfolio (10,44%), the non-ESG portfolio generated a slightly higher annualized return (11,56%) while maintaining marginally lower volatility. However, the Welch two-sample t-test (p = 0,9473) indicates that this difference is not statistically significant, implying that both portfolios delivered essentially comparable average monthly returns. In terms of risk-adjusted performance, the Sharpe ratio of the non-ESG portfolio (0,49) marginally exceeded that of the ESG portfolio (0,41). This suggests that, over the sample period, conventional portfolios achieved slightly more efficient risk–return trade-offs. Nonetheless, the magnitude of the difference remains economically small and statistically inconclusive. The maximum drawdown figures (approximately 27% for both portfolios) reveal similar downside exposure, indicating that ESG-oriented investments did not offer superior protection during market downturns. This finding aligns with previous studies suggesting that ESG portfolios tend to move closely in line with traditional benchmarks during periods of systemic market stress (e.g., Friede et al., 2015; Statman & Glushkov, 2016).

Table 1: Returns and volatility of ESG and non-ESG portfolios

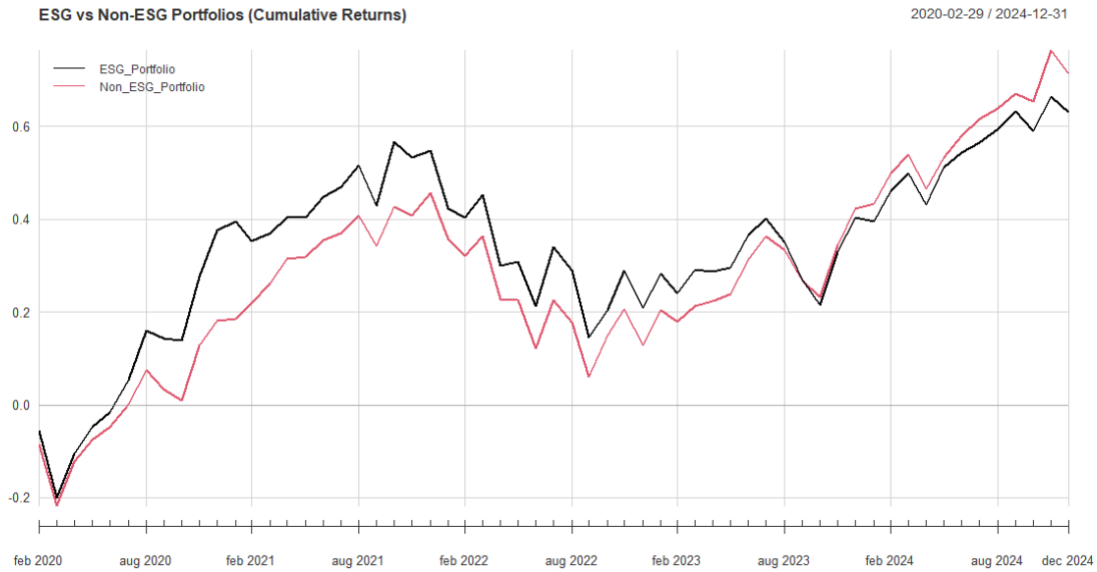
Metric	ESG portfolio	non-ESG portfolio
Annualized Return	10,44%	11,56%
Annualized Volatility	20,18%	19,22%
Sharpe Ratio (Rf = 2%)	0,41	0,49
Maximum Drawdown	26,9%	27,2%
t-test (p-value)	0,9473	—

Source: prepared by the author

The cumulative return trajectory (Figure 1) illustrates the nearly identical movement of the two portfolios throughout the analysed period. Both portfolios experienced a sharp contraction in early 2020 amid the COVID-19 market crash, followed by a strong recovery in 2021. The patterns diverged temporarily during 2022, when growth-oriented ESG sectors were more affected by rising interest rates, yet converged again toward the end of 2024.

Overall, the results indicate that ESG investments track the performance of traditional portfolios remarkably closely across varying macroeconomic environments.

Figure 1: ESG vs Non-ESG Portfolios (Cumulative Returns)

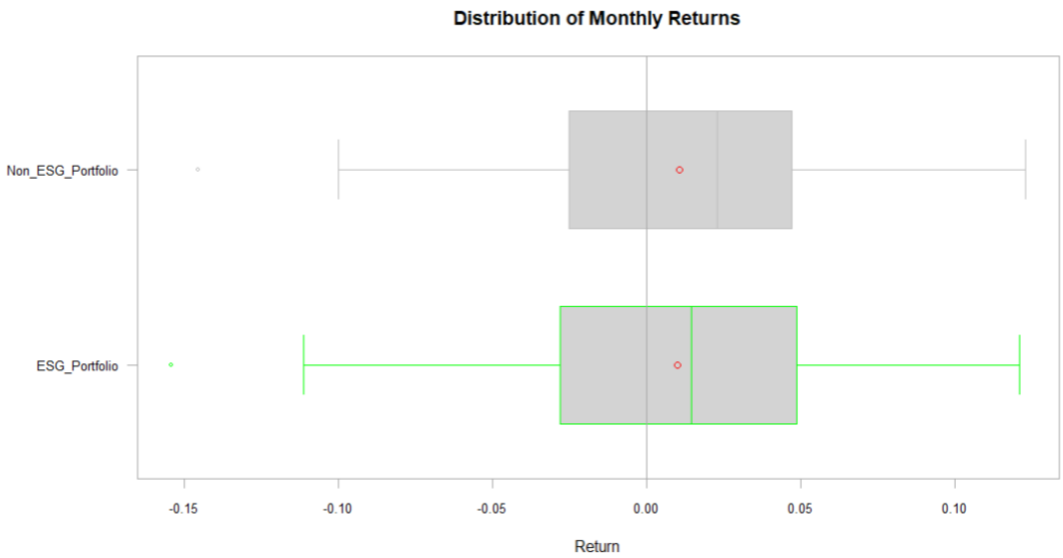


Source: prepared by the author

3.2 Distribution of Monthly Returns

The distributional characteristics of monthly portfolio returns were examined to gain deeper insight into the risk–return dynamics of ESG and non-ESG portfolios. Figure 2 presents boxplots of the monthly returns for both portfolios over the 2020–2024 period. The graphical results reveal that both distributions are approximately symmetric around the mean, with median returns close to zero, indicating the absence of persistent bias toward gains or losses across months. The interquartile range (IQR) is slightly wider for the ESG portfolio, suggesting marginally higher dispersion of returns and therefore higher short-term volatility relative to the non-ESG portfolio. While both portfolios exhibit comparable central tendencies, the ESG portfolio displays a few extreme observations (outliers) on both the positive and negative sides.

Figure 2: Distribution of monthly returns



Source: prepared by the author

These fluctuations are attributable primarily to sharp fluctuations in energy and technology markets, which tend to have greater representation in ESG indices. The presence of such outliers does not, however, materially affect the overall return profile, as confirmed by the insignificant difference in mean returns identified by the Welch t test (p = 0,9473). From a statistical standpoint, the similarity in boxplot structures underscores the finding that ESG portfolios do not exhibit materially different distributional properties than their non-ESG counterparts do. This suggests that incorporating sustainability criteria does not substantially alter the shape, skewness, or kurtosis of the return distribution over medium-term investment horizons. These results are consistent with prior evidence (e.g., Pedersen et al., 2021), which argues that ESG and conventional portfolios tend to follow similar distributional patterns, differing primarily in sectoral composition rather than in risk asymmetry or tail behaviour. Consequently, the observed return distributions reinforce the hypothesis that ESG integration influences portfolio composition but not its statistical return profile.

3.3 CAPM Regression Results

To evaluate whether ESG portfolios exhibit abnormal performance after accounting for market risk, a single-factor CAPM was estimated for both ESG and non-ESG portfolios. The model regressed the portfolios' monthly excess returns (returns above the 2% annual risk-free rate) on the excess returns of the market proxy, represented by the S&P 500 index (SPY).

Table 2: CAPM Regression Results (Alpha, Beta, and R^2)

Portfolio	Alpha (α)	Beta (β)	R^2
ESG	−0,00196	1,045	0,901
Non-ESG	−0,00122	1,041	0,985

Source: prepared by the author

Both portfolios demonstrate a beta coefficient slightly above 1, indicating a strong and positive relationship with overall market movements. The ESG portfolio exhibits a marginally higher beta (1,045) than the non-ESG portfolio does (1,041), suggesting that ESG investments are slightly more sensitive to market fluctuations. This may be attributed to the relatively higher weighting of growth-oriented and renewable energy sectors within ESG indices, which tend to react more strongly to macroeconomic shocks and investor sentiment. The alpha coefficients for both portfolios are negative (−0,00196 for ESG and −0,00122 for non-ESG) but statistically insignificant (p values > 0,1).

This finding indicates that neither portfolio achieved abnormal risk-adjusted returns beyond what could be explained by exposure to systematic market risk. In other words, ESG portfolios do not outperform or underperform the market once risk is accounted for. The R^2 values (0,901 for ESG and 0,985 for non-ESG) demonstrate that market movements explain most of the variance in portfolio returns, particularly for the non-ESG portfolio, where nearly 98% of return variation is attributable to the market factor. The slightly lower explanatory power for the ESG portfolio suggests a greater influence of idiosyncratic or sector-specific factors, such as environmental regulation, clean energy price volatility, or shifts in investor preferences toward sustainability. From a financial economics perspective, these findings imply that ESG portfolios behave as "market-like" assets, offering similar systematic exposure and performance dynamics to broad market indices. The absence of a statistically significant alpha aligns with the EMH, which posits that consistent outperformance after adjusting for risk is unlikely. It also echoes the conclusions of prior studies (e.g., Krüger, 2015; Pedersen et al., 2021), showing that ESG criteria do not systematically generate excess returns once common risk factors are controlled for. In summary, the CAPM regression results suggest that ESG and non-ESG portfolios share nearly identical sensitivities to market risk. Neither portfolio produces statistically significant excess returns ($\alpha \approx 0$). ESG investments exhibit modestly greater exposure to market volatility, which is consistent with their composition of growth-oriented sectors.

3.4 Jensen's Alpha and Volatility Comparison

To further assess risk-adjusted performance, Jensen's alpha was computed for both portfolios via the CAPM framework. This measure evaluates the extent to which a portfolio's realized return exceeds (or falls short of) the return predicted by its market exposure (beta). It is expressed as:

$$a_J = \overline{R_i - R_f} - \beta_i * \overline{R_M - R_f}$$

where a_J denotes Jensen's alpha, $\overline{R_i - R_f}$ is the mean excess return of the portfolio, and β_i represents the CAPM beta coefficient estimated in the previous section.

The results demonstrate that both ESG and non-ESG portfolios produced negative but economically negligible Jensen's alphas. The ESG portfolio's Jensen's alpha of −0,00196 and the non-ESG portfolio's −0,00122 confirm that, on average, both portfolios slightly underperformed the market-adjusted benchmark. However, these differences are statistically insignificant, indicating that there is no evidence of abnormal returns after we adjust for systematic risk. The volatility comparison, conducted via an F-test for the equality of variances, yielded an F-statistic of 1,10 with a p-value of 0,7112, suggesting that the null hypothesis of equal variances cannot be rejected.

Table 3: Jensen's Alpha Ratio

Portfolio	Jensen's Alpha	Variance Ratio (F-statistic)	p-value
ESG	−0,00196	1,1026	0,7112
Non-ESG	−0,00122	—	—

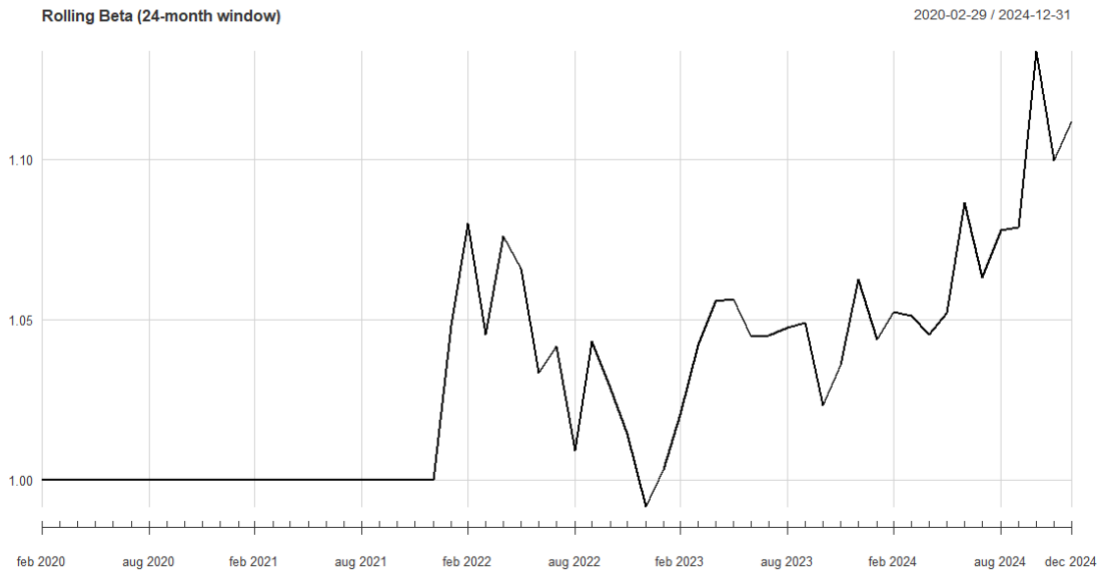
Source: prepared by the author

This implies that the ESG and non-ESG portfolios exhibit statistically similar volatility levels, reinforcing the notion that the integration of sustainability criteria does not necessarily reduce or increase total risk exposure. From a risk management perspective, these findings are significant. They suggest that investors seeking exposure to ESG-compliant assets do not experience meaningfully different volatility patterns than traditional investors do. This contrasts with early expectations that ESG funds might demonstrate lower risk due to superior governance or ethical screening mechanisms. Instead, the empirical evidence supports a more nuanced conclusion: ESG portfolios mirror the risk characteristics of conventional investments while maintaining similar return efficiency. These results align with the findings of Friede et al. (2015), who noted that the majority of studies report neutral or slightly positive relationships between ESG performance and financial outcomes. Likewise, Statman & Glushkov (2016) observed that while ESG integration can influence sectoral allocation and firm-level risk exposure, it does not fundamentally alter overall portfolio variance when measured at the aggregate level.

3.5 Rolling Metrics

To capture the time-varying dynamics of portfolio risk and performance, rolling window analyses were conducted using a 24-month moving period. This approach allows the identification of how sensitivity to market movements (beta) and risk-adjusted efficiency (Sharpe ratio) evolved across distinct economic phases between 2020 and 2024. Figure 3 illustrates the rolling beta of the ESG portfolio relative to the market (proxied by the S&P 500). During the early phase of the COVID-19 pandemic in 2020, both portfolios exhibited betas slightly below 1, reflecting the heightened volatility and defensive investor behaviour that temporarily weakened the linear relationship with the overall market.

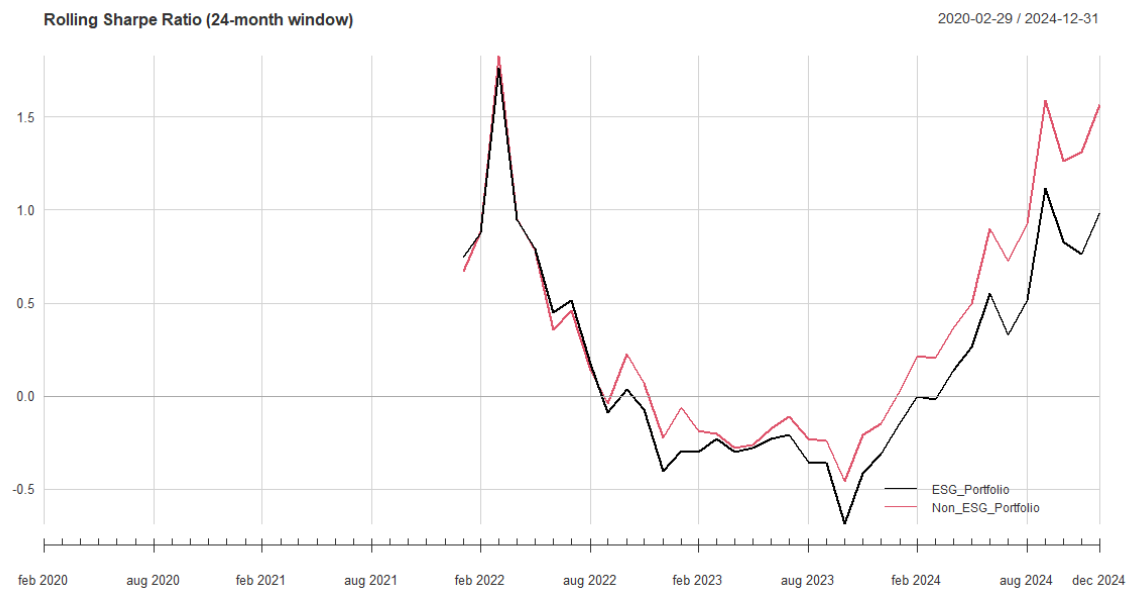
Figure 3: Rolling Beta (24-month window)



Source: prepared by the author

Figure 4 presents the rolling Sharpe ratios for both portfolios, highlighting fluctuations in risk-adjusted performance over time. The results reveal that the Sharpe ratios for both ESG and non-ESG portfolios followed similar cyclical patterns, closely aligned with broader market conditions. During 2020, the Sharpe ratios of both portfolios declined sharply as the COVID-19 crisis triggered widespread losses. However, a strong recovery was observed in 2021, coinciding with the rebound in global equity markets. From mid-2022 onwards, both portfolios experienced another decline in Sharpe ratios, reflecting tightening monetary policy, heightened inflation, and increased market volatility. Although the Non-ESG portfolio consistently maintained slightly higher Sharpe ratios, the difference between the two remained modest and transient. By late 2024, the Sharpe ratio of the ESG portfolio had nearly converged with that of the non-ESG portfolio, indicating comparable efficiency in converting risk into return.

Figure 4: Rolling Shape Ratio (24-month window)



Source: prepared by the author

The rolling analyses provide valuable insights beyond static measures. They show that while ESG portfolios may experience short-term periods of greater volatility and market sensitivity, their long-term risk-adjusted performance trajectory remains closely aligned with that of conventional portfolios. These patterns reflect the maturing nature of the ESG investment universe: as sustainable funds become more diversified and attract greater institutional capital, their performance and risk dynamics increasingly resemble those of traditional equity markets. This convergence supports the notion that ESG portfolios are no only niche or defensive assets but rather integrated components of the mainstream financial ecosystem. The time-varying results further substantiate the conclusions drawn from the CAPM and Sharpe analyses, namely, that ESG integration does not systematically enhance or diminish portfolio performance. Instead, ESG investing behaves as a comparable alternative to conventional market exposure, providing investors with the dual benefit of sustainability alignment and competitive financial returns.

4. Discussion

The results of this study provide a comprehensive view of how ESG and non-ESG portfolios have performed over the period 2020–2024, a timeframe marked by considerable market volatility and structural shifts in global finance. The findings highlight the increasing integration of sustainability criteria into mainstream investment behaviour while also demonstrating that ESG-oriented portfolios do not systematically outperform or underperform traditional portfolios once risk is properly accounted for.

The ESG portfolio presented slightly lower average returns (10,44%) than did the traditional portfolio (11,56%), coupled with marginally greater volatility. A beta greater than one ($\beta = 1,045$) suggests that ESG assets are somewhat more sensitive to market movements, particularly during periods of heightened macroeconomic uncertainty. This pattern may stem from the sectoral concentration of ESG indices, which tend to be overweight in technology, renewable energy, and other growth-oriented sectors, areas that react more strongly to interest rates and liquidity shocks. Sector-level analyses show that ESG impacts can be heterogeneous, reflecting cost structures, regulatory exposure, and the maturity of sustainability reporting. Studies in the European automotive sector shows that while social and governance dimensions may influence profitability or market value, these effects do not translate into broad return differentials at the portfolio level (Glova & Panko, 2025). Despite this higher market sensitivity, the ESG portfolio maintained a Sharpe ratio comparable to that of the non-ESG benchmark, implying that its risk-adjusted performance was not meaningfully inferior. The absence of a statistically significant alpha ($-0,00196$, $p > 0,1$) indicates that ESG funds neither consistently outperformed nor underperformed after we adjusted for market risk.

This finding aligns with the view of market neutrality in ESG investing, as reported by studies such as Krüger (2015) and Pedersen et al. (2021). These findings are consistent with recent evidence from sector-specific European research, which similarly reports that ESG characteristics no longer generate systematic return premiums or penalties. For example, Glova & Panko (2025) find that while environmental and governance effects may shape firm-level profitability in the automotive sector, the aggregate ESG profile does not systematically improve or worsen market valuation once risk factors are controlled for. From a structural standpoint, the rolling analyses reveal that ESG portfolios have evolved from being niche products with distinct performance profiles into diversified instruments that closely mirror broader market dynamics. This convergence reflects the mainstream of sustainable investing and the growing institutional demand for ESG-aligned assets.

The Non-ESG portfolio displayed slightly higher returns and lower volatility, producing a marginally higher Sharpe ratio (0,49 vs. 0,41). Its CAPM parameters ($\alpha = -0,00122$, $\beta = 1,041$, $R^2 = 0,985$) demonstrate a near-perfect alignment with overall market performance, confirming its role as a reliable proxy for traditional equity exposure. Importantly, the non-ESG portfolio benefited from a broader sectoral base, which mitigated the effects of sector-specific shocks that impacted ESG assets, particularly during 2022, when renewable energy and technology segments underperformed owing to tightening monetary conditions.

When compared directly, the ESG and non-ESG portfolios show no statistically significant differences in mean returns (p = 0,9473) or variance (p = 0,7112). These findings are consistent with recent JAES evidence showing that ESG characteristics can influence firm-level returns without systematically generating over- or under-performance once market dynamics are accounted for (Singh & Singh, 2024), and recent large-scale empirical analyses confirm the robustness of risk-adjusted returns across ESG portfolios (De Giuli, 2024; Díaz et al., 2024). This empirical neutrality suggests that investors can adopt ESG strategies without sacrificing financial performance, a conclusion supported by meta-analyses such as Friede et al. (2015). The rolling beta and Sharpe ratio analyses further confirm that both portfolios respond similarly to market cycles and shocks, with ESG portfolios occasionally displaying slightly higher sensitivity during recovery phases. For example, Díaz et al. (2024) report that ESG-labelled energy portfolios achieved risk-adjusted returns comparable to broad market indices, further supporting financial equivalence. This aligns with research suggesting that stronger sustainability practices can, in some contexts, mitigate downside or credit-related risks, even if such effects do not always translate into higher returns (Yadav, 2024).

Overall, these results reinforce the argument that ESG investment has matured into a viable, risk-competitive alternative to conventional approaches. The financial equivalence between ESG and non-ESG portfolios documented in this study carries meaningful implications for both market efficiency and investor welfare. In traditional asset-pricing theory, investors who prioritize ethical, environmental, or social objectives are typically expected to accept lower financial returns in exchange for non-pecuniary utility. Such a trade-off would emerge if ESG screening constrained diversification or shifted capital toward overpriced assets. However, the absence of statistically significant differences in risk-adjusted performance and alpha suggests that this penalty has effectively disappeared. Instead, the neutrality of outcomes indicates that ESG characteristics have become sufficiently incorporated into asset prices, consistent with semi-strong market efficiency. In practical terms, this means that investors can obtain non-pecuniary benefits like moral satisfaction, ethical consistency, or alignment with sustainability values at zero financial cost. In this sense, ESG investors effectively receive a "discount" on their values-based preferences, as the market no longer penalizes them with inferior financial performance for choosing sustainability-aligned assets. Rather than generating distortions, heterogeneous sustainability preferences appear to be absorbed into market equilibrium, supported by rising institutional demand and regulatory disclosure frameworks. Consequently, ESG investing now represents an economically neutral alternative to traditional strategies, it neither compromises expected returns nor introduces systematic mispricing.

Similar conclusions emerge in recent quantitative portfolio studies, which show that integrating sustainability constraints does not inherently compromise efficiency under conditions of market uncertainty (Frolov et al., 2025). This compatibility between sustainability preferences and efficient asset pricing reinforces the financial legitimacy of ESG-oriented investment in contemporary capital markets. This alignment with market efficiency is also observable in bibliometric and meta-analytical evidence, which documents that the integration of ESG factors into corporate strategy and capital allocation has become mainstream and is no longer associated with performance trade-offs. Recent high-volume analyses of ESG research confirm that sustainability metrics are increasingly incorporated into investor decision-making without diminishing financial returns (Panko & Glova, 2024). From an investor's perspective, ESG integration enables portfolio alignment with sustainability objectives while maintaining comparable financial outcomes. From a policy standpoint, the evidence supports initiatives promoting ESG transparency and disclosure, as such measures enhance investor confidence without distorting market efficiency. This micro-level neutrality corresponds with evidence that CSR and sustainability practices contribute to broader economic and institutional development across countries (Przybysz, 2020), reinforcing the systemic relevance of ESG integration. In essence, the study demonstrates that ESG portfolios behave as economic equals to non-ESG portfolios, not necessarily superior in returns but equivalent in efficiency and robustness, underscoring the financial legitimacy of sustainable investing in contemporary capital markets.

The practical implications of these results are twofold. First, from an investor perspective, the evidence demonstrates that incorporating ESG considerations into portfolio construction does not entail a financial trade-off. ESG portfolios offer returns and risk profiles that are statistically equivalent to traditional portfolios, making them viable substitutes for investors seeking to align their capital with sustainable objectives. This finding supports the "no performance penalty" hypothesis in sustainable finance, the idea that ethical investment choices can coexist with competitive financial performance. Second, for policymakers and regulatory bodies, the results underscore the importance of ESG disclosure and standardization. As ESG investment grows, consistent reporting frameworks become essential for maintaining market transparency and efficiency. The convergence in performance between ESG portfolios and non-ESG portfolios suggests that policy efforts should focus not on artificially incentivizing ESG investment but rather on ensuring the reliability and comparability of ESG metrics to support informed decision-making.

This research reinforces and extends several theoretical insights. From a financial economics standpoint, the results provide empirical validation for the CAPM under conditions of ESG integration, illustrating that systematic market risk remains the dominant determinant of portfolio returns. From a sustainability perspective, the findings challenge the notion that ESG investing is inherently defensive or constrained; instead, it behaves as a mainstream, risk-equivalent strategy. By combining static and rolling analyses, this study contributes a temporal dimension to the literature, showing that ESG portfolios' risk exposure evolves in tandem with market cycles. This dynamic alignment underscores the maturation of ESG assets from a peripheral investment segment into an integrated component of global capital markets.

While the findings are robust, several limitations warrant attention. The study's focus on U.S.-based ETFs may limit generalizability to other markets with differing regulatory or cultural attitudes toward ESG. Additionally, the analysis employed a single-factor CAPM, which captures only market-wide systematic risk. Future research could extend this framework using multifactor models, such as the Fama–French five-factor or Carhart four-factor models, to incorporate size, value, and momentum effects. Moreover, incorporating ESG scoring data at the firm or index level could allow for a more granular assessment of how specific ESG dimensions (environmental, social, or governance) influence performance. Finally, as ESG investing continues to evolve, future studies should examine longer post-2024 horizons to evaluate whether the observed convergence between ESG portfolios and non-ESG portfolios persists in different macroeconomic contexts, such as periods of sustained decarbonization policies or technological transition.

Conclusion

This study set out to examine the financial performance and risk characteristics of ESG and non-ESG portfolios over the period 2020–2024, using data from ten major US -listed ETFs. Through a combination of descriptive analysis, performance metrics, and econometric modelling, the research aimed to determine whether the integration of environmental, social, and governance (ESG) factors influences portfolio returns, volatility, or market sensitivity. The findings contribute to the growing body of empirical evidence assessing the intersection of sustainability and finance, particularly within the context of modern portfolio theory and risk–return optimization.

The analytical foundation of this study is rooted in the capital asset pricing model (CAPM) and the efficient market hypothesis (EMH), both of which posit that expected asset returns are primarily a function of systematic market risk, represented by beta (β), whereas abnormal returns (alpha, α) should theoretically converge to zero in an efficient market. Within this framework, ESG investing represents a unique test case: it introduces nonfinancial screening criteria into portfolio construction, potentially influencing diversification, sectoral exposure, and risk–return dynamics. Traditional finance theory has long debated whether the inclusion of such nonfinancial parameters enhances or constrains portfolio efficiency. On the one hand, proponents argue that ESG screening can improve performance by mitigating exposure to firms with governance risks, regulatory penalties, or reputational damage, mechanisms that are consistent with risk reduction through information asymmetry. On the other hand, critics suggest that ESG screening restricts the investment universe, possibly lowering diversification and return potential,

in line with portfolio constraint theory (Markowitz, 1952; Statman, 2000). The empirical analysis conducted in this paper directly engages with this theoretical debate by testing whether ESG portfolios, in practice, deviate materially from their non-ESG counterparts in terms of performance and risk.

The results indicate that, over the observed period, ESG portfolios achieved an annualized return of 10,44% and an annualized volatility of 20,18%, whereas non-ESG portfolios generated 11,56% with volatility of 19,22%. The difference in average returns was statistically insignificant (Welch t-test, p = 0,9473), suggesting that ESG and traditional portfolios yield comparable performance outcomes. Similarly, the F-test for the equality of variances (p = 0,7112) confirmed that both portfolios exhibit statistically indistinguishable volatility patterns. From a risk-adjusted perspective, the Sharpe ratios for ESG (0,41) and non-ESG (0,49) portfolios were also closely aligned, indicating near-identical efficiency in converting risk into return. These results collectively demonstrate that ESG investment does not compromise financial performance, reinforcing the growing empirical consensus that sustainable portfolios perform on par with conventional benchmarks. The CAPM regression analysis further substantiates this conclusion. Both portfolios exhibited betas slightly above unity ($\beta_{ESG} = 1,045$; $\beta_{non\text{-}ESG} = 1,041$), indicating high market sensitivity and confirming that their performance is largely driven by systematic risk factors. The R^2 values (0.901 for ESG and 0.985 for non-ESG) highlight that the majority of portfolio return variability can be explained by market movements, particularly for traditional portfolios. Most notably, the alpha coefficients for both ESG (−0,00196) and non-ESG (−0,00122) are negative but statistically insignificant, indicating the absence of persistent abnormal returns. This finding is consistent with the EMH, which predicts that, in competitive markets with high liquidity and transparency, opportunities for systematic outperformance are rare. It also aligns with the meta-analysis by Friede et al. (2015), which concluded that the vast majority of empirical studies report either neutral or slightly positive relationships between ESG integration and financial performance.

Rolling analyses of the beta and Sharpe ratios revealed meaningful insights into the time-varying behaviour of ESG portfolios. During the early COVID-19 crisis in 2020, both portfolios presented subunitary betas, reflecting defensive investor positioning and temporary market dislocation. However, from 2021 onwards, ESG portfolios displayed a modest rise in beta values, reaching peaks above 1,1 during 2022. This period coincided with heightened inflation, aggressive monetary tightening, and a sectoral rotation away from technology and clean energy, segments heavily represented

in ESG indices. The rolling Sharpe ratio analysis illustrated similar cyclical movements for both portfolios, with sharp declines during crisis periods followed by recoveries during market expansions. By the end of 2024, the Sharpe ratios of ESG and non-ESG portfolios had nearly converged, demonstrating a shared efficiency pattern across changing economic conditions. These dynamic findings suggest that ESG portfolios have increasingly mirrored the cyclical sensitivities of traditional equity markets. The evolution of the ESG beta toward parity with the market indicates the mainstreaming of ESG investing; once viewed as an ethical niche, it now functions as a standard component of diversified portfolios.

In conclusion, this research provides compelling evidence that ESG investing has reached a state of financial equivalence with traditional investment strategies. Over the 2020–2024 period, ESG portfolios displayed no significant disadvantage in returns, volatility, or risk-adjusted efficiency. Their behaviour conforms to market expectations under CAPM and EMH, affirming that sustainability and performance are not mutually exclusive. The broader implications are clear: investors can pursue ESG-aligned objectives without compromising financial outcomes, whereas policymakers can focus on strengthening ESG data integrity rather than performance intervention. As global finance increasingly embraces sustainability as a core principle, ESG investing should no be viewed as an alternative but rather as a natural evolution of modern portfolio theory in an era of responsible capitalism.

Credit Authorship Contribution Statement

Panko, M. was responsible for the conceptualization of the study, the development of the methodological design, data curation, software implementation, formal analysis, validation, and preparation of the original manuscript draft. Šafár, L. contributed to the conceptualization and methodological refinement of the research, and provided project administration, supervision, and critical review and editing of the manuscript. Sopko, J. contributed to formal analysis, data curation, visualization, and supervision, as well as writing—review and editing, and secured funding for the study. All authors reviewed and approved the final version of the manuscript.

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Conflict of Interest Statement

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as potential conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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