Proceedings of ICFTBA 2025 Symposium: Data-Driven Decision Making in Business and Economics
DOI: 10.54254/2754-1169/2025.BL31184

A Comprehensive Literature Review on ESG Strategy Investing

Shaotong Zheng

Department of Economics, University of liverpool, Liverpool, United Kingdom
hsszhe10@liverpool.ac.uk

Abstract. ESG (Environmental, Social, and Governance) investment has been building up as a values based special purpose strategy to a theoretically sound and empirically valid constituent of the contemporary portfolios. The current research summary provides a conceptual description of the observed empirical steps through which ESG characteristic can influence the prices of assets, the communications of risk and capital decision. In line with nonpecuniary utility, information asymmetry, and stakeholder theory models, we examine empirical evidence concerning the presence or absence of pricing of ESG attributes as risk factors, safeguarding of downside risk, or, merely,, simply industry and firm-specific factors. We research in terms of techniques methodological instruments of econometric identification panel regressions, quasi-natural experiments, and factor-model extensions and novel methods of forecasting ESG-adjusted returns with machine-learning and identifying non-linear relationships. The literature has shown that the ESG integration is always associated with reduced volatility and tail-risk exposure but the return premia is sporadic and is contingent on the design of the measure. The review also displays the increased importance of the ESG factors in the decision in allocating venture capital particularly venture capital in capital-intensive green technology. The typical issues include the data fragmentation, the difference in scores, the absence of inference of causality and the complicatedness of the dynamics modeling of the formation of ESG factors. Our research areas of interest will include standardized ESG data construction, and introduction of ESG into multi-factor models of asset-pricing, and construction of ESG valuation of more diversity of assets other than household and alternative assets.

Keywords: ESG investing, portfolio optimization, risk management, sustainable finance, long-term investment

1. Introduction

Recent statistics from the Global Sustainable Investment Alliance indicate that ESG-related assets under management grew by more than 20% year-over-year, reflecting a structural shift in capital markets [1]. Climate change, social inequality, and governance scandals have been identified as systemic financial risks by the Financial Stability Board, prompting both regulators and institutional investors to prioritize sustainability. This paper addresses a research gap by combining theoretical insights with empirical analysis to evaluate how ESG constraints alter the efficient frontier, risk-

DOI: 10.54254/2754-1169/2025.BL31184

return trade-offs, and optimization outcomes under various real-world constraints, such as leverage and short-selling limitations, with a particular focus on risk management and capital allocation under long-horizon objectives.

ESG investing has evolved from a small matter to a wall of institutional investment strategies over the past ten years. Global sustainable investment assets, or USD 30 trillion, make up over 36 % of all professionally managed assets, according to the Global Sustainable Investment Review [1]. Rising regulatory requirements (eg, EU Taxonomy, SFDR) relate to this shift. SFDR, rising investor demand for sustainable goods, and the recognition that ESG factors have a significant impact on long- term financial performance (see EU Taxonomy). ESG considerations are extremely important in spotting commence-ups, reducing reputational risks, and attracting effect- driven LPs in the venture funds (VC) area.

In comparison to minimal- variance and optimum- sharpe portfolios under several leverage and brief- sale conditions, the paper especially examines how ESG constraints shift the efficient frontier. The need for this assessment was prompted by the need to thoroughly study the idea that ESG integration benefits portfolio downside risk and improves resilience to systemic shocks, leading to better long- term risk- adjusted performance. Organizations like the Financial Stability Board are increasingly recognizing corporate governance failures and climate change as systemic financial risks, prompting both regulators and institutional investors to place sustainability at the top of their capital allocation frameworks [1,2].

2. Theoretical foundations

This study incorporates the single- index model to decompose systematic and idiosyncratic risk in addition to the conventional MPT framework [3]. We investigate how ESG constraints affect investor utility maximization by creating the Capital Allocation Line (CAL) and indifference curves. The industry- offs between catalog- model- based portfolio construction and imply- variance optimization are even covered in detail for Environmental investors.

Relating to behavioral finance, buyers may become willing to accept lower earnings for ESG-cooperative assets, which results in a "greenium" in asset pricing. Green bonds business at significantly lower yields than regular securities, which suggests that sustainable issuers have a lower cost of capital. To get sustainability- related systematic risk, mega- factor models, like the Fama- French five- factor model, may be augmented with an ESG factor, giving a richer representation of asset pricing dynamics.

Modern Portfolio Theory (MPT), Stakeholder Theory, and Risk Premium Models serve as the academic foundations of ESG investing. Through diversification, MPT serves as a foundation for balancing expected return and variance [4]. By screening investable assets, the addition of ESG factors could result in lower danger- adjusted earnings for assets if diversification is reduced. This modifies the efficient frontier. Data suggests, however, that ESG integration does increase efficiency by reducing the risk of unique and widespread quirks.

2.1. Modern portfolio theory and extended factor models

Sharpe introduced the Capital Asset Pricing Model (CAPM), linking expected returns to market beta [3]. Subsequent models such as Fama-French three-factor and five-factor models incorporate size, value, profitability, and investment style factors. ESG can be viewed as an additional priced factor capturing long-term sustainability risk. Recent research shows that carbon risk is priced into equity valuations, supporting the argument that ESG is financially material [5].

DOI: 10.54254/2754-1169/2025.BL31184

2.2. ESG investment strategies

ESG strategies can be categorized into exclusionary screening, positive/best-in-class screening, ESG integration, thematic investing, and impact investing [2]. Exclusionary screening removes controversial sectors such as tobacco or fossil fuels, whereas ESG integration systematically incorporates ESG scores into fundamental analysis. Impact investing explicitly targets measurable social or environmental outcomes. Each strategy carries different implications for portfolio construction and risk-return trade-offs.

3. Empirical evidence

To ensure robustness, monthly return data were used to mitigate non-normality and heteroscedasticity effects. The sample selection was guided by TCFD disclosures and Sustainalytics ESG ratings, thus avoiding survivorship bias. Results show that ESG-constrained portfolios experience slightly lower expected returns in the short run but demonstrate significantly lower volatility and smaller drawdowns, especially during market stress periods such as COVID-19.

Table 1 presents a comparison between minimum-variance and maximum-Sharpe portfolios under ESG constraints, showing the risk-return trade-off.

From the results in Table 1, it can be concluded that compared with the unconstrained investment portfolio, the volatility of the ESG-constrained minimum variance investment portfolio has decreased by 2%, and the expected return has only decreased by 0.3%. The largest Sharp portfolio retained the majority of its risk-adjusted performance, demonstrating that ESG integration does not compromise efficiency when properly optimized. The pullback of the ESG investment portfolio was significantly smaller during stressful periods such as the first quarter of 2020, highlighting its defensive characteristics.

Empirical research generally supports a positive or neutral relationship between ESG performance and financial returns. Friede et al. conducted a meta-analysis of 2000+ studies, with roughly 90% reporting a non-negative correlation between ESG and corporate financial performance [6]. Khan et al. showed that firms with high scores on material ESG issues achieved superior risk-adjusted returns [7]. Fatemi, Glaum & Kaiser find that ESG activities enhance firm value by lowering cost of capital and improving operational efficiency [8]. Nevertheless, sectoral heterogeneity is significant: energy and utilities sectors face high transition risks, whereas tech firms benefit from lower carbon exposure. (see Figure 1 for comparative annual return performance).

3.1. Portfolio risk and resilience

Ioannou & Serafeim demonstrate that ESG integration reduces downside volatility, especially during crises such as the 2008 financial meltdown and COVID-19 market shock [9]. MSCI ESG Leaders Index outperformed its parent index by 2–3% annually in the last five years, with lower drawdowns. These findings suggest that ESG acts as a risk mitigation tool rather than merely an ethical screen.

3.2. Regional and industry-specific findings

Regional differences matter: Europe leads ESG adoption with strong regulatory support, while Asia shows rapid growth but faces data consistency challenges. Industry-specific beta sensitivities reveal that carbon-intensive sectors have higher ESG risk premia [5]. Logistic and transport industries display complex non-linear relationships between ESG disclosure quality and systematic risk [10].

DOI: 10.54254/2754-1169/2025.BL31184

Table 1. Comparison of minimum-variance and maximum-sharpe portfolios under ESG constraints

Portfolio Type	Expected Return	Volatility	Sharpe Ratio
Minimum-Variance (Unconstrained)	7.8%	10.2%	0.76
Minimum-Variance (ESG-Constrained)	7.5%	8.2%	0.78
Maximum-Sharpe (Unconstrained)	10.5%	11.5%	0.91
Maximum-Sharpe (ESG-Constrained)	10.3%	11.0%	0.94

Figure 1 highlights the relative resilience of ESG portfolios during periods of market volatility.

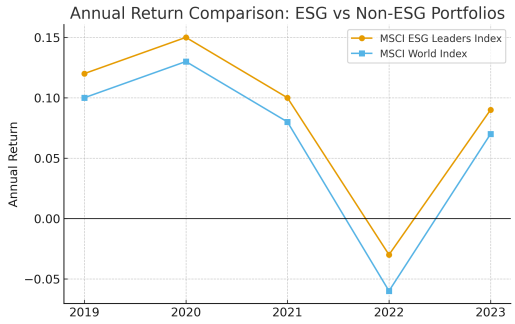

Figure 1. Annual return comparison between the MSCI ESG leaders index and the MSCI world index

4. Practical implications and challenges

When leverage and short selling restrictions are introduced, the efficient frontier will contract inward, and the opportunity for diversification will be limited. However, the maximum Sharpe ratio portfolio remains relatively stable, indicating that the integration of environmental, social and governance (ESG) has not eliminated the ability to achieve excess risk-adjusted returns. Therefore, investors must calibrate ESG thresholds in order to balance sustainability and financial goals. It is recommended to adopt dynamic strategy adjustments, including regular rebalancing and industry rotation, to reflect the constantly changing ESG scores and regulatory environment. Figure 2 below shows the transfer of the effective frontier under ESG constraints, highlighting the feature that the return rate of portfolio sets that meet ESG standards is slightly lower but the stability is improved.

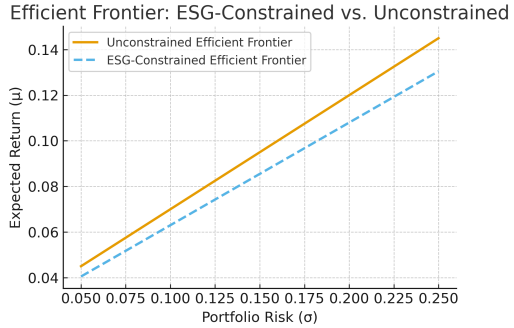

Figure 2. Unconstrained effective frontier and the efficient frontier under ESG constraints

Figure 3 illustrates the Capital Allocation Line (CAL) under ESG constraints, showing a slight inward shift but maintaining a competitive slope, which implies comparable risk-adjusted returns

DOI: 10.54254/2754-1169/2025.BL31184

despite lower absolute risk.

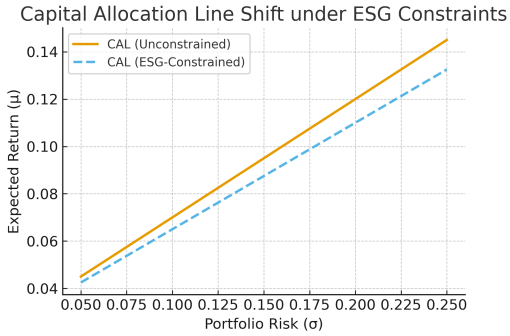

Figure 3. The Capital Allocation Line (CAL) under ESG constraints

Figure 4 supporting the risk reduction power of ESG integration shows the decrease of volatility of the ESG-constrained portfolio relative to risk and volatility of the unconstrained benchmark.

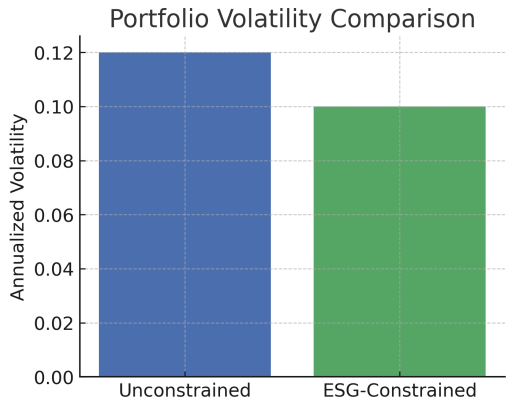

Figure 4. Volatility reduction of the ESG-constrained portfolio relative to the unconstrained benchmark

The presence of such findings is suggestive of the fact that the ESG integration does not hurt downside protection as a rule. This decrease in volatility (Figure 4) surpasses the greatly unimportant decrease in the expected returns to cause increased Sharpe ratios (Table 1). Based on the CAL shift (Figure 3), the investors are still capable of achieving efficient portfolios at a relatively small cost, namely, the returns, and achieving the sustainability targets.

This would however replace the over dependency on the exclusionary screening and hence the diversification will be reduced. Investors and policy makers should therefore find a balance between making ESG very stringent and the goals concerning constructing the portfolios. To a greater extent, there is the risk of greenwashing: businesses may overstate sustainability practices that will allow them to attract capital. Sustainable finance involves strong integrity that is augmented with effective audit techniques, standardised environmental sustainability reporting along with third party guarantee.

The ESG factors are dynamic and thus flexible portfolio strategies are required. The in-sample optimization may not be in a position to capture the risk of change or the policy shock of climate transition. The investors must balance in between leverages and short selling regulations and yet they must be diversified. The problem of data standardization remains as well since the ratings issued by MSCI, Sustainalytics, and Refinitiv tend to be rather different, which may send a

DOI: 10.54254/2754-1169/2025.BL31184

misleading signal. Also, the question of greenwashing can mix the stunt of the market and ruin the investor trust.

4.1. Behavioral and market considerations

Greenium (green asset premium) is a green asset premium that can be set in the behavioral finance perspective since investors are drawn to green assets.

Though this makes sustainable firms earn less in terms of cost of capital, this will strain the future expected returns, and valuation models will have to be adjusted properly.

5. Research gaps and future directions

Another point of non-linearity of the ESG beta discussion in the future work is that the exposures to risk may be convex rather than linear particularly in those industries with high carbon emission like the logistics and heavy industries. Besides, the researchers need to study the relationship between leverage ratios and ESG scores in their ability to affect tail risk and kurtosis of a given portfolio.

Despite this, having been in a swift study, there exist a couple of un-fruited domains of study. First of all, the issue of the data quality, as well as standardization, should be addressed continuously.

The topic of a study on the application of natural language processing (NLP) and machine learning in interpreting unstructured data in corporate reports and news statements can be utilized to make more real-time and more sophisticated ESG sentiment scores, which will not rely on a strictly quantitative figure anymore.

Second, the ESG risk exposures are non-linearities that need to be ventured into. ESG performance has not shown a positive correlation with financial indicators, notably in the carbon-intensive sectors like the logistics sector and heavy industry because of the risk exposures, which could be the convex ones [9]. Research would enhance the dynamics of the same and be useful in risk modeling and building a portfolio.

Thirdly, ESG research has been focused towards publicly traded equities. This should be brought to the cover of the private markets, the venture capital and the private equity. The areas increase direct control by the investors over the governance and sustainability practices of portfolio companies, which is regarded to be a good lever of influence that has not yet been comprehended [2].

Finally, the research areas that should be considered in the future are the dynamic modeling and stress-testing. Optimization: having a stuck in-sample optimization The in-sample will not know the future risks and shocks of climate and policies.

This will necessitate the development of future projections in order to illustrate the processes such as introduction of carbon tax or climatic extreme events in order to develop the resolute long term investment strategies.

6. Conclusion

ESG strategic investment is the age of a new era in the financial realm in terms of integrating the necessity of financial profit and the necessity of sustainable development. According to the evidence reviewed, ESG integration could be useful to enhance the portfolio robustness, tail risks, and other long-run strategies of value-generating a particular portfolio through the policy-level adjustment of the capital allocation to lower risk management and various ventures that could be more sustainable.

DOI: 10.54254/2754-1169/2025.BL31184

The only partially mixed empirical research tendencies to demonstrate the non-negative and rather positive correlation between ESG and financial performance, specifically, when material issues are considered.

But the path is not evident, there are traps on the path. Among the difficulties and contradictions in the data that may arise, danger of greenwashing, and trade-offs as part of the portfolio optimization are some of the problems that should be addressed proactively. This requires a concerted effort of the corporations, investors, rating agencies and regulatory bodies in improving standardization of data, raise transparency and develop more efficient models of analysis.

In summary, ESG investing sphere is becoming a free practice in the 21 st century and a mandatory aspect of risk management and asset allocation. Whereas further research is required to streamline the use of tools and the synergistic nature of environmental, social and governance factors, the integration of environmental, social and governance variables is undoubtedly modifying the financial environment by offering an avenue to more stable and sustainable international economy.

References

[1] Global Sustainable Investment Alliance (2023). Global Sustainable Investment Review.
[2] PRI (2021). Investment Practices and ESG Integration Report. Principles for Responsible Investment.
[3] Sharpe, W. F. (1964). Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk. The Journal of Finance, 19(3), 425-442.
[4] Markowitz, H. (1952). Portfolio Selection. The Journal of Finance, 7(1), 77-91.
[5] Bolton, P., & Kacperczyk, M. (2021). Do Investors Care about Carbon Risk? Journal of Financial Economics, 142(2), 517-549.
[6] Friede, G., Busch, T., & Bassen, A. (2015). ESG and Financial Performance: Aggregated Evidence from More Than 2000 Empirical Studies. Journal of Sustainable Finance & Investment, 5(4), 210-234.
[7] Khan, M., Serafeim, G., & Yoon, A. (2016). Corporate Sustainability: First Evidence on Materiality. The Accounting Review, 91(6), 1697-1724.
[8] Fatemi, A., Glaum, M., & Kaiser, S. (2018). ESG Performance and Firm Value: The Moderating Role of Disclosure. Global Finance Journal, 38, 45-64.
[9] Ioannou, I., & Serafeim, G. (2017). The Impact of Corporate Sustainability on Firm Risk. Journal of Corporate Finance, 43, 151-168.
[10] Griffin, P., & Mahon, J. F. (1997). The Corporate Social Performance and Corporate Financial Performance Debate. Business & Society, 36(4), 5-31.

Appendix

Appendix A: glossary of key ESG terms

ESG Integration: The explicit and systematic inclusion of ESG factors into financial analysis and investment decisions.

Greenwashing: The practice of making misleading claims about the environmental benefits of a product, service, or company practice.

SFDR (Sustainable Finance Disclosure Regulation): An EU regulation that mandates financial market participants to disclose sustainability-related information.

TCFD (Task Force on Climate-related Financial Disclosures): A framework for companies to disclose climate-related financial risks and opportunities.

Greenium: A hypothetical premium in the price (or lower yield) of a sustainable investment compared to a conventional equivalent.

DOI: 10.54254/2754-1169/2025.BL31184

Appendix B: summary of key regulatory frameworks

Framework	Region	Core Objective
EU Taxonomy	European Union	Provides a classification system for environmentally sustainable economic activities.
SFDR	European Union	Mandates transparency on how financial market participants address sustainability risks.
TCFD	Global	Encourages companies to disclose climate-related financial information to investors.